

Pub. No. 9

# AMERICAN PRACTICAL NAVIGATOR

AN EPITOME OF NAVIGATION

ORIGINALLY BY

NATHANIEL BOWDITCH, LL.D.

VOLUME II

USEFUL TABLES

CALCULATIONS

GLOSSARY OF MARINE NAVIGATION



**2019 EDITION**

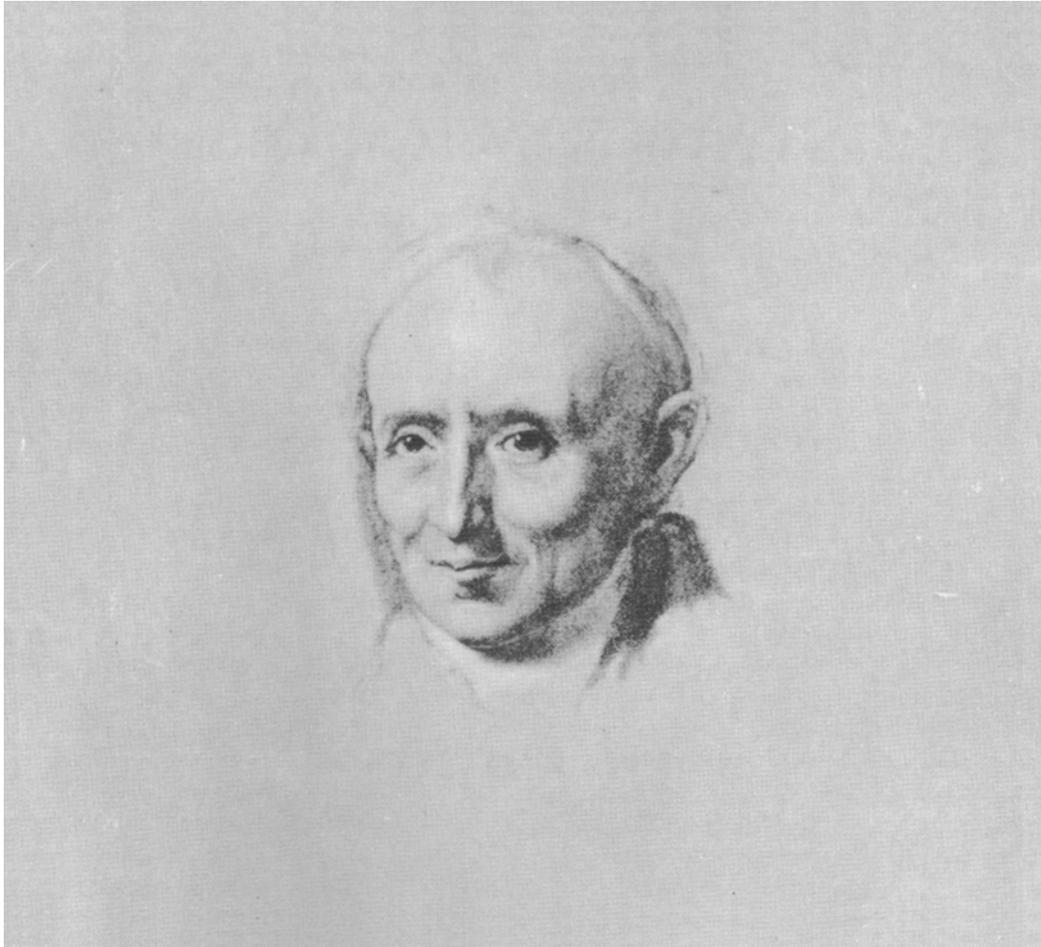
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Last painting by Gilbert Stuart (1828). Considered by the family of Bowditch to be the best of various paintings made, although it was unfinished when the artist died.

# NATHANIEL BOWDITCH

(1773-1838)

Nathaniel Bowditch was born on March 26, 1773, in Salem, Massachusetts, fourth of the seven children of shipmaster Habakkuk Bowditch and his wife, Mary.

From the time William Bowditch migrated from England in the 17th century, the Bowditch family resided in Salem. Most of its sons, like those of other families in this New England seaport, had gone to sea, and many of them became shipmasters. Nathaniel Bowditch himself sailed as master on his last voyage, and two of his brothers met untimely deaths while pursuing careers at sea.

Nathaniel Bowditch's father, Habakkuk, was said to have lost two ships at sea, and by late Revolutionary days he was forced to return to the cooper trade that he had learned in his youth. Although cooper products such as the cask and barrel containers used for shipping flour, gunpowder, tobacco and liquids were in very high demand, this work delivered an insufficient income to properly provide for the needs of this growing family, who were often hungry and cold.

For many years the nearly destitute family received an annual grant of 15 to 20 dollars from the Salem Marine Society. By the time Nathaniel had reached the age of 10, the family's poverty forced him to leave school and join his father in the cooperage trade to help support the family.

Nathaniel was unsuccessful as a cooper, and when he was about 12 years of age, he entered the first of two shipchandlery firms by which he was employed. It was during the nearly 10 years he was so employed that his great mind first attracted public attention. From the time he began school, Bowditch had an all-consuming interest in learning, particularly mathematics. By his middle teens he was recognized in Salem as an authority on that subject. Salem being primarily a shipping town, most of the inhabitants sooner or later found their way to the ship chandler, and news of the brilliant young clerk spread until eventually it came to the attention of the learned men of his day. Impressed by his desire to educate himself, they supplied him with books that he might learn of the discoveries of other men. Since many of the best books were written by Europeans, Bowditch first taught himself their languages, learning French, Spanish, Latin, Greek and German which were among the two dozen or more languages and dialects he studied during his life. At the age of 16 he began the study of Newton's *Principia*, translating parts of it from the Latin. He even found an error in that classic text, and though lacking the confidence to announce it at the time, he later published findings that were accepted by the scientific community.

During the Revolutionary War, a privateer out of Beverly, a neighboring town to Salem, had taken as one of its prizes an English vessel which was carrying the philosophical library of

a famed Irish scholar, Dr. Richard Kirwan. The books were brought to the Colonies and there bought by a group of educated Salem men who used them to found the Philosophical Library Company, reputed to have been the best library north of Philadelphia at the time. In 1791, when Bowditch was 18, two Harvard-educated ministers, Rev. John Prince and Rev. William Bentley, persuaded the Company to allow Bowditch the use of its library. Encouraged by these two men and a third, Nathan Read, an apothecary who was also a Harvard man, Bowditch studied the works of the great men who had preceded him, especially the mathematicians and the astronomers. By the time he reached adulthood, this knowledge, acquired when not working long hours at the chandlery, had made young Nathaniel the outstanding mathematician in the Commonwealth, and perhaps even the country.

In the seafaring town of Salem, Bowditch was drawn to navigation early, learning the subject at the age of 13 from an old British sailor. A year later he began studying surveying, and in 1794 he assisted in a survey of the town. At 15 he devised an almanac reputed to have been of great accuracy. His other youthful accomplishments included the construction of a crude barometer and a sundial.

When Bowditch went to sea at the age of 21, it was as captain's writer and nominal second mate, the officer's berth being offered him because of his reputation as a scholar. Under Captain Henry Prince, the ship *Henry* sailed from Salem in the winter of 1795 on what was to be a year-long voyage to the Ile de Bourbon (now called Reunion) in the Indian Ocean.

Bowditch began his seagoing career when accurate time was not available to the average naval or merchant ship. A reliable marine chronometer had been invented some 60 years before, but the prohibitive cost, plus the long voyages without opportunity to check the error of the timepiece, made the large investment impractical. A system of determining longitude by "lunar distance," a method which did not require an accurate timepiece, was known, but this product of the minds of mathematicians and astronomers was so involved as to be beyond the capabilities of the uneducated seamen of that day. Consequently, ships were navigated by a combination of dead reckoning and parallel sailing (a system of sailing north or south to the latitude of the destination and then east or west to the destination). The navigational routine of the time was "lead, log, and lookout."

To Bowditch, the mathematical genius, computation of lunar distances was no mystery, of course, but he recognized the need for an easier method of working them in order to navigate ships more safely and efficiently.

Through analysis and observation, he derived a new and simplified formula during his first voyage.

John Hamilton Moore's *The Practical Navigator* was the leading navigational text when Bowditch first went to sea, and had been for many years. Early in his first voyage, however, the captain's writer-second mate began turning up errors in Moore's book, and before long he found it necessary to recompute some of the tables he most often used in working his sights. Bowditch recorded the errors he found, and by the end of his second voyage, made in the higher capacity of supercargo, the news of his findings in *The New Practical Navigator* had reached Edmund Blunt, a printer at Newburyport, Mass. At Blunt's request, Bowditch agreed to participate with other learned men in the preparation of an American edition of the thirteenth (1798) edition of Moore's work. The first American edition was published at Newburyport by Blunt in 1799. This edition corrected many of the errors that Moore had introduced.

Although most of the errors were of little significance to practical navigation because they were errors in the fifth and sixth places of logarithm tables, some errors were significant. The most significant mistake was listing the year 1800 as a leap year in the table of the sun's declination. The consequence was that Moore gave the declination for March 1, 1800, as  $7^{\circ}11'$ . Since the actual value was  $7^{\circ}33'$ , the calculation of a meridian altitude would be in error by 22 minutes of latitude, or 22 nautical miles. This infamous mathematical error would result in loss of life and at least two vessels, and contributed to numerous other hazardous situations. An outcome that Bowditch personally considered to be criminal.

Bowditch's principal contribution to the first American edition was his chapter "The Method of Finding the Longitude at Sea," which discussed his new method for computing lunar distances. Following publication of the first American edition, Blunt obtained Bowditch's services in checking the American and English editions for further errors. Blunt then published a second American edition of Moore's thirteenth edition in 1800. When preparing a third American edition for the press, Blunt decided that Bowditch had revised Moore's work to such an extent that Bowditch should be named as author. The title was changed to *The New American Practical Navigator* and the book was published in 1802 as a first edition. Bowditch vowed while writing this edition to "put down in the book nothing I can't teach the crew," and it is said that every member of his crew including the cook could take a lunar observation and plot the ship's position.

Bowditch made a total of five trips to sea, over a period of about nine years, his last as master and part owner of the three-masted *Putnam*. Homeward bound from a 13-month voyage to Sumatra and the Ile de France (now called Mauritius), the *Putnam* approached Salem Harbor on December 25, 1803, during a thick fog without having had

a celestial observation since noon on the 24th. Relying upon his dead reckoning, Bowditch coned his wooden-hulled ship to the entrance of the rocky harbor, where he had the good fortune to get a momentary glimpse of Eastern Point, Cape Ann, enough to confirm his position. The *Putnam* proceeded in, past such hazards as "Bowditch's Ledge" (named after a great-grandfather who had wrecked his ship on the rock more than a century before) and anchored safely at 1900 that evening. Word of the daring feat, performed when other masters were hove-to outside the harbor, spread along the coast and added greatly to Bowditch's reputation. He was, indeed, the "practical navigator."

His standing as a mathematician and successful shipmaster earned him a well-paid position ashore within a matter of weeks after his last voyage. He was installed as president of a Salem fire and marine insurance company at the age of 30, and during the 20 years he held that position the company prospered. In 1823 he left Salem to take a similar position with a Boston insurance firm, serving that company with equal success until his death.

From the time he finished the "*Navigator*" until 1814, Bowditch's mathematical and scientific pursuits consisted of studies and papers on the orbits of comets, applications of Napier's rules, magnetic variation, eclipses, calculations on tides, and the charting of Salem Harbor. In that year, however, he turned to what he considered the greatest work of his life, the translation into English of *Mecanique Celeste*, by Pierre Laplace. *Mecanique Celeste* was a summary of all the then known facts about the workings of the heavens. Bowditch translated four of the five volumes before his death, and published them at his own expense. He gave many formula derivations which Laplace had not shown, and also included further discoveries following the time of publication. His work made this information available to American astronomers and enabled them to pursue their studies on the basis of that which was already known. Continuing his style of writing for the learner, Bowditch presented his English version of *Mecanique Celeste* in such a manner that the student of mathematics could easily trace the steps involved in reaching the most complicated conclusions.

Shortly after the publication of *The New American Practical Navigator*, Harvard College honored its author with the presentation of the honorary degree of Master of Arts, and in 1816 the college made him an honorary Doctor of Laws. From the time the Harvard graduates of Salem first assisted him in his studies, Bowditch had a great interest in that college, and in 1810 he was elected one of its Overseers, a position he held until 1826, when he was elected to the Corporation. During 1826-27 he was the leader of a small group of men who saved the school from financial disaster by forcing necessary economies on the college's reluctant president. At one time Bowditch was offered a Professorship in Mathematics at Harvard but this, as well as similar offers from West Point and the University

of Virginia, he declined. In all his life he was never known to have made a public speech or to have addressed any large group of people.

Many other honors came to Bowditch in recognition of his astronomical, mathematical, and marine accomplishments. He became a member of the American Academy of Arts and Sciences, the East India Marine Society, the Royal Academy of Edinburgh, the Royal Society of London, the Royal Irish Academy, the American Philosophical Society, the Connecticut Academy of Arts and Sciences, the Boston Marine Society, the Royal Astronomical Society, the Palermo Academy of Science, and the Royal Academy of Berlin.

Nathaniel Bowditch outlived all of his brothers and sisters by nearly 30 years. He died on March 16, 1838, in his sixty-fifth year. The following eulogy by the Salem

Marine Society indicates the regard in which this distinguished American was held by his contemporaries:

“In his death a public, a national, a human benefactor has departed. Not this community, nor our country only, but the whole world, has reason to do honor to his memory. When the voice of Eulogy shall be still, when the tear of Sorrow shall cease to flow, no monument will be needed to keep alive his memory among men; but as long as ships shall sail, the needle point to the north, and the stars go through their wonted courses in the heavens, the name of Dr. Bowditch will be revered as of one who helped his fellow-men in a time of need, who was and is a guide to them over the pathless ocean, and of one who forwarded the great interests of mankind.”

Bowditch is buried in historic Mount Auburn Cemetery in Cambridge, Massachusetts. There is a bronze statue of Nathaniel Bowditch within the cemetery that marks his life.

*THE NEW AMERICAN*  
**PRACTICAL NAVIGATOR;**  
 BEING AN  
**EPITOME OF NAVIGATION;**  
 CONTAINING ALL THE TABLES NECESSARY TO BE USED WITH THE  
*NAUTICAL ALMANAC,*  
 IN DETERMINING THE  
**L A T I T U D E;**  
 AND THE  
**LONGITUDE BY LUNAR OBSERVATIONS;**  
 AND  
**KEEPING A COMPLETE RECKONING AT SEA:**  
 ILLUSTRATED BY  
**PROPER RULES AND EXAMPLES:**  
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**FROM THE BEST AUTHORITIES.**

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BY **NATHANIEL BOWDITCH,**  
 FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

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Original title page of *The New American Practical Navigator*, First Edition, published in 1802.

## PREFACE

The Naval Observatory library in Washington, D.C., is unnaturally quiet. It is a large circular room, filled with thousands of books. Its acoustics are perfect; a mere whisper from the room's open circular balcony can be easily heard by those standing on the ground floor. A fountain in the center of the ground floor softly breaks the room's silence as its water stream gently splashes into a small pool. From this serene room, a library clerk will lead you into an antechamber, beyond which is a vault containing the Observatory's most rare books. In this vault, one can find an original 1802 first edition of the *New American Practical Navigator*.

One cannot hold this small, delicate, slipcovered book without being impressed by the nearly 200-year unbroken chain of publication that it has enjoyed. It sailed on U.S. merchantmen and Navy ships shortly after the quasi-war with France and during British impressment of merchant seamen that led to the War of 1812. It sailed on U.S. Naval vessels during operations against Mexico in the 1840's, on ships of both the Union and Confederate fleets during the Civil War, and with the U.S. Navy in Cuba in 1898. It went around the world with the Great White Fleet, across the North Atlantic to Europe during both World Wars, to Asia during the Korean and Vietnam Wars, and to the Middle East during Operation Desert Storm. It has circled the globe with countless thousands of merchant ships for 200 years.

As navigational requirements and procedures have changed throughout the years, *Bowditch* has changed with them. Originally devoted almost exclusively to celestial navigation, it now also covers a host of modern topics. It is as practical today as it was when Nathaniel Bowditch, master of the *Putnam*, gathered the crew on deck and taught them the mathematics involved in calculating lunar distances. It is that practicality that has been the publication's greatest strength, and that makes the publication as useful today as it was in the age of sail.

Seafarers have long memories. In no other profession is tradition more closely guarded. Even the oldest and most cynical acknowledge the special bond that connects those who have made their livelihood plying the sea. This bond is not comprised of a single strand; rather, it is a rich and varied tapestry that stretches from the present back to the birth of our nation and its seafaring culture. As this book is a part of that tapestry, it should not be lightly regarded; rather, it should be preserved, as much for its historical importance as for its practical utility.

Since antiquity, mariners have gathered available navigation information and put it into a text for others to follow. One of the first attempts at this involved volumes of

Spanish and Portuguese navigational manuals translated into English between about 1550 and 1750. Writers and translators of the time "borrowed" freely in compiling navigational texts, a practice which continues today with works such as *Sailing Directions and Pilots*.

Colonial and early American navigators depended exclusively on English navigation texts because there were no American editions. The first American navigational text, *Orthodoxal Navigation*, was completed by Benjamin Hubbard in 1656. The first American navigation text published in America was Captain Thomas Truxton's *Remarks, Instructions, and Examples Relating to the Latitude and Longitude; also the Variation of the Compass, Etc., Etc.*, published in 1794.

The most popular navigational text of the late 18th century was John Hamilton Moore's *The New Practical Navigator*. Edmund M. Blunt, a Newburyport publisher, decided to issue a revised copy of this work for American navigators. Blunt convinced Nathaniel Bowditch, a locally famous mariner and mathematician, to revise and update *The New Practical Navigator*. Several other learned men assisted in this revision. Blunt's *The New Practical Navigator* was published in 1799. Blunt also published a second American edition of Moore's book in 1800.

By 1802, when Blunt was ready to publish a third edition, Nathaniel Bowditch and others had corrected so many errors in Moore's work that Blunt decided to issue the work as a first edition of the *New American Practical Navigator*. It is to that 1802 work that the current edition of the *American Practical Navigator* traces its pedigree.

*The New American Practical Navigator* stayed in the Bowditch and Blunt family until the government bought the copyright in 1867. Edmund M. Blunt published the book until 1833; upon his retirement, his sons, Edmund and George, took over publication. The elder Blunt died in 1862; his son Edmund followed in 1866. The next year, 1867, George Blunt sold the copyright to the government for \$25,000. The government has published *Bowditch* ever since. George Blunt died in 1878.

Nathaniel Bowditch continued to correct and revise the book until his death in 1838. Upon his death, the editorial responsibility for the *American Practical Navigator* passed to his son, J. Ingersoll Bowditch. Ingersoll Bowditch continued editing the *Navigator* until George Blunt sold the copyright to the government. He outlived all of the principals involved in publishing and editing the *Navigator*, dying in 1889.

The U.S. government has published numerous editions of the *American Practical Navigator* since acquiring the copyright. Over time the book has come to be known simply by its original author's name and by its year of publishing. Thus, this work represents the 2019 edition of *Bowditch*. Like the previous edition, this one is also composed of a two volume set.

Today, mariners can access the official "digital" version of *Pub No. 9 - American Practical Navigator - Bowditch*, free of charge, from NGA's Maritime Safety Information web portal. As with NGA's other nautical publications, the digital *online* edition eliminates the need "to print" new editions in order to convey new information to the marine navigation community. The *online* edition is under continuous maintenance and therefore represents the most up-to-date version of this text, unlike a printed edition which is only a static picture in time.

As much as it is a part of history, *Bowditch* is not a history book. In this edition, as in past editions, dated material was dropped and new methods, technologies and techniques added to keep pace with changes in the practice of navigation. The changes are intended to ensure *Bowditch* remains the premier reference work for modern, practical marine navigation. This edition replaces but does not cancel former editions, which may be retained and consulted as to historical navigation methods not discussed herein.

CHAPTER 1, MATHEMATICS once again includes sections on basic arithmetic including: expressing numbers, significant digits, addition, subtraction, rounding off, reciprocals, multiplication and division. Likewise, the expanded chapter includes discussions on calculus and differential equations. Though rarely used today, an in-depth discussion on logarithms returns to this chapter. This topic is supplemented by the inclusion of haversine tables (found in Appendix B), which makes this publication perhaps the last

in existence to provide this esoteric data, should the need arise to perform complex calculation manually.

CHAPTER 2, INTERPOLATION includes discussion on single, double, triple and nonlinear interpolation (with Bessel's formula included).

CHAPTER 3, NAVIGATIONAL ERROR was greatly expanded and updated by Johns Hopkins University-Applied Physics Laboratory.

CHAPTER 4, CALCULATIONS AND CONVERSIONS summarizes the formulas the navigator depends upon during voyage planning, piloting, celestial navigation, and various related tasks.

CHAPTER 5, COMPASS CONVERSIONS contains information on magnetic compass error, deviation table, applying variation and deviation, along with several example problems.

CHAPTER 6, COMPASS ERROR examines the process for determining compass error using *Pub No. 229 - Sight Reduction Tables for Marine Navigation*.

**This edition is updated to June 2021.**

NGA seeks and encourages critical feedback on this publication. Suggestions and comments for changes and additions may be sent to:

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This 2019 edition of *The American Practical Navigator (Bowditch)*, Pub No. 9, exists to codify the latest body of marine navigation knowledge and practical application. Its publication success is a result of the dedicated efforts of many hands and voices from academia, science and seafaring experts. This edition has advanced from the judiciously shaped recommendations—some comprehensive, some minute, all indispensable—of a multitude of maritime and science professionals. At the same time, it was equally essential that those recommendations be compared, vetted, and applied in a consistent manner and with a clear vision, a challenging task performed in exemplary fashion by this edition's principal editor, **Dr. Gerard J. Clifford, Jr.**

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# EXPLANATION OF NAVIGATION TABLES

## Mathematical Tables

**Table 1. Logarithms of Numbers** – The first page of this table gives the complete common logarithm (characteristic and mantissa) of numbers 1 through 250. Succeeding pages give the mantissa only of the common logarithm of any number. Values are given for four significant digits of entering values, the first three being in the left-hand column, and the fourth at the heading of one of the other columns. Thus, the mantissa of a three-digit number is given in the column headed 0, on the line with the given number; while the mantissa of a four-digit number is given in the column headed by the fourth digit, on the line with the first three digits. As an example, the mantissa of 328 is 51587, while that of 3.284 is 51640. For additional digits, interpolation should be used. The difference between each tabulated mantissa and the next larger tabulated mantissa is given in the “d” column to the right of the smaller mantissa. This difference can be used to enter the appropriate proportional parts (“Prop. parts”) auxiliary table to interpolate for the fifth digit of the given number. If an accuracy of more than five significant digits is to be preserved in a computation, a table of logarithms to additional decimal places should be used. For a number of one or two digits, use the first page of the table or add zeros to make three digits. That is, the mantissa of 3, 30, and 300 is the same, 47712. Interpolation on the first page of the table is not recommended. The second part should be used for values not listed on the first page.

**Table 2. Natural Trigonometric Functions** – This table gives the values of natural sines, cosecants, tangents, cotangents, secants, and cosines of angles from  $0^\circ$  to  $180^\circ$ , at intervals of  $1'$ . For angles between  $0^\circ$  and  $45^\circ$  use the column labels at the top and the minutes at the left; for angles between  $45^\circ$  and  $90^\circ$  use the column labels at the bottom and the minutes at the right; for angles between  $90^\circ$  and  $135^\circ$  use the column labels at the bottom and the minutes at the left; and for angles between  $135^\circ$  and  $180^\circ$  use the column labels at the top and the minutes at the right. These combinations are indicated by the arrows accompanying the figures representing the number of degrees. For angles between  $180^\circ$  and  $360^\circ$ , subtract  $180^\circ$  and proceed as indicated above to obtain the numerical values of the various functions.

Differences between consecutive entries are shown in the “Diff. 1” column to the right of each column of values of a trigonometric function, as an aid to interpolation. These differences are one-half line out of step with the numbers to which they apply, as in a critical table. Each difference ap-

plies to the values half a line above and half a line below. To determine the correction to apply to the value for the smaller entering angle, multiply the difference by the number of tenths of a minute (or seconds  $\div 60$ ) of the entering angle. Note whether the function is increasing or decreasing, and add or subtract the correction as appropriate, so that the interpolated value lies between the two values between which interpolation is made.

**Table 3. Logarithms of Trigonometric Functions** – This table gives the common logarithms (+10) of sines, cosecants, tangents, cotangents, secants, and cosines of angles from  $0^\circ$  to  $180^\circ$ , at intervals of  $1'$ . For angles between  $0^\circ$  and  $45^\circ$  use the column labels at the top and the minutes at the left; for angles between  $45^\circ$  and  $90^\circ$  use the column labels at the bottom and the minutes at the right; for angles between  $90^\circ$  and  $135^\circ$  use the column labels at the bottom and the minutes at the left; and for angles between  $135^\circ$  and  $180^\circ$  use the column labels at the top and the minutes at the right. These combinations are indicated by the arrows accompanying the figures representing the number of degrees. For angles between  $180^\circ$  and  $360^\circ$ , subtract  $180^\circ$  and proceed as indicated above to obtain the numerical values of the various functions.

Differences between consecutive entries are shown in the “Diff. 1” columns, except that one difference column is used for both sines and cosecants, another for both tangents and cotangents, and a third for both secants and cosines. These differences, given as an aid to interpolation, are one-half line out of step with the numbers to which they apply, as in a critical table. Each difference applies to the values half a line above and half a line below. To determine the correction to apply to the value for the smaller entering angle, multiply the difference by the number of tenths of a minute (or seconds  $\div 60$ ) of the entering angle. Note whether the function is increasing or decreasing, and add or subtract the correction as appropriate, so that the interpolated value lies between the two values between which interpolation is made.

**Table 4. Traverse Table** – This table can be used in the solution of any of the sailings except great-circle and composite. In providing the values of the difference of latitude and departure corresponding to distances up to 600 miles and for courses for every degree of the compass, Table 4 is essentially a tabulation of the solutions of plane right triangles. Since the solutions are for integral values of the acute angle and the distance, interpolation for intermediate values may be required. Through appropriate interchanges of the headings of the

columns, solutions for other than plane sailings can be made. The interchanges of the headings of the different columns are summarized at the foot of each table opening.

The distance, difference of latitude, and departure columns are labeled Dist., D. Lat., and Dep., respectively.

For solution of a plane right triangle, any number N in the distance column is the hypotenuse; the number opposite in the difference of latitude column is N times the cosine of the acute angle; and the other number opposite in the departure column is N times the sine of the acute angle. Or, the number in the column labeled D. Lat. is the value of the side adjacent and the number in the column labeled Dep. is the value of the side opposite the acute angle.

**Appendix B. Haversines** – These tables list the common logarithms (+10) of haversines and natural haversines of angles from 0° to 360°, at intervals of 1'. For angles between 0° and 180° use the degrees as given at the tops of the columns and the minutes at the left; for angles between 180° and 360° use the degrees as given at the bottom of the columns and the minutes at the right.

## Cartographic Tables

### Table 5. Natural and Numerical Chart Scales –

This table gives the numerical scale equivalents for various natural or fractional chart scales. The scale of a chart is the ratio of a given distance on the chart to the actual distance which it represents on the earth. The scale may be expressed as a simple ratio or fraction, known as the **natural scale**. For example, 1:80,000 or  $\frac{1}{80000}$  means that one unit (such as an inch) on the chart represents 80,000 of the same unit on the surface of the earth. The scale may also be expressed as a statement of that distance on the earth shown as one unit (usually an inch) on the chart, or vice versa. This is the **numerical scale**.

The table was computed using 72,913.39 inches per nautical mile and 63,360 inches per statute mile.

**Table 6. Meridional Parts** – In this table the meridional parts used in the construction of Mercator charts and in Mercator sailing are tabulated to one decimal place for each minute of latitude from the equator to the poles.

The table was computed using the formula:

$$M = a \log_e 10 \log \tan \left( 45 + \frac{L}{2} \right) - a \left( e^2 \sin L + \frac{e^4}{3} \sin^3 L + \right.$$

$$\left. \frac{e^6}{5} \sin^5 L + \dots \right),$$

in which M is the number of meridional parts between the equator and the given latitude, a is the equatorial radius of the earth, expressed in minutes of arc of the equator, or

$$a = \frac{21600}{2\pi} = 3437.74677078 (\log = 3.5362739),$$

$\log_e$  is the natural (Naperian) logarithm, using the base  $e = 2.71828182846$ ,

$$\log_e 10 = 2.3025851 \quad (\log = 0.36221569)$$

L is the latitude,

f is earth's flattening, or

$$f = \frac{1}{298.257223563} \\ = 3.35281066475 \cdot 10^{-3} \quad (\log = 7.474591 - 10)$$

the squared eccentricity of the earth,  $e^2$  [not to be confused with Euler's constant, the base of natural logarithms] is

$$e^2 = 2f - f^2 \\ = 6.694379990141 \cdot 10^{-3} \quad (\log = 7.1742896 - 10)$$

Using these values,

$$a \log_e 10 = 7915.7 \quad (\log = 3.8984893)$$

$$ae^2 = 23.01358319 \quad (\log = 1.3619842)$$

$$\frac{ae^4}{3} = 0.05135389 (\log = 8.2894349 - 10)$$

$$\frac{ae^6}{5} = 0.00020627 (\log = 6.6855639 - 10)$$

Hence, the formula becomes

$$M = 7915.7 \log \tan \left( 45^\circ + \frac{L}{2} \right) - 23.01358319 \\ \sin L - 0.05135389 \sin^3 L - 0.00020627 \sin^5 L \dots$$

The constants used in this derivation and in the table are based upon the World Geodetic System 1984 (WGS 84) ellipsoid.

**Table 7. Length of a Degree of Latitude and Longitude** – This table gives the length of one degree of latitude and longitude at intervals of 1° from the equator to the poles. In the case of latitude, the values given are the lengths of the arcs extending half a degree on each side of

the tabulated latitudes. Lengths are given in nautical miles, statute miles, feet, and meters.

The values were computed in meters, using parameters of the World Geodetic System 1984 (WGS 84) ellipsoid, and converted to other units. The following formulas were used:

$$M = \left( \frac{\pi}{180} \right) \left[ \frac{a(1 - e^2)}{w^3} \right] \text{ where}$$

$a = 6378137$ , the semi - major axis of the WGS 84 ellipsoid

$$e^2 = 2f - f^2 = 6.694379990141 \cdot 10^{-3}$$

$$w = \sqrt{1 - e^2 \sin^2 \varphi}$$

$\varphi =$  geodetic latitude

And

$$P = \left( \frac{\pi}{180} \right) \left[ \frac{a(\cos \varphi)}{w} \right]$$

### Piloting Tables

**Table 8. Conversion Table for Meters, Feet, and Fathoms** – The number of feet and fathoms corresponding to a given number of meters, and vice versa, can be taken directly from this table for any value of the entering argument from 1 to 120. The entering value can be multiplied by any power of 10, including negative powers, if the corresponding values of the other units are multiplied by the same power. Thus, 420 meters are equivalent to 1378.0 feet, and 11.2 fathoms are equivalent to 20.483 meters.

The table was computed by means of the relationships:

1 meter = 39.370079 inches,

1 foot = 12 inches,

1 fathom = 6 feet.

**Table 9. Conversion Table for Nautical and Statute Miles** – This table gives the number of statute miles corresponding to any whole number of nautical miles from 1 to 100, and the number of nautical miles corresponding to any whole number of statute miles within the same range. The entering value can be multiplied by any power of 10, including negative powers, if the corresponding value of the other unit is multiplied by the same power. Thus, 2,700 nautical miles are equivalent to 3,107.1 statute miles, and 0.3 statute mile is equivalent to 0.2607 nautical mile.

The table was computed using the conversion factors:

1 nautical mile = 1.15077945 statute miles,

1 statute mile = 0.86897624 nautical mile.

**Table 10. Speed Table for Measured Mile** – To find the speed of a vessel on a measured nautical mile in a given number of minutes and seconds of time, enter this table at the top or bottom with the number of minutes, and at either side with the number of seconds. The number taken from the table is speed in knots. Accurate results can be obtained by interpolating to the nearest 0.1 second.

This table was computed by means of the formula:

$$S = \frac{3600}{T}, \text{ in which } S \text{ is speed in knots, and } T \text{ is}$$

elapsed time in seconds.

**Table 11. Speed, Time, and Distance Table** – To find the distance steamed at any given speed between 0.5 and 40 knots in any given number of minutes from 1 to 60, enter this table at the top with the speed, and at the left with the number of minutes. The number taken from the table is the distance in nautical miles. If hours are substituted for minutes, the tabulated distance should be multiplied by 60; if seconds are substituted for minutes, the tabulated distance should be divided by 60.

The table was computed by means of the formula:

$$D = \frac{ST}{60}, \text{ in which } D \text{ is distance in nautical miles,}$$

$S$  is speed in knots, and  $T$  is elapsed time in minutes.

**Table 12. Distance of the Horizon** – This table gives the distance in nautical and statute miles of the visible sea horizon for various heights of eye in feet and meters. The actual distance varies somewhat as refraction changes. However, the error is generally less than that introduced by nonstandard atmospheric conditions. Also the formula used contains an approximation which introduces a small error at the greatest heights tabulated.

The table was computed using the formula:

$$D = \sqrt{\frac{2r_o h_f}{6076.1 \beta_o}}$$

in which  $D$  is the distance to the horizon in nautical miles;  $r_o$  is the mean radius of the earth, 3440.1 nautical miles;  $h_f$  is the height of eye in feet; and  $\beta_o$  (0.8279) accounts for terrestrial refraction.

This formula simplifies to:  $D \text{ (nm)} = 1.169 \sqrt{h_f}$

$$\text{(statute miles)} = 1.345 \sqrt{h_f}$$

**Table 13. Geographic Range** – This table gives the geographic range or the maximum distance at which the curvature of the earth permits a light to be seen from a particular height of eye without regard to the luminous intensity of the light. The geographic range depends upon the height of both the light and the eye of the observer.

The table was computed using the formula:

$$D = 1.17 \sqrt{H} + 1.17 \sqrt{h}$$

in which D is the geographic range in nautical miles, H is the height in feet of the light above sea level, and h is the height in feet of the eye of the observer above sea level.

**Table 14. Dip of the Sea Short of the Horizon** – If land, another vessel, or other obstruction is between the observer and the sea horizon, use the waterline of the obstruction as the horizontal reference for altitude measurements, and substitute dip from this table for the dip of the horizon (height of eye correction) given in the *Nautical Almanac*. The values below the bold rules are for normal dip, the visible horizon being between the observer and the obstruction.

The table was computed with the formula:

$$D_s = 60 \tan^{-1} \left( \frac{h_f}{6076.1 d_s} + \frac{\beta_o d_s}{2r_o} \right)$$

in which  $D_s$  is the dip short of the sea horizon, in minutes of arc;  $h_f$  is the height of eye of the observer above sea level in feet;  $\beta_o$  (0.8321) accounts for terrestrial refraction;  $r_o$  is the mean radius of the earth, 3440.1 nautical miles; and  $d_s$  is the distance to the waterline of the obstruction in nautical miles.

**Table 15. Distance by Vertical Angle Measured Between Sea Horizon and Top of Object Beyond Sea Horizon** – This table tabulates the distance to an object of known height above sea level when the object lies beyond the horizon. The vertical angle between the top of the object and the visible horizon is measured with a sextant and corrected for index error and dip only. The table is entered with the difference in the height of the object and the height of eye of the observer and the corrected vertical angle; and the distance in nautical miles is taken directly from the table. An error may be introduced if refraction differs from the standard value used in the computation of the table.

The table was computed using the formula:

$$D = \sqrt{\left( \frac{\tan \alpha}{0.0002419} \right)^2 + \frac{H-h}{0.7349}} - \frac{\tan \alpha}{0.0002419}$$

in which D is the distance in nautical miles,  $\alpha$  is the corrected vertical angle, H is the height of the top of the object above sea level in feet, and h is the height of eye of the observer above sea level in feet. The constants 0.0002419 and 0.7349 account for terrestrial refraction.

**Table 16. Distance by Vertical Angle Measured Between Waterline at Object and Top of Object** – This table tabulates the angle subtended by an object of known height lying at a particular distance within the observer's visible horizon or vice versa.

The table provides the solution of a plane right triangle having its right angle at the base of the observed object and its altitude coincident with the vertical dimension of the observed object. The solutions are based upon the following simplifying assumptions: (1) the eye of the observer is at sea level, (2) the sea surface between the observer and the object is flat, (3) atmospheric refraction is negligible, and (4) the waterline at the object is vertically below the peak of the object. The error due to the height of eye of the observer does not exceed 3 percent of the distance-off for sextant angles less than  $20^\circ$  and heights of eye less than one-third of the object height. The error due to the waterline not being below the peak of the object does not exceed 3 percent of the distance-off when the height of eye is less than one-third of the object height and the offset of the waterline from the base of the object is less than one-tenth of the distance-off. Errors due to earth's curvature and atmospheric refraction are negligible for cases of practical interest.

**Table 17. Distance by Vertical Angle Measured Between Waterline at Object and Sea Horizon Beyond Object** – This table tabulates the distance to an object lying within or short of the horizon when the height of eye of the observer is known. The vertical angle between the waterline at the object and the visible (sea) horizon beyond is measured and corrected for index error. The table is entered with the corrected vertical angle and the height of eye of the observer in feet; the distance in yards is taken directly from the table

The table was computed from the formula:

$$\tan h_s = (A - B) / (1 + AB) \text{ where}$$

$$A = \frac{h}{d_s} + \frac{\beta_o d_s}{2r_o} \text{ and}$$

$$B = \sqrt{2\beta_o h/r_o}$$

in which  $\beta_o$  (0.8279) accounts for terrestrial refraction,  $r_o$  is the mean radius of the earth, 3440.1 nautical miles; h is the height of eye of the observer in feet;  $h_s$  is the observed ver-

tical angle corrected for index error; and  $d_s$  is the distance to the waterline of the object in nautical miles.

**Table 18. Distance of an Object by Two Bearings –**

To determine the distance of an object as a vessel on a steady course passes it, observe the difference between the course and two bearings of the object, and note the time interval between bearings. Enter this table with the two differences. Multiply the distance run between bearings by the number in the first column to find the distance of the object at the time of the second bearing, and by the number in the second column to find the distance when abeam.

The table was computed by solving plane oblique and right triangles.

### Celestial Navigation Tables

**Table 19. Table of Offsets –** This table gives the corrections to the straight line of position (LOP) as drawn on a chart or plotting sheet to provide a closer approximation to the arc of the circle of equal altitude, a small circle of radius equal to the zenith distance.

In adjusting the straight LOP to obtain a closer approximation of the arc of the circle of equal altitude, points on the LOP are offset at right angles to the LOP in the direction of the celestial body. The arguments for entering the table are the distance from the DR to the foot of the perpendicular and the altitude of the body.

The table was computed using the formulas:

$$R = 3438' \cot h$$

$$\sin \theta = D/R$$

$$X = R(1 - \cos \theta),$$

in which X is the offset, R is the radius of a circle of equal altitude for altitude h, and D is the distance from the intercept to the point on the LOP to be offset.

**Table 20. Meridian Angle and Altitude of a Body on the Prime Vertical Circle –** A celestial body having a declination of contrary name to the latitude does not cross the prime vertical above the celestial horizon, its nearest approach being at rising or setting.

If the declination and latitude are of the same name, and the declination is numerically greater, the body does not cross the prime vertical, but makes its nearest approach (in azimuth) when its meridian angle, east or west, and altitude are as shown in this table, these values being given in italics above the heavy line. At this time the body is stationary in azimuth.

If the declination and latitude are of the same name and numerically equal, the body passes through the zenith as it crosses both the celestial meridian and the prime vertical, as shown in the table.

If the declination and latitude are of the same name, and the declination is numerically less, the body crosses

the prime vertical when its meridian angle, east or west, and altitude are as tabulated in vertical type below the heavy line.

The table is entered with declination of the celestial body and the latitude of the observer. Computed altitudes are given, with no allowance made for refraction, dip, parallax, etc. The tabulated values apply to any celestial body, but values are not given for declination greater than  $23^\circ$  because the tabulated information is generally desired for the sun only.

The table was computed using the following formulas, derived by Napier's rules:

Nearest approach (in azimuth) to the prime vertical:

$$\csc h = \text{sind} \csc L$$

$$\sec t = \text{tand} \cot L$$

On the prime vertical:

$$\sin h = \text{sind} \csc L$$

$$\cos t = \text{tand} \cot L$$

In these formulas, h is the altitude, d is the declination, L is the latitude, t is the meridian angle.

**Table 21. Latitude and Longitude Factors –** The latitude obtained by an ex-meridian sight is inaccurate if the longitude used in determining the meridian angle is incorrect. Similarly, the longitude obtained by solution of a time sight is inaccurate if the latitude used in the solution is incorrect, unless the celestial body is on the prime vertical. This table gives the errors resulting from unit errors in the assumed values used in the computations. There are two columns for each tabulated value of latitude. The first gives the latitude factor, f, which is the error in minutes of latitude for a one-minute error of longitude. The second gives the longitude factor, F, which is the error in minutes of longitude for a one-minute error of latitude. In each case, the total error is the factor multiplied by the number of minutes error in the assumed value. Although the factors were originally intended for use in correcting ex-meridian altitudes and time-sight longitudes, they have other uses as well.

The azimuth angle used for entering the table can be measured from either the north or south, through  $90^\circ$ ; or it may be measured from the elevated pole, through  $180^\circ$ . If the celestial body is in the southeast ( $090^\circ$ – $180^\circ$ ) or northwest ( $270^\circ$ – $360^\circ$ ) quadrant, the f correction is applied to the northward if the correct longitude is east of that used in the solution, and to the southward if the correct longitude is west of that used; while the F correction is applied to the eastward if the correct latitude is north of that used in the solution, and to the westward if the correct latitude is south of that used. If the body is in the northeast ( $000^\circ$ – $090^\circ$ ) or southwest ( $180^\circ$ – $270^\circ$ ) quadrant, the correction is applied in the opposite direction. These rules apply in both north and south latitude.

The table was computed using the formulas:

$$f = \cos L \tan Z = \frac{1}{\sec L \cot Z} = \frac{1}{F}$$

$$F = \sec L \cot Z = \frac{1}{\cos L \tan Z} = \frac{1}{f}$$

in which  $f$  is the tabulated latitude factor,  $L$  is the latitude,  $Z$  is the azimuth angle, and  $F$  is the tabulated longitude factor.

**Table 22. Amplitudes** – This table lists amplitudes of celestial bodies at rising and setting. Enter with the declination of the body and the latitude of the observer. The value taken from the table is the amplitude when the *center* of the body is on the *celestial* horizon. For the sun, this occurs when the lower limb is a little more than half a diameter above the visible horizon. For the moon it occurs when the upper limb is about on the horizon. Use the prefix E if the body is rising, and W if it is setting; use the suffix N or S to agree with the declination of the body. Table 23 can be used with reversed sign to correct the tabulations to the values for the visible horizon.

The table was computed using the following formula, derived by Napier's rules:

$$\sin A = \sec L \sin d$$

in which  $A$  is the amplitude,  $L$  is the latitude of the observer, and  $d$  is the declination of the celestial body.

**Table 23. Correction of Amplitude Observed on the Visible Horizon** – This table contains a correction to be applied to the amplitude observed when the center of a celestial body is on the visible horizon, to obtain the corresponding amplitude when the center of the body is on the celestial horizon. For the sun, a planet, or a star, apply the correction in the direction away from the elevated pole, thus *increasing* the *azimuth angle*. For the moon apply *half* the correction *toward* the elevated pole. This correction can be applied in the opposite direction to a value taken from Table 22 to find the corresponding amplitude when the center of a celestial body is on the visible horizon. The table was computed for a height of eye of 41 feet. For other heights normally encountered, the error is too small to be of practical significance in ordinary navigation.

The values in the table were determined by computing the azimuth angle when the center of the celestial body is on the visible horizon, converting this to amplitude, and determining the difference between this value and the corresponding value from Table 22. Computation of azimuth angle was made for an altitude of  $(-)^{\circ}42.0'$  determined as follows:

Azimuth angle was computed by means of the formula:

$$\cos Z = \frac{\sin d - \sin h \sin L}{\cos h \cos L}$$

in which  $Z$  is the azimuth angle,  $d$  is the declination of the celestial body,  $h$  is the altitude ( $-0^{\circ}42.0'$ ), and  $L$  is the latitude of the observer.

**Table 24. Altitude Factors** – In one minute of time from meridian transit the altitude of a celestial body changes by the amount shown in this table if the altitude is between  $6^{\circ}$  and  $86^{\circ}$ , the latitude is not more than  $60^{\circ}$ , and the declination is not more than  $63^{\circ}$ . The values taken from this table are used to enter Table 25 for solving reduction to the meridian (ex-meridian) problems.

For upper transit, use the left-hand pages if the declination and latitude are of the same name (both north or both south) and the right-hand pages if of contrary name. For lower transit, use the values below the heavy lines on the last three contrary-name pages. When a factor is taken from this part of the table, the correction from table 25 is *subtracted* from the observed altitude to obtain the corresponding meridian altitude. All other corrections are added.

The table was computed using the formula:

$$a = 1.9635'' \cos L \cos d \csc (L \sim d)$$

in which  $a$  is the change of altitude in one minute from meridian transit (the tabulated value),  $L$  is the latitude of the observer, and  $d$  is the declination of the celestial body.

This formula can be used to compute values outside the limits of the table, but is not accurate if the altitude is greater than  $86^{\circ}$ .

**Table 25. Change of Altitude in Given Time from Meridian Transit** – Enter this table with the altitude factor from table 24 and the meridian angle, in either arc or time units, and take out the difference between the altitude at the given time and the altitude at meridian transit. Enter the table separately with whole numbers and tenths of a, interpolating for  $t$  if necessary, and add the two values to obtain the total difference. This total can be applied as a correction to observed altitude to obtain the corresponding meridian altitude, adding for upper transit and subtracting for lower transit.

The table was computed using the formulas:

$$C = \frac{at^2}{60}$$

in which  $C$  is the tabulated difference to be used as a correction to observed altitude in minutes of arc;  $a$  is the altitude factor from table 24 in seconds of arc; and  $t$  is the meridian angle in minutes of time.

This formula should not be used for determining val-

ues beyond the limits of the table unless reduced accuracy is acceptable.

**Table 26. Time Zones, Descriptions, and Suffixes –**

The zone description and the single letter of the alphabet designating a time zone and sometimes used as a suffix to zone time for all time zones are given in this table.

**Table 27. Altitude Correction for Air Temperature –**

This table provides a correction to be applied to the altitude of a celestial body when the air temperature varies from the 50° F used for determining mean refraction with the *Nautical Almanac*. For maximum accuracy, apply index correction and dip to sextant altitude first, obtaining apparent (rectified) altitude for use in entering this table. Enter the table with altitude and air temperature in degrees Fahrenheit. Apply the correction in accordance with its tabulated sign to altitude.

The table was computed using formula:

$$\text{Correction} = R_m \left( 1 - \frac{510}{460 + T} \right)$$

in which  $R_m$  is mean refraction and  $T$  is temperature in degrees Fahrenheit.

**Table 28. Altitude Correction for Atmospheric Pressure –**

This table provides a correction to be applied to the altitude of a celestial body when the atmospheric pressure varies from the 29.83 inches (1010 millibars) used for determining mean refraction using the *Nautical Almanac*. For most accurate results, apply index correction and dip to sextant altitude first, obtaining apparent (rectified) altitude for use in entering this table. Enter the table with altitude and atmospheric pressure. Apply the correction to altitude, *adding* if the pressure is less than 29.83 inches and *subtracting* if it is more than 29.83 inches. The table was computed by means of the formula:

$$\text{Correction} = R_m \left( 1 - \frac{P}{29.83} \right)$$

in which  $R_m$  is mean refraction and  $P$  is atmospheric pressure in inches of mercury.

### Meteorological Tables

**Table 29. Conversion Table for Thermometer Scales –** Enter this table with temperature Fahrenheit,  $F$ ; Celsius (centigrade),  $C$ ; or Kelvin,  $K$ ; and take out the corresponding readings on the other two temperature scales.

On the Fahrenheit scale, the freezing temperature of pure water at standard sea level pressure is 32°, and the boiling point under the same conditions is 212°. The corresponding temperatures are 0° and 100° on the Celsius scale

and 273.15° and 373.15°, respectively, on the Kelvin scale. The value of (–) 273.15° C for absolute zero, the starting point of the Kelvin scale, is the value recognized officially by the National Institute of Standards and Technology (NIST).

The formulas are:

$$C = 5/9(F - 32^\circ) = K - 273.15^\circ$$

$$F = 9/5C + 32^\circ = 9/5 K - 459.67^\circ$$

$$K = 5/9(F + 459.67^\circ) = C + 273.15^\circ$$

**Table 30. Direction and Speed of True Wind –**

This table converts apparent wind to true wind. To use the table, divide the apparent wind in knots by the vessel's speed in knots. This gives the apparent wind speed in units of ship's speed. Enter the table with this value and the difference between the heading and the apparent wind direction. The values taken from the table are (1) the difference between the heading and the true wind direction, and (2) the speed of the true wind in units of ship's speed. The true wind is on the same side as the apparent wind, and from a point farther aft.

To convert wind speed in units of ship's speed to speed in knots, multiply by the vessel's speed in knots. The steadiness of the wind and the accuracy of its measurement are seldom sufficient to warrant interpolation in this table. If speed of the true wind and relative direction of the apparent wind are known, enter the column for direction of the apparent wind, and find the speed of the true wind in units of ship's speed. The number to the left is the relative direction of the true wind. The number on the same line in the side columns is the speed of the apparent wind in units of ship's speed. Two solutions are possible if speed of the true wind is less than ship's speed.

The table was computed by solving the triangle involved in a graphical solution, using the formulas:

$$\tan \alpha = \frac{\sin B_A}{S_A - \cos B_A}$$

$$B_T = B_A + \alpha$$

$$S_T = \frac{\sin B_A}{\sin \alpha}$$

in which  $\alpha$  is an auxiliary angle,  $B_A$  is the difference between the heading and the apparent wind direction,  $S_A$  is the speed of the apparent wind in units of ship's speed,  $B_T$  is the difference between the heading and the true wind direction, and  $S_T$  is the speed of the true wind in units of ship's speed.

**Table 31. Correction of Barometer Reading for Height Above Sea Level** – If simultaneous barometer readings at different heights are to be of maximum value in weather analysis, they should be converted to the corresponding readings at a standard height, usually sea level. To convert the observed barometer reading to this level, enter this table with the outside temperature and the height of the barometer above sea level. The height of a barometer is the height of its sensitive element; in the case of a mercurial barometer, this is the height of the free surface of mercury in the cistern. The correction taken from this table applies to the readings of any type barometer, and is always *added* to the observed readings, unless the barometer is below sea level.

The table was computed using the formula:

$$C = 29.92126 \left( 1 - \frac{1}{\text{antilog} \left( \frac{0.0081350H}{T + 0.00178308H} \right)} \right)$$

in which C is the correction in inches of mercury, H is the height of the barometer above sea level in feet, and T is the mean temperature, in degrees Rankine (degrees Fahrenheit plus 459.67°), of the air between the barometer and sea level. At sea the outside air temperature is sufficiently accurate for this purpose.

**Table 32. Correction of Barometer Reading for Gravity** – The height of the column of a mercury barometer is affected by the force of gravity, which changes with latitude and is approximately equal along any parallel of latitude. The average gravitational force at latitude 45°32'40" is used as the standard for calibration. This table provides a correction to convert the observed reading at any other latitude to the corresponding value at latitude 45°32'40". Enter the table with the latitude, take out the correction, and apply in accordance with the sign given. This correction does not apply to aneroid barometers.

The correction was computed using the formula:

$$C = B(-0.002637 \cos 2L + 0.000006 \cos^2 2L - 0.000050)$$

in which C is the correction in inches, B is the observed reading of the barometer (corrected for temperature and instrumental errors) in inches of mercury, and L is the latitude. This table was computed for a standard height of 30 inches.

**Table 33. Correction of Barometer Reading for Temperature** – Because of the difference in expansion of the mercury column of a mercurial barometer and that of the brass scale by which the height is measured, a correction should be applied to the reading when the temperature differs from the standard used for calibration of the instrument. To find the correction, enter this table with the temperature in degrees Fahrenheit and the barometer read-

ing. Apply the correction in accordance with the sign given. This correction does not apply to aneroid barometers.

The standard temperature used for calibration is 32° F for the mercury, and 62° F for the brass. The correction was computed using the formula:

$$C = -B \frac{m(T - 32^\circ) - l(T - 62^\circ)}{1 + m(T - 32^\circ)}$$

in which C is the correction in inches, B is the observed reading of the barometer in inches of mercury, m is the coefficient of cubical expansion of mercury = 0.0001010 cubic inches per degree F, l is the coefficient of linear expansion of brass = 0.0000102 inches per degree F, and T is the temperature of the attached thermometer in degrees F. Substituting the values for m and l and simplifying:

$$C = -B \frac{T - 28.630^\circ}{1.1123T + 10978^\circ}$$

The minus sign before B indicates that the correction is negative if the temperature is more than 28.630°.

**Table 34. Conversion Table for hecto-Pascals (Millibars), Inches of Mercury, and Millimeters of Mercury** – The reading of a barometer in inches or millimeters of mercury corresponding to a given reading in hecto-Pascals can be found directly from this table.

The formula for the pressure in hecto-Pascals is:

$$P = \frac{B_m D}{1000} g$$

in which P is the atmospheric pressure in hecto-Pascals, B<sub>m</sub> is the height of the column of mercury in millimeters, D is the density of mercury = 13.5951 grams per cubic centimeter, and g is the standard value of gravity = 980.665 dynes. Substituting numerical values:

$$P = 1.33322B_m, \text{ and}$$

$$B_m = \frac{P}{1.33322} = 0.750064P$$

Since one millimeter = 0.750064 inches

$$B_i = \frac{0.03937P}{1.33322} = 0.0295300P,$$

in which B<sub>i</sub> is the height of the column of mercury in inches.

**Table 35. Relative Humidity** – To determine the relative humidity of the atmosphere, enter this table with

the dry-bulb (air) temperature (F), and the *difference* between the dry-bulb and wet-bulb temperatures (F). The value taken from the table is the approximate percentage of relative humidity. If the dry-bulb and wet-bulb temperatures are the same, relative humidity is 100 percent.

The table was computed using the formula:

$$R = \frac{100e}{e_w}$$

in which R is the approximate relative humidity in percent, e is the ambient vapor pressure, and  $e_w$  is the saturation vapor pressure over water at dry-bulb temperature. Professor Ferrel's psychrometric formula was used for computation of e:

$$e' = \left( 0.000367P(t - t') \left( 1 + \frac{t - 32^\circ}{1571} \right) \right)$$

in which e is the ambient vapor pressure in millibars, e' is the saturation vapor pressure in millibars at wet-bulb temperature with respect to water, P is the atmospheric pressure (the millibar equivalent of 30 inches of mercury is used for this table), t is the dry-bulb temperature in degrees Fahrenheit, and t' is the wet-bulb temperature in degrees Fahrenheit.

The values of  $e_w$  were taken from the International Meteorological Organization Publication Number 79, 1951, table 2, pages 82–83.

**Table 36. Dew Point** – To determine the dew point, enter this table with the dry-bulb (air) temperature (F), and the *difference* between the dry-bulb and wet-bulb temperatures (F). The value taken from the table is the dew point in degrees Fahrenheit. If the dry-bulb and wet-bulb temperatures are the same, the air is at or below the dew point.



TABLE 1  
Logarithms of Number  
1500-2000

Table with columns: No., 0, d, 1, d, 2, d, 3, d, 4, d, 5, d, 6, d, 7, d, 8, d, 9, d, Prop. parts. Rows 150-2000.

TABLE 1  
Logarithms of Number  
2000-2500

Table with columns: No., 0, d, 1, d, 2, d, 3, d, 4, d, 5, d, 6, d, 7, d, 8, d, 9, d, Prop. parts. Rows 2000-2500.



TABLE 1  
Logarithms of Number  
3500-4000

Table with 18 columns: No., 0, d, 1, d, 2, d, 3, d, 4, d, 5, d, 6, d, 7, d, 8, d, 9, d, Prop. parts. Rows range from 350 to 400.

TABLE 1  
Logarithms of Number  
4000-4500

Table with 18 columns: No., 0, d, 1, d, 2, d, 3, d, 4, d, 5, d, 6, d, 7, d, 8, d, 9, d, Prop. parts. Rows range from 400 to 450.



















TABLE 2 Natural Trigonometric Functions

Table with columns: 6° →, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 173° ←. Rows include values for angles 0 to 60 degrees.

TABLE 2 Natural Trigonometric Functions

Table with columns: 7° →, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 172° ←. Rows include values for angles 0 to 60 degrees.



TABLE 2  
Natural Trigonometric Functions

Table with columns for angle (10 to 169 degrees), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', and angle (169 to 10 degrees). Rows 0-60.

TABLE 2  
Natural Trigonometric Functions

Table with columns for angle (11 to 168 degrees), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', and angle (168 to 11 degrees). Rows 0-60.



TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 14° to 165°, trigonometric functions (sin, cos, tan, cot, sec, csc), and their differences. Includes a bottom section for angles 104° to 75°.

TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 15° to 164°, trigonometric functions (sin, cos, tan, cot, sec, csc), and their differences. Includes a bottom section for angles 105° to 74°.

TABLE 2  
Natural Trigonometric Functions

Table with columns: 16° (degrees), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', and 163° (degrees). Rows 0-60. Bottom row contains 106° cos and 73°.

TABLE 2  
Natural Trigonometric Functions

Table with columns: 17° (degrees), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', and 162° (degrees). Rows 0-60. Bottom row contains 107° cos and 72°.

TABLE 2
Natural Trigonometric Functions

Table with 14 columns: 18°, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 161°. Rows 0-60. Bottom row: 108°, cos, Diff. 1', sec, Diff. 1', cot, Diff. 1', tan, Diff. 1', csc, Diff. 1', sin, Diff. 1', 71°.

TABLE 2
Natural Trigonometric Functions

Table with 14 columns: 19°, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 160°. Rows 0-60. Bottom row: 109°, cos, Diff. 1', sec, Diff. 1', cot, Diff. 1', tan, Diff. 1', csc, Diff. 1', sin, Diff. 1', 70°.



TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 22° to 157°, and rows for trigonometric functions: sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1'. Includes a bottom row for 112° and 67°.

TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 23° to 156°, and rows for trigonometric functions: sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1'. Includes a bottom row for 113° and 66°.



TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 26° to 153°, trigonometric functions (sin, csc, tan, cot, sec, cos), and differences. Includes a section for 116° at the bottom.

TABLE 2  
Natural Trigonometric Functions

Table with columns for angles 27° to 152°, trigonometric functions (sin, csc, tan, cot, sec, cos), and differences. Includes a section for 117° at the bottom.











TABLE 2  
Natural Trigonometric Functions

Table with columns for angle (38° to 141°), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1'. Includes values for angles 0 to 60 and 128 to 51 degrees.

TABLE 2  
Natural Trigonometric Functions

Table with columns for angle (39° to 140°), sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1'. Includes values for angles 0 to 60 and 129 to 50 degrees.



TABLE 2 Natural Trigonometric Functions

Table with columns: 42° down arrow, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 137° left arrow. Rows include values for angles from 0 to 60 degrees.

TABLE 2 Natural Trigonometric Functions

Table with columns: 43° down arrow, sin, Diff. 1', csc, Diff. 1', tan, Diff. 1', cot, Diff. 1', sec, Diff. 1', cos, Diff. 1', 136° left arrow. Rows include values for angles from 0 to 60 degrees.









































TABLE 3 Common Logarithms of Trigonometric Function (offset +10) Table with columns for angles 38° to 128° and values for sin, csc, tan, cot, sec, cos, and their differences.

TABLE 3 Common Logarithms of Trigonometric Function (offset +10) Table with columns for angles 39° to 129° and values for sin, csc, tan, cot, sec, cos, and their differences.





















































































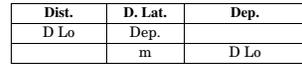
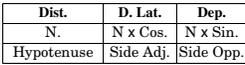






TABLE 4 Traverse 43° Table. Grid of latitude/longitude coordinates and distance measurements for Table 4.

TABLE 4 Traverse 43° Table. Grid of latitude/longitude coordinates and distance measurements for Table 4.







| TABLE 5<br>Natural and Numerical Chart Scales |                                  |                               |                                  |                               |                           |
|---|----------------------------------|-------------------------------|----------------------------------|-------------------------------|---------------------------|
| Natural Scale                                 | Miles Per Inch                   |                               | Inches Per Mile                  |                               | Feet Per Inch             |
|   | Nautical                         | Statute                       | Nautical                         | Statute                       |                           |
| 1:500   | 0.007                            | 0.008                         | 145.83                           | 126.72                        | 41.67                     |
| 1:600   | 0.008                            | 0.009                         | 121.52                           | 105.60                        | 50.00                     |
| 1:1,000                                       | 0.014                            | 0.016                         | 72.91                            | 63.36                         | 83.33                     |
| 1:1,200                                       | 0.016                            | 0.019                         | 60.76                            | 52.80                         | 100.00                    |
| 1:1,500                                       | 0.021                            | 0.024                         | 48.61                            | 42.24                         | 125.00                    |
| 1:2,000                                       | 0.027                            | 0.032                         | 36.46                            | 31.68                         | 166.67                    |
| 1:2,400                                       | 0.033                            | 0.038                         | 30.38                            | 26.40                         | 200.00                    |
| 1:2,500                                       | 0.034                            | 0.039                         | 29.17                            | 25.34                         | 208.33                    |
| 1:3,000                                       | 0.041                            | 0.047                         | 24.30                            | 21.12                         | 250.00                    |
| 1:3,600                                       | 0.049                            | 0.057                         | 20.25                            | 17.60                         | 300.00                    |
| 1:4,000                                       | 0.055                            | 0.063                         | 18.23                            | 15.84                         | 333.33                    |
| 1:4,800                                       | 0.066                            | 0.076                         | 15.19                            | 13.20                         | 400.00                    |
| 1:5,000                                       | 0.069                            | 0.079                         | 14.58                            | 12.67                         | 416.67                    |
| 1:6,000                                       | 0.082                            | 0.095                         | 12.15                            | 10.56                         | 500.00                    |
| 1:7,000                                       | 0.096                            | 0.110                         | 10.42                            | 9.05                          | 583.33                    |
| 1:7,200                                       | 0.099                            | 0.114                         | 10.13                            | 8.80                          | 600.00                    |
| 1:7,920                                       | 0.109                            | 0.125                         | 9.21                             | 8.00                          | 660.00                    |
| 1:8,000                                       | 0.110                            | 0.126                         | 9.11                             | 7.92                          | 666.67                    |
| 1:8,400                                       | 0.115                            | 0.133                         | 8.68                             | 7.54                          | 700.00                    |
| 1:9,000                                       | 0.123                            | 0.142                         | 8.10                             | 7.04                          | 750.00                    |
| 1:9,600                                       | 0.132                            | 0.152                         | 7.60                             | 6.60                          | 800.00                    |
| 1:10,000                                      | 0.137                            | 0.158                         | 7.29                             | 6.34                          | 833.33                    |
| 1:10,800                                      | 0.148                            | 0.170                         | 6.75                             | 5.87                          | 900.00                    |
| 1:12,000                                      | 0.165                            | 0.189                         | 6.08                             | 5.28                          | 1,000.00                  |
| 1:13,200                                      | 0.181                            | 0.208                         | 5.52                             | 4.80                          | 1,100.00                  |
| 1:14,400                                      | 0.197                            | 0.227                         | 5.06                             | 4.40                          | 1,200.00                  |
| 1:15,000                                      | 0.206                            | 0.237                         | 4.86                             | 4.22                          | 1,250.00                  |
| 1:15,600                                      | 0.214                            | 0.246                         | 4.67                             | 4.06                          | 1,300.00                  |
| 1:15,840                                      | 0.217                            | 0.250                         | 4.60                             | 4.00                          | 1,320.00                  |
| 1:16,000                                      | 0.219                            | 0.253                         | 4.56                             | 3.96                          | 1,333.33                  |
| 1:16,800                                      | 0.230                            | 0.265                         | 4.34                             | 3.77                          | 1,400.00                  |
| 1:18,000                                      | 0.247                            | 0.284                         | 4.05                             | 3.52                          | 1,500.00                  |
| 1:19,200                                      | 0.263                            | 0.303                         | 3.80                             | 3.30                          | 1,600.00                  |
| 1:20,000                                      | 0.274                            | 0.316                         | 3.65                             | 3.17                          | 1,666.67                  |
| 1:20,400                                      | 0.280                            | 0.322                         | 3.57                             | 3.11                          | 1,700.00                  |
| 1:21,120                                      | 0.290                            | 0.333                         | 3.45                             | 3.00                          | 1,760.00                  |
| 1:21,600                                      | 0.296                            | 0.341                         | 3.38                             | 2.93                          | 1,800.00                  |
| 1:22,800                                      | 0.313                            | 0.360                         | 3.20                             | 2.78                          | 1,900.00                  |
| 1:24,000                                      | 0.329                            | 0.379                         | 3.04                             | 2.64                          | 2,000.00                  |
| 1:25,000                                      | 0.343                            | 0.395                         | 2.92                             | 2.53                          | 2,083.33                  |
| 1:40,000                                      | 0.549                            | 0.631                         | 1.82                             | 1.58                          | 3,333.33                  |
| 1:48,000                                      | 0.658                            | 0.758                         | 1.52                             | 1.32                          | 4,000.00                  |
| 1:50,000                                      | 0.686                            | 0.789                         | 1.46                             | 1.27                          | 4,166.67                  |
| 1:62,500                                      | 0.857                            | 0.986                         | 1.17                             | 1.01                          | 5,208.33                  |
| 1:63,360                                      | 0.869                            | 1.000                         | 1.15                             | 1.00                          | 5,280.00                  |
| 1:75,000                                      | 1.029                            | 1.184                         | 0.97                             | 0.85                          | 6,250.00                  |
| 1:80,000                                      | 1.097                            | 1.263                         | 0.91                             | 0.79                          | 6,666.67                  |
| 1:100,000                                     | 1.371                            | 1.578                         | 0.73                             | 0.63                          | 8,333.33                  |
| 1:125,000                                     | 1.714                            | 1.973                         | 0.58                             | 0.51                          | 10,416.67                 |
| 1:200,000                                     | 2.743                            | 3.157                         | 0.36                             | 0.32                          | 16,666.67                 |
| 1:250,000                                     | 3.429                            | 3.946                         | 0.29                             | 0.25                          | 20,833.33                 |
| 1:400,000                                     | 5.486                            | 6.313                         | 0.18                             | 0.16                          | 33,333.33                 |
| 1:500,000                                     | 6.857                            | 7.891                         | 0.15                             | 0.13                          | 41,666.67                 |
| 1:750,000                                     | 10.286                           | 11.837                        | 0.10                             | 0.08                          | 62,500.00                 |
| 1:1,000,000                                   | 13.715                           | 15.783                        | 0.07                             | 0.06                          | 83,333.33                 |
| FORMULAS                                      | $\frac{\text{SCALE}}{72,913.39}$ | $\frac{\text{SCALE}}{63,360}$ | $\frac{72,913.39}{\text{SCALE}}$ | $\frac{63,360}{\text{SCALE}}$ | $\frac{\text{SCALE}}{12}$ |



TABLE 6

Meridional Parts

Table with 12 columns (Lat., 20°, 21°, 22°, 23°, 24°, 25°, 26°, 27°, 28°, 29°, Lat.) and 61 rows of numerical data.

TABLE 6

Meridional Parts

Table with 12 columns (Lat., 30°, 31°, 32°, 33°, 34°, 35°, 36°, 37°, 38°, 39°, Lat.) and 61 rows of numerical data.











































TABLE 18  
Distance of an Object by Two Bearings

Table with columns for Difference between the course and second bearing (88-160) and Difference between the course and first bearing (78-92, 94-108, 110-124, 126-140, 142-156, 158-160). Rows list bearing differences from 88 to 160 degrees.

TABLE 18  
Distance of an Object by Two Bearings

Table with columns for Difference between the course and second bearing (120-160) and Difference between the course and first bearing (110-122, 124-136, 138-150, 152-160). Rows list bearing differences from 120 to 160 degrees.





TABLE 20  
Meridian Angle and Altitude of a Body on the Prime Vertical Circle

Table with columns for Latitude and Declination (12° to 17°) and rows for Latitude (0 to 85). Values include meridian angle and altitude.

Numbers in italics indicate nearest approach to prime vertical

TABLE 20  
Meridian Angle and Altitude of a Body on the Prime Vertical Circle

Table with columns for Latitude and Declination (18° to 23°) and rows for Latitude (0 to 85). Values include meridian angle and altitude.

Numbers in italics indicate nearest approach to prime vertical

















TABLE 24

Altitude Factor

a, the change of altitude in one minute from meridian transit.

Table with columns for Latitude (0 to 60), Declination (12 to 24), and Latitude (0 to 60). The table provides altitude factor values for various declinations and latitudes.

TABLE 24

Altitude Factor

a, the change of altitude in one minute from meridian transit.

Table with columns for Latitude (0 to 60), Declination (12 to 24), and Latitude (0 to 60). The table provides altitude factor values for various declinations and latitudes, mirroring the first table but with a different declination convention.

TABLE 24  
Altitude Factor

$a$ , the change of altitude in one minute from meridian transit.

Table with 15 columns (Latitude 25° to 37°, Latitude) and 15 rows (Latitude 0 to 60). Declination same name as latitude, upper transit: add correction to observed altitude.

TABLE 24  
Altitude Factor

$a$ , the change of altitude in one minute from meridian transit.

Table with 15 columns (Latitude 25° to 37°, Latitude) and 15 rows (Latitude 0 to 60). Declination contrary name to latitude upper transit: add correction to observed altitude.















TABLE 30  
Direction and Speed of True Wind in Units of Ship's Speed

Table with columns for Apparent wind speed and Difference between the heading and apparent wind direction (0°, 10°, 20°, 30°, 40°). Rows list apparent wind speeds from 0.0 to 10.0.

TABLE 30  
Direction and Speed of True Wind in Units of Ship's Speed

Table with columns for Apparent wind speed and Difference between the heading and apparent wind direction (90°, 100°, 110°, 120°, 130°). Rows list apparent wind speeds from 0.0 to 10.0.









# CHAPTER 1

## MATHEMATICS

### ARITHMETIC

#### 100. Definition

**Arithmetic** is that branch of mathematics dealing with computation by numbers. The principal processes involved are addition, subtraction, multiplication, and division. A number consisting of a single symbol (1, 2, 3, etc.) is a **digit**. Any number that can be stated or indicated, however large or small, is called a **finite number**; one too large to be stated or indicated is called an **infinite number**; and one too small to be stated or indicated is called an **infinitesimal number**.

The **sign** of a number is the indication of whether it is positive (+) or negative (-). This may sometimes be indicated in another way. Thus, latitude is usually indicated as *north* (N) or *south* (S), but if north is considered positive, south is then negative with respect to north. In navigation, the north or south designation of latitude and declination is often called the "name" of the latitude or declination. A **positive number** is one having a positive sign (+); a **negative number** is one having a negative sign (-). The **absolute value** of a number is that number without regard to sign. Thus, the absolute value of both (+) 8 and (-) 8 is 8. Generally, a number without a sign can be considered positive.

#### 101. Significant Digits

**Significant digits** are those digits of a number which have a significance. Zeros at the left of the number and sometimes those at the right are excluded. Thus, 1,325, 1,001, 1,408, 0.00005926, 625.0, and 0.4009 have four significant digits each. But in the number 186,000 there may be three, four, five, or six significant digits depending upon the accuracy with which the number has been determined. If the quantity has only been determined to the nearest thousand then there are three significant digits, the zeros at the right not being counted. If the number has been determined to the nearest one hundred, there are four significant digits, the first zero at the right being counted. If the number has been determined to the nearest ten, there are five significant digits, the first two zeros on the right being counted. If the quantity has been determined to the nearest unit, there are six significant digits, the three zeros at the right being counted.

This ambiguity is sometimes avoided by expressing numbers in powers of 10. Thus,  $18.6 \times 10^4$  ( $18.6 \times 10,000$ ) indicates accuracy to the nearest thousand,  $18.60 \times 10^4$  to the

nearest hundred,  $18.600 \times 10^4$  to the nearest ten, and  $18.6000 \times 10^4$  to the nearest unit. The position of the decimal is not important if the correct power of 10 is given. For example,  $18.6 \times 10^4$  is the same as  $1.86 \times 10^6$ ,  $186 \times 10^3$ , etc. The small number above and to the right of 10 (the **exponent**) indicates the number of places the decimal point is to be moved to the right. If the exponent is negative, it indicates a reciprocal, and the decimal point is moved to the left. Thus,  $1.86 \times 10^{-6}$  is the same as 0.00000186. This system is called **scientific notation**.

#### 102. Expressing Numbers

In navigation, fractions are usually expressed as decimals. Thus,  $1/4$  is expressed as 0.25 and  $1/3$  as 0.33. To determine the decimal equivalent of a fraction, divide the **numerator** (the number above the line) by the **denominator** (the number below the line). When a decimal is less than 1, as in the examples above, it is good practice to show the zero at the left of the decimal point (0.25, not .25).

A number should not be expressed using more significant digits than justified. The *implied* accuracy of a decimal is indicated by the number of digits shown to the right of the decimal point. Thus, the expression "14 miles" implies accuracy to the nearest whole mile, or any value between 13.5 and 14.5 miles. The expression "14.0 miles" implies accuracy of a tenth of a mile, or any value between 13.95 and 14.05 miles.

A quantity may be expressed to a greater implied accuracy than is justified by the accuracy of the information from which the quantity is derived. For instance, if a ship steams 1 mile in  $3^m21^s$ , its speed is  $60^m \div 3^m21^s = 60 \div 3.35 = 17.910447761194$  knots, approximately. The division can be carried to as many places as desired, but if the time is measured only to the nearest second, the speed is accurate only to one decimal place in this example, because an error of 0.5 second introduces an error of more than 0.05 knot in the speed. Hence, the additional places are meaningless and possibly misleading, unless more accurate time is available. In general, it is not good practice to state a quantity to imply accuracy greater than what is justified. However, in marine navigation the accuracy of information is often unknown, and it is customary to give positions as if they











Thus, to find  $\sqrt[3]{0.7}$  by logarithms:

$$\begin{array}{r} 7 \log \underline{29.84510} - 30 \ (\div 3) \\ 0.88792 \log 09.94837 - 10 \end{array}$$

or, carrying the -30 and -10 mentally,

$$\begin{array}{r} 0.7 \log \underline{29.84510} \ (\div 3) \\ 0.88792 \log 9.94837 \end{array}$$

### 112. Cologarithms

The **cologarithm** (“colog”) of a number is the value obtained by subtracting the logarithm of that number from zero, usually in the form 10-10. Thus, the logarithm of 18.615 is 1.26987. The cologarithm is:

$$\begin{array}{r} 10.00000-10 \\ (-)1.26987 \\ \hline 8.73013 - 10 \end{array}$$

Similarly, the logarithm of 0.0018615 is 7.26987 -10, and its cologarithm is:

$$\begin{array}{r} 10.00000 - 10 \\ (-)7.26987 - 10 \\ \hline 2.73013 \end{array}$$

The *cologarithm* of a number is the *logarithm* of the reciprocal of that number. Thus, the cologarithm of 2 is the logarithm of  $\frac{1}{2}$ . Since division by a number is the same as multiplication by its reciprocal, the use of cologarithms permits division problems to be converted to problems of multiplication, eliminating the need for subtraction of logarithms. This is particularly useful when both multiplication and division are involved in the same problem. Thus, to find  $\frac{92.732 \cdot 0.0137 \cdot 724.3}{0.516 \cdot 3941.1}$  by logarithm, one might *add* the logarithms of the three numbers in the numerator, and *subtract* the logarithms of the two numbers in the denominator. If cologarithms are used for the numbers in the denominator, all logarithmic values are added. Thus, the solution might be made as follows:

$$\begin{array}{ll} 92.732 & \log 1.96723 \\ 0.0137 & \log 8.13672 \\ 724.3 & \log 2.85992 \\ 0.516 & \log 9.71265 \text{ colog } 0.28735 \\ 3941.1 & \log 3.59562 \text{ colog } 6.40438 \\ 0.45248 & \log 9.65560 \end{array}$$

### 113. Various Kinds of Logarithms

As indicated above, **common logarithms** use 10 as the base. These are also called **Brigg's logarithms**. For some purposes, it is convenient to use 2.7182818 approximately

(designated *e*) as the base for logarithms. These are called **natural logarithms** or **Naperian logarithms** ( $\log_e$ ). Common logarithms are shown as  $\log_{10}$  when the base might otherwise be in doubt.

**Addition and subtraction logarithms** are logarithms of the sum and difference of two numbers. They are used when the logarithms of two numbers to be added or subtracted are known, making it unnecessary to find the numbers themselves.

### 114. Slide Rule

A **slide rule** is a mechanical analog computer. The slide rule is used primarily for multiplication and division, and also for functions such as roots, logarithms and trigonometry. The device is now obsolete with the advent of the hand held electronic calculator in the mid-1970's. Figure 114 depicts a typical slide rule.

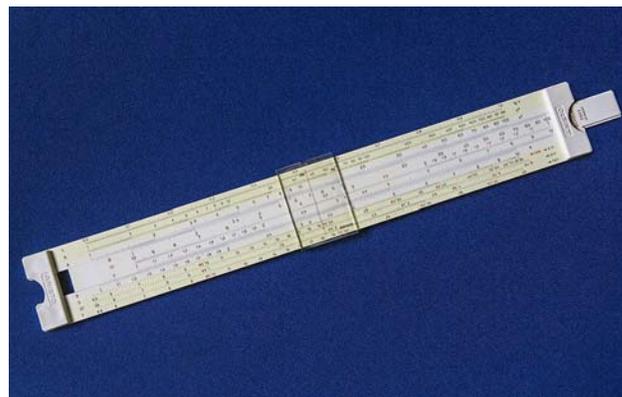


Figure 114. Slide rule. By Jan1959 (own work) via Wikimedia Commons

Slide rules come in many types and sizes, some designed for specific purposes. The most common form consists of an outer “body” or “frame” with grooves to permit a “slide” to be moved back and forth between the two outer parts, so that any graduation of a scale on the slide can be brought opposite any graduation of a scale on the body. A cursor called an “indicator” or “runner” is provided to assist in aligning the desired graduations. In a **circular slide rule** the “slide” is an inner disk surrounded by a larger one, both pivoted at their common center. The scales of a slide rule are *logarithmic*. That is, they increase proportionally to the logarithms of the numbers indicated, rather than to the numbers themselves. This permits addition and subtraction of logarithms by simply measuring off part of the length of the slide from a graduated point on the body, or vice versa. Two or three complete scales within the length of the rule may be provided for finding squares, cubes, square roots, and cube roots.

Properly used, a slide rule can provide quick answers to many of the problems of navigation. However, its precision is usually limited to from two to four significant digits, and should not be used if greater precision is desired.

Great care should be used in placing the decimal point in an answer obtained by slide rule, as the correct location often is not immediately apparent. Its position is usually determined by making a very rough mental solution. Thus,  $2.93 \times 8.3$  is about  $3 \times 8 = 24$ . Hence, when the answer by slide rule is determined to be "243," it is known that the correct value is 24.3, not 2.43 or 243.

### 115. Mental Arithmetic

Many of the problems of the navigator can be solved mentally. The following are a few examples.

If the speed is a number divisible into 60 a whole number of times, distance problems can be solved by a simple relationship. Thus, at 10 knots a ship steams 1 mile in  $\frac{60}{10} = 6$  minutes. At 12 knots it requires 5 minutes, at 15 knots 4 minutes, etc. As an example of the use of such a relationship, a vessel steaming at 12 knots travels 5.6 miles in 28 minutes, since  $\frac{28}{5} = 5 + \frac{3}{5} = 5.6$ , or 0.1 mile every half minute.

For relatively short distances, one nautical mile can be considered equal to 6,000 feet. Since one hour has 60 min-

utes, the speed in hundreds of feet per minute is equal to the speed in knots. Thus, a vessel steaming at 15 knots is moving at the rate of 1,500 feet per minute.

With respect to time, 6 minutes = 0.1 hour, and 3 minutes = 0.05 hour. Hence, a ship steaming at 13 knots travels 3.9 miles in 18 minutes ( $13 \times 0.3$ ), and 5.8 miles in 27 minutes ( $13 \times 0.45$ ).

In arc units,  $6' = 0.1^\circ$  and  $6'' = 0.1'$ . This relationship is useful in rounding off values given in arc units. Thus,  $17^\circ 23' 44'' = 17^\circ 23.7'$  to the nearest 0.1', and  $17.4^\circ$  to the nearest 0.1°. A thorough knowledge of the six multiplication table is valuable. The 15 multiplication table is also useful, since  $15^\circ = 1^h$ . Hence,  $16^h = 16 \times 15 = 240^\circ$ . This is particularly helpful in quick determination of zone description. Pencil and paper or a table should not be needed, for instance, to decide that a ship at sea in longitude  $157^\circ 18.4' W$  is in the (+)10 zone.

It is also helpful to remember that  $1^\circ = 4^m$  and  $1' = 4^s$ . In converting the LMT of sunset to ZT, for instance, a quick mental solution can be made without reference to a table. Since this correction is usually desired only to the nearest whole minute, it is necessary only to multiply the longitude difference in degrees (to the nearest quarter degree) by four.

## VECTORS

### 116. Scalars and Vector Quantities

A **scalar** is a quantity which has *magnitude* only; a **vector quantity** has both *magnitude* and *direction*. If a vessel is said to have a tank of 5,000 gallons capacity, the number 5,000 is a scalar. As used in this book, *speed* alone is considered a scalar, while *speed* and *direction* are considered to constitute *velocity*, a vector quantity. Thus, if a vessel is said to be steaming at 18 knots, without regard to direction, the number 18 is considered a scalar; but if the vessel is said to be steaming at 18 knots on course  $157^\circ$ , the combination of 18 knots, and  $157^\circ$  constitutes a vector quantity. *Distance* and *direction* also constitute a vector quantity.

A *scalar* can be represented fully by a number. A *vector quantity* requires, in addition, an indication of direction. This is conveniently done graphically by means of a straight line, the length of which indicates the *magnitude*, and the direction of which indicates the *direction* of application of the magnitude. Such a line is called a **vector**. Since a straight line has two directions, reciprocals of each other, an arrowhead is placed along or at one end of a vector to indicate the direction represented, unless this is apparent or indicated in some other manner.

### 117. Addition and Subtraction of Vectors

Two vectors can be *added* by starting the second at the termination (rather than the origin) of the first. A common navigational use of vectors is the dead reckoning plot of a vessel. Refer to Figure 117 depicting the addition and subtraction of vectors. If a ship starts at A and steams 18 miles

on course  $090^\circ$  and then 12 miles on course  $060^\circ$ , it arrives by dead reckoning at C. The line AB is the vector for the first run, and BC is the vector for the second. Point C is the position found by adding vectors AB and BC. The vector AC, in this case the *course and distance made good*, is the **resultant**. Its value, both in direction and amount, can be determined by measurement. Lines AB, BC, and AC are all **distance vectors**. **Velocity vectors** are used when determining the effect of, or allowing for, current, interconverting true and apparent wind, and solving relative motion problems.

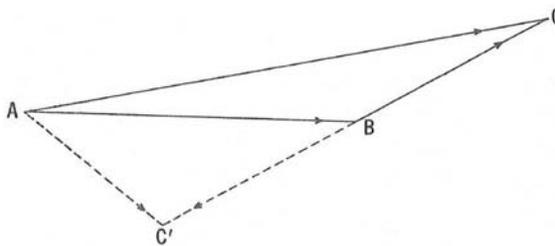


Figure 117. Addition and subtraction of vectors.

The **reciprocal** of a vector has the same magnitude but opposite direction of the vector. To *subtract* a vector, *add* its reciprocal. This is indicated by the broken lines in Figure 117, in which the vector  $BC'$  is drawn in the opposite direction to BC. In this case the resultant is  $AC'$ . Subtraction of vectors is involved in some current and wind problems.







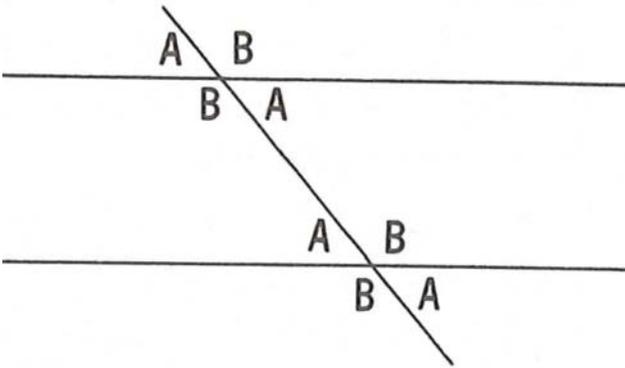


Figure 126c. Angles formed by a transversal.

of another, the two angles are either equal or supplementary.

When two straight lines intersect, forming four angles, the two opposite angles, called **vertical angles**, are equal. Angles which have the same vertex and lie on opposite sides of a common side are **adjacent angles**. Adjacent angles formed by intersecting lines are supplementary, since each pair of adjacent angles forms a straight angle. Thus, in Figure 126a, lines  $AE$  and  $BF$  intersect at  $G$ . Angles  $AGB$  and  $EGF$  form a pair of equal acute vertical angles, and  $BGE$  and  $AGF$  form a pair of equal obtuse vertical angles.

A **transversal** is a line that intersects two or more other lines. If two or more parallel lines are cut by a transversal, groups of adjacent and vertical angles are formed, as shown in Figure 126c. In this situation, all acute angles ( $A$ ) are equal, all obtuse angles ( $B$ ) are equal, and each acute angle is supplementary to each obtuse angle.

A **dihedral angle** is the angle between two intersecting planes.

## 127. Triangles

A **plane triangle** is a closed figure formed by three straight lines, called **sides**, which meet at three points called **vertices**. The vertices are labeled with capital letters and the sides with lowercase letters, as shown in Figure 127a, which depicts a triangle.

An **equilateral triangle** is one with its three sides equal in length. It must also be **equiangular**, with its three angles equal.

An **isosceles triangle** is one with two equal sides, called **legs**. The angles opposite the legs are equal. A line which **bisects** (divides into two equal parts) the unequal angle of an isosceles triangle is the perpendicular bisector of the opposite side, and divides the triangle into two equal right triangles.

A **scalene triangle** is one with no two sides equal. In such a triangle, no two angles are equal.

An **acute triangle** is one with three acute angles.

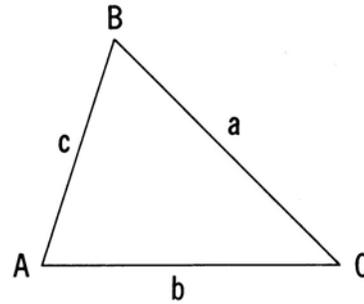


Figure 127a. A triangle.

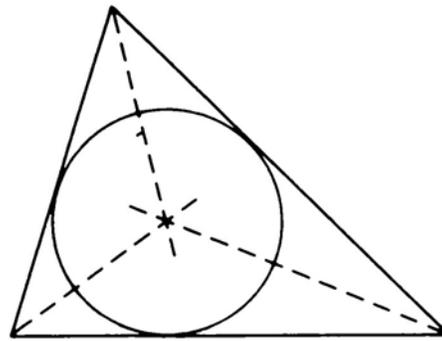


Figure 127b. A circle inscribed in a triangle.

A **right triangle** is one having a right angle. The side opposite the right angle is called the **hypotenuse**. The other two sides may be called **legs**. A plane triangle can have only one right angle.

An **obtuse triangle** is one with an obtuse angle. A plane triangle can have only one obtuse angle.

An **oblique triangle** is one which does not contain a right angle.

The **altitude** of a triangle is a line or the distance from any vertex perpendicular to the opposite side.

A **median** of a triangle is a line from any vertex to the center of the opposite side. The three medians of a triangle meet at a point called the **centroid** of the triangle. This point divides each median into two parts, that part between the centroid and the vertex being twice as long as the other part.

Lines bisecting the three *angles* of a triangle meet at a point which is equidistant from the three sides, which is the center of the **inscribed circle**, as shown in Figure 127b. This point is of particular interest to navigators because it is the point theoretically taken as the fix when three lines of position of equal weight and having only random errors do not meet at a common point. In practical navigation, the point is found visually, not by construction, and other factors often influence the chosen fix position.

The perpendicular bisectors of the three *sides* of a triangle meet at a point which is equidistant from the three vertices, which is the center of the **circumscribed circle**, the circle through the three vertices and the smallest circle



$$\text{Area of a trapezoid: } A = \frac{(a + b)h}{2}$$

$$\text{Sum of angles in convex polygon: } S = (n - 2)180^\circ$$

**129. Circles**

A **circle** is a plane, closed curve, all points of which are equidistant from a point within, called the **center**. See Figure 129 depicting elements of a circle.

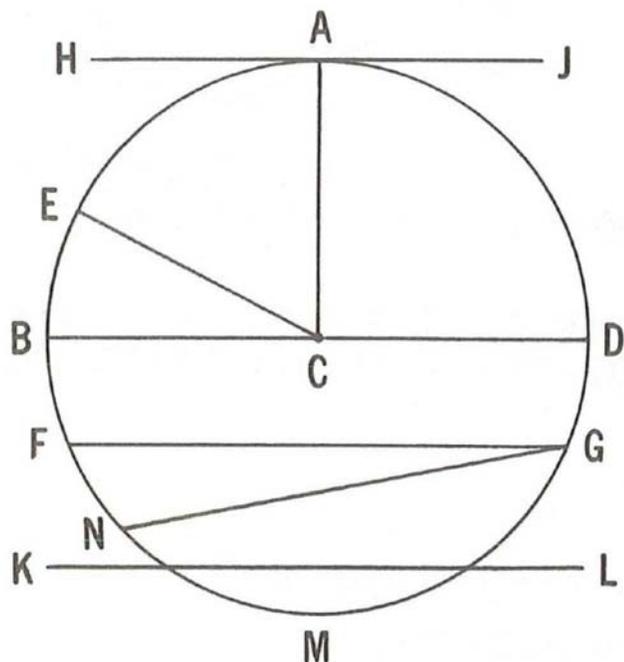


Figure 129. Elements of a circle.

The distance around a circle is called the **circumference**. Technically the length of this line is the **perimeter**, although the term “circumference” is often used. An arc is part of a circumference. A **major arc** is more than a semicircle ( $180^\circ$ ), a **minor arc** is less than a semicircle ( $180^\circ$ ). A **semi-circle** is half a circle ( $180^\circ$ ), a **quadrant** is a quarter of a circle ( $90^\circ$ ), a **quintant** is a fifth of a circle ( $72^\circ$ ), a **sextant** is a sixth of a circle ( $60^\circ$ ), an **octant** is an eighth of a circle ( $45^\circ$ ). Some of these names have been applied to instruments used by navigators for measuring altitudes of celestial bodies because of the part of a circle used for the length of the arc of the instrument.

**Concentric** circles have a common center. A **radius** (plural **radii**) or **semidiameter** is a straight line connecting the center of a circle with any point on its circumference. In Figure 129, CA, CB, CD, and CE are radii

A **diameter** of a circle is a straight line passing through its center and terminating at opposite sides of the circumference, or two radii in opposite directions (BCD, Figure 129). It divides a circle into two equal parts. The ratio of the length of the circumference of any circle to the length of its

diameter is 3.14159+, or  $\pi$  (the Greek letter pi), a relationship that has many useful applications.

A **sector** is that part of a circle bounded by two radii and an arc. In Figure 129, BCE, ECA, ACD, BCA, and ECD are sectors. The angle formed by two radii is called a **central angle**. Any pair of radii divides a circle into sectors, one less than a semicircle ( $180^\circ$ ) and the other greater than a semicircle (unless the two radii form a diameter).

A **chord** is a straight line connecting any two points on the circumference of a circle (FG, GN in Figure 129). Chords equidistant from the center of a circle are equal in length.

A **segment** is the part of a circle bounded by a chord and the intercepted arc (FGMF, NGMN in Figure 129). A chord divides a circle into two segments, one less than a semicircle ( $180^\circ$ ), and the other greater than a semicircle (unless the chord is a diameter). A diameter perpendicular to a chord bisects it, its arc, and its segments. Either pair of vertical angles formed by intersecting chords has a combined number of degrees equal to the sum of the number of degrees in the two arcs intercepted by the two angles.

An **inscribed angle** is one whose vertex is on the circumference of a circle and whose sides are chords (FGN in Figure 129). It has half as many degrees as the arc it intercepts. Hence, an angle inscribed in a semicircle is a right angle if its sides terminate at the ends of the diameter forming the semicircle.

A **secant** of a circle is a line intersecting the circle, or a chord extended beyond the circumference (KL in Figure 129).

A **tangent** to a circle is a straight line, in the plane of the circle, which has only one point in common with the circumference (HJ in Figure 129). A tangent is perpendicular to the radius at the **point of tangency** (A in Figure 129). Two tangents from a common point to opposite sides of a circle are equal in length, and a line from the point to the center of the circle bisects the angle formed by the two tangents. An angle formed outside a circle by the intersection of two tangents, a tangent and a secant, or two secants has *half* as many degrees as the *difference* between the two intercepted arcs. An angle formed by a tangent and a chord, with the apex at the point of tangency, has half as many degrees as the arc it intercepts. A **common tangent** is one tangent to more than one circle. Two circles are tangent to each other if they touch at one point only. If of different sizes, the smaller circle may be either inside or outside the larger one.

Parallel lines intersecting a circle intercept equal arcs.

If  $A$  = area;  $r$  = radius;  $d$  = diameter;  $C$  = circumference;  $s$  = linear length of an arc;  $a$  = angular length of an arc, or the angle it subtends at the center of a circle, in degrees;  $b$  = angular length of an arc, or the angle it subtends at the center of a circle, in radians;  $rad$  = radians and  $sin$  = sine:







If  $A$  = area,  $a$  = semimajor axis,  $b$  = semiminor axis,  $e$  = eccentricity, and  $V$  = volume of an oblate spheroid:

$$\text{Area: } A = 4\pi a^2 \left( 1 - \frac{e^2}{3} - \frac{e^4}{15} - \frac{e^6}{35} - \dots \right)$$

$$\text{Eccentricity: } e = \sqrt{\frac{a^2 - b^2}{a^2}}$$

$$\text{Volume: } V = \frac{4\pi a^2 b}{3}$$

### 135. Coordinates

**Coordinates** are magnitudes used to define a position. Many different types of coordinates are used. Important navigational ones are described below.

If a position is known to be at a stated point, no magnitudes are needed to identify the position, although they may be required to locate the point. Thus, if a vessel is at port  $A$ , its position is known if the location of port  $A$  is known, but latitude and longitude may be needed to locate port  $A$ .

If a position is known to be on a given line, a single magnitude (coordinate) is needed to identify the position if an origin is stated or understood. Thus, if a vessel is known to be *south* of port  $B$ , it is known to be on a line extending southward from port  $B$ . If its distance from port  $B$  is known, and the position of port  $B$  is known, the position of the vessel is uniquely defined.

If a position is known to be on a given surface, two magnitudes (coordinates) are needed to define the position. Thus, if a vessel is known to be on the surface of the earth, its position can be identified by means of latitude and longitude. Latitude indicates its angular distance north or south of the equator, and longitude its angular distance east or west of the prime meridian.

If nothing is known regarding a position other than that it exists in space, three magnitudes (coordinates) are needed to define its position. Thus, the position of a submarine may be defined by means of latitude, longitude, and depth below the surface.

Each coordinate requires an origin, either stated or implied. If a position is known to be on a given plane, it might be defined by means of its distance from each of two intersecting lines, called **axes**. These are called **rectangular coordinates**. In Figure 135a,  $OY$  is called the **ordinate**, and  $OX$  is called the **abscissa**. Point  $O$  is the **origin**, and lines  $OX$  and  $OY$  the axes (called the  $X$  and  $Y$  axes, respectively). Point  $A$  is at position  $x, y$ . If the axes are not perpendicular but the lines  $x$  and  $y$  are drawn parallel to the axes, **oblique coordinates** result. Either type are called **Cartesian coordinates**. A three-dimensional system of Cartesian coordinates, with  $X, Y,$  and  $Z$  axes, is called **space coordinates**.

Another system of plane coordinates in common usage consists of the *direction* and *distance* from the origin (called the **pole**), as shown in Figure 135b. A line extending

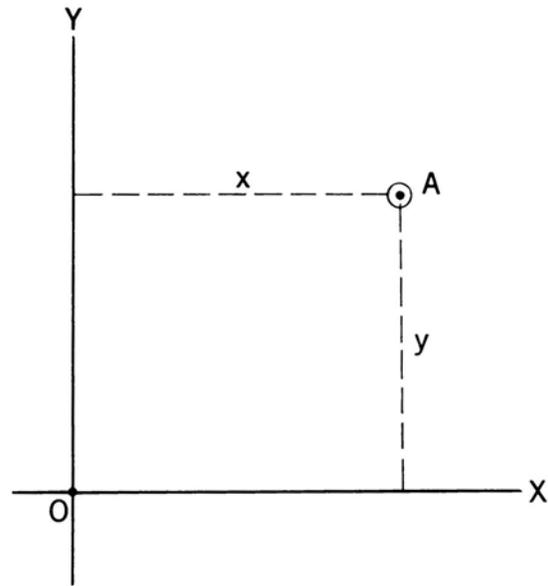


Figure 135a. Rectangular coordinates.

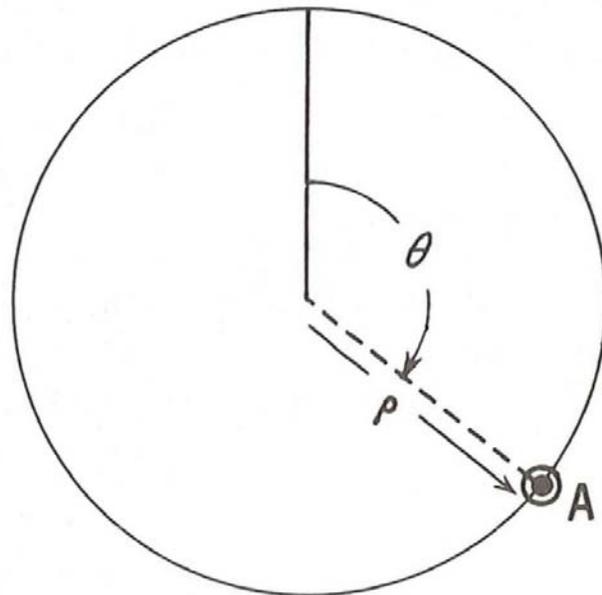


Figure 135b. Polar coordinates.

in the direction indicated is called a **radius vector**. Direction and distance from a fixed point constitute **polar coordinates**, sometimes called the rho- (the Greek  $\rho$ , to indicate distance) theta (the Greek  $\theta$ , to indicate direction) system. An example of its use is the radar scope.

**Spherical coordinates** are used to define a position on the surface of a sphere or spheroid by indicating angular distance from a primary great circle and a reference secondary great circle. Examples used in navigation are latitude and longitude, altitude and azimuth, and declination and hour angle.

## TRIGONOMETRY

### 136. Definitions

**Trigonometry** deals with the relations among the angles and sides of triangles. **Plane trigonometry** deals with plane triangles, those on a plane surface. **Spherical trigonometry** deals with spherical triangles, which are drawn on the surface of a sphere. In navigation, the common methods of celestial sight reduction use spherical triangles on the surface of the Earth. For most navigational purposes, the Earth is assumed to be a sphere, though it is somewhat flattened.

### 137. Angular Measure

A circle may be divided into 360 **degrees** ( $^{\circ}$ ), which is the **angular length** of its circumference. Each degree may be divided into 60 **minutes** ( $'$ ), and each minute into 60 **seconds** ( $''$ ). The angular measure of an arc is usually expressed in these units. By this system a right angle or quadrant has  $90^{\circ}$  and a straight angle or semicircle  $180^{\circ}$ . In marine navigation, altitudes, latitudes, and longitudes are usually expressed in degrees, minutes, and tenths ( $27^{\circ}14.4'$ ). Azimuths are usually expressed in degrees and tenths ( $164.7^{\circ}$ ). The system of degrees, minutes, and seconds indicated above is the **sexagesimal system**. In the **centesimal system**, used chiefly in France, the circle is divided into 400 **centesimal degrees** (sometimes called **grades**) each of which is divided into 100 centesimal minutes of 100 **centesimal seconds** each.

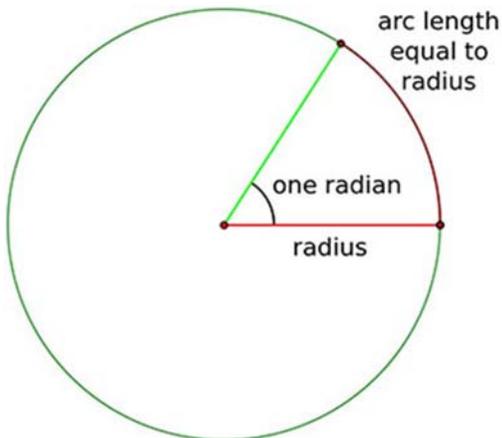


Figure 137. Image depicting one radian.

A **radian** is the angle subtended at the center of a circle by an arc having a linear length equal to the radius of the circle. A radian is equal to  $57.2957795131^{\circ}$  approximately, or  $57^{\circ}17'44.80625''$  approximately. The radian is sometimes used as a unit of angular measure. See Figure 137. A circle ( $360^{\circ}$ ) =  $2\pi$  radians, a semicircle ( $180^{\circ}$ ) =  $\pi$  radi-

ans, a right angle measure ( $90^{\circ}$ ) =  $\frac{\pi}{2}$  radians, and  $1' = 0.0002908882$  radians approximately. The length of the arc of a circle is equal to the radius multiplied by the angle subtended in radians.

### 138. Trigonometric Functions

**Trigonometric functions** are the various proportions or ratios of the sides of a plane right triangle, defined in relation to one of the acute angles. In Figure 138a, let  $\theta$  be any acute angle. From any point R on line OA, draw a line perpendicular to OB at F. From any other point R' on OA, draw a line perpendicular to OB at F'. Then triangles OFR and OF'R' are similar right triangles because all their corresponding *angles* are equal. Since in any pair of similar triangles the ratio of any two sides of one triangle is equal to the ratio of the corresponding two sides of the other triangle.

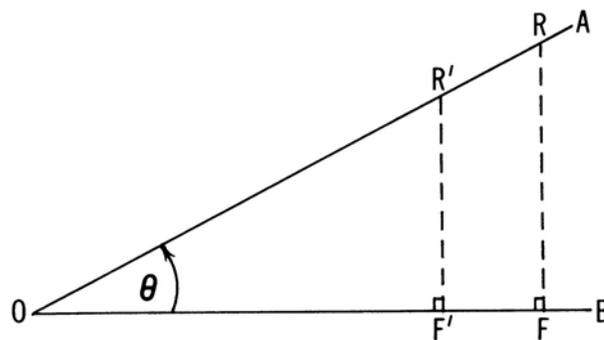


Figure 138a. Similar right triangles.

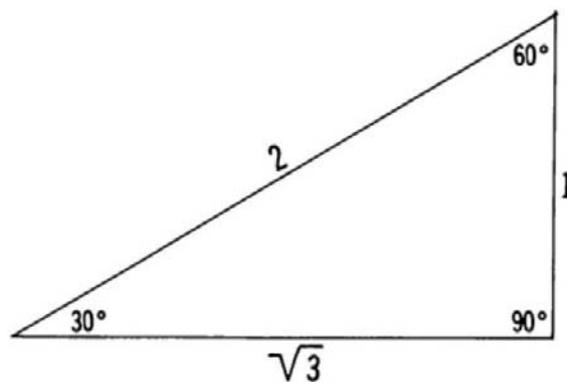


Figure 138b. Numerical relationship of sides of a  $30^{\circ}$ - $60^{\circ}$ - $90^{\circ}$  triangle.

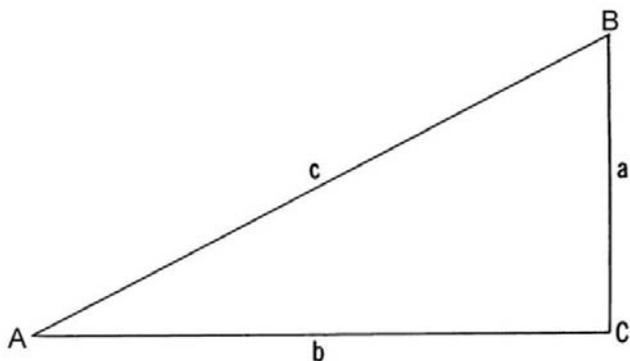


Figure 138c. A right triangle.

$$\frac{RF}{OF} = \frac{R'F'}{OF'}, \frac{RF}{OR} = \frac{R'F'}{OR'}, \text{ and } \frac{OF}{OR} = \frac{OF'}{OR'}$$

No matter where the point R is located on OA, the ratio between the lengths of any two sides in the triangle OFR has a constant value. Hence, for any value of the acute angle  $\theta$ , there is a fixed set of values for the ratios of the various sides of the triangle. These ratios are defined as follows:

$$\text{sine } \theta = \sin \theta = \frac{\text{side opposite}}{\text{hypotenuse}}$$

$$\text{cosine } \theta = \cos \theta = \frac{\text{side adjacent}}{\text{hypotenuse}}$$

$$\text{tangent } \theta = \tan \theta = \frac{\text{side opposite}}{\text{side adjacent}}$$

$$\text{cosecant } \theta = \csc \theta = \frac{\text{hypotenuse}}{\text{side opposite}}$$

$$\text{secant } \theta = \sec \theta = \frac{\text{hypotenuse}}{\text{side adjacent}}$$

$$\text{cotangent } \theta = \cot \theta = \frac{\text{side adjacent}}{\text{side opposite}}$$

Of these six principal functions, the second three are the reciprocals of the first three; therefore

$$\sin \theta = \frac{1}{\csc \theta} \qquad \csc \theta = \frac{1}{\sin \theta}$$

$$\cos \theta = \frac{1}{\sec \theta} \qquad \sec \theta = \frac{1}{\cos \theta}$$

$$\tan \theta = \frac{1}{\cot \theta} \qquad \cot \theta = \frac{1}{\tan \theta}$$

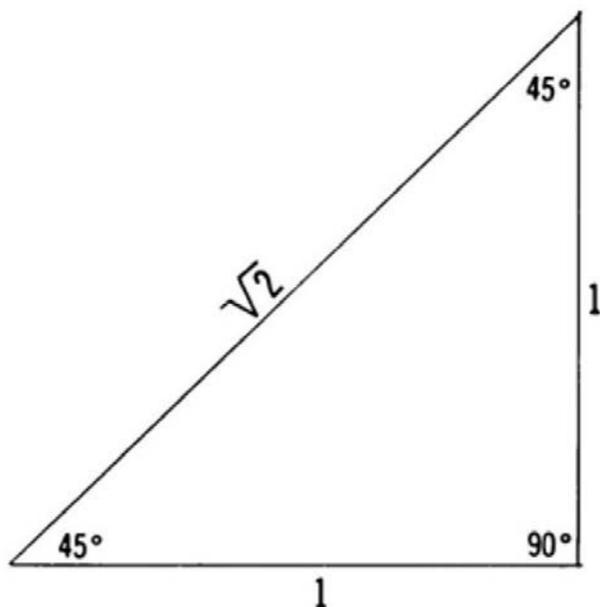


Figure 138d. Numerical relationship of sides of a  $45^\circ - 45^\circ - 90^\circ$  triangle.

In Figure 138c,  $A$ ,  $B$ , and  $C$  are the angles of a plane right triangle, with the right angle at  $C$ . The sides are labeled  $a$ ,  $b$ ,  $c$ , with opposite angles labeled  $A$ ,  $B$ , and  $C$  respectively.

The six principal trigonometric functions of angle  $B$  are:

$$\sin B = \frac{b}{c} = \cos A = \cos(90^\circ - B)$$

$$\cos B = \frac{a}{c} = \sin A = \sin(90^\circ - B)$$

$$\tan B = \frac{b}{a} = \cot A = \cot(90^\circ - B)$$

$$\cot B = \frac{a}{b} = \tan A = \tan(90^\circ - B)$$

$$\sec B = \frac{c}{a} = \csc A = \csc(90^\circ - B)$$

$$\csc B = \frac{c}{b} = \sec A = \sec(90^\circ - B)$$





$$\cot\theta = \frac{+x}{+y}$$

$$\cot(180^\circ - \theta) = \frac{-x}{+y} = -\cot\theta$$

$$\cot(180^\circ + \theta) = \frac{-x}{-y} = \cot\theta$$

$$\cot(360^\circ - \theta) = \frac{+x}{-y} = \cot(-\theta) = -\cot\theta.$$

The signs of the functions in the four different quadrants are shown below in Table 139b.

|                       | I | II | III | IV |
|-----------------------|---|----|-----|----|
| sine and cosecant     | + | +  | -   | -  |
| cosine and secant     | + | -  | -   | +  |
| tangent and cotangent | + | -  | +   | -  |

Table 139b. Signs of trigonometric functions by quadrants.

These relationships are shown in Table 139c and graphically in Figure 139d through Figure 139g.

|     | I               | II              | III             | IV              |
|-----|-----------------|-----------------|-----------------|-----------------|
| sin | 0 to +1         | +1 to 0         | 0 to -1         | -1 to 0         |
| csc | $+\infty$ to +1 | +1 to 0         | $-\infty$ to -1 | -1 to $-\infty$ |
| cos | +1 to 0         | 0 to -1         | -1 to 0         | 0 to +1         |
| sec | +1 to $+\infty$ | $-\infty$ to -1 | -1 to $-\infty$ | $+\infty$ to +1 |
| tan | 0 to $+\infty$  | $-\infty$ to 0  | 0 to $+\infty$  | $-\infty$ to 0  |
| cot | $+\infty$ to 0  | 0 to $-\infty$  | $+\infty$ to 0  | 0 to $-\infty$  |

Table 139c. Values of trigonometric functions in various quadrants.

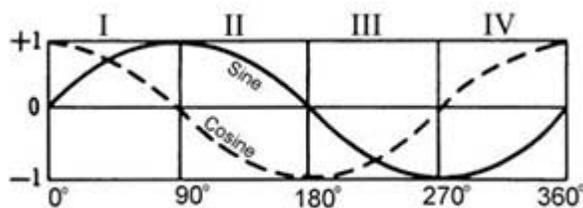


Figure 139d. Sine and cosine functions in various quadrants.

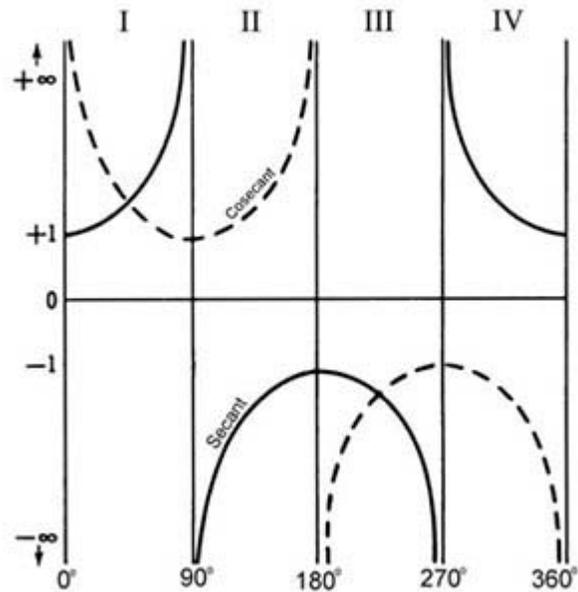


Figure 139e. Secant and cosecant functions in various quadrants.

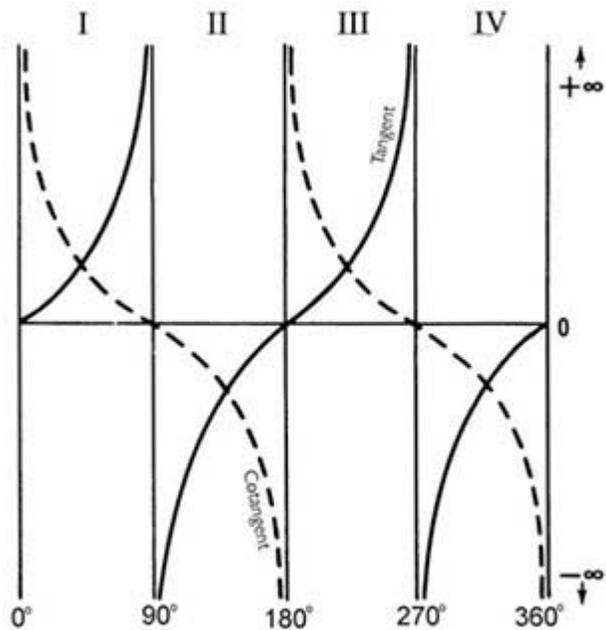


Figure 139f. Tangent and cotangent functions in various quadrants.

The numerical values vary by quadrant as shown above.

As shown in Figure 139a and Table 139b, the sign (+ or -) of the functions varies with the quadrant of an angle. In Figure 139a radius OR is imagined to rotate in a counter-





| Known     | To find | Formula                       | Comments                |
|-----------|---------|-------------------------------|-------------------------|
|           | $B$     | $B = 180^\circ - (A + C)$     | $A + B + C = 180^\circ$ |
|           | $c$     | $c = \frac{a \sin C}{\sin A}$ | Sine law                |
| $a, A, B$ | $b$     | $b = \frac{a \sin B}{\sin A}$ | Sine law                |
|           | $C$     | $C = 180^\circ - (A + B)$     | $A + B + C = 180^\circ$ |
|           | $c$     | $c = \frac{a \sin C}{\sin A}$ | Sine law                |

Table 144. Formulas for solving oblique plane triangles.

Law of sines:  $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Law of cosines:  $a^2 = b^2 + c^2 - 2bc \cos A.$

The unknown parts of oblique plane triangles can be computed by the formulas in Table 144, among others. By reassignment of letters to sides and angles, these formulas can be used to solve for all unknown parts of oblique plane triangles.

### SPHERICAL TRIGONOMETRY

#### 145. Napier's Rules

**Right spherical triangles** can be solved with the aid of **Napier's Rules of Circular Parts**. If the right angle is omitted, the triangle has five parts: two angles and three sides, as shown in Figure 145a. Since the right angle is already known, the triangle can be solved if any two other parts are known. If the two sides forming the right angle, and the *complements* of the other three parts are used, these elements (called "parts" in the rules) can be arranged in five sectors of a circle in the same order in which they occur in the triangle, as shown in Figure 145b. Considering any part as the middle part, the two parts nearest it in the diagram are considered the adjacent parts, and the two farthest from it the opposite parts.

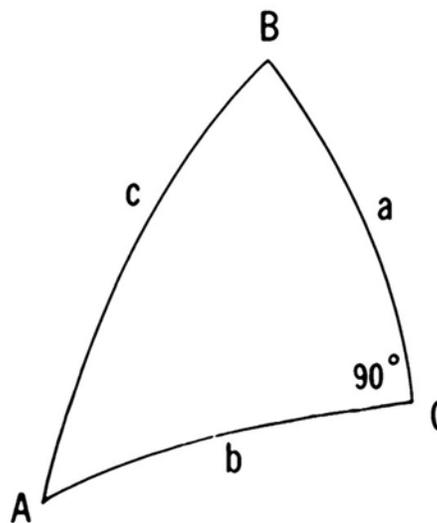


Figure 145a. Parts of a right spherical triangle as used in Napier's rules.

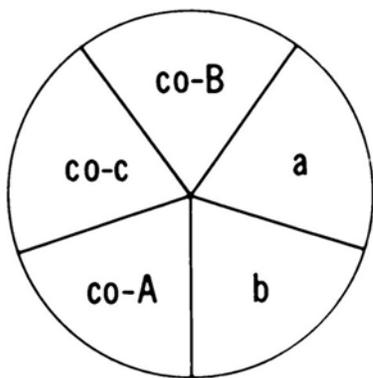


Figure 145b. Diagram for Napier's Rules of Circular Parts.

The following rules apply:

Napier's Rules state: The sine of a middle part equals the product of (1) the tangents of the adjacent parts or (2) the cosines of the opposite parts.

In the use of these rules, the co-function of a complement can be given as the function of the element. Thus, the cosine of co-A is the same as the sine of A. From these rules

the following formulas can be derived:

$$\begin{aligned} \sin a &= \tan b \cot B = \sin c \sin A \\ \sin b &= \tan a \cot A = \sin c \sin B \\ \cos c &= \cot A \cot B = \cos a \cos b \\ \cos A &= \tan b \cot c = \cos a \sin B \\ \cos B &= \tan a \cot c = \cos b \sin A \end{aligned}$$

1. An oblique angle and the side opposite are in the same quadrant.

2. Side  $c$  (the hypotenuse) is less than  $90^\circ$  when  $a$  and  $b$  are in the same quadrant, and more than  $90^\circ$  when  $a$  and  $b$  are in different quadrants.

If the known parts are an angle and its opposite side, two solutions are possible.

A **quadrantal spherical triangle** is one having one side of  $90^\circ$ . A **biquadrantal spherical triangle** has two sides of  $90^\circ$ . A **triquadrantal spherical triangle** has three sides of  $90^\circ$ . A biquadrantal spherical triangle is isosceles and has two right angles opposite the  $90^\circ$  sides. A triquadrantal spherical triangle is equilateral, has three right

angles, and bounds an octant (one-eighth) of the surface of the sphere. A quadrantal spherical triangle can be solved by Napier's rules provided any two elements in addition to the  $90^\circ$  side are known. The  $90^\circ$  side is omitted and the other parts are arranged in order in a five-sectored circle, using the complements of the three parts farthest from the  $90^\circ$  side. In the case of a quadrantal triangle, rule 1 above is used, and rule 2 restated: angle  $C$  (the angle opposite the side of  $90^\circ$ ) is *more* than  $90^\circ$  when  $A$  and  $B$  are in the same quadrant, and *less* than  $90^\circ$  when  $A$  and  $B$  are in different quadrants. If the rule requires an angle of more than  $90^\circ$  and the solution produces an angle of less than  $90^\circ$ , subtract the solved angle from  $180^\circ$ .

**146. Oblique Spherical Triangles**

An **oblique spherical triangle** can be solved by dropping a perpendicular from one of the apexes to the opposite side, subtended if necessary, to form two right spherical triangles. It can also be solved by the following formulas in Table 146, reassigning the letters as necessary.

| Known     | To find | Formula   | Comments                                  |
|-----------|---------|---|---|
| $a, b, C$ | A       | $\tan A = \frac{\sin D \tan C}{\sin (b - D)}$   | $\tan D = \tan a \cos C$                  |
|           | B       | $\sin B = \frac{\sin C \sin b}{\sin c}$         |   |
| $c, A, B$ | C       | $\cos C = \sin A \sin B \cos c - \cos A \cos B$ |   |
|           | $a$     | $\tan a = \frac{\tan c \sin E}{\sin (B + E)}$   | $\tan E = \tan A \cos c$                  |
|           | $b$     | $\tan b = \frac{\tan c \sin F}{\sin (A + F)}$   | $\tan F = \tan B \cos c$                  |
| $a, b, A$ | $c$     | $\sin(c + G) = \frac{\cos a \sin G}{\cos b}$    | $\cot G = \cos A \tan b$<br>Two solutions |
|           | B       | $\sin B = \frac{\sin A \sin b}{\sin a}$         | Two solutions                             |
|           | C       | $\sin(C + H) = \sin H \tan b \cot a$            | $\tan H = \tan A \cos b$<br>Two solutions |
| $a, A, B$ | C       | $\sin(C - K) = \frac{\cos A \sin K}{\cos B}$    | $\cot K = \tan B \cos a$<br>Two solutions |

Table 146. Formulas for solving oblique spherical triangles.

| <i>Known</i> | <i>To find</i> | <i>Formula</i>                          | <i>Comments</i>                           |
|--------------|----------------|---|---|
|              | <i>b</i>       | $\sin b = \frac{\sin a \sin B}{\sin A}$ | Two solutions                             |
|              | <i>c</i>       | $\sin(c - M) = \cot A \tan B \sin M$    | $\tan M = \cos B \tan a$<br>Two solutions |

Table 146. Formulas for solving oblique spherical triangles.

### 147. Other Useful Formulas

In addition to the fundamental trigonometric identities and reduction formulas given in Section 139, the following formulas apply to plane and spherical trigonometry:

#### Addition and Subtraction Formulas

$$\sin(\theta + \phi) = \sin\theta \cos\phi + \cos\theta \sin\phi$$

$$\cos(\theta + \phi) = \cos\theta \cos\phi - \sin\theta \sin\phi$$

$$\sin(\theta - \phi) = \sin\theta \cos\phi - \cos\theta \sin\phi$$

$$\cos(\theta - \phi) = \cos\theta \cos\phi + \sin\theta \sin\phi$$

$$\tan(\theta + \phi) = \frac{\tan\theta + \tan\phi}{1 - \tan\theta \tan\phi}.$$

#### Double-Angle Formulas

$$\sin 2\theta = 2 \sin\theta \cos\theta$$

$$\cos 2\theta = \cos^2\theta - \sin^2\theta$$

$$\tan 2\theta = \frac{2 \tan\theta}{1 - \tan^2\theta}.$$

#### Half-Angle Formulas

$$\sin \frac{\theta}{2} = \pm \sqrt{\frac{1 - \cos\theta}{2}}$$

$$\cos \frac{\theta}{2} = \pm \sqrt{\frac{1 + \cos\theta}{2}}$$

$$\tan \frac{\theta}{2} = \pm \sqrt{\frac{1 - \cos\theta}{1 + \cos\theta}}.$$

The following are useful formulas of spherical trigonometry:

#### Law of Cosines for Sides

$$\cos a = \cos b \cos c + \sin b \sin c \cos A$$

$$\cos b = \cos c \cos a + \sin c \sin a \cos B$$

$$\cos c = \cos a \cos b + \sin a \sin b \cos C$$

#### Law of Cosines for Angles

$$\cos A = -\cos B \cos C + \sin B \sin C \cos a$$

$$\cos B = -\cos C \cos A + \sin C \sin A \cos b$$

$$\cos C = -\cos A \cos B + \sin A \sin B \cos c.$$

#### Law of Sines

$$\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}.$$

#### Napier's Analogies

$$\tan \frac{1}{2}(A + B) = \frac{\cos \frac{1}{2}(a - b)}{\cos \frac{1}{2}(a + b)} \cot \frac{1}{2}C$$

$$\tan \frac{1}{2}(A - B) = \frac{\sin \frac{1}{2}(a - b)}{\sin \frac{1}{2}(a + b)} \cot \frac{1}{2}C$$

$$\tan \frac{1}{2}(a + b) = \frac{\cos \frac{1}{2}(A - B)}{\cos \frac{1}{2}(A + B)} \tan \frac{1}{2}c$$

$$\tan \frac{1}{2}(a - b) = \frac{\sin \frac{1}{2}(A - B)}{\sin \frac{1}{2}(A + B)} \tan \frac{1}{2}c.$$





number of vertical strips, each  $\Delta x$  wide, and if  $y$  is the height of each strip at the midpoint of  $\Delta x$ , the area of each strip is approximately  $y\Delta x$ ; and the approximate total area of all strips is the sum of the areas of the individual strips. This may be written  $\sum_{x_1}^{x_2} y\Delta x$ , meaning the sum of all  $y \Delta x$  values between  $x_1$  and  $x_2$ . The symbol  $\Sigma$  is the Greek letter *sigma*, the equivalent of the English *S*. If  $\Delta x$  is made progressively smaller, the sum of the small areas becomes ever closer to the true total area. If  $\Delta x$  becomes infinitely small, the summation expression is written  $\int_{x_1}^{x_2} ydx$ , the symbol  $dx$  denoting an infinitely small  $\Delta x$ . The symbol  $\int$ , called the "integral sign," is a distorted *S*.

An expression such as  $\int_{x_1}^{x_2} ydx$  is called a **definite integral** because limits are specified ( $x_1$  and  $x_2$ ). If limits are not specified, as in  $\int ydx$ , the expression is called an **indefinite integral**.

A navigational application of integration is the finding of meridional parts, Table 6. The *rate* of change of meridional parts with respect to latitude changes progressively. The formula given in the explanation of the table is the equivalent of an integral representing the sum of the meridional parts from the equator to any given latitude.

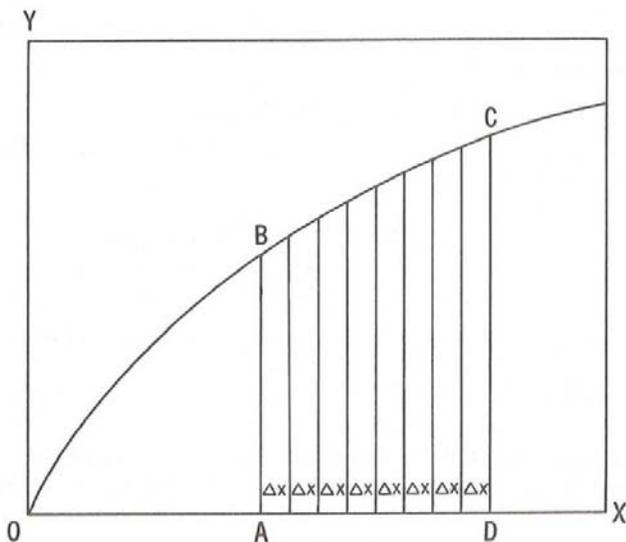


Figure 151. Integration.

**152. Differential Equations**

An expression such as  $dy$  or  $dx$  is called a **differential**. An equation involving a differential or a derivative is called a **differential equation**.

As shown in Section 150, if  $y = x^2$ ,  $\frac{dy}{dx} = 2x$ . Neither  $dy$  nor  $dx$  is a finite quantity, but both are limits to which  $\Delta y$  and  $\Delta x$  approach as they are made progressively smaller. Therefore  $\frac{dy}{dx}$  is merely a ratio, the limiting value of  $\frac{\Delta y}{\Delta x}$ , and not one finite number divided by another. However, since the ratio is the same as would be obtained by using finite quantities, it is possible to use the two differentials  $dy$  and  $dx$  independently in certain relationships. Differential equations involve such relationships.

Other examples of differential equations are:

$$d \sin x = \cos x \, dx \quad d \csc x = - \cot x \csc x \, dx$$

$$d \cos x = - \sin x \, dx \quad d \sec x = \tan x \sec x \, dx$$

$$d \tan x = \sec^2 x \, dx \quad d \cot x = - \csc^2 x \, dx.$$

Some differential equations indicating the variations in the astronomical triangle are:

$$dh = - \cos L \sin Z \, dt; L \text{ and } d \text{ constant}$$

$$dh = \cos Z \, dL; d \text{ and } t \text{ constant}$$

$$dh = - \cos h \tan M \, dZ; L \text{ and } d \text{ constant}$$

$$dZ = - \sec L \cot t \, dL; d \text{ and } h \text{ constant}$$

$$dZ = \tan h \sin Z \, dL; d \text{ and } t \text{ constant}$$

$$dt = - \sec L \cot Z \, dL; d \text{ and } h \text{ constant}$$

$$dZ = \cos d \sec h \cos M \, dt; L \text{ and } d \text{ constant}$$

$$dd = \cos d \tan M \, dt; L \text{ and } h \text{ constant}$$

$$dd = \cos L \sin t \, dZ; L \text{ and } h \text{ constant,}$$

where  $h$  is the altitude,  $L$  is the latitude,  $Z$  is the azimuth angle,  $d$  is the declination,  $t$  is the meridian angle, and  $M$  is the parallactic angle.

# CHAPTER 2

## INTERPOLATION

### FINDING THE VALUE BETWEEN TABULATED ENTRIES

#### 200. Introduction

When one quantity varies with changing values of a second quantity, and the mathematical relationship of the two is known, a curve can be drawn to represent the values of one corresponding to various values of the other. To find the value of either quantity corresponding to a given value of the other, one finds that point, on the curve defined by the given value, and reads the answer on the scale relating to the other quantity. This assumes, of course, that for each value of one quantity, there is only one value of the other quantity.

Information of this kind can also be tabulated. Each entry represents one point on the curve. The finding of value *between* tabulated entries is called **interpolation**. The extending of tabulated values to find values *beyond* the limits of the table is called **extrapolation**.

Thus, the *Nautical Almanac* tabulates values of declination of the sun for each hour of Coordinated Universal Time (UTC) or Universal Time (UT). The finding of declination for a time between two whole hours requires interpolation. Since there is only one entering **argument** (in this case UT), **single interpolation** is involved.

Table 11 gives the distance traveled in various times at certain speeds. In this table there are two entering arguments. If both given values are between tabulated values, **double interpolation** is needed.

In *Pub. No. 229*, azimuth angle varies with a change in any of the three variables: latitude, declination, and local hour angle. With intermediate values of all three, **triple interpolation** is needed.

Interpolation can sometimes be avoided. A table having a single entering argument can be arranged as a **critical table**. An example is the dip (height of eye) correction on the inside front cover of the *Nautical Almanac*. Interpolation is avoided through dividing the argument into intervals so chosen that successive intervals correspond to successive values of the required quantity, the respondent. For any value of the argument within these intervals, the respondent can be extracted from the table without interpolation. The lower and upper limits (critical values) of the argument correspond to half-way values of the respondent and, by convention, are chosen so that when the argument is equal to one of the critical values, the respondent corresponding to the preceding (upper) interval is to be used. Another way of avoiding interpolation would be to include every possi-

ble entering argument. If this were done for *Pub. No. 229*, interpolation being eliminated for declination only, and assuming declination values to 0'.1, the number of volumes would be increased from six to more than 3,600. If interpolation for meridian angle and latitude, to 0'.1, were also to be avoided, a total of more than 1,296,000,000 volumes would be needed. A more practical method is to select an assumed position to avoid the need for interpolation for two of the variables.

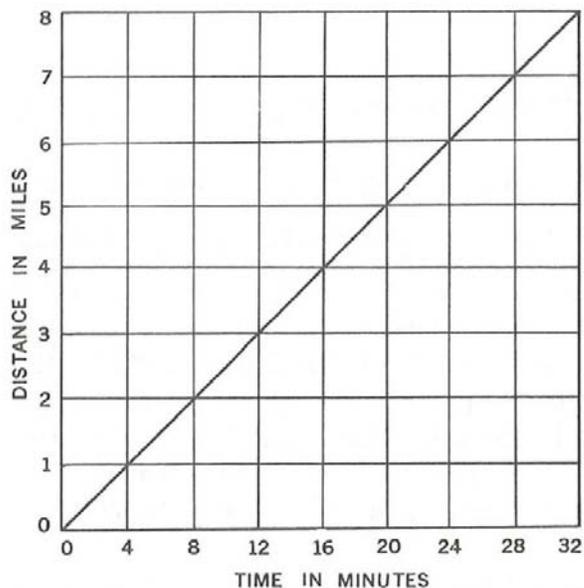


Figure 201a. Plot of  $D = t / 4$ .

#### 201. Single Interpolation

The accurate determination of intermediate values requires knowledge of the nature of the change between tabulated values. The simplest relationship is linear, the change in the tabulated value being directly proportional to the change in the entering argument. Thus, if a vessel is proceeding at 15 knots, the distance traveled is directly proportional to the time, as shown in Figure 201a. The same information might be given in tabular form, as shown in table 201b. Mathematically, this relationship for 15 knots is written  $D = \frac{15t}{60} = \frac{t}{4}$ , where D is distance in

















# CHAPTER 3

## NAVIGATIONAL ERRORS

### DEFINING NAVIGATIONAL ERRORS

#### 300. Introduction

As commonly practiced, navigation is not an exact science. A number of approximations which would be unacceptable in careful scientific work are used by the navigator, because greater accuracy may not be consistent with the requirements or time available, or because there is no alternative.

Thus, when the navigator uses his latitude graduations as a mile scale or computes a great-circle course and distance, s/he neglects the flattening of the earth at the poles, a practice that is not acceptable to the geodetic surveyor. When the navigator plots a visual bearing or an azimuth line for a celestial line of position, s/he uses a rhumb line to represent a great circle on a Mercator chart. When s/he plots the celestial line of position, s/he substitutes a rhumb line for a small circle. When the navigator interpolates in sight reduction or lattice tables, s/he assumes a linear (constant-rate) change between tabulated values. When s/he measures distance by radar or depth by echo sounder, s/he assumes that the radio- or sound-wave has constant speed under all conditions. When the navigator applies dip and refraction corrections to his or her sextant altitude, s/he generally assumes standard atmospheric conditions. These are only a few of the approximations commonly applied by a navigator.

There are so many that there is a natural tendency for some of them to cancel others. Thus, under favorable conditions, a position at sea determined from celestial observation by an experienced observer should seldom be in error by more than 2 miles. However, if the various small errors in a particular observation all have the same sign (all plus or all minus), the error might be several times this amount without any mistake having been made by the navigator.

Greater accuracy could be attained, but at a price. The navigator is a practical individual. In the course of ordinary navigation, s/he would rather spend 10 minutes determining a position having a probable error of plus or minus 2 miles, than to spend several hours learning where s/he was to an accuracy of a few meters. But if the navigator can determine a recent or present position to greater accuracy, the decrease in error is attractive. The various navigational aids have been designed with this in mind. Greater accuracy in plotting could be achieved by increasing the scale of the chart or plotting sheet. This has

been done for confined waters where a higher degree of accuracy is needed, but a large scale plotting sheet would be a nuisance at sea. The hand-held marine sextant is not sufficiently accurate for use in determining an astronomical position in a geodetic survey. But, it is much more satisfactory at sea than the surveyor's astrolabe or theodolite, which require stable platforms if their potential accuracy is to be realized.

An understanding of the kinds of errors involved in navigation, and of the elementary principles of probability, should be of assistance to a navigator in interpreting his or her results.

#### 301. Definitions

The following definitions apply to the discussions of this chapter:

**Error** is the difference between a specific value and the correct or standard value. As used here it does not include mistakes, but is related to lack of perfection. Thus, an altitude determined by marine sextant is corrected for a standard amount of refraction, but if the actual refraction at the time of observation varies from the standard, the value taken from the table is in error by the difference between standard and actual refraction. This error will be compounded with others in the observed altitude. Similarly, depth determined by echo sounder is in error, among other things, by the difference between the actual speed of sound waves in the water and the speed used for calibration of the instrument. The depth will also be in error if an echo is returned from a phantom bottom instead of from the actual bottom. This chapter is concerned primarily with the deviation from standards. Thus, while variation of the compass is an error when referred to true directions, the difference between the assumed variation and that actually existing is an error with reference to magnetic direction. Corrections can be applied for standard values of error. It is the deviation from standard, as well as mistakes, that produce inaccurate results in navigation. Various kinds of errors are discussed in the following articles.

**Mistake** is a blunder, such as an incorrect reading of an instrument, the taking of a wrong value from a table, or the plotting of a reciprocal bearing. The mistake is discussed in more detail in Section 312.

**Standard** is something established by custom, agreement, or authority as a basis for comparison. It is customary to use nautical miles for measuring distances



spects, this error is similar to coastal refraction of a radio wave.

Additional examples of systematic error are uncorrected deviation of the compass, error due to a position in a pattern of hyperbolas, error due to incorrect location of a Loran transmitter, uncorrected parallax, and uncorrected personal error.

**303. Random Errors**

Random errors are chance errors, unpredictable in magnitude or sign. They are governed by the laws of probability. If the altitude of a celestial body is observed, the reading may be (1) too great, (2) correct, or (3) too small. If a number of observations are made, and there is no systematic error, the probability of a positive error is exactly equal to the probability of a negative error. This does not mean that every second observation having an error will be too great. However, the greater the number of observations, the greater is the probability that the percentage of positive errors will equal the percentage of negative ones, and that their magnitudes will correspond.

| Error | No. of obs. | Percent of obs. |
|-------|-------------|-----------------|
| - 10' | 0           | 0.0             |
| - 9'  | 1           | 0.2             |
| - 8'  | 2           | 0.4             |
| - 7'  | 4           | 0.8             |
| - 6'  | 9           | 1.8             |
| - 5'  | 17          | 3.4             |
| - 4'  | 28          | 5.6             |
| - 3'  | 40          | 8.0             |
| - 2'  | 53          | 10.6            |
| - 1'  | 63          | 12.6            |
| 0     | 66          | 13.2            |
| + 1'  | 63          | 12.6            |
| + 2'  | 53          | 10.6            |
| + 3'  | 40          | 8.0             |
| + 4'  | 28          | 5.6             |
| + 5'  | 17          | 3.4             |
| + 6'  | 9           | 1.8             |
| + 7'  | 4           | 0.8             |
| + 8'  | 2           | 0.4             |
| + 9'  | 1           | 0.2             |
| +10'  | 0           | 0.0             |
| 0     | 500         | 100.0           |

Table 303. Normal distribution of random errors.

Suppose that 500 observations are made, with the results shown in Table 303. A close approximation of the plot of these errors is shown in Figure 303a. The plot has been modified slightly to constitute the normal curve of random errors, which is the same as the actual curve except that the normal curve approaches zero as the error increases, while the actual curve reaches zero at (+)10' and (-)10'. The height

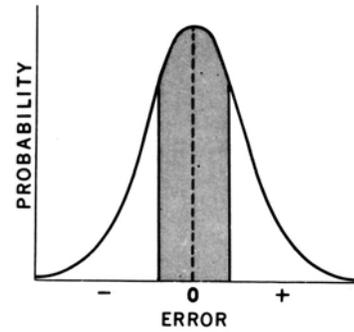


Figure 303a. Normal curve of random error with 50 percent of area shaded. Limits of shaded area indicate probable error.

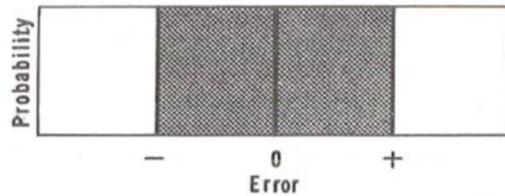


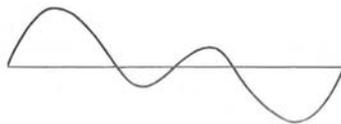
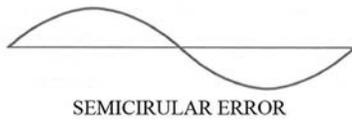
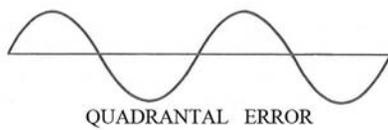
Figure 303b. Rectangular error, with 50 percent area shaded.

of the curve at any point represents the percentage of observations that can be expected to have the error indicated at that point. The probability of any similar observation having any given error is the proportion of the number of observations having this error to the total number of observations, or the percentage expressed as a decimal. Thus, the probability of an observation having an error of -3' is

$$\frac{40}{500} = \frac{1}{12.5} = 0.08(8\%)$$

If the area under the curve represents 100 percent of the observations, half the area (the shaded portion of Figure 303c) represents 50 percent of the observations. The value of the error at the limits of this shaded portion is often called the "50 percent error," or **probable error**, meaning that 50 percent of the observations can be expected to have less error, and 50 percent greater error. Similarly, the limits which contain the central 95 percent of the area denote the 95 percent error. The percentage of error is found mathematically. For a normal curve, each error is squared, the sum of the squares is divided by one less than the number of observations, and the square root of the quotient is determined. This value is called the **standard deviation** or **standard error** ( $\sigma$ , the Greek letter sigma). In the illustration, the standard deviation is the square root of:





COMBINED QUADRANTAL ERROR AND SEMICIRCULAR ERROR

Figure 304. Combining systemic error.

individual errors. Thus, a magnetic compass may have a quadrantal error as shown by the top curve of Figure 304, and a semicircular error as shown by the second curve. The sum of these two errors is shown in the bottom curve. If, in addition, the compass has a constant error, the bottom curve is moved vertically upward or downward by the amount of the constant error, without undergoing a change of form. If the constant error is greater than the maximum value of the combined curves, all errors are positive or all are negative, but of varying magnitude.

If a number of random errors are combined, the result tends to follow a normal curve regardless of the shape of the individual errors, and the greater the number, the more nearly the result can be expected to approach the normal curve (Figure 303a). If a given result is subject to errors of plus or minus 3, 2, 1, 2, 4, 2, 1, 8, 1, and 2, the total error could be as much as 26 if all errors had the same sign. However, if these are truly random, the probability of them all having the same sign is only 1 in 1024. This is so because the chance of any one being positive (or negative) is one half. By the same reasoning, approximately half of the positive (or negative) results will have any one particular additional correction positive (or negative). Thus, the probability of any two particular corrections having a positive (or negative) sign is  $1/2 \times 1/2 = (1/2)^2 = \frac{1}{4}$ . The probability of all 10 corrections having a positive (or negative) sign is  $(1/2)^{10} = \frac{1}{1024}$ . If there were 20 corrections, the probability of all having a positive (or negative) sign would be  $(1/2)^{20} = \frac{1}{1048576}$ .

When both systematic and random errors are present in a process, both effects are present. An increase in the number of readings decreases the residual random error, but

regardless of the number of readings, a systematic error is present in its entirety. Thus, if a number of phase-difference readings are made at a fixed point, the average should be a good approximation of the true value if there is no systematic error. But if the equipment is out of adjustment to the extent that the lane is incorrectly identified, no number of readings will correct this error. In this illustration, a constant error is combined with a normal random error. The normal curve has the correct shape, but is offset from the zero value.

Under some conditions, systematic errors can be eliminated from the results even when the magnitude is not determined. Thus, if two celestial bodies differ in azimuth by  $180^\circ$ , and the altitude of each is observed, the line midway between the lines of position resulting from these observations is free from any *constant* error in the *altitude* (such as abnormal refraction or dip, or incorrect IC). It would *not* be free from such a constant error as one in time (unless the bodies were on the celestial meridian). Similarly, a fix obtained by observations of three stars differing in azimuth by  $120^\circ$ , or four stars differing by  $90^\circ$  is free from constant error in the altitude, if the center of the figure made by the lines of position is used. The center of the figure formed by circles of position from distances of objects equally spaced in azimuth is free from a constant error in range. A constant error in bearing lines does not introduce an error in the fix if the objects are equally spaced in azimuth. In all of these examples, the correct position is *outside* the figure formed by the lines of position if all objects observed are on the same side of the observer (that is, if they lie within an arc of less than  $180^\circ$ ).

### 305. Navigation Accuracy

**Navigation accuracy** is normally expressed in terms of the probability of being within a specified distance of a desired point during the navigation process.

If the accuracy of only a single line of position is being considered, the specified distance may be stated as the standard deviation (Section 303) or some multiple thereof, assuming that the errors of the line of position follow a **single-axis normal distribution**. The distance as stated for the standard deviation of a line of position is measured from the arithmetic mean of the positions which could be established from a large number of observations at a given place and time. Therefore, this distance does not indicate the separation between the line of position and the observer's actual position, except by chance. If the error is stated as  $1 \sigma$ , 68.27 percent of the cases should result in line of position displacements from the arithmetic mean in any direction not exceeding the distance specified for  $1 \sigma$ . If the error is stated as  $2 \sigma$ , 95.45 percent of the lines of position should not be displaced from the arithmetic mean in any direction by more than the distance specified for  $2 \sigma$ . If the error is stated as the probable error, 50 percent of the lines

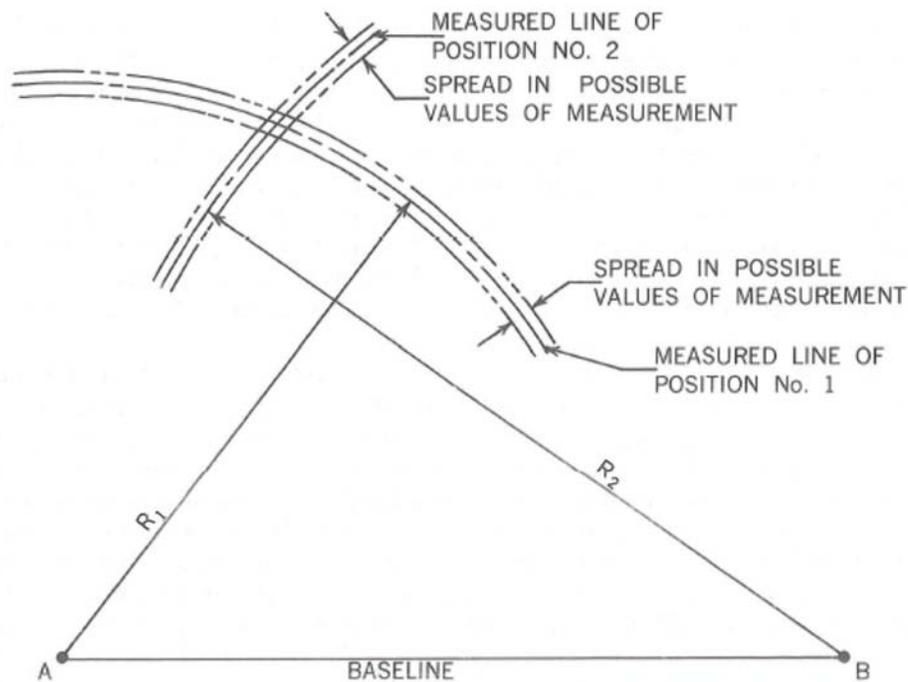


Figure 305a. Fix established at intersection of two lines of position having different values of error.

of position should not be displaced from the arithmetic mean in any direction by more than the distance specified for  $0.6745\sigma$ .

The standard deviation is also employed in developing expressions for the probability of a fix position being within a specified distance of the mean of the positions which could be established from a large number of observations at a given place and time by means of the system used to establish the fix.

In the following discussion, the fix is established by the intersection of two lines of position, each of which may be in error. The lines of position (Figure 305a) are range measurements from two points at the extremities of a baseline of known length. Because of inaccuracies in measurement, the actual ranges differ from the measured values and may lie somewhere between the limits which are shown as additional arcs either side of the measured arc.

The intersection of the two lines of position together with the standard deviations associated with each is drawn to an expanded scale in Figure 305b. It can be shown that the *contours of equal probability density* about such an intersection are ellipses with their center at the intersection. Thus, the ellipse shown in Figure 305b might be the 75 percent probability ellipse, meaning that there are three chances in four that a fix will lie within such ellipse centered upon the mean of the positions which would be established from a large number of observations at a given place and time by means of the system used to establish the fix.

For simplicity in this discussion of navigation accuracy, the following assumptions are made:

1. All constant errors or **bias errors** have been removed, leaving only the random errors. Thus, the mean or average error is assumed to be zero.
2. These random errors are assumed to be normally distributed.
3. The errors associated with the two intersecting lines of position are assumed to be independent. This assumption implies that a change in the error of one line of position has no effect upon the other.
4. The lines of position are assumed to be straight lines in the small area in the immediate vicinity of their intersection. This assumption is valid so long as the standard deviation is small compared to the radius of curvature of the line of position.
5. Errors of position are limited to the two-dimensional case. As shown in Figure 305b, the general case of the intersection of two lines of position at any angle of cut and with different values of error associated with each line of position results in an elliptical error figure. Figure 305c shows the ellipse simplified to geometrical terms.

One may readily surmise from Figure 305c that the exact shape of the error figure varies with the magnitudes of the two one-dimensional input errors,  $\sigma_1$  and  $\sigma_2$  as well as with the angle of cut,  $\alpha$ . The angle  $\alpha$  is also the angle between the two values of sigma because the standard

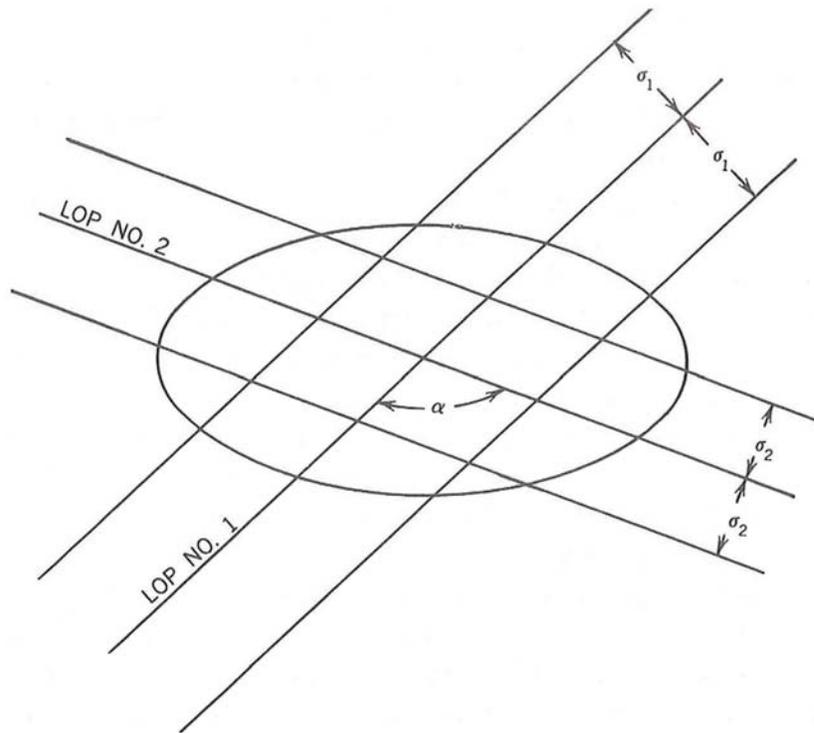


Figure 305b. Expanded view of intersection of two lines of position.

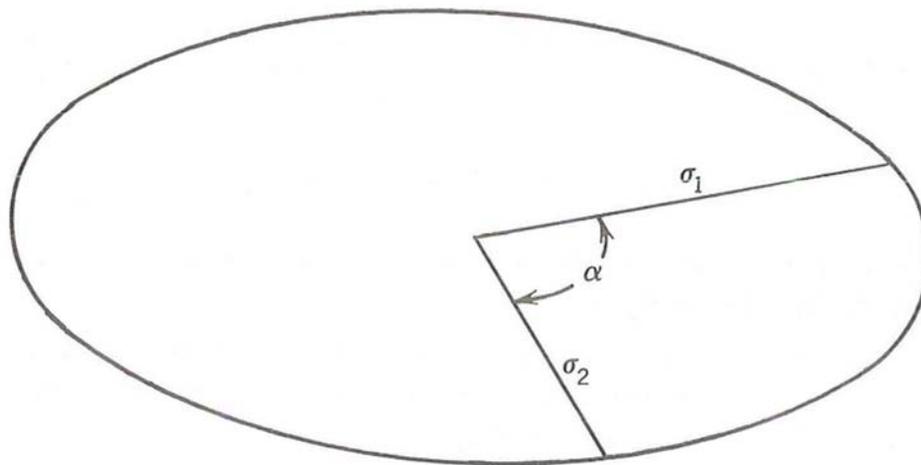


Figure 305c. Basic error ellipse.

deviations are mutually perpendicular to their corresponding lines of position. These variations can be calculated to provide the probability that a point is located within a circle of stated radius.

When this is done, the error is stated in terms more meaningful to the practicing navigator. The basis of this concept may best be seen by first considering the special case when the two errors are equal, and the angle of intersection of the lines of position is a right angle. In this case, and in this case alone, the error figure becomes a circle and

is described by the circular normal distribution. A plot of this special function is given in Figure 305d. In this plot, the horizontal axis is measured in terms of  $R/\sigma$ ,  $R$  being the stated radius of the circle and  $\sigma$  being the measure of error. The error measure is given simply as  $\sigma$ , for in this circular case  $\sigma_1 = \sigma_2$ . To illustrate, a measurement system gives a circular error figure and has a value of  $\sigma = 100$  meters; the probability of actually being located within a circle of 100 meters radius when  $R/\sigma = 1.0$  may be read from the verti-

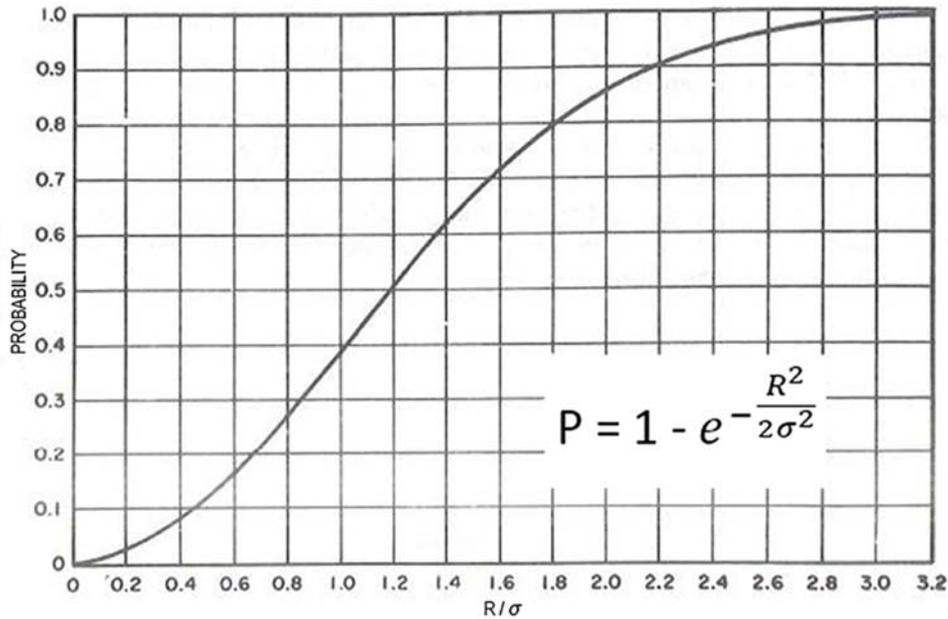


Figure 305d. Circular normal distribution.

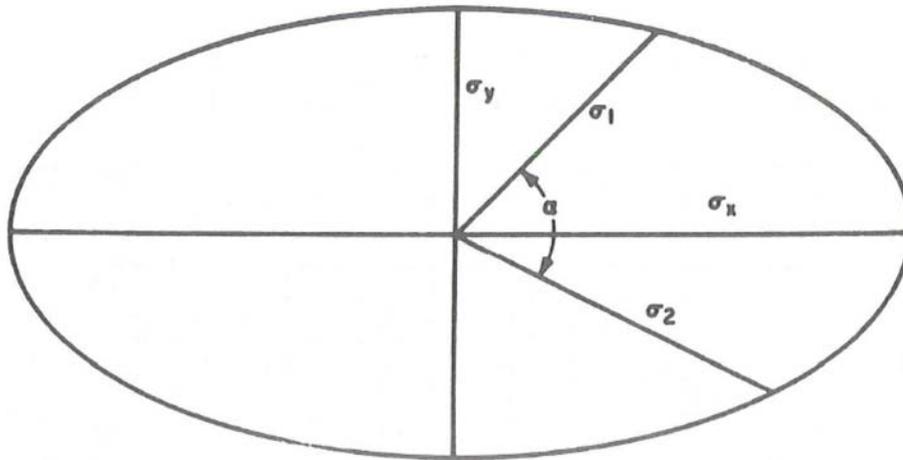


Figure 305e. Transformation to standard deviations along ellipse axes.

cal axis to be 39.3 percent. To obtain the radius of a circle within which a 50 percent probability results, the corresponding value of  $R/\sigma$  is seen to be 1.18 from the graph. Thus, for this example, the **circular probable error (CPE or CEP or circle of 50% probability)** would be 118 meters..

In one method of using error ellipses to obtain the radii of **circles of equivalent probability**, new values of  $\sigma$  are found along the major and minor axes of the ellipse (Figure 305e) using the following equations:

$$\sigma_x^2 = \frac{1}{2\sin^2\alpha}[\sigma_1^2 + \sigma_2^2 + \sqrt{(\sigma_1^2 + \sigma_2^2)^2 - 4\sin 2\alpha\sigma_1^2\sigma_2^2}]$$

$$\sigma_y^2 = \frac{1}{2\sin^2\alpha}[\sigma_1^2 + \sigma_2^2 - \sqrt{(\sigma_1^2 + \sigma_2^2)^2 - 4\sin 2\alpha\sigma_1^2\sigma_2^2}]$$

Then the ratio  $c = \frac{\sigma_y}{\sigma_x}$  where  $\sigma_x$  is the larger of the two

new standard deviations, is used in entering Table 305a which relates ellipses of varying values of ellipticity to the radii of circles of equivalent probability.

For a numerical example to illustrate the method of calculation, assume that the angle of cut  $\alpha$  is  $50^\circ$ ,  $\sigma_1$  is 15 meters, and  $\sigma_2$  is 20 meters to determine the probability of location within a circle of 30 meters radius.







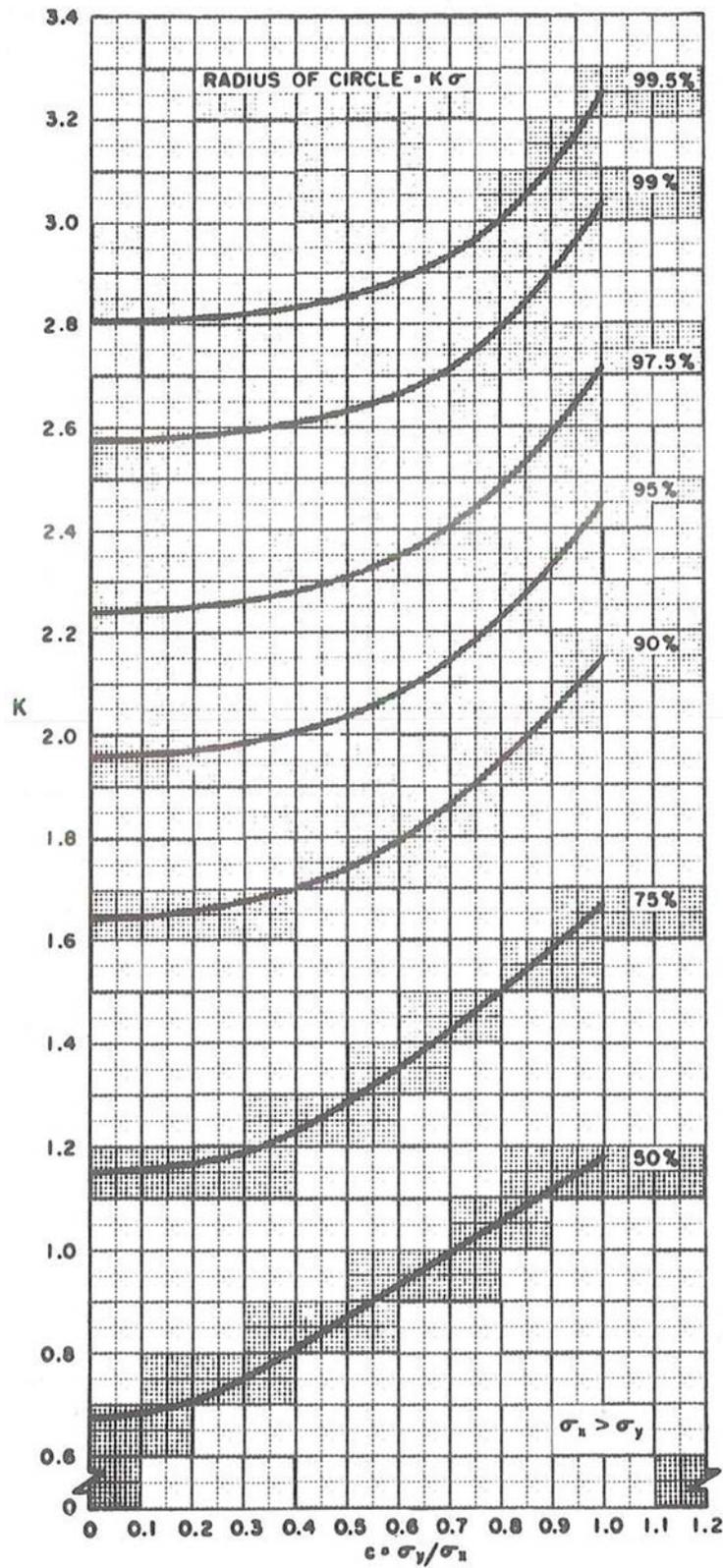


Figure 305g. Factors for conversion of probability ellipse to circle of equivalent probability.

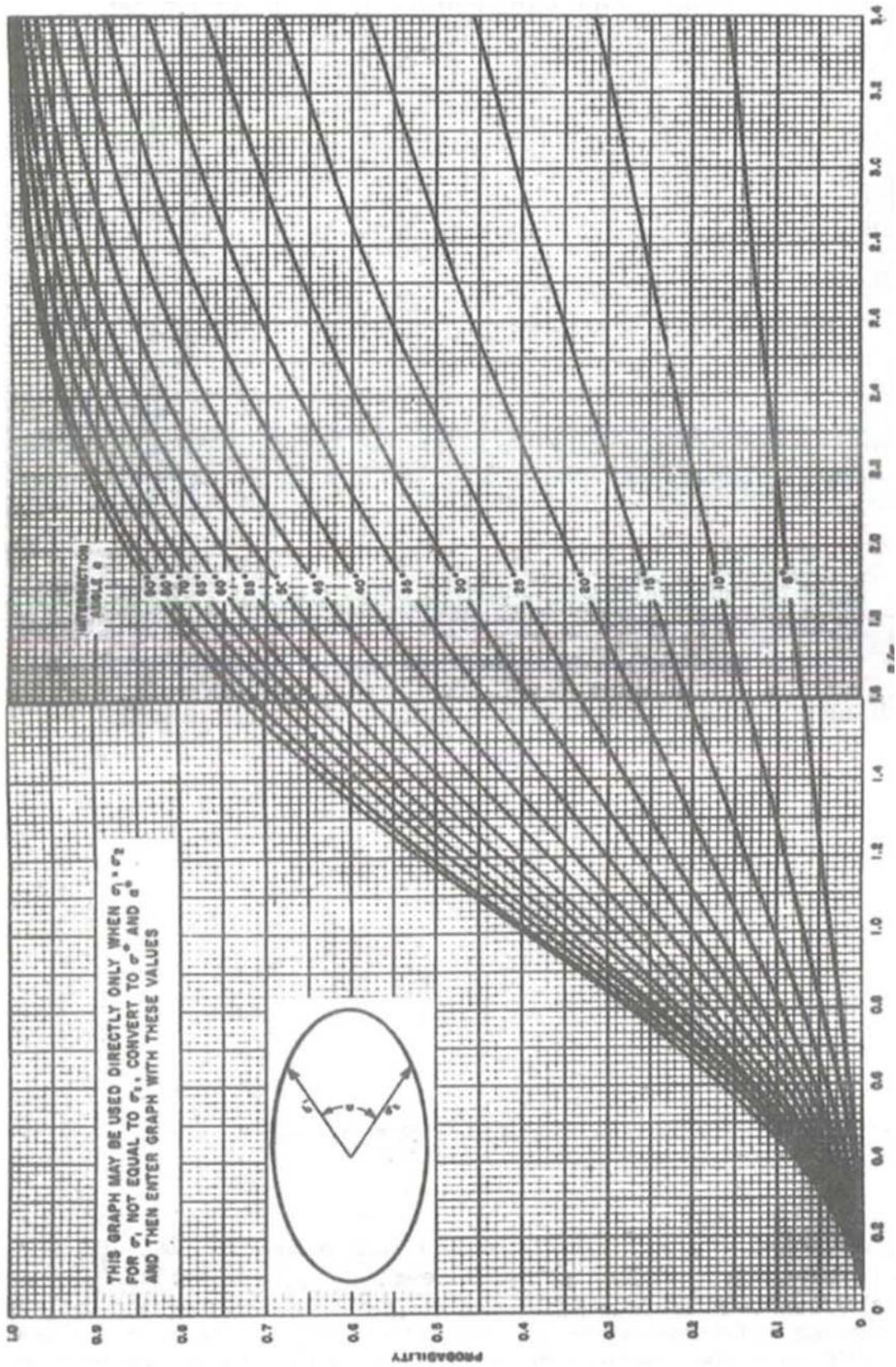


Figure 305h. Probability versus the radius of the circle divided by the standard error and the angle of cut for elliptical bivariate distributions with two equal standard deviations.

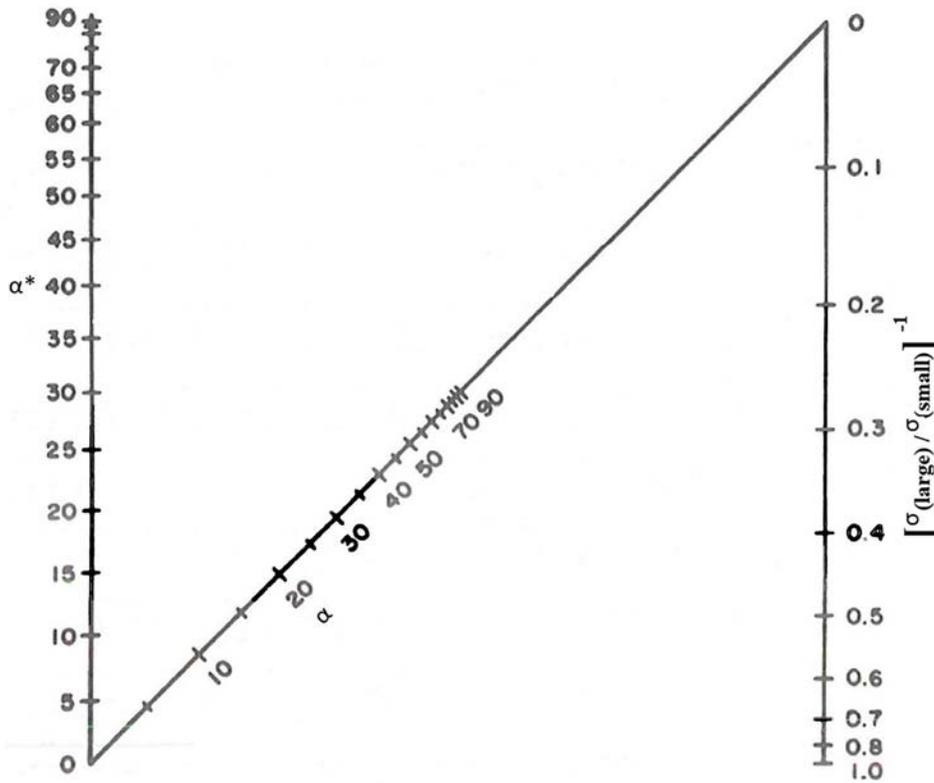


Figure 305i. Nomogram to obtain  $\alpha^*$ .

**308. One-Dimensional Errors**

The terms **standard deviation, sigma ( $\sigma$ ), and root mean square (RMS) error** have the same meaning in reference to one-dimensional errors. The basic equation of the normal (Gaussian) distribution indicates the use of the Greek letter sigma,  $\sigma$ , from which its use for standard deviation arises:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad -\infty < x < \infty$$

where the Greek letter  $\mu$  is the mean of the distribution.

Standard deviation of a measurement system is a property that may be determined experimentally. If a large number of measurements of the same quantity, a length for example, are made and compared with their mean value, the standard deviation is the square root of the sum of the squares of the differences (deviations) of the measurements from the mean value divided by one less than the number of measurements taken. The mean, or average value, is the sum of the measurements divided by the number of the measurements. Symbolically this operation is represented as:

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n - 1}}, \quad \mu = \frac{\sum_{i=1}^n x_i}{n}$$

The term root-mean-square (RMS) error comes from this latter method of computation.

Numerically, the values between the mean plus or minus one sigma (one standard deviation) corresponds to 68.27 percent of the distribution. That is, if a large number of measurements were made of a given quantity, 68.27 percent of the errors would be within the value of the mean plus or minus one standard deviation, or within  $\mu \pm 1\sigma$ . Likewise, errors within  $\mu \pm 2\sigma$  correspond to 95.45 percent of the total errors and errors within  $\mu \pm 3\sigma$  correspond to 99.73 percent of the total errors. Colloquially, these conditions are described as not exceeding the one-, two-, and three-sigma values, respectively.

The term probable error is identical in concept to standard deviation. The term differs from standard deviation in that it refers to the median error; that is, no more than half the errors in the measurement sample are greater than the value of the probable error. Linear probable error is related to standard deviation by a multiplication factor (Table 308a). One probable error equals 0.6745 times one standard deviation.

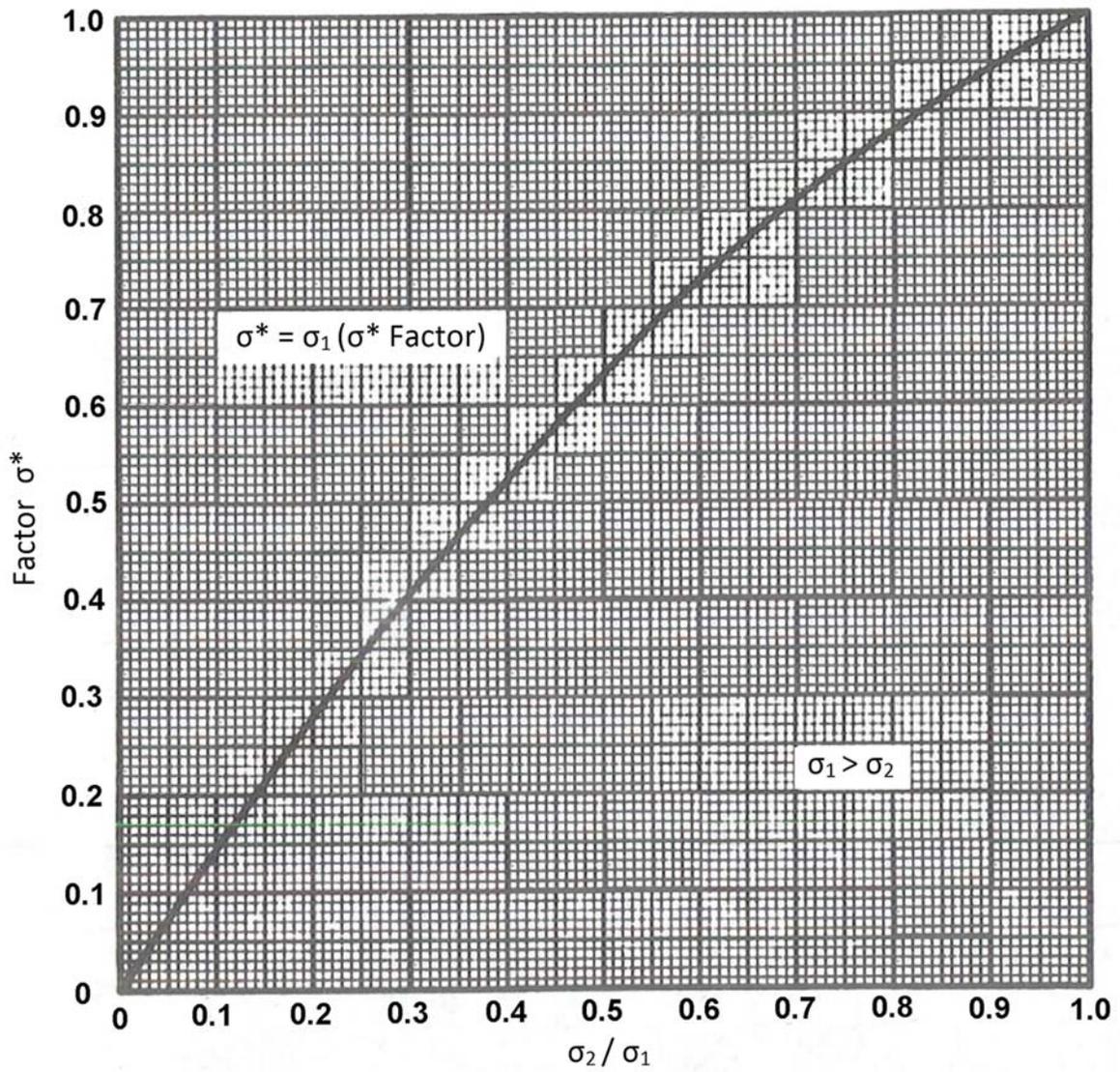


Figure 305j.  $\sigma^*$  factors versus  $\sigma_2/\sigma_1$  ratio.

| $\alpha$ | $\sigma_x$ | $\sigma_y$ | $c$   | $K$   | CEP   | Error Factor |
|----------|------------|------------|-------|-------|-------|--------------|
| 90       | 1.0        | 1.0        | 1.0   | 1.177 | 1.177 | 1.00         |
| 80       | 1.10       | 0.924      | 0.839 | 1.078 | 1.186 | 1.01         |
| 70       | 1.234      | 0.865      | 0.700 | 0.996 | 1.228 | 1.042        |
| 60       | 1.414      | 0.817      | 0.577 | 0.914 | 1.292 | 1.099        |
| 50       | 1.672      | 0.782      | 0.466 | 0.847 | 1.420 | 1.206        |
| 45       | 1.847      | 0.766      | 0.414 | 0.815 | 1.508 | 1.281        |
| 40       | 2.06       | 0.753      | 0.364 | 0.783 | 1.620 | 1.376        |
| 30       | 2.74       | 0.733      | 0.268 | 0.734 | 2.01  | 1.710        |
| 20       | 4.06       | 0.718      | 0.176 | 0.700 | 2.85  | 2.42         |
| 10       | 8.11       | 0.710      | 0.087 | 0.680 | 5.52  | 4.69         |

Table 306a. Significant parameters of error ellipses when  $\sigma_1 = \sigma_2$

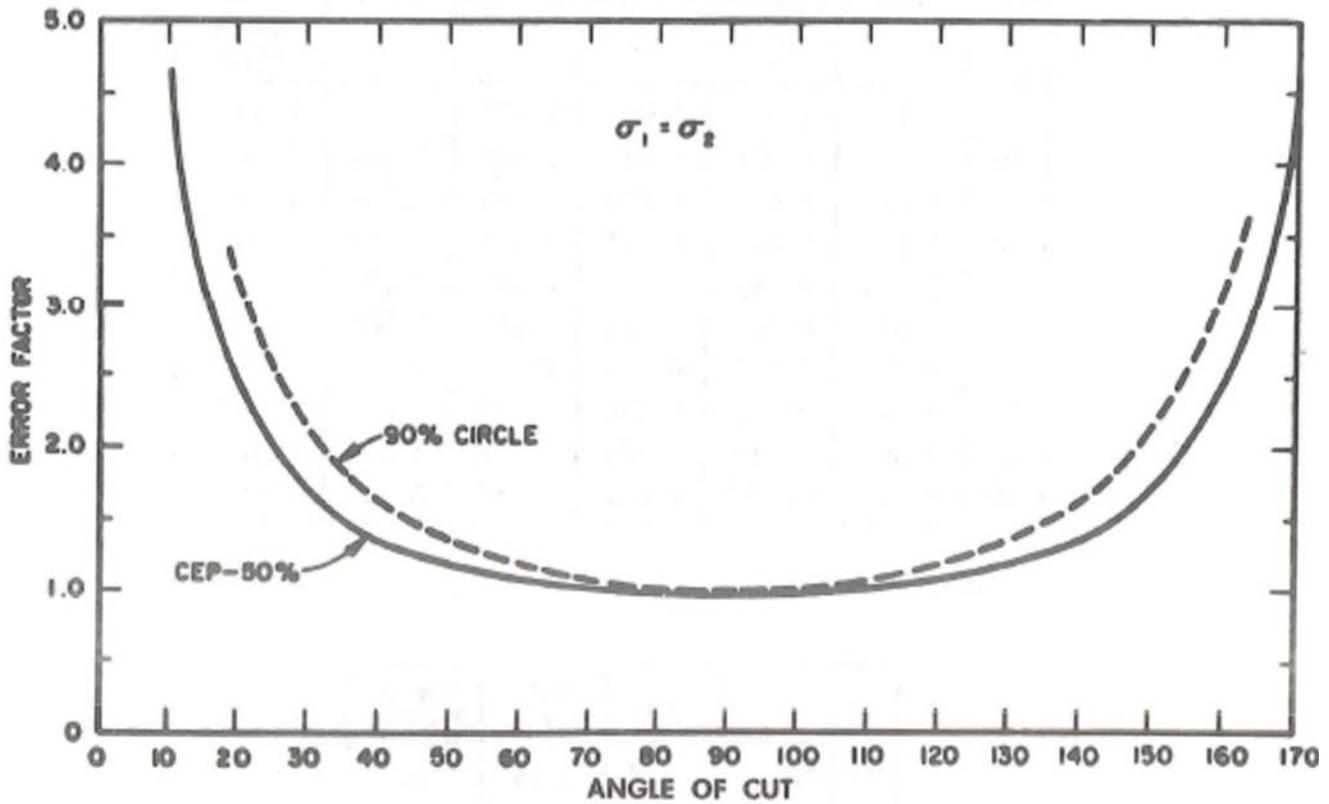


Figure 306b. CEP magnification versus angle of cut.

| $\alpha$ | $c$   | $K$   | 90% R | Error Factor |
|----------|-------|-------|-------|--------------|
| 90       | 1.0   | 2.145 | 2.145 | 1.00         |
| 80       | 0.839 | 1.98  | 2.18  | 1.015        |
| 70       | 0.700 | 1.86  | 2.30  | 1.07         |
| 60       | 0.577 | 1.775 | 2.51  | 1.7          |
| 50       | 0.466 | 1.72  | 2.88  | 1.34         |
| 45       | 0.414 | 1.702 | 3.15  | 1.47         |
| 40       | 0.364 | 1.687 | 3.47  | 1.615        |
| 30       | 0.268 | 1.665 | 4.53  | 2.11         |
| 20       | 0.176 | 1.652 | 6.72  | 3.13         |
| 10       | 0.087 | 1.645 | 13.35 | 6.22         |

Table 306c. 90 percent error factor

| $\alpha$ | $P$  | $P$  |
|----------|------|------|
| 90       | 50   | 90   |
| 80       | 49.4 | 89.2 |
| 70       | 47.5 | 86.9 |
| 60       | 44.0 | 82.4 |
| 50       | 39.5 | 76   |
| 40       | 37   | 66   |
| 30       | 25   | 53   |
| 20       | 17   | 37   |
| 10       | 8    | 19   |

Table 306d. Probability decrease with decreasing angle of cut for a circle of constant radius

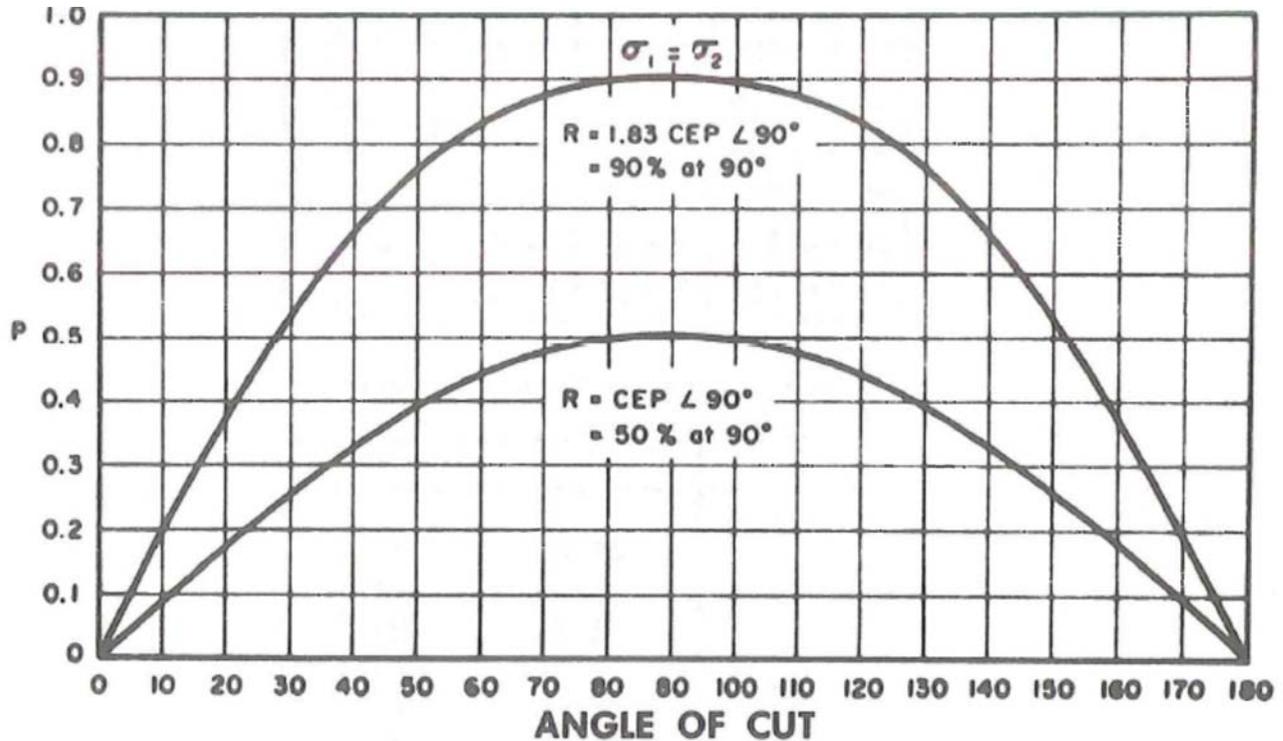


Figure 306e. Decrease in probability for a circle of constant radius versus angle of cut.

The term **variance** is met most frequently in detailed mathematical discussions.

| From/To | 50.00% | 68.27% | 95.00% | 99.73% |
|---------|--------|--------|--------|--------|
| 50.00%  | 1.0000 | 1.4826 | 2.9059 | 4.4475 |
| 68.27%  | 0.6745 | 1.0000 | 1.9600 | 3.0000 |
| 95.00%  | 0.3441 | 0.5102 | 1.0000 | 1.5307 |
| 99.73%  | 0.2248 | 0.3333 | 0.6533 | 1.0000 |

Table 308a. Linear error conversion factors.

**309. Two-Dimensional Error**

Terms similar or identical in words to those used for one-dimensional error descriptions are also used with two-dimensional or **bivariate error** descriptions. However, in the two-dimensional case, not all of these terms have the same

meaning as before; considerable care is needed to avoid confusion.

**Standard deviation** or **sigma** has a definable meaning only in the specific case of the circular normal distribution where  $\sigma_x = \sigma_y$ :

$$P_R = 1 - e^{-\frac{R^2}{2\sigma^2}}$$

In the case of the circular normal distribution, the standard deviation  $\sigma$  is equivalent to the standard deviation along both orthogonal axes. Because of concern with a radial distribution, the total distribution of errors involves numbers different from those of the linear case (Table 308a and Table 309a). In the circular case,  $1\sigma$  error indicates that 39.35 percent of the errors would not exceed the value of the  $1\sigma$  error; 86.47 percent would not exceed the  $2\sigma$  error; 98.89 percent would not exceed the  $3\sigma$  error; and 99.78 percent would not exceed the  $3.5\sigma$  error.

| From/To | 39.35% | 50.00% | 63.21% | 95.00% | 99.78% |
|---------|--------|--------|--------|--------|--------|
| 39.35%  | 1.0000 | 1.1774 | 1.4142 | 2.4477 | 3.5000 |
| 50.00%  | 0.8493 | 1.0000 | 1.2011 | 2.0789 | 2.9726 |
| 63.21%  | 0.7071 | 0.8325 | 1.0000 | 1.7308 | 2.4749 |
| 95.00%  | 0.4085 | 0.4810 | 0.5778 | 1.0000 | 1.4299 |

Table 309a. Circular error conversion factors.

|               |               |               |               |               |               |
|---------------|---------------|---------------|---------------|---------------|---------------|
| From/To       | <b>39.35%</b> | <b>50.00%</b> | <b>63.21%</b> | <b>95.00%</b> | <b>99.78%</b> |
| <b>99.78%</b> | 0.2857        | 0.3364        | 0.4040        | 0.6993        | 1.0000        |

Table 309a. Circular error conversion factors.

Because the usual case where there are two-dimensional distributions is that the standard deviations are different, resulting in an elliptical distribution, the circular standard deviation is less useful than the linear standard deviation. It is more common to describe two-dimensional distributions by the two separate one-dimensional standard deviations associated with each error axis. References, however, often do not make this distinction, referring to the

position accuracy of a system as 600 feet ( $2\sigma$ ), for example. Such a description should leave the reader wondering whether the measure is circular error, in which case the numbers describe the 86 percent probability circle, or whether the numbers are to be interpreted as one-dimensional sigmas along each axis, in which case the 95 percent probability circle is indicated (assuming the distribution to be circular, which actually it may not be).

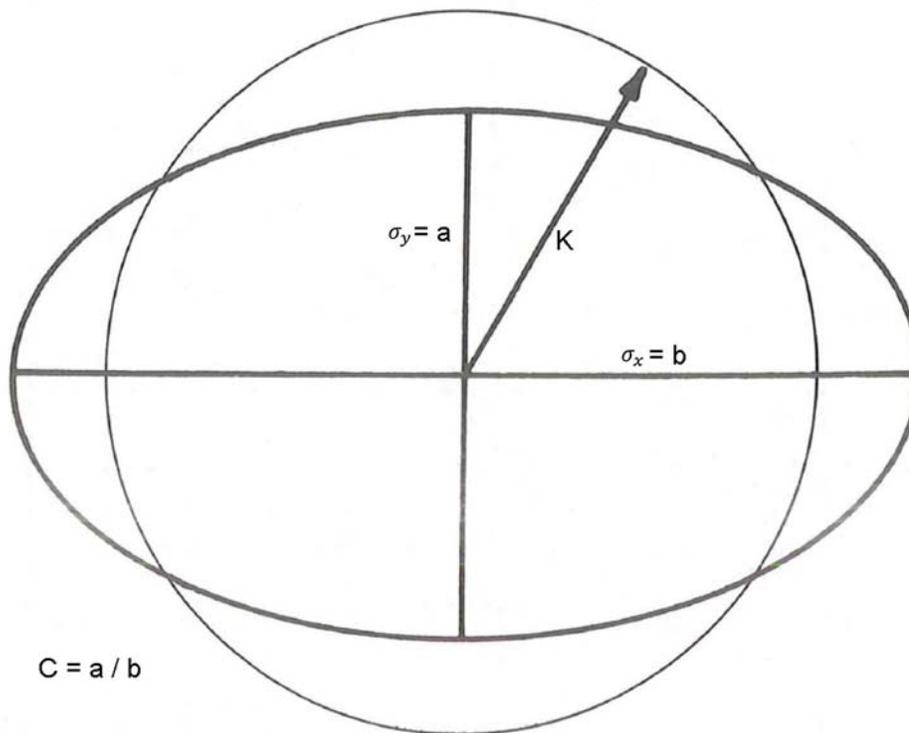


Figure 309b. Error ellipse and circle of equivalent probability.

The term **RMS (root mean square) error** when applied to two-dimensional errors does not have the same meaning as standard deviation. The term has the same meaning as radial error or  $d_{rms}$ , discussed later. Such use of the term is deprecated.

In a circular normal distribution, the term **circular probable error (CPE)** or **circular error probable (CEP)** refers to the radius of the circle inside of which there is a 50 percent probability of being located.

The term CEP is also used to indicate the radius of a circle inside of which there is a 50 percent probability of being located, even though the actual error figure (Figure 309b) is an ellipse. Article 305 describes one of the methods of obtaining such CEP equivalents when given ellipses of varying eccentricities. Curves and tables are available for

performing this calculation. Despite the availability of these curves and tables, approximations are often made for this calculation of a CEP when the actual error distribution is elliptical. Several of these approximations are indicated and plotted for comparison with the exact curve in Figure 309c. Of the various approximations shown, the top curve, the one which diverges the most rapidly, appears to be the most commonly used.

Another factor of interest concerning the relationship of the CEP to various ellipses is that the area of the CEP circle is always greater than the basic ellipse. Table 309d indicates that the divergence between the actual area of the ellipse of interest and the circle of equivalent probability increases as the ellipse becomes thinner and more elongated.

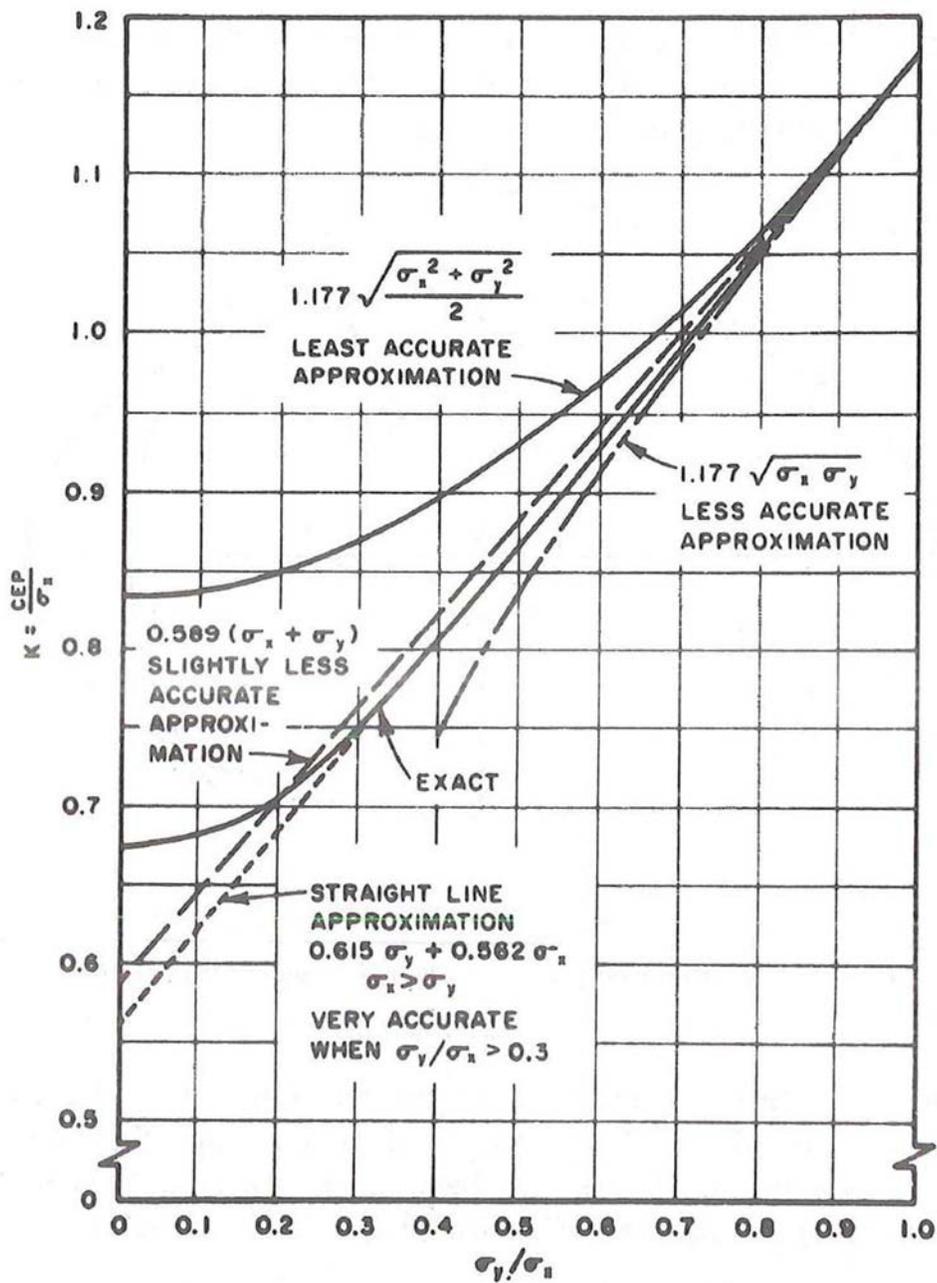


Figure 309c. CEP for elliptical error distribution approximations.

| C = a / b | Area of 50% ellipse | Area of equivalent circle |
|-----------|---------------------|---------------------------|
| 0.0       | 0                   | 1.43                      |
| 0.1       | 0.437               | 1.46                      |
| 0.2       | 0.874               | 1.56                      |
| 0.3       | 1.31                | 1.76                      |
| 0.4       | 1.75                | 2.06                      |

Table 309d. Comparison of areas of 50% ellipses of varying eccentricities with areas of circles of equivalent probabilities.

| C = a / b | Area of 50% ellipse | Area of equivalent circle |
|-----------|---------------------|---------------------------|
| 0.5       | 2.08                | 2.37                      |
| 0.6       | 2.62                | 2.74                      |
| 0.7       | 3.06                | 3.12                      |
| 0.8       | 3.49                | 3.52                      |
| 0.9       | 3.93                | 3.94                      |
| 1.0       | 4.37                | 4.37                      |

Table 309d. Comparison of areas of 50% ellipses of varying eccentricities with areas of circles of equivalent probabilities.

The value of the CEP may be related to the radius of other values of probability circles analytically for the case of the circular normal distribution by solving the basic equation for various values of probability. For this special case of the circular normal distribution, these relationships are shown drawn to scale in Figure 309e with the associated values tabulated in Table 309f.

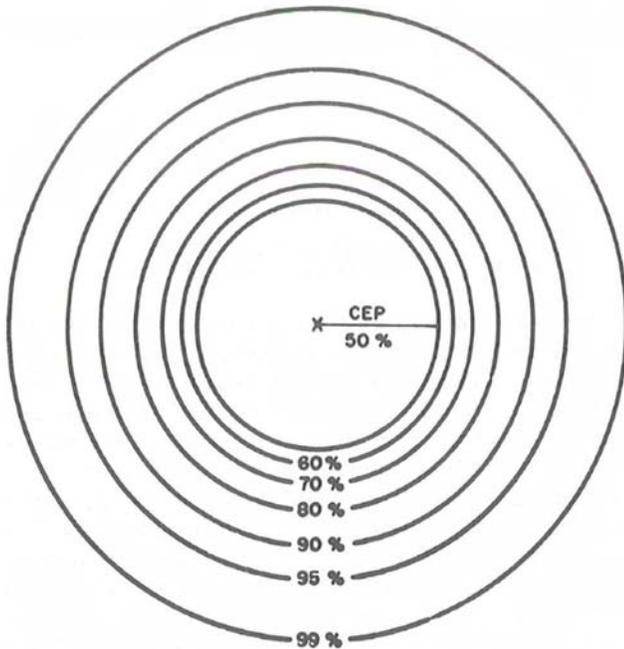


Figure 309e. Relationship between CEP and other probability circles.

| Multiply values of CEP by | To obtain radii of circle of probability |
|---------------------------|--|
| 1.150                     | 60%                                      |
| 1.318                     | 70%                                      |

Table 309f. Relationship between CEP and radii of other probabilities circles of the circular normal distribution.

| Multiply values of CEP by | To obtain radii of circle of probability |
|---------------------------|--|
| 1.414                     | 75%                                      |
| 1.524                     | 80%                                      |
| 1.655                     | 85%                                      |
| 1.823                     | 90%                                      |
| 2.079                     | 95%                                      |
| 2.578                     | 99%                                      |

Table 309f. Relationship between CEP and radii of other probabilities circles of the circular normal distribution.

The derivation of these values is shown in the following analysis. First, the factor relating the CEP to the circular sigma is derived, then, as a second example, the relationship between the 75 percent probability circle and the circular sigma is derived. The ratio of these two values is then the value shown in Table 309f for the 75 percent value.

The circular normal distribution equation is:

$$P_R = 1 - e^{-\frac{R^2}{2\sigma^2}},$$

and

$$CEP = P(R) = 0.5$$

$$1 - e^{-\frac{R^2}{2\sigma^2}} = 0.5$$

$$e^{-\frac{R^2}{2\sigma^2}} = 0.5.$$

Take the natural logarithm of both sides

$$\ln\left(e^{-\frac{R^2}{2\sigma^2}}\right) = \ln 0.5$$

$$\frac{R^2}{2\sigma^2} = \ln 2 \quad (\ln 0.5 = -\ln 2)$$

$$R = 1.1774\sigma.$$

For the 75 percent probability circle,

$$1 - e^{-\frac{R^2}{2\sigma^2}} = 0.75$$

$$e^{-\frac{R^2}{2\sigma^2}} = 0.25$$

$$\ln\left(e^{-\frac{R^2}{2\sigma^2}}\right) = \ln 0.25$$

$$\frac{R^2}{2\sigma^2} = \ln 4$$

$$R = 1.665\sigma$$

$$\frac{R(75\%)}{R(50\%)} = \frac{1.665\sigma}{1.177\sigma} = 1.414.$$

The factors tabulated in Table 309f are sometimes used to relate varying probability circles when the basic distribution is not circular, but elliptical. That such a procedure is inaccurate may be seen by the curves of . It can be seen that the errors involved are small when the eccentricities are small. But the errors increase significantly when both high values of probability are desired and when the ellipticity increases in the direction of long, narrow distributions.

The terms **radial error**, **root mean square error**, and  $d_{rms}$  are identical in meaning when applied to two-dimensional errors. Figure 309h illustrates the definition of  $d_{rms}$ . It is seen to be the square root of the sum of the square of the 1 sigma error components along the major and minor axes of a probability ellipse. The figure details the definition of 1  $d_{rms}$ . Similarly, other values of  $d_{rms}$  can be derived by using the corresponding values of sigma. The measure  $d_{rms}$  is not equal to the square root of the sum of the squares of  $\sigma_1$  and  $\sigma_2$  that are the basic errors associated with the lines of position of a particular measuring system. The procedures described in section 305 must first be utilized to obtain the values shown as  $\sigma_x$  and  $\sigma_y$ .

The three terms (radial error, root-mean-square error, and  $d_{rms}$ ) used as a measure of error are somewhat confusing because they do not correspond to a fixed value of probability for a given value of the error measure. The

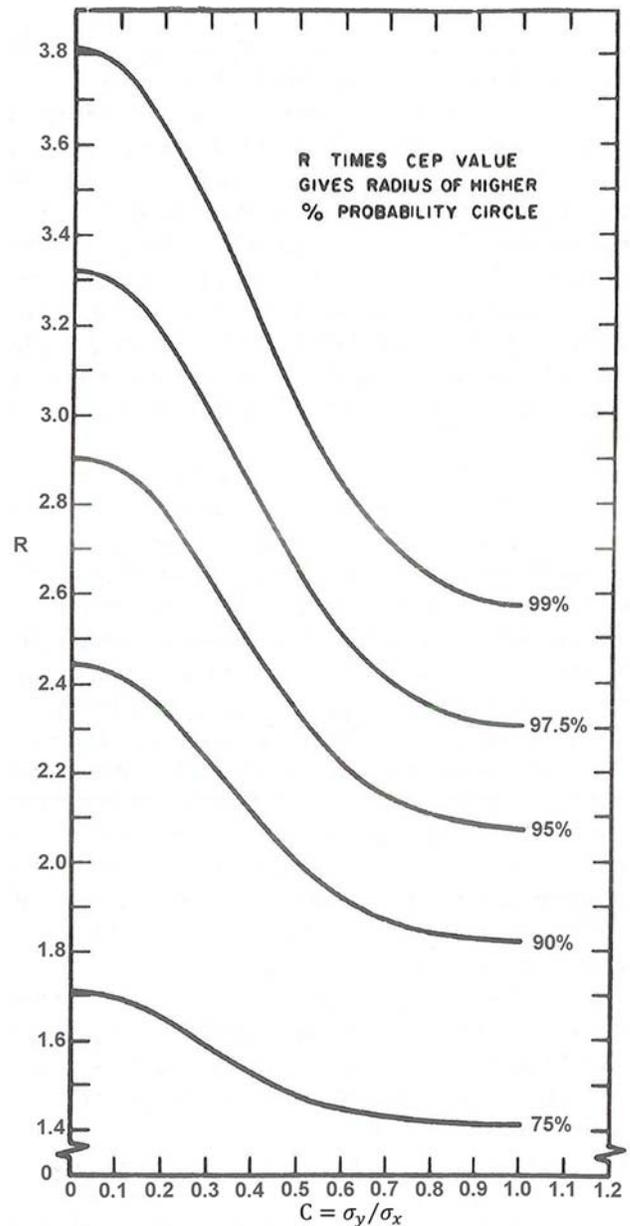


Figure 309g. Relation of probability circles to CEP versus ellipticity.

terms can be conveniently related to other error measures only when  $\sigma_x = \sigma_y$ , and the probability figure is a circle. In the more common elliptical cases, the probability associated with a fixed value of  $d_{rms}$  varies as a function of the eccentricity of the ellipse. One  $d_{rms}$  is defined as the radius of the circle obtained when  $\sigma_x = 1$ , in Figure 309h, and  $\sigma_y$  varies from 0 to 1. Likewise,  $2 d_{rms}$  is the radius of the circle obtained when  $\sigma_x = 2$ , and  $\sigma_y$  varies from 0 to 2. Values of the length of the radius  $d_{rms}$  can be calculated as shown in Table 309j. From these values the associated

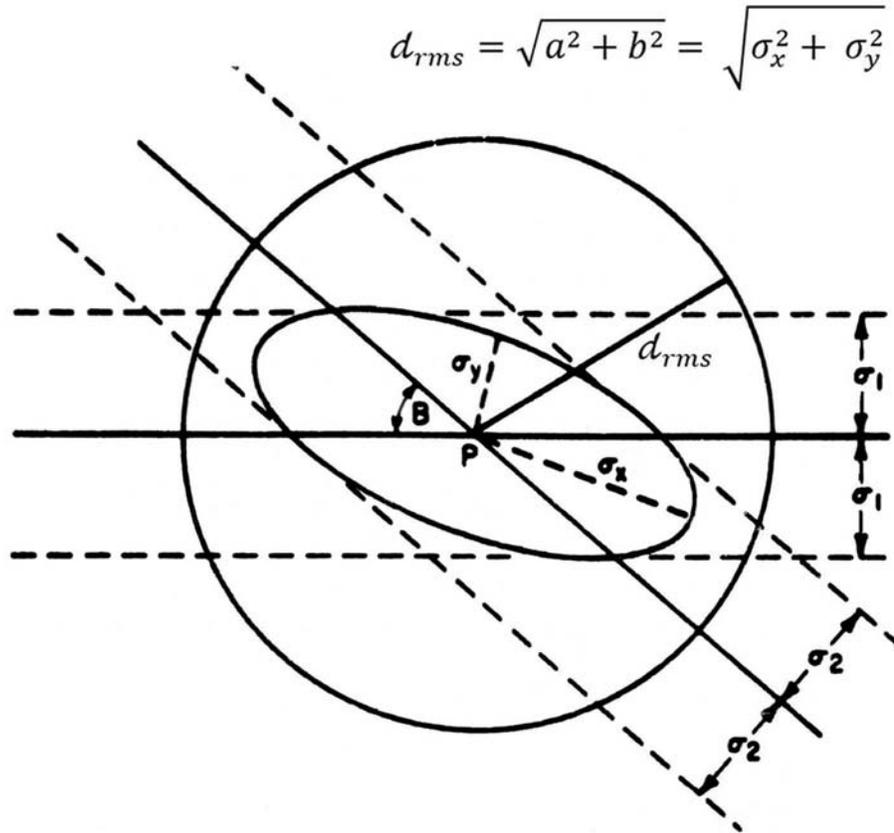


Figure 309h. CEP for elliptical error distribution approximations.

probabilities can be determined from the tables of section 305. The variations of probability associated with the values of  $1 d_{rms}$  and  $2 d_{rms}$  are shown in the curves of and . shows the lack of a constant relationship in a slightly different way. Here the ratio  $d_{rms}/CEP$  is plotted against the same measure of ellipticity. The three figures show graphically that there is not a constant value of probability associated with a single value of  $d_{rms}$ .

Figure 309i shows the substitution of the circular form for elliptical error distributions. When  $\sigma_x$  and  $\sigma_y$  are equal, the probability represented by  $1 d_{rms}$  is 63.21 percent. When  $\sigma_x$  and  $\sigma_y$  are unequal ( $\sigma_x$  being the greater value), the probability varies from 64 percent when  $\sigma_y/\sigma_x = 0.8$  to 68 percent when  $\sigma_y/\sigma_x = 0.3$ .

### 310. Navigation System Accuracy

In a navigation system, **predictability** is the measure of the accuracy with which the system can define the position in terms of geographical coordinates; **repeatability** is the measure of the accuracy with which the system permits the user to return to a position as defined only in terms of the coordinates peculiar to that system. **Predictable accuracy**,

therefore, is the accuracy of positioning with respect to geographical coordinates; **repeatable accuracy** is the accuracy with which the user can return to a position whose coordinates have been measured previously with the same system. For example, the distance specified for the repeatable accuracy of a system such as GPS is the distance between two GPS positions established using the same satellites at different times. The correlation between the geographical coordinates and the system coordinates may or may not be known.

**Relative accuracy** is the accuracy with which a user can determine their position relative to that of another user of the same navigation system at the same time. Hence, a system with high relative accuracy provides good rendezvous capability for the users of the system. The correlation between the geographical coordinates and the system coordinates is not relevant.

### 311. Most Probable Position

Some navigators, particularly those of little experience, have been led by the simplified definitions and explanations usually given in texts to conclude that the line of position is infallible, and that a fix is without error, overlooking the frequent incompatibility of these two notions. Too often the idea has prevailed that information is either all right or all

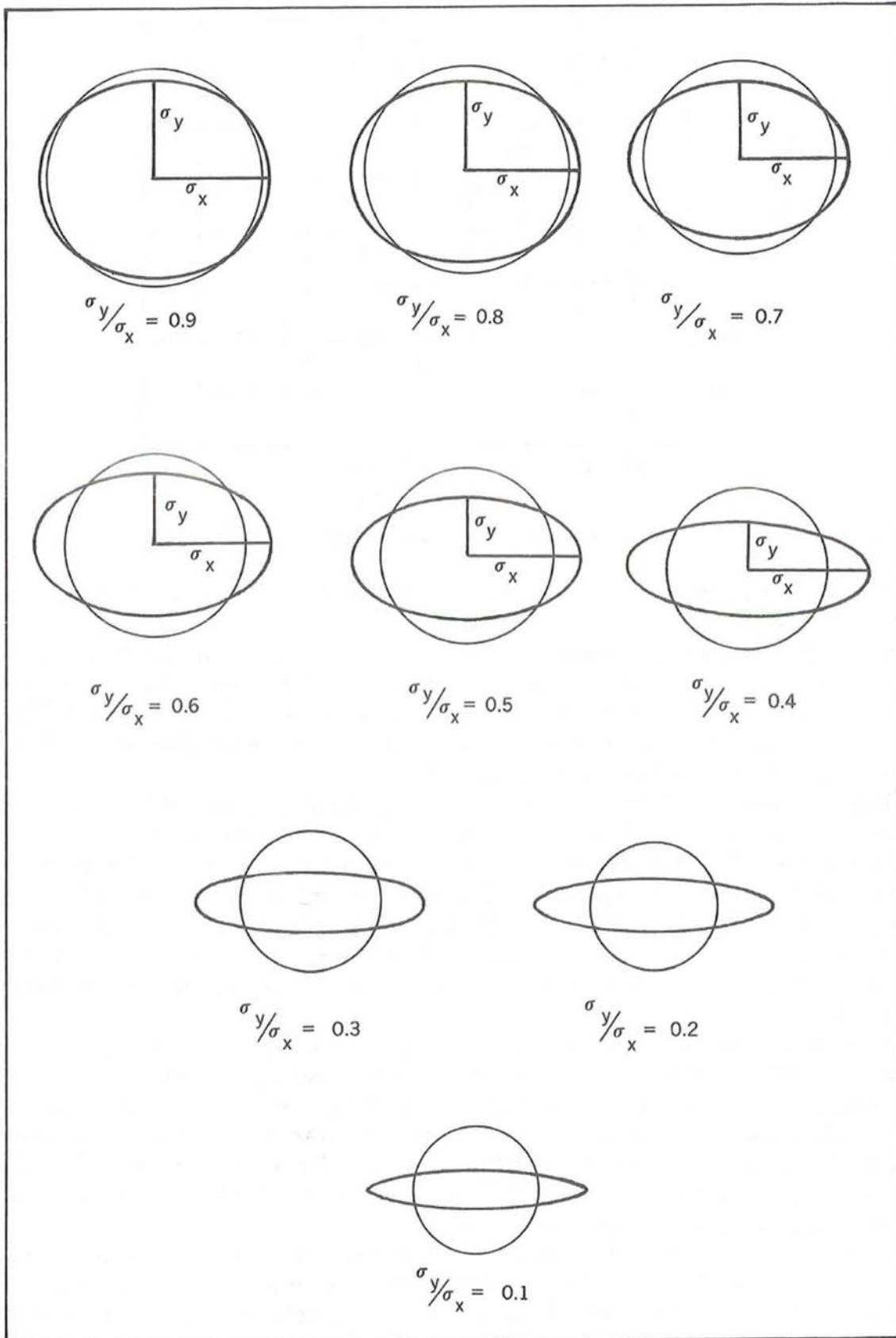
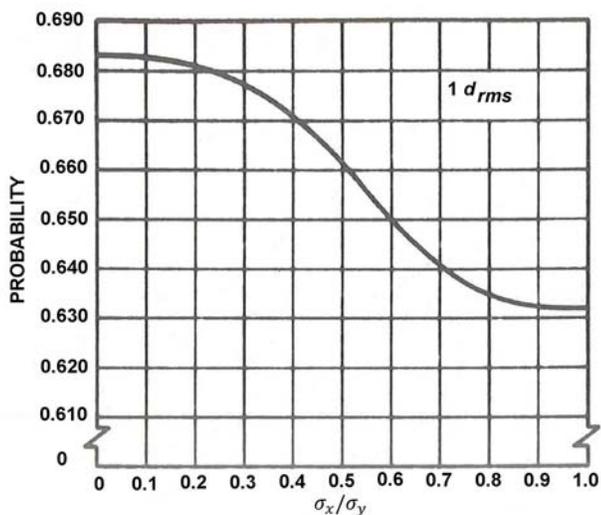


Figure 309i. Substitution of the circular form for elliptical error distributions.

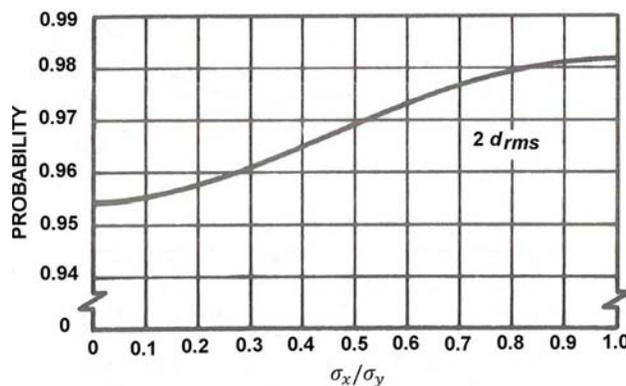
| $\sigma_y$ | $\sigma_x$ | LENGTH OF<br>$1 d_{rms}$ | PROBABILITY |             |
|------------|------------|--------------------------|-------------|-------------|
|            |            |                          | $1 d_{rms}$ | $2 d_{rms}$ |
| 0.0        | 1.0        | 1.000                    | 0.683       | 0.954       |
| 0.1        | 1.0        | 1.005                    | 0.682       | 0.955       |
| 0.2        | 1.0        | 1.020                    | 0.682       | 0.957       |
| 0.3        | 1.0        | 1.042                    | 0.676       | 0.961       |
| 0.4        | 1.0        | 1.077                    | 0.671       | 0.966       |
| 0.5        | 1.0        | 1.118                    | 0.662       | 0.969       |
| 0.6        | 1.0        | 1.166                    | 0.650       | 0.973       |
| 0.7        | 1.0        | 1.220                    | 0.641       | 0.977       |
| 0.8        | 1.0        | 1.280                    | 0.635       | 0.980       |
| 0.9        | 1.0        | 1.345                    | 0.632       | 0.981       |
| 1.0        | 1.0        | 1.414                    | 0.632       | 0.982       |

$d_{rms} = \sqrt{\sigma_x^2 + \sigma_y^2}$  when  $\sigma_x$  and  $\sigma_y$  are at right angles to each other.

Table 309j. Calculations of  $d_{rms}$ .Figure 309k. Variation in  $d_{rms}$  with ellipticity ( $1 d_{rms}$ ).

wrong. An example is the practice of establishing an estimated position at the foot of the perpendicular from a dead reckoning position to a line of position. The assumption is that the vessel *must* be somewhere on the line of position. The limitations of this often valuable practice are not understood by these inexperienced navigators.

A more realistic concept is that of the **most probable position (MPP)**, which recognizes the probability of error

Figure 309l. Variation in  $d_{rms}$  with ellipticity ( $2 d_{rms}$ ).

in all navigational information, and determines position by an evaluation of all available information, using the principles of errors.

Suppose a vessel were to start from a completely accurate position and proceed on dead reckoning. If course and speed over the bottom were of equal accuracy, the uncertainty of dead reckoning positions would increase equally in all directions with either distance or elapsed time (for any one speed these would be directly proportional and therefore either could be used). Therefore, a circle of uncertainty would grow around the dead reckon-



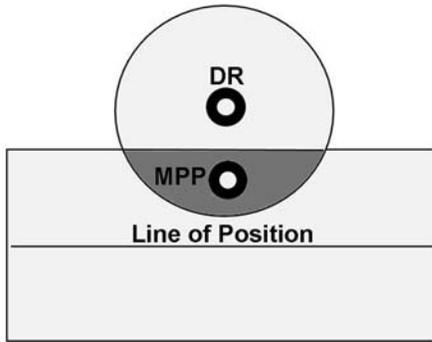


Figure 311a. A most probable position based upon a dead reckoning position and line of position having equal probable errors.

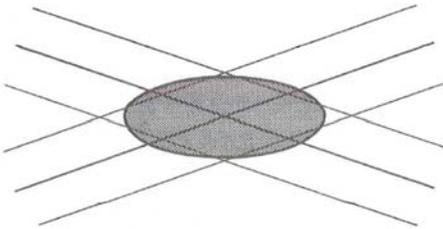


Figure 311b. Ellipse of uncertainty with line of positions of equal probable errors crossing at an oblique angle.

If a fix is obtained from three or more lines of position spread in azimuth by more than  $180^\circ$ , and the error of each line is normal and equal to that of the others, the most probable position is the center of the figure. By “center” is meant that point within the figure which is equidistant from the sides. If the lines are of unequal likely error, the distance of the most probable position from each line of position is proportional to the *square* of the likely error of that line times the sine of the angle formed by the other two lines.

In the discussion of most probable position from lines of position, it has been assumed that no other positional information is available. Usually, this is an incorrect assumption, for there is nearly always a dead reckoning or estimated position. This can be considered in any of several ways. The square of its likely error can be used in the same manner as the square of the likely error of each line of position. A most probable position based upon the dead reckoning or estimated position and the most reliable line of position might be determined as explained above, and that line of position replaced with a new one parallel to it but passing through the most probable position just determined. This adjusted line of position can then be assigned a smaller likely error and used with the other lines of position to determine the overall most probable position. A third way is to establish a likely error for the fix, and consider the most probable position as that point along the

straight line joining the fix and the dead reckoning or estimated position, the relative distances being equal to the square of the likely error of each position.

The value of the most probable position determined as suggested above depends upon the degree to which the various errors are in fact normal, and the accuracy with which the likely error of each is established. From a practical standpoint, the second factor is largely a matter of judgment based upon experience. It might seem that interpretation of results and establishment of most probable position is a matter of judgment anyway, and that the procedure outlined above is not needed. If a person will follow this procedure while gaining experience, and evaluate his or her results, the judgment developed should be more reliable than if developed without benefit of knowledge of the principles that are involved. The important point to remember is that the relative effects of normal random errors in any one direction are proportional to their *squares*.

Systematic errors are treated differently. Generally, an attempt is made to discover the errors and eliminate them or compensate for them. In the case of a position determined by three or more lines of position resulting from readings with constant error, the error might be eliminated by finding and applying that correction (including sign) which will bring all lines through a common point.

### 312. Mistakes

The recognition of a mistake, as contrasted with an error (Section 301), is not always easy, since a mistake may have any magnitude, and may be either positive or negative. A large mistake should be readily apparent if the navigator is alert and has an understanding of the size of error to be reasonably expected. A small mistake is usually not detected unless the work is checked.

If results by two methods are compared, as a dead reckoning position and a line of position, exact agreement is not to be expected. But if the discrepancy is unreasonably large, a mistake is logically suspected. The definition of “unreasonably large” is a matter of opinion. If the 99.9 percent areas of the two results just touch, it is *possible* that no mistake has been made. However, the *probability* of either one having so great an error is remote if the errors are normal. The probability of both having 99.9 percent error of opposite sign at the same instant is very small indeed. Perhaps a reasonable standard is that unless the most accurate result lies within the 95 percent area of the least accurate result, the possibility of a mistake should be investigated. Thus, if the areas of uncertainty shown in Figure 311a represent the 95 percent areas, it is probable that a mistake has been made.

As in other matters pertaining to navigation, judgment is important. The use to be made of the results is certainly a consideration. In the middle of an ocean passage a mistake is usually not serious, and will undoubtedly be corrected before it jeopardizes the safety of the vessel. But if landfall

is soon to be made, or if search and rescue operations are to be based upon the position, almost any mistake is intolerable.

### 313. Conclusion

The correct identification of the nature of an error is important if the error is to be handled intelligently. Thus, the statement is sometimes made that a radio bearing need not be corrected if the receiver is within 50 miles of the transmitter.

The need for a correction arises from the fact that radio waves are assumed to follow great circles, and if radio bearings are to be plotted on a Mercator chart, the equivalent rhumb line is needed. The statement regarding 50 miles implies that the size of the correction is proportional to distance only. It overlooks the fact that latitude and direction of the bearing line are also important factors, and is therefore a dangerous statement unless its limitations are understood.

The recognition of the type of error is also important. A systematic error has quite a different effect than a random error, and cannot be reduced by additional readings unless some method or procedure is instituted which will cause the errors to cancel each other.

The errors for various percentage probabilities are usually of greater interest than the "average" value. The average of a large number of normal errors approaches zero, but the probable (50 percent) error might be quite large.

A person who understands the nature of errors avoids many pitfalls. Thus, the magnitude of the errors of individual lines of position is not a reliable indication of the size of the error of the fix obtained from them. The size of the triangle formed by three lines of position has often been used as a guide to the accuracy of the fix, although a large triangle might be the result of a large constant error if the objects observed are equally spaced in azimuth. On the other hand, two lines of position with small errors might produce a fix having a much larger error if the lines cross at a small angle.

### 314. References

Burt, W. A., Kaplan, D. J., Keenly, R. R., et al. (1965). *Mathematical Considerations Pertaining to the Accuracy of Position Location and Navigation Systems*. Naval Warfare Research Center Research Memorandum NWRC-RM 34, Stanford Research Institute, Menlo Park, California.

Greenwalt, C. R. and Shultz, M. E. (1962). *Principles of Error Theory and Cartographic Applications*. Aeronautical Chart and Information Center Technical Report No. 96, St. Louis, Missouri.

# CHAPTER 4

## CALCULATIONS AND CONVERSIONS

### INTRODUCTION

#### 400. Purpose and Scope

This chapter discusses the use of calculators and computers in navigation and summarizes the formulas the navigator depends on during voyage planning, piloting, celestial navigation, and various related tasks. To fully utilize this chapter, the navigator should be competent in basic mathematics including algebra and trigonometry (see Chapter 1 - Mathematics in Volume II) and be familiar with the use of a basic scientific calculator. The navigator should choose a calculator based on personal needs, which may vary greatly from person to person according to individual abilities and responsibilities.

#### 401. Use of Calculators in Navigation

Any common calculator can be used in navigation, even one providing only the four basic arithmetic functions of addition, subtraction, multiplication, and division. Any good scientific calculator can be used for sight reduction, sailings, and other tasks. However, the use computer applications and handheld calculators specifically designed for navigation will greatly reduce the workload of the navigator, reduce the possibility of errors, and assure accuracy of the results calculated.

Calculations of position based on celestial observations have become increasingly uncommon since the advent of GPS as a dependable position reference for all modes of navigation. This is especially true since GPS units provide worldwide positioning with far greater accuracy and reliability than celestial navigation.

However, for those who use celestial techniques, a celestial navigation calculator or computer application can improve celestial position accuracy by easily solving numerous sights, and by reducing mathematical and tabular errors inherent in the manual sight reduction process. They can also provide weighted plots of the LOP's from any number of celestial bodies, based on the navigator's subjective analysis of each sight, and calculate the best fix with latitude/longitude readout.

In using a calculator for any navigational task, it is important to remember that the accuracy of the result, even if carried out many decimal places, is only as good as the least accurate entry. If a sextant observation is taken to an accuracy of only a minute, that is the best accuracy of the final

solution, regardless the calculator's ability to solve to 12 decimal places. See Chapter 3 - Navigational Error in Volume II for a discussion of the sources of error in navigation.

Some basic calculators require the conversion of degrees, minutes and seconds (or tenths) to decimal degrees before solution. A good navigational calculator, however, should permit entry of degrees, minutes and tenths of minutes directly, and should do conversions automatically. Though many non-navigational computer programs have an on-screen calculator, they are generally very simple versions with only the four basic arithmetical functions. They are thus too simple for complex navigational problems. Conversely, a good navigational computer program requires no calculator per se, since the desired answer is calculated automatically from the entered data.

The following articles discuss calculations involved in various aspects of navigation.

#### 402. Calculations of Piloting

- **Hull speed in knots** is found by:

$$S = 1.34\sqrt{\text{waterline length (in feet)}}$$

This is an approximate value which varies with hull shape.

- **Nautical and U.S. survey miles** can be interconverted by the relationships:

$$1 \text{ nautical mile} = 1.15077945 \text{ U.S. survey miles.}$$

$$1 \text{ U.S. survey mile} = 0.86897624 \text{ nautical miles.}$$

- **The speed of a vessel over a measured mile** can be calculated by the formula:

$$S = \frac{3600}{T}$$

where S is the speed in knots and T is the time in seconds.

- **The distance traveled at a given speed** is computed

by the formula:

$$D = \frac{ST}{60}$$

where D is the distance in nautical miles, S is the speed in knots, and T is the time in minutes.

- Distance to the visible horizon in nautical miles can be calculated using the formula:

$$D = 1.17 \sqrt{h_f} \text{ , or}$$

$$D = 2.07 \sqrt{h_m}$$

depending upon whether the height of eye of the observer above sea level is in feet ( $h_f$ ) or in meters ( $h_m$ ).

- Dip of the visible horizon in minutes of arc can be calculated using the formula:

$$D = 0.97' \sqrt{h_f} \text{ , or}$$

$$D = 1.76' \sqrt{h_m}$$

depending upon whether the height of eye of the observer above sea level is in feet ( $h_f$ ) or in meters ( $h_m$ )

- Distance to the radar horizon in nautical miles can be calculated using the formula:

$$D = 1.22 \sqrt{h_f} \text{ , or}$$

$$D = 2.21 \sqrt{h_m}$$

depending upon whether the height of the antenna above sea level is in feet ( $h_f$ ) or in meters ( $h_m$ ).

- Dip of the sea short of the horizon can be calculated using the formula:

$$Ds = 60 \tan^{-1} \left( \frac{h_f}{6076.1 d_s} + \frac{d_s}{8268} \right)$$

where Ds is the dip short of the horizon in minutes of arc;  $h_f$  is the height of eye of the observer above sea level, in feet and  $d_s$  is the distance to the waterline of the object in nautical miles.

- Distance by vertical angle between the waterline and the top of an object is computed by solving the right triangle formed between the observer, the top of the object, and the waterline of the object by simple trigonometry. This assumes that the observer is at sea

level, the Earth is flat between observer and object, there is no refraction, and the object and its waterline form a right angle. For most cases of practical significance, these assumptions produce no large errors.

$$D = \sqrt{\frac{\tan^2 a}{0.0002419^2} + \frac{H-h}{0.7349}} - \frac{\tan a}{0.0002419}$$

where D is the distance in nautical miles, a is the corrected vertical angle, H is the height of the top of the object above sea level, and h is the observer's height of eye in feet. The constants (0.0002419 and 0.7349) account for refraction.

**403. Tide Calculations**

- The rise and fall of a diurnal tide can be roughly calculated from the following table, which shows the fraction of the total range the tide rises or falls during flood or ebb.

| Hour | Amount of flood/ebb |
|------|---------------------|
| 1    | 1/12                |
| 2    | 2/12                |
| 3    | 3/12                |
| 4    | 3/12                |
| 5    | 2/12                |
| 6    | 1/12                |

**404. Calculations of Celestial Navigation**

Unlike sight reduction by tables, sight reduction by calculator permits the use of nonintegral values of latitude of the observer, and LHA and declination of the celestial body. Interpolation is not needed, and the sights can be readily reduced from any assumed position. Simultaneous, or nearly simultaneous, observations can be reduced using a single assumed position. Using the observer's DR or MPP for the assumed longitude usually provides a better representation of the circle of equal altitude, particularly at high observed altitudes.

- The dip correction is computed in the *Nautical Almanac* using the formula:

$$D = 0.97 \sqrt{h}$$

where dip is in minutes of arc and h is height of eye in feet. This correction includes a factor for refraction. The *Air Almanac* uses a different formula intended for air navigation. The differences are of no significance in practical navigation.

- **The computed altitude (Hc)** is calculated using the basic formula for solution of the undivided navigational triangle:

$$\sin h = \sin L \sin d + \cos L \cos d \cos LHA,$$

in which h is the altitude to be computed (Hc), L is the latitude of the assumed position, d is the declination of the celestial body, and LHA is the local hour angle of the body. Meridian angle (*t*) can be substituted for LHA in the basic formula.

Restated in terms of the inverse trigonometric function:

$$Hc = \sin^{-1}[(\sin L \sin d) + (\cos L \cos d \cos LHA)].$$

When latitude and declination are of contrary name, declination is treated as a negative quantity. No special sign convention is required for the local hour angle, as in the following azimuth angle calculations.

- **The azimuth angle (Z)** can be calculated using the altitude azimuth formula if the altitude is known. The formula stated in terms of the inverse trigonometric function is:

$$Z = \cos^{-1}\left(\frac{\sin d - (\sin L \sin Hc)}{(\cos L \cos Hc)}\right)$$

If the altitude is unknown or a solution independent of altitude is required, the azimuth angle can be calculated using the time azimuth formula:

$$Z = \tan^{-1}\left(\frac{\sin LHA}{(\cos L \tan d) - (\sin L \cos LHA)}\right)$$

The sign conventions used in the calculations of both azimuth formulas are as follows: (1) if latitude and declination are of contrary name, declination is treated as a negative quantity; (2) if the local hour angle is greater than 180°, it is treated as a negative quantity.

If the azimuth angle as calculated is negative, add 180° to obtain the desired value.

- **Amplitudes** can be computed using the formula:

$$A = \sin^{-1}(\sin d \sec L)$$

this can be stated as

$$A = \sin^{-1}\left(\frac{\sin d}{\cos L}\right)$$

where A is the arc of the horizon between the prime vertical and the body, L is the latitude at the point of observation, and d is the declination of the celestial body.

#### 405. Calculations of the Sailings

- **Plane sailing** is based on the assumption that the meridian through the point of departure, the parallel through the destination, and the course line form a plane right triangle, as shown in Figure 405.

$$\text{From this: } \cos C = \frac{1}{D}, \sin C = \frac{p}{D}, \text{ and } \tan C = \frac{p}{1}.$$

$$\text{From this: } 1 = D \cos C, D = 1 \sec C, \text{ and } p = D \sin C.$$

From this, given course and distance (C and D), the difference of latitude (l) and departure (p) can be found, and given the latter, the former can be found, using simple trigonometry. See Chapter 12 - The Sailings, Volume I.

- **Traverse sailing** combines plane sailings with two or more courses, computing course and distance along a series of rhumb lines. See Chapter 12 - The Sailings, Volume I.

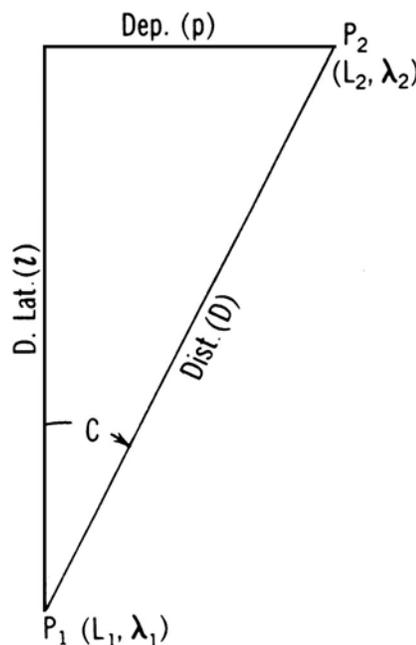


Figure 405. The plane sailing triangle.

- **Parallel sailing** consists of interconverting departure and difference of longitude. Refer to Figure 405.

$$DLo = p \sec L, \text{ and } p = DLo \cos L$$

- **Mid-latitude sailing** combines plane and parallel sailing, with certain assumptions. The mean latitude (Lm) is half of the arithmetical sum of the latitudes of two places on the same side of the equator. For places on

opposite sides of the equator, the N and S portions are solved separately.

In mid-latitude sailing:

$$DLo = p \sec Lm, \text{ and } p = DLo \cos Lm$$

$$DLo_v = \sin^{-1} \left( \frac{\cos C}{\sin L_v} \right).$$

- **Mercator Sailing** problems are solved graphically on a Mercator chart. For mathematical Mercator solutions the formulas are:

$$\tan C = \frac{DLo}{m} \text{ or } DLo = m \tan C$$

where m is the meridional part from Table 6 in the Tables Part of this volume. Following solution of the course angle by Mercator sailing, the distance is by the plane sailing formula:

$$D = l \sec C.$$

- **Great-circle solutions for distance and initial course angle** can be calculated from the formulas:

$$D = \cos^{-1} [(\sin L_1 \sin L_2 + \cos L_1 \cos L_2 \cos DLo)],$$

and

$$C = \tan^{-1} \left( \frac{\sin DLo}{(\cos L_1 \tan L_2) - (\sin L_1 \cos DLo)} \right)$$

where D is the great-circle distance, C is the initial great-circle course angle,  $L_1$  is the latitude of the point of departure,  $L_2$  is the latitude of the destination, and DLo is the difference of longitude of the points of departure and destination. If the name of the latitude of the destination is contrary to that of the point of departure, it is treated as a negative quantity.

- **The latitude of the vertex,  $L_v$ ,** is always numerically equal to or greater than  $L_1$  or  $L_2$ . If the initial course angle C is less than  $90^\circ$ , the vertex is toward  $L_2$ , but if C is greater than  $90^\circ$ , the nearer vertex is in the opposite direction. The vertex nearer  $L_1$  has the same name as  $L_1$ .

The latitude of the vertex can be calculated from the formula:

$$L_v = \cos^{-1}(\cos L_1 \sin C)$$

The difference of longitude of the vertex and the point of departure ( $DLo_v$ ) can be calculated from the formula: The distance from the point of departure to the vertex

( $D_v$ ) can be calculated from the formula:

$$D_v = \sin^{-1}(\cos L_1 \sin DLo_v).$$

- **The latitudes of points on the great-circle track** can be determined for equal DLo intervals each side of the vertex ( $DLo_{vx}$ ) using the formula:

$$L_x = \tan^{-1}(\cos DLo_{vx} \tan L_v)$$

The  $DLo_v$  and  $D_v$  of the nearer vertex are never greater than  $90^\circ$ . However, when  $L_1$  and  $L_2$  are of contrary name, the other vertex,  $180^\circ$  away, may be the better one to use in the solution for points on the great-circle track if it is nearer the mid point of the track.

The method of selecting the longitude (or  $DLo_{vx}$ ), and determining the latitude at which the great-circle crosses the selected meridian, provides shorter legs in higher latitudes and longer legs in lower latitudes. Points at desired distances or desired equal intervals of distance on the great-circle from the vertex ( $D_{vx}$ ) can be calculated using the formulas:

$$L_x = \sin^{-1} [\sin L_v \cos D_{vx}],$$

and

$$DLo_{vx} = \sin^{-1} \left( \frac{\sin D_{vx}}{\cos L_x} \right).$$

A calculator which converts rectangular to polar coordinates provides easy solutions to plane sailings. However, the user must know whether the difference of latitude corresponds to the calculator's X-coordinate or to the Y-coordinate.

#### 406. Calculations of Meteorology and Oceanography

- **Converting thermometer scales** between centigrade, Fahrenheit, and Kelvin scales can be done using the

following formulas:

$$C^{\circ} = \frac{5(F^{\circ} - 32^{\circ})}{9},$$

$$F^{\circ} = \frac{9}{5}C^{\circ} + 32^{\circ}, \text{ and}$$

$$K^{\circ} = C^{\circ} + 273.15^{\circ}.$$

- **Maximum length of sea waves** can be found by the

formula:

$$W = 1.5 \sqrt{\text{fetch in nautical miles}}.$$

- **Wave height** = 0.026 S<sup>2</sup> where S is the wind speed in knots.

- **Wave speed** in knots

$$= 1.34 \sqrt{\text{wavelength in feet}}, \text{ or}$$

$$= 3.03 \sqrt{\text{wave period in seconds}}.$$

## UNIT CONVERSION

Use the conversion tables that appear on the following pages to convert between different systems of units. Conversions followed by an asterisk \* are exact relationships.

### MISCELLANEOUS DATA

#### Area

|                         |       |                                     |
|-------------------------|-------|-------------------------------------|
| 1 square inch           | ----- | = 6.4516 square centimeters*        |
| 1 square foot           | ----- | = 144 square inches*                |
|                         |       | = 0.09290304 square meter*          |
|                         |       | = 0.000022957 acre                  |
| 1 square yard           | ----- | = 9 square feet*                    |
|                         |       | = 0.83612736 square meter           |
| 1 square (statute) mile | ----- | = 27,878,400 square feet*           |
|                         |       | = 640 acres*                        |
|                         |       | = 2.589988110336 square kilometers* |
| 1 square centimeter     | ----- | = 0.1550003 square inch             |
|                         |       | = 0.00107639 square foot            |
| 1 square meter          | ----- | = 10.76391 square feet              |
|                         |       | = 1.19599005 square yards           |
| 1 square kilometer      | ----- | = 247.1053815 acres                 |
|                         |       | = 0.38610216 square statute mile    |
|                         |       | = 0.29155335 square nautical mile   |

#### Astronomy

|                   |       |  |
|-------------------|-------|--|
| 1 mean solar unit | ----- | = 1.00273791 sidereal units  |
| 1 sidereal unit   | ----- | = 0.99726957 mean solar units  |
| 1 microsecond     | ----- | = 0.000001 second*   |
| 1 second          | ----- | = 1,000,000 microseconds*  |
|                   |       | = 0.01666667 minute  |
|                   |       | = 0.00027778 hour  |
|                   |       | = 0.00001157 day   |
| 1 minute          | ----- | = 60 seconds*  |
|                   |       | = 0.01666667 hour  |
|                   |       | = 0.00069444 day   |
| 1 hour            | ----- | = 3,600 seconds*   |
|                   |       | = 60 minutes*  |
|                   |       | = 0.04166667 day   |
| 1 mean solar day  | ----- | = 24 <sup>h</sup> 03 <sup>m</sup> 56 <sup>s</sup> .55536 of mean sidereal time |
|                   |       | = 1 rotation of Earth with respect to Sun (mean)*                              |
|                   |       | = 1.00273791 rotations of Earth  |
|                   |       | with respect to vernal equinox (mean)  |
|                   |       | = 1.0027378118868 rotations of Earth   |
|                   |       | with respect to stars (mean)   |

|  |  |
|--|--|
| 1 mean sidereal day                        | = 23 <sup>h</sup> 56 <sup>m</sup> 04 <sup>s</sup> .09054 of mean solar time  |
| 1 sidereal month                           | = 27.321661 days<br>= 27 <sup>d</sup> 07 <sup>h</sup> 43 <sup>m</sup> 11 <sup>s</sup> .5   |
| 1 synodical month                          | = 29.530588 days<br>= 29 <sup>d</sup> 12 <sup>h</sup> 44 <sup>m</sup> 02 <sup>s</sup> .8   |
| 1 tropical (ordinary) year                 | = 31,556,925.975 seconds<br>= 525,948.766 minutes<br>= 8,765.8128 hours<br>= 365 <sup>d</sup> .24219879 – 0 <sup>d</sup> .0000000614( <i>t</i> –1900),<br>where <i>t</i> = the year (date)<br>= 365 <sup>d</sup> 05 <sup>h</sup> 48 <sup>m</sup> 46 <sup>s</sup> (–) 0 <sup>s</sup> .0053( <i>t</i> –1900) |
| 1 sidereal year                            | = 365 <sup>d</sup> .25636042 + 0.0000000011( <i>t</i> –1900),<br>where <i>t</i> = the year (date)<br>= 365 <sup>d</sup> 06 <sup>h</sup> 09 <sup>m</sup> 09 <sup>s</sup> .5 (+) 0 <sup>s</sup> .0001( <i>t</i> –1900)   |
| 1 calendar year (common)                   | = 31,536,000 seconds*<br>= 525,600 minutes*<br>= 8,760 hours*<br>= 365 days*   |
| 1 calendar year (leap)                     | = 31,622,400 seconds*<br>= 527,040 minutes*<br>= 8,784 hours*<br>= 366 days  |
| 1 light-year                               | = 9,460,000,000,000 kilometers<br>= 5,880,000,000,000 statute miles<br>= 5,110,000,000,000 nautical miles<br>= 63,240 astronomical units<br>= 0.3066 parsecs   |
| 1 parsec                                   | = 30,860,000,000,000 kilometers<br>= 19,170,000,000,000 statute miles<br>= 16,660,000,000,000 nautical miles<br>= 206,300 astronomical units<br>= 3.262 light years  |
| 1 astronomical unit                        | = 149,600,000 kilometers<br>= 92,960,000 statute miles<br>= 80,780,000 nautical miles<br>= 499 <sup>s</sup> .012 light-time<br>= mean distance, Earth to Sun   |
| Mean distance, Earth to Moon               | = 384,400 kilometers<br>= 238,855 statute miles<br>= 207,559 nautical miles  |
| Mean distance, Earth to Sun                | = 149,600,000 kilometers<br>= 92,957,000 statute miles<br>= 80,780,000 nautical miles<br>= 1 astronomical unit   |
| Sun's diameter                             | = 1,392,000 kilometers<br>= 865,000 statute miles<br>= 752,000 nautical miles  |
| Sun's mass                                 | = 1,987,000,000,000,000,000,000,000,000 grams<br>= 2,200,000,000,000,000,000,000,000,000 short tons<br>= 2,000,000,000,000,000,000,000,000,000 long tons   |
| Speed of Sun relative to neighboring stars | = 19.4 kilometers per second<br>= 12.1 statute miles per second<br>= 10.5 nautical miles per second  |
| Orbital speed of Earth                     | = 29.8 kilometers per second<br>= 18.5 statute miles per second<br>= 16.1 nautical miles per second  |
| Obliquity of the ecliptic                  | = 23°27'08".26 – 0".4684 ( <i>t</i> –1900),<br>where <i>t</i> = the year (date)  |
| General precession of the equinoxes        | = 50".2564 + 0".000222 ( <i>t</i> –1900), per year,<br>where <i>t</i> = the year (date)  |

Precession of the equinoxes in right ascension \_ =  $46''.0850 + 0''.000279 (t-1900)$ , per year,  
 where  $t$  = the year (date)

Precession of the equinoxes in declination \_ \_ =  $20''.0468 - 0''.000085 (t-1900)$ , per year,  
 where  $t$  = the year (date)

Magnitude ratio \_ \_ \_ \_ \_ = 2.512  
 =  $\sqrt[5]{100}$ \*

**Charts**

Nautical miles per inch \_ \_ \_ \_ \_ = reciprocal of natural scale 72,913.39

Statute miles per inch \_ \_ \_ \_ \_ = reciprocal of natural scale 63,360\*

Inches per nautical mile \_ \_ \_ \_ \_ = 72,913.39 natural scale

Inches per statute mile \_ \_ \_ \_ \_ = 63,360 natural scale\*

Natural scale \_ \_ \_ \_ \_ = 1:72,913.39 nautical miles per inch  
 = 1:63,360 statute miles per inch\*

**Earth**

Acceleration due to gravity (standard) \_ \_ \_ \_ = 980.665 centimeters per second per second  
 = 32.1740 feet per second per second

Mass-ratio—Sun/Earth \_ \_ \_ \_ \_ = 332,958

Mass-ratio—Sun/(Earth & Moon) \_ \_ \_ \_ \_ = 328,912

Mass-ratio—Earth/Moon \_ \_ \_ \_ \_ = 81.30

Mean density \_ \_ \_ \_ \_ = 5.517 grams per cubic centimeter

Velocity of escape \_ \_ \_ \_ \_ = 6.94 statute miles per second

Curvature of surface \_ \_ \_ \_ \_ = 0.8 foot per nautical mile

*World Geodetic System (WGS) Ellipsoid of 1984*

Equatorial radius (a) \_ \_ \_ \_ \_ = 6,378,137 meters  
 = 3,443.918 nautical miles

Polar radius (b) \_ \_ \_ \_ \_ = 6,356,752.314 meters  
 = 3432.372 nautical miles

Mean radius (2a + b)/3 \_ \_ \_ \_ \_ = 6,371,008.770 meters  
 = 3440.069 nautical miles

Flattening or ellipticity (f = 1 - b/a) \_ \_ \_ \_ \_ = 1/298.257223563  
 = 0.003352811

Eccentricity (e = (2f - f<sup>2</sup>)<sup>1/2</sup>) \_ \_ \_ \_ \_ = 0.081819191

Eccentricity squared (e<sup>2</sup>) \_ \_ \_ \_ \_ = 0.006694380

**Length**

1 inch \_ \_ \_ \_ \_ = 25.4 millimeters\*  
 = 2.54 centimeters\*

1 foot (U.S.) \_ \_ \_ \_ \_ = 12 inches\*  
 = 1 British foot  
 = 1/3 yard\*  
 = 0.3048 meter\*  
 = 1/6 fathom\*

1 foot (U.S. Survey) \_ \_ \_ \_ \_ = 0.30480061 meter

1 yard \_ \_ \_ \_ \_ = 36 inches\*  
 = 3 feet\*  
 = 0.9144 meter\*

1 fathom \_ \_ \_ \_ \_ = 6 feet\*  
 = 2 yards\*  
 = 1.8288 meters\*

1 cable \_ \_ \_ \_ \_ = 720 feet\*  
 = 240 yards\*  
 = 219.4560 meters\*

1 cable (British) \_ \_ \_ \_ \_ = 0.1 nautical mile

1 statute mile \_ \_ \_ \_ \_ = 5,280 feet\*  
 = 1,760 yards\*  
 = 1,609.344 meters\*  
 = 1.609344 kilometers\*  
 = 0.86897624 nautical mile

|                 |                             |
|-----------------|-----------------------------|
| 1 nautical mile | = 6,076.11548556 feet       |
|                 | = 2,025.37182852 yards      |
|                 | = 1,852 meters*             |
|                 | = 1.852 kilometers*         |
|                 | = 1.150779448 statute miles |
| 1 meter         | = 100 centimeters*          |
|                 | = 39.370079 inches          |
|                 | = 3.28083990 feet           |
|                 | = 1.09361330 yards          |
|                 | = 0.54680665 fathom         |
|                 | = 0.00062137 statute mile   |
|                 | = 0.00053996 nautical mile  |
| 1 kilometer     | = 3,280.83990 feet          |
|                 | = 1,093.61330 yards         |
|                 | = 1,000 meters*             |
|                 | = 0.62137119 statute mile   |
|                 | = 0.53995680 nautical mile  |

**Mass**

|              |                             |
|--------------|-----------------------------|
| 1 ounce      | = 437.5 grains*             |
|              | = 28.349523125 grams*       |
|              | = 0.0625 pound*             |
|              | = 0.028349523125 kilogram*  |
| 1 pound      | = 7,000 grains*             |
|              | = 16 ounces*                |
|              | = 0.45359237 kilogram*      |
| 1 short ton  | = 2,000 pounds*             |
|              | = 907.18474 kilograms*      |
|              | = 0.90718474 metric ton*    |
|              | = 0.8928571 long ton        |
| 1 long ton   | = 2,240 pounds*             |
|              | = 1,016.0469088 kilograms*  |
|              | = 1.12 short tons*          |
|              | = 1.0160469088 metric tons* |
| 1 kilogram   | = 2.204623 pounds           |
|              | = 0.00110231 short ton      |
|              | = 0.0009842065 long ton     |
| 1 metric ton | = 2,204.623 pounds          |
|              | = 1,000 kilograms*          |
|              | = 1.102311 short tons       |
|              | = 0.9842065 long ton        |

**Mathematics**

|   |  |
|---|--|
| $\pi$   | = 3.1415926535897932384626433832795028841971 |
| $\pi^2$                                       | = 9.8696044011                               |
| $\sqrt{\pi}$                                  | = 1.7724538509                               |
| Base of Naperian logarithms (e)               | = 2.718281828459                             |
| Modulus of common logarithms ( $\log_{10}e$ ) | = 0.4342944819032518                         |
| 1 radian                                      | = 206,264".80625                             |
|   | = 3,437'.7467707849                          |
|   | = 57°.2957795131                             |
|   | = 57°17'44".80625                            |
| 1 circle                                      | = 1,296,000"*                                |
|   | = 21,600"*                                   |
|   | = 360°*                                      |
|   | = 2 $\pi$ radians*                           |
| 180°  | = $\pi$ radians*                             |
| 1°  | = 3600"*                                     |
|   | = 60'*                                       |
|   | = 0.0174532925199432957666 radian            |
| 1'  | = 60"*                                       |
|   | = 0.000290888208665721596 radian             |
| 1"  | = 0.000004848136811095359933 radian          |
| Sine of 1'                                    | = 0.00029088820456342460                     |
| Sine of 1"                                    | = 0.00000484813681107637                     |

**Meteorology**

|  |   |
|--|---|
| Atmosphere (dry air)                       |   |
| Nitrogen                                   | = 78.08% } 99.99%                                 |
| Oxygen                                     | = 20.95% }  |
| Argon                                      | = 0.93% }   |
| Carbon dioxide                             | = 0.03% }   |
| Neon                                       | = 0.0018%   |
| Helium                                     | = 0.000524%                                       |
| Krypton                                    | = 0.0001%   |
| Hydrogen                                   | = 0.00005%  |
| Xenon                                      | = 0.0000087%                                      |
| Ozone                                      | = 0 to 0.000007% (increasing with altitude)       |
| Radon                                      | = 0.00000000000000006% (decreasing with altitude) |
| Standard atmospheric pressure at sea level |   |
|  | = 1,013.250 dynes per square centimeter           |
|  | = 1,033.227 grams per square centimeter           |
|  | = 1,033.227 centimeters of water                  |
|  | = 1,013.250 hectopascals (millibars)*             |
|  | = 760 millimeters of mercury                      |
|  | = 76 centimeters of mercury                       |
|  | = 33.8985 feet of water                           |
|  | = 29.92126 inches of mercury                      |
|  | = 14.6960 pounds per square inch                  |
|  | = 1.033227 kilograms per square centimeter        |
|  | = 1.013250 bars*                                  |
| Absolute zero                              | = (-)273.16°C                                     |
|  | = (-)459.69°F                                     |

**Pressure**

|                              |  |
|------------------------------|--|
| 1 dyne per square centimeter | = 0.001 hectopascal (millibar)*<br>= 0.000001 bar*   |
| 1 gram per square centimeter | = 1 centimeter of water<br>= 0.980665 hectopascal (millibar)*<br>= 0.07355592 centimeter of mercury<br>= 0.0289590 inch of mercury<br>= 0.0142233 pound per square inch<br>= 0.001 kilogram per square centimeter*<br>= 0.000967841 atmosphere                       |
| 1 hectopascal (millibar)     | = 1,000 dynes per square centimeter*<br>= 1.01971621 grams per square centimeter<br>= 0.7500617 millimeter of mercury<br>= 0.03345526 foot of water<br>= 0.02952998 inch of mercury<br>= 0.01450377 pound per square inch<br>= 0.001 bar*<br>= 0.00098692 atmosphere |
| 1 millimeter of mercury      | = 1.35951 grams per square centimeter<br>= 1.3332237 hectopascals (millibars)<br>= 0.1 centimeter of mercury*<br>= 0.04460334 foot of water<br>= 0.039370079 inch of mercury<br>= 0.01933677 pound per square inch<br>= 0.001315790 atmosphere                       |
| 1 centimeter of mercury      | = 10 millimeters of mercury*   |
| 1 inch of mercury            | = 34.53155 grams per square centimeter<br>= 33.86389 hectopascals (millibars)<br>= 25.4 millimeters of mercury*<br>= 1.132925 feet of water<br>= 0.4911541 pound per square inch<br>= 0.03342106 atmosphere  |
| 1 centimeter of water        | = 1 gram per square centimeter<br>= 0.001 kilogram per square centimeter   |
| 1 foot of water              | = 30.48000 grams per square centimeter<br>= 29.89067 hectopascals (millibars)<br>= 2.241985 centimeters of mercury<br>= 0.882671 inch of mercury<br>= 0.4335275 pound per square inch<br>= 0.02949980 atmosphere   |

|  |   |
|--|---|
| 1 pound per square inch_ _ _ _ _           | = 68,947.57 dynes per square centimeter<br>= 70.30696 grams per square centimeter<br>= 70.30696 centimeters of water<br>= 68.94757 hectopascals (millibars)<br>= 51.71493 millimeters of mercury<br>= 5.171493 centimeters of mercury<br>= 2.306659 feet of water<br>= 2.036021 inches of mercury<br>= 0.07030696 kilogram per square centimeter<br>= 0.06894757 bar<br>= 0.06804596 atmosphere |
| 1 kilogram per square centimeter _ _ _ _ _ | = 1,000 grams per square centimeter*<br>= 1,000 centimeters of water  |
| 1 bar _ _ _ _ _                            | = 1,000,000 dynes per square centimeter*<br>= 1,000 hectopascals (millibars)*   |

**Speed**

|   |  |
|---|--|
| 1 foot per minute _ _ _ _ _   | = 0.01666667 foot per second<br>= 0.00508 meter per second*  |
| 1 yard per minute _ _ _ _ _   | = 3 feet per minute*<br>= 0.05 foot per second*<br>= 0.03409091 statute mile per hour<br>= 0.02962419 knot<br>= 0.01524 meter per second*  |
| 1 foot per second _ _ _ _ _   | = 60 feet per minute*<br>= 20 yards per minute*<br>= 1.09728 kilometers per hour*<br>= 0.68181818 statute mile per hour<br>= 0.59248380 knot<br>= 0.3048 meter per second*                               |
| 1 statute mile per hour _ _ _ _ _   | = 88 feet per minute*<br>= 29.33333333 yards per minute<br>= 1.609344 kilometers per hour*<br>= 1.46666667 feet per second<br>= 0.86897624 knot<br>= 0.44704 meter per second*                           |
| 1 knot _ _ _ _ _  | = 101.26859143 feet per minute<br>= 33.75619714 yards per minute<br>= 1.852 kilometers per hour*<br>= 1.68780986 feet per second<br>= 1.15077945 statute miles per hour<br>= 0.51444444 meter per second |
| 1 kilometer per hour _ _ _ _ _  | = 0.62137119 statute mile per hour<br>= 0.53995680 knot  |
| 1 meter per second_ _ _ _ _   | = 196.85039340 feet per minute<br>= 65.6167978 yards per minute<br>= 3.6 kilometers per hour*<br>= 3.28083990 feet per second<br>= 2.23693632 statute miles per hour<br>= 1.94384449 knots               |
| Light in vacuum_ _ _ _ _  | = 299,792.5 kilometers per second<br>= 186,282 statute miles per second<br>= 161,875 nautical miles per second<br>= 983.570 feet per microsecond   |
| Light in air _ _ _ _ _  | = 299,708 kilometers per second<br>= 186,230 statute miles per second<br>= 161,829 nautical miles per second<br>= 983.294 feet per microsecond   |
| Sound in dry air at 59°F or 15°C<br>and standard sea level pressure _ _ _ _ _ | = 1,116.45 feet per second<br>= 761.22 statute miles per hour<br>= 661.48 knots<br>= 340.29 meters per second  |

Sound in 3.485 percent saltwater at 60°F \_ \_ \_ = 4,945.37 feet per second  
 = 3,371.85 statute miles per hour  
 = 2,930.05 knots  
 = 1,507.35 meters per second

**Volume**

1 cubic inch \_ \_ \_ \_ \_ = 16.387064 cubic centimeters\*  
 = 0.016387064 liter\*  
 = 0.004329004 gallon

1 cubic foot \_ \_ \_ \_ \_ = 1,728 cubic inches\*  
 = 28.316846592 liters\*  
 = 7.480519 U.S. gallons  
 = 6.228822 imperial (British) gallons  
 = 0.028316846592 cubic meter\*

1 cubic yard \_ \_ \_ \_ \_ = 46,656 cubic inches\*  
 = 764.554857984 liters\*  
 = 201.974026 U.S. gallons  
 = 168.1782 imperial (British) gallons  
 = 27 cubic feet\*  
 = 0.764554857984 cubic meter\*

1 milliliter \_ \_ \_ \_ \_ = 0.06102374 cubic inch  
 = 0.0002641721 U.S. gallon  
 = 0.00021997 imperial (British) gallon

1 cubic meter \_ \_ \_ \_ \_ = 264.172035 U.S. gallons  
 = 219.96878 imperial (British) gallons  
 = 35.31467 cubic feet  
 = 1.307951 cubic yards

1 quart (U.S.) \_ \_ \_ \_ \_ = 57.75 cubic inches\*  
 = 32 fluid ounces\*  
 = 2 pints\*  
 = 0.9463529 liter  
 = 0.25 gallon\*

1 gallon (U.S.) \_ \_ \_ \_ \_ = 3,785.412 milliliters  
 = 231 cubic inches\*  
 = 0.1336806 cubic foot  
 = 4 quarts\*  
 = 3.785412 liters  
 = 0.8326725 imperial (British) gallon

1 liter \_ \_ \_ \_ \_ = 1,000 milliliters  
 = 61.02374 cubic inches  
 = 1.056688 quarts  
 = 0.2641721 gallon

1 register ton \_ \_ \_ \_ \_ = 100 cubic feet\*  
 = 2.8316846592 cubic meters\*

1 measurement ton \_ \_ \_ \_ \_ = 40 cubic feet\*  
 = 1 freight ton\*

1 freight ton \_ \_ \_ \_ \_ = 40 cubic feet\*  
 = 1 measurement ton\*

**Volume-Mass**

1 cubic foot of seawater \_ \_ \_ \_ \_ = 64 pounds  
 1 cubic foot of freshwater \_ \_ \_ \_ \_ = 62.428 pounds at temperature of maximum  
 density (4°C = 39°.2F)  
 1 cubic foot of ice \_ \_ \_ \_ \_ = 56 pounds  
 1 displacement ton \_ \_ \_ \_ \_ = 35 cubic feet of seawater\*  
 = 1 long ton

**Prefixes to Form Decimal Multiples and Sub-Multiples  
of International System of Units (SI)**

| Multiplying factor        |                     | Prefix | Symbol |
|---------------------------|---------------------|--------|--------|
| 1 000 000 000 000         | = 10 <sup>12</sup>  | tera   | T      |
| 1 000 000 000             | = 10 <sup>9</sup>   | giga   | G      |
| 1 000 000                 | = 10 <sup>6</sup>   | mega   | M      |
| 1 000                     | = 10 <sup>3</sup>   | kilo   | k      |
| 100                       | = 10 <sup>2</sup>   | hecto  | h      |
| 10                        | = 10 <sup>1</sup>   | deka   | da     |
| 0.1                       | = 10 <sup>-1</sup>  | deci   | d      |
| 0.01                      | = 10 <sup>-2</sup>  | centi  | c      |
| 0.001                     | = 10 <sup>-3</sup>  | milli  | m      |
| 0.000 001                 | = 10 <sup>-6</sup>  | micro  | μ      |
| 0.000 000 001             | = 10 <sup>-9</sup>  | nano   | n      |
| 0.000 000 000 001         | = 10 <sup>-12</sup> | pico   | p      |
| 0.000 000 000 000 001     | = 10 <sup>-15</sup> | femto  | f      |
| 0.000 000 000 000 000 001 | = 10 <sup>-18</sup> | atto   | a      |

### NGA MARITIME SAFETY INFORMATION NAUTICAL CALCULATORS

NGA's **Maritime Safety Office website** offers a variety of online Nautical Calculators for public use. These calculators solve many of the equations and conversions typically associated with marine navigation. See Figure 406.



*Figure 406. Link to NGA Nautical Calculators.*

[https://msi.nga.mil/NGAPortal/MSI.portal?\\_nfpb=true&\\_st=&\\_pageLabel=msi\\_portal\\_page\\_145](https://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_st=&_pageLabel=msi_portal_page_145)

**List of NGA Maritime Safety information Nautical Calculators** <https://msi.nga.mil>

|   |
|---|
| <b>Celestial Navigation Calculators</b>                       |
| Compass Error from Amplitudes Observed on the Visible Horizon |
| Altitude Correction for Air Temperature                       |
| Table of Offsets  |
| Latitude and Longitude Factors                                |
| Altitude Corrections for Atmospheric Pressure                 |
| Altitude Factors & Change of Altitude                         |

**List of NGA Maritime Safety information Nautical Calculators** <https://msi.nga.mil>

|   |
|---|
| Pub 229   |
| Compass Error from Amplitudes observed on the Celestial Horizon                               |
| <b>Conversion Calculators</b>   |
| Chart Scales and Conversions for Nautical and Statute Miles                                   |
| Conversions for Meters, Feet and Fathoms  |
| <b>Distance Calculators</b>   |
| Length of a Degree of Latitude and Longitude  |
| Speed for Measured Mile and Speed, Time and Distance  |
| Distance of an Object by Two Bearings   |
| Distance of the Horizon   |
| Distance by Vertical Angle Measured Between Sea Horizon and Top of Object Beyond Sea Horizon  |
| Traverse Table  |
| Geographic Range  |
| Distance by Vertical Angle Measured Between Waterline at Object and Top of Object             |
| Dip of Sea Short of the Horizon   |
| Distance by Vertical Angle Measured Between Waterline at Object and Sea Horizon Beyond Object |
| Meridional Parts  |
| <b>Log and Trig Calculators</b>   |
| Logarithmic and Trigonometric Functions   |
| <b>Sailings Calculators</b>   |
| Great Circle Sailing  |
| Mercator NGA Sailing  |
| <b>Time Zones Calculators</b>   |
| Time Zones, Zone Descriptions and Suffixes  |
| <b>Weather Data Calculators</b>   |
| Direction and Speed of True Wind  |
| Correction of Barometer Reading for Height Above Sea Level                                    |
| Correction of Barometer Reading for Gravity   |
| Temperature Conversions   |
| Relative Humidity and Dew Point   |
| Corrections of Barometer Reading for Temperature  |
| Barometer Measurement Conversions   |

# CHAPTER 5

## COMPASS CONVERSIONS

### INTRODUCTION

#### 500. Magnetic Compass Error

Directions relative to the northerly direction along a geographic meridian are **true**. In this case, true north is the **reference direction**. If a compass card is horizontal and oriented so that a straight line from its center to 000° points to true north, any direction measured by the card is a true direction and has no error (assuming there is no calibration or observational error). If the card remains horizontal but is rotated so that it points in any other direction, the amount of the rotation is the **compass error**. Stated differently, compass error is the angular difference between true north and **compass north** (the direction north as indicated by a magnetic compass). It is named east or west to indicate the side of true north on which compass north lies.

If a magnetic compass is influenced by no other magnetic field than that of the earth, and there is no instrumental error, its magnets are aligned with the magnetic meridian at the compass, and 000° of the compass card coincides with **magnetic north**. All directions indicated by the card are **magnetic**. As stated in volume I, the angle between geographic and magnetic meridians is called **variation (V or Var.)**. Therefore, if a compass is aligned with the magnetic meridian, compass error and variation are the same.

When a compass is mounted in a vessel, it is generally subjected to various magnetic influences other than that of the earth. These arise largely from induced magnetism in metal decks, bulkheads, masts, stacks, boat davits, guns, etc., and from electromagnetic fields associated with direct current in electrical circuits. Some metal in the vicinity of the compass may have acquired permanent magnetism. The actual magnetic field at the compass is the vector sum, or resultant of all individual fields at that point. Since the direction of this resultant field is generally not the same as that of the earth's field alone, the compass magnets do not lie in the magnetic meridian, but in a direction that makes an angle with it. This angle is called **deviation (D or Dev.)**. Thus, deviation is the angular difference between magnetic north and compass north. It is expressed in angular units and named east or west to indicate the side of magnetic north on which compass north lies. Thus, deviation is the error of the compass in pointing to magnetic north, and all directions measured with compass north as the reference direction are **compass directions**. Since variation and deviation may each be either east or west, the effect of deviation may be to either increase or decrease the error due

to variation alone. The algebraic sum of variation and deviation is the total compass error.

For computational purposes, deviation and compass error, like variation, may be designated positive (+) if east and negative (-) if west.

Variation changes with location. Deviation depends upon the magnetic latitude and also upon the individual vessel, its trim and loading, whether it is pitching or rolling, the heading (orientation of the vessel with respect to the earth's magnetic field), and the location of the compass within the vessel. Therefore, deviation is not published on charts. The effects of variation and deviation on the compass card is depicted in Figure 500.

#### 501. Deviation Table

In practice aboard ship, the deviation is reduced to a minimum through adjustment of the compass. The remaining value, called **residual deviation**, is determined on various headings and recorded in some form of **deviation table**. Figure 502 shows the form used by the United States Navy. This table is entered with the magnetic heading, and the deviation on that heading is determined from the tabulation, separate columns being given for degaussing (DG) equipment off and on. If the deviation is not more than about 2° on any heading, satisfactory results may be obtained by entering the values at intervals of 45° only.

If the deviation is small, no appreciable error is introduced by entering the table with either magnetic or compass heading. If the deviation on some headings is large, the desirable action is to reduce it, but if this is not practicable, a separate deviation table for compass heading entry may be useful. This may be made by applying the tabulated deviation to each entry value of magnetic heading, to find the corresponding compass heading, and then interpolating between these to find the value of deviation at each 15° compass heading.

#### 502. Applying Variation and Deviation

As indicated in Section 500, a single direction may have any of several numerical values depending upon the reference direction used. One should keep clearly in mind the relationship between the various expressions of a direction. Thus, true and magnetic directions differ by the

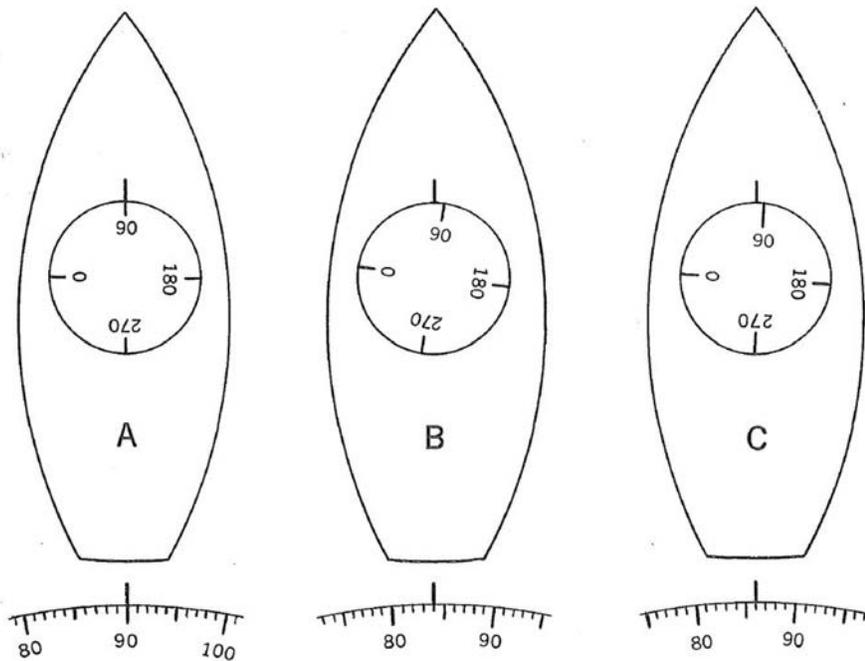


Figure 500. Effects of variation and deviation on the compass card.

variation, magnetic and compass directions differ by the deviation, and true and compass directions differ by the compass error.

If variation or deviation is easterly, the compass card is rotated in a clockwise direction. This brings smaller numbers opposite the lubber's line. Conversely, if either error is westerly, the rotation is counterclockwise and larger numbers are brought opposite the lubber's line. Thus, if the heading is  $090^\circ$  true (Figure 500, A) and variation is  $6^\circ$  E, the magnetic heading is  $090^\circ - 6^\circ = 084^\circ$  (Figure 500, B). If the deviation on this heading is  $2^\circ$  W, the compass heading is  $084^\circ + 2^\circ = 086^\circ$  (Figure 500, C). Also, compass error is  $6^\circ$  E -  $2^\circ$  W =  $4^\circ$  E, and compass heading is  $090^\circ - 4^\circ = 086^\circ$ . If compass error is easterly, the compass reads too low (in comparison with true directions), and if it is westerly, the reading is too high. Many rules-of-thumb have been devised as an aid to the memory, and any which assist in applying compass errors in the right direction are of value. However, one may forget the rule or its method of application, or may wish to have an independent check. If they understand the explanation given above, they can determine the correct sign without further information. The same rules apply to the use of gyro error. Since variation and deviation are compass errors, the process of removing either from an indication of a direction (converting compass to magnetic or magnetic to true) is often called **correcting**. Conversion in the opposite direction (inserting errors) is then called **uncorrecting**.

*Example.* - A vessel is on course  $215^\circ$  true in an area where the variation is  $7^\circ$  W. The deviation is as shown in Figure 502. Degaussing is off. The gyro error (GE) is  $1^\circ$  E. A lighthouse bears  $306.5^\circ$  by magnetic compass.

- Required.* - (1) Magnetic heading (MH).  
 (2) Deviation.  
 (3) Compass heading (CH).  
 (4) Compass error.  
 (5) Gyro heading.  
 (6) Magnetic bearing of the lighthouse.  
 (7) True bearing of the lighthouse.  
 (8) Relative bearing of the lighthouse.

*Solution.* -

|     |    |               |
|-----|----|---------------|
|     | TH | $215^\circ$   |
|     | V  | $7^\circ$ W   |
| (1) | MH | $222^\circ$   |
| (2) | D  | $1.5^\circ$ W |
| (3) | CH | $223.5^\circ$ |

The deviation is taken from the deviation table (Figure 502) to the nearest half degree.

(4) Compass error is  $7^\circ$  W +  $1.5^\circ$  W =  $8.5^\circ$  W.

|     |      |        |
|-----|------|--------|
|     | TH   | 215°   |
|     | GE   | 1°E    |
| (5) | Hpgc | 214°   |
|     | CB   | 306.5° |
|     | D    | 1.5°W  |
| (6) | MB   | 305°   |
|     | V    | 7°W    |
| (7) | TB   | 298°   |

Answers -

- (1) MH 222°
- (2) D 1.5W°
- (3) CH 223.5°
- (4) CE 8.5°W
- (5) Hpgc 214°
- (6) MB 305°
- (7) TB 298°
- (8) RB 083°

(8) RB=TB-TH=298°-215°= 083°.

| Problem 1 - Fill in the blanks to this table |     |      |     |     |     |      |
|--|-----|------|-----|-----|-----|------|
|  | TC  | V    | MC  | D   | CC  | CE   |
|  | °   | °    | °   | °   | °   | °    |
| (1)  | 105 | 15 E | -   | 5W  | -   | -    |
| (2)  | -   | -    | -   | 4 E | 215 | 14 E |
| (3)  | -   | 12 W | -   | -   | 067 | 7 W  |
| (4)  | 156 | -    | 166 | -   | 160 | -    |
| (5)  | 222 | -    | 216 | 3 W | -   | -    |
| (6)  | 009 | -    | 357 | -   | -   | 10 E |
| (7)  | -   | 2 W  | -   | 6 E | 015 | -    |
| (8)  | -   | -    | 210 | -   | 214 | 1 W  |

Answers to Problem 1.- (1) MC 090°, CC 095°, CE 10°E; (2) TC 229°, V 10°E, MC 219°; (3) TC 060°, MC 072°, D 5°E; (4) V 10°W, D 6°E, CE 4°W; (5) V 6°E, CC 219°, CE 3°E; (6) V 12°E, D 2°W, CC 359°; (7) TC 019°, MC 021°, CE 4°E; (8) TC 213°, V 3°E, D 4°W.

**Problem 2:** A vessel is on course 150° by compass in an area where the variation is 19°E. The deviation is as shown in Figure 502. Degaussing is on.

- Required. - (1) Deviation.  
 (2) Compass error.  
 (3) Magnetic heading.  
 (4) True heading.

Answers to Problem 2. - (1) D 1° E, (2) XE 20° E, (3) MH 151°, (4) TH 170°.

**Problem 3:** A vessel on a course of 055° by gyro and 041° by magnetic compass. The gyro error is 1° W. The variation is 15° E.

- Required. - The deviation on this heading.  
 Answer to Problem 3. - 2° W.

**Problem 4:** A vessel is on course 177° by gyro. The gyro error is 0.5° E. A beacon bears 088° by magnetic compass in an area where variation is 11° W. The deviation is as shown in Figure 502. degaussing off.

- Required. - The true bearing of the beacon.  
 Answer to Problem 4. - TB 076°.

**MAGNETIC COMPASS TABLE** NAVSHIPS RPT. 3530-2  
 NAVSHIPS 3120/4 (REV. 6-67) (FRONT) (Formerly NAVSHIPS 1104)  
 S/N 0105-601-9520

U. S. S. Truckee NO. AO 147  
(RR, CL, DD, etc.)

PILOT HOUSE  SECONDARY CORRECTING STATION  OTHER \_\_\_\_\_  
 BINNACLE TYPE:  NAVY ST'D  OTHER \_\_\_\_\_

COMPASS 7 1/2 MAKE Lionel SERIAL NO. 1592

TYPE CC COILS "K" DATE \_\_\_\_\_

**READ INSTRUCTIONS ON BACK BEFORE STARTING ADJUSTMENT**

| SHIPS HEAD MAGNETIC | DEVIATIONS |       | SHIPS HEAD MAGNETIC | DEVIATIONS |       |
|---------------------|------------|-------|---------------------|------------|-------|
|                     | DG OFF     | DG ON |                     | DG OFF     | DG ON |
| 0                   | 0.5E       | 0.5E  | 180                 | 0.5W       | 0.0   |
| 15                  | 1.0E       | 1.0E  | 195                 | 1.0W       | 0.5W  |
| 30                  | 1.5E       | 1.5E  | 210                 | 1.0W       | 1.0W  |
| 45                  | 2.0E       | 1.5E  | 225                 | 1.5W       | 1.5W  |
| 60                  | 2.0E       | 2.0E  | 240                 | 2.0W       | 2.0W  |
| 75                  | 2.5E       | 2.5E  | 255                 | 2.0W       | 2.5W  |
| 90                  | 2.5E       | 3.0E  | 270                 | 1.5W       | 2.0W  |
| 105                 | 2.0E       | 2.5E  | 285                 | 1.0W       | 1.5W  |
| 120                 | 1.5E       | 2.0E  | 300                 | 1.0W       | 1.0W  |
| 135                 | 1.5E       | 1.5E  | 315                 | 0.5W       | 0.5W  |
| 150                 | 1.0E       | 1.0E  | 330                 | 0.5W       | 0.5W  |
| 165                 | 0.0        | 0.5E  | 345                 | 0.0        | 0.0   |

DEVIATIONS DETERMINED BY:  SUN'S AZIMUTH  GYRO  SHORE BEARINGS

B 4 MAGNETS RED  FORE AT 14 " FROM COMPASS CARD  
 AFT

C 4 MAGNETS RED  PORT AT 10 " FROM COMPASS CARD  
 STBD

D 2-7"  SPHERES AT 12 "  ATHHART-SHIP  CLOCKWISE  
 CYLS  SLEWED  CTR. CLOCKWISE

HEELING MAGNET:  RED UP 10 " FROM COMPASS CARD FLINDERS BAR:  FORE 14 "  
 BLUE UP  AFT

LAT 36° 10' N  LONG 75° 20' W  
 H  Z

SIGNED (Adjuster or Navigator) T. PARRISH APPROVED (Commanding) R. MOSS

Figure 502. Deviation table.

# CHAPTER 6

## COMPASS ERROR

### DETERMINING COMPASS ERROR USING (PUB. NO. 229) SIGHT REDUCTION TABLES FOR MARINE NAVIGATION

#### 600. Compass Error

One of the more frequent applications of sight reduction tables is their use in computing the azimuth of a celestial body for comparison with an observed azimuth in order to determine the error of the compass. In computing the azimuth of a celestial body, for the time and place of observation, it is normally necessary to interpolate the tabular azimuth angle as extracted from the tables for the differences between the table arguments and the actual values of declination, latitude, and local hour angle. The required triple interpolation of the azimuth angle is effected as follows:

1. The main tables are entered with the nearest integral values of declination, latitude, and local hour angle; for these arguments, a base azimuth angle is extracted.
2. The tables are reentered with the same latitude and LHA arguments but with the declination argument  $1^\circ$  greater or less than the base declination argument depending upon whether the actual declination is greater or less than the base argument. The difference between the respondent azimuth angle and the base azimuth angle establishes the azimuth angle difference (Z Diff.) for the increment of declination.
3. The tables are reentered with the base declination and LHA arguments but with the latitude argument  $1^\circ$  greater or less than the base latitude argument depending upon whether the actual (usually DR) latitude is greater or less than the base argument to find the Z Diff. for the increment of latitude.
4. The tables are reentered with the base declination and latitude arguments, but with the LHA argument  $1^\circ$  greater or less than the base LHA argument depending upon whether the actual LHA is greater or less than the base argument to find the Z Diff. for the increment of LHA.
5. The correction to the base azimuth angle for each increment is Z Diff.  $\frac{\text{Inc.}}{60'}$ .

*Example.*-In DR Lat.  $13^\circ 24.0' \text{N}$ , the azimuth of the Sun is observed as  $070.3^\circ$  pgc. At the time of the observation, the declination of the Sun is  $20^\circ 13.8' \text{N}$ ; the local hour angle of the Sun is  $276^\circ 41.2'$ . The error of the gyrocompass is found as follows:

| Actual                           | Base Arguments    | Base Z       | Tab* Z       | Z Diff       | Increments | Correction<br>(Z Diff Inc. 60) |
|----------------------------------|-------------------|--------------|--------------|--------------|------------|--------------------------------|
| Dec. $20^\circ 13.8' \text{N}$   | $20^\circ$        | $71.8^\circ$ | $70.8^\circ$ | $-1.0^\circ$ | $13.8'$    | $-0.2^\circ$                   |
| DR Lat. $13^\circ 24.0 \text{N}$ | $13^\circ$ (Same) | $71.8^\circ$ | $71.9^\circ$ | $+0.1^\circ$ | $24.0'$    | $0.0^\circ$                    |
| LHA $276^\circ 41.2'$            | $277^\circ$       | $71.8^\circ$ | $71.6^\circ$ | $-0.2^\circ$ | $18.8'$    | $-0.1^\circ$                   |
| Base Z $71.8^\circ$              |                   |              |              |              |            | Total Corr. $-0.3^\circ$       |
| Corr. $(-) 0.3^\circ$            |                   |              |              |              |            |                                |
| Z $\text{N}71.5^\circ \text{E}$  |                   |              |              |              |            |                                |
| Zn $071.5^\circ$                 |                   |              |              |              |            |                                |
| Zn pgc $070.3^\circ$             |                   |              |              |              |            |                                |
| Gyro Error $1.2^\circ \text{E}$  |                   |              |              |              |            |                                |

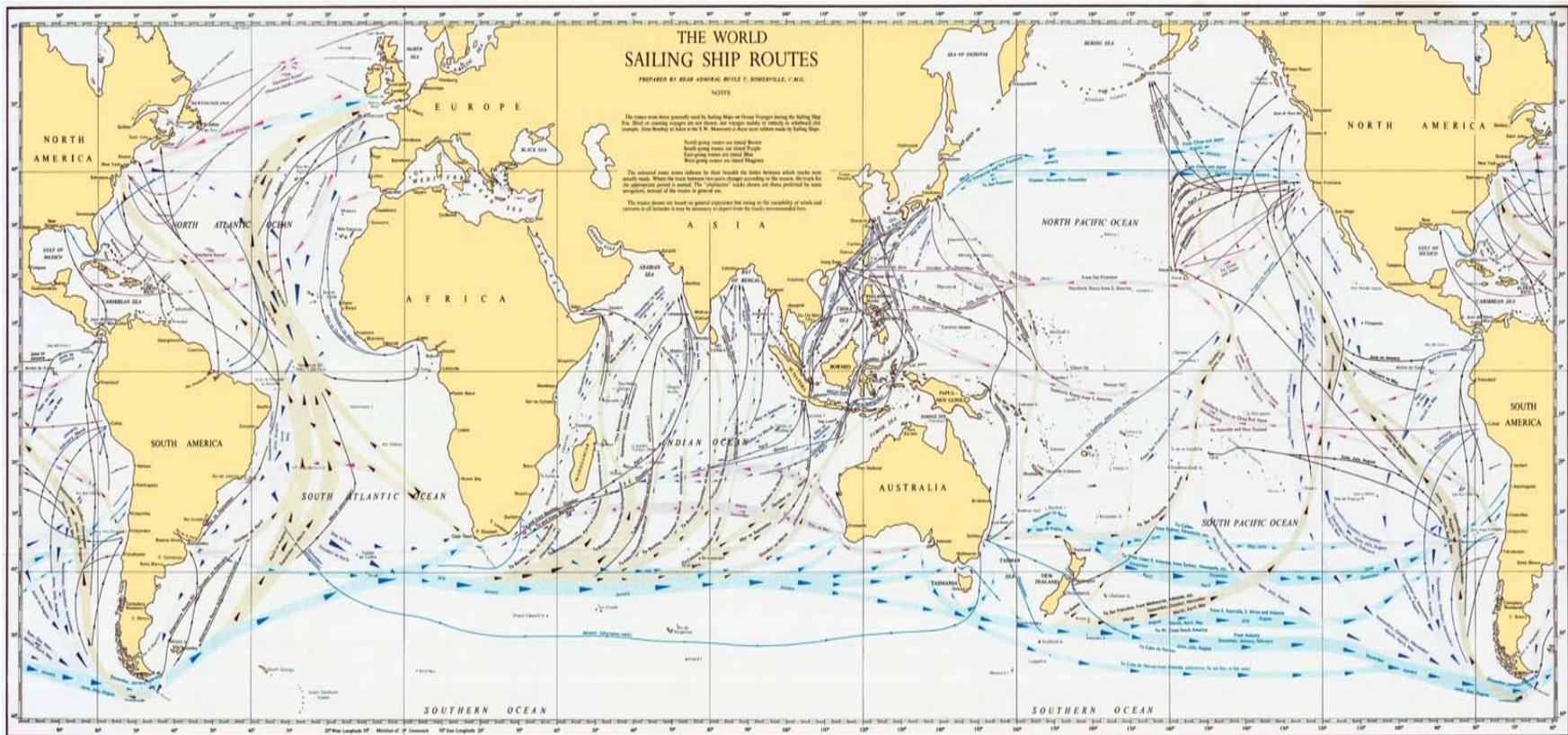
\* Respondent for two base arguments and  $1^\circ$  change from third base argument, in vertical order of Dec., DR Lat., and LHA.

## APPENDICES

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# APPENDIX A

## THE WORLD SAILING SHIP ROUTES (2017)











































































## APPENDIX C

# CONVERSION OF COMPASS POINTS TO DEGREES

| Conversion of Compass Points to Degrees |        |                    |               |        |                    |
|---|--------|--------------------|---------------|--------|--------------------|
|   | Points | Angular<br>measure |               | Points | Angular<br>measure |
| NORTH TO EAST                           |        | ° ' "              | SOUTH TO WEST |        | ° ' "              |
| North                                   | 0      | 0 00 00            | South         | 16     | 180 00 00          |
| N1/4E                                   | 1/4    | 2 48 45            | S1/4W         | 16 1/4 | 182 48 45          |
| N1/2E                                   | 1/2    | 5 37 30            | S1/2W         | 16 1/2 | 185 37 30          |
| N3/4E                                   | 3/4    | 8 26 15            | S3/4W         | 16 3/4 | 188 26 15          |
| N by E                                  | 1      | 11 15 00           | S by W        | 17     | 191 15 00          |
| N by E1/4E                              | 1 1/4  | 14 03 45           | S by W1/4W    | 17 1/4 | 194 03 45          |
| N by E1/2E                              | 1 1/2  | 16 52 30           | S by W1/2W    | 17 1/2 | 196 52 30          |
| N by E3/4E                              | 1 3/4  | 19 41 15           | S by W3/4W    | 17 3/4 | 199 41 15          |
| NNE                                     | 2      | 22 30 00           | SSW           | 18     | 202 30 00          |
| NNE1/4E                                 | 2 1/4  | 25 18 45           | SSW1/4W       | 18 1/4 | 205 18 45          |
| NNE1/2E                                 | 2 1/2  | 28 07 30           | SSW1/2W       | 18 1/2 | 208 07 30          |
| NNE3/4E                                 | 2 3/4  | 30 56 15           | SSW3/4W       | 18 3/4 | 210 56 15          |
| NE by N                                 | 3      | 33 45 00           | SW by S       | 19     | 213 45 00          |
| NE3/4N                                  | 3 1/4  | 36 33 45           | SW3/4S        | 19 1/4 | 216 33 45          |
| NE1/2N                                  | 3 1/2  | 39 22 30           | SW1/2S        | 19 1/2 | 219 22 30          |
| NE1/4N                                  | 3 3/4  | 42 11 15           | SW1/4S        | 19 3/4 | 222 11 15          |
| NE                                      | 4      | 45 00 00           | SW            | 20     | 225 00 00          |
| NE1/4E                                  | 4 1/4  | 47 48 45           | SW1/4W        | 20 1/4 | 227 48 45          |
| NE1/2E                                  | 4 1/2  | 50 37 30           | SW1/2W        | 20 1/2 | 230 37 30          |
| NE3/4E                                  | 4 3/4  | 53 26 15           | SW3/4W        | 20 3/4 | 233 26 15          |
| NE by E                                 | 5      | 56 15 00           | SW by W       | 21     | 236 15 00          |
| NE by E1/4E                             | 5 1/4  | 59 03 45           | SW by W1/4W   | 21 1/4 | 239 03 45          |
| NE by E1/2E                             | 5 1/2  | 61 52 30           | SW by W1/2W   | 21 1/2 | 241 52 30          |
| NE by E3/4E                             | 5 3/4  | 64 41 15           | SW by W3/4W   | 21 3/4 | 244 41 15          |
| ENE                                     | 6      | 67 30 00           | WSW           | 22     | 247 30 00          |
| ENE1/4E                                 | 6 1/4  | 70 18 45           | WSW1/4W       | 22 1/4 | 250 18 45          |
| ENE1/2E                                 | 6 1/2  | 73 07 30           | WSW1/2W       | 22 1/2 | 235 07 30          |
| ENE3/4E                                 | 6 3/4  | 75 56 15           | WSW3/4W       | 22 3/4 | 255 56 15          |
| E by N                                  | 7      | 78 45 00           | W by S        | 23     | 258 45 00          |
| E3/4N                                   | 7 1/4  | 81 33 45           | W3/4S         | 23 1/4 | 261 33 45          |

| Conversion of Compass Points to Degrees |        |           |               |        |           |
|---|--------|-----------|---------------|--------|-----------|
| E1/2N                                   | 7 1/2  | 84 22 30  | W1/2S         | 23 1/2 | 264 22 30 |
| E1/4N                                   | 7 3/4  | 87 11 15  | W1/4S         | 23 3/4 | 267 11 15 |
| EAST TO SOUTH                           |        |           | WEST TO NORTH |        |           |
| East                                    | 8      | 00 00 00  | West          | 24     | 270 00 00 |
| E1/4S                                   | 8 1/4  | 92 48 45  | W1/4N         | 24 1/4 | 272 48 45 |
| E1/2S                                   | 8 1/2  | 95 37 30  | W1/2N         | 24 1/2 | 275 37 30 |
| E3/4S                                   | 8 3/4  | 98 26 15  | W3/4N         | 24 3/4 | 278 26 15 |
| E by S                                  | 9      | 101 15 00 | W by N        | 25     | 281 15 00 |
| ESE3/4E                                 | 9 1/4  | 104 03 45 | WNW3/4W       | 25 1/4 | 284 03 45 |
| ESE1/2E                                 | 9 1/2  | 106 52 30 | WNW1/2W       | 25 1/2 | 286 52 30 |
| ESE1/4E                                 | 9 3/4  | 109 41 15 | WNW1/4W       | 25 3/4 | 289 41 15 |
| ESE                                     | 10     | 112 30 00 | WNW           | 26     | 292 30 00 |
| SE by E3/4E                             | 10 1/4 | 115 18 45 | NW by W3/4W   | 26 1/4 | 295 18 45 |
| SE by E1/2E                             | 10 1/2 | 118 07 30 | NW by W1/2W   | 26 1/2 | 298 07 30 |
| SE by E1/4E                             | 10 3/4 | 120 56 15 | NW by W1/4W   | 26 3/4 | 300 56 15 |
| SE by E                                 | 11     | 123 45 00 | NW by W       | 27     | 303 45 00 |
| SE3/4E                                  | 11 1/4 | 126 33 45 | NW3/4W        | 27 1/4 | 306 33 45 |
| SE1/2E                                  | 11 1/2 | 129 22 30 | NW1/2W        | 27 1/2 | 309 22 30 |
| SE1/4E                                  | 11 3/4 | 132 11 15 | NW1/4W        | 27 3/4 | 312 11 15 |
| SE                                      | 12     | 135 00 00 | NW            | 28     | 315 00 00 |
| SE1/4S                                  | 12 1/4 | 137 48 45 | NW1/4N        | 28 1/4 | 317 48 45 |
| SE1/2S                                  | 12 1/2 | 140 37 30 | NW1/2N        | 28 1/2 | 320 37 30 |
| SE3/4S                                  | 12 3/4 | 143 26 15 | NW3/4N        | 28 3/4 | 323 26 15 |
| SE by S                                 | 13     | 146 15 00 | NW by N       | 29     | 326 15 00 |
| SSE3/4E                                 | 13 1/4 | 149 03 45 | NNW3/4W       | 29 1/4 | 329 03 45 |
| SSE1/2E                                 | 13 1/2 | 151 52 30 | NNW1/2W       | 29 1/2 | 331 52 30 |
| SSE1/4E                                 | 13 3/4 | 154 41 15 | NNW1/4W       | 29 3/4 | 334 41 15 |
| SSE                                     | 14     | 157 30 00 | NNW           | 30     | 337 30 00 |
| S by E3/4E                              | 14 1/4 | 160 18 45 | N by W3/4W    | 30 1/4 | 340 18 45 |
| S by E1/2E                              | 14 1/2 | 163 07 30 | N by W1/2W    | 30 1/2 | 343 07 30 |
| S by E1/4E                              | 14 3/4 | 165 56 15 | N by W1/4W    | 30 3/4 | 345 56 15 |
| S by E                                  | 15     | 168 45 00 | N by W        | 31     | 348 45 00 |
| S3/4E                                   | 15 1/4 | 171 33 45 | N3/4W         | 31 1/4 | 351 33 45 |
| S1/2E                                   | 15 1/2 | 174 22 30 | N1/2W         | 31 1/2 | 354 22 30 |
| S1/4E                                   | 15 3/4 | 177 11 15 | N1/4W         | 31 3/4 | 357 11 15 |
| South                                   | 16     | 180 00 00 | North         | 32     | 360 00 00 |

# GLOSSARY OF MARINE NAVIGATION

## A

- abaft**, *adv.* In a direction farther aft in a ship than a specified reference position, such as abaft the mast. See also ABAFT THE BEAM, AFT, ASTERN.
- abaft the beam**. Any direction between broad on the beam and astern. See also FORWARD OF THE BEAM.
- abampere**, *n.* The unit of current in the centimeter-gram-second electro-magnetic system. The abampere is 10 amperes.
- abeam**, *adv.* In a line approximately at right angle to the ship's keel or centerline - opposite the waist or middle part of a ship. See also BROAD ON THE BEAM.
- aberration**, *n.* 1. The apparent displacement of a celestial body in the direction of motion of the earth in its orbit caused by the motion of the earth combined with the finite velocity of light. When, in addition to the combined effect of the velocity of light and the motion of the earth, account is taken of the motion of the celestial body in space during the interval that the light is traveling to the earth from the luminous body, as in the case of planets, the phenomenon is termed planetary aberration. The aberration due to the rotation of the earth on its axis is termed diurnal aberration or daily aberration. The aberration due to the revolution of the earth about the sun is termed annual aberration. The aberration due to the motion of the center of mass of the solar system in space is termed secular aberration but is not taken into account in practical astronomy. See also CONSTANT OF ABERRATION. 2. The convergence to different foci, by a lens or mirror, of parallel rays of light. In a single lens having spherical surfaces, aberration may be caused by differences in the focal lengths of the various parts of the lens: rays passing through the outer part of the lens come to a focus nearer the lens than do rays passing through its central part. This is termed spherical aberration and, being due to the faulty figure of the lens, is eliminated by correcting that figure. A lens so corrected is called an aplanatic lens. Aberration may also result from differences in the wavelengths of light of different colors: light of the shorter wavelengths (violet end of the spectrum) comes to a focus nearer the lens than light of the longer wavelengths (red end of the spectrum). This is termed chromatic aberration, and is practically eliminated over a moderate range of wavelengths by using a composite lens, called an achromatic lens, composed of parts having different dispersive powers.
- aberration constant**. . See CONSTANT OF ABERRATION.
- ablation**, *n.* Wasting of snow or ice by melting or evaporation.
- abnormal**, *adj.* Deviating from normal.
- abrasion**, *n.* Rubbing or wearing away, or the result of such action.
- abroholos**, *n.* A squall frequent from May through August between Cabo de Sao Tome and Cabo Frio on the coast of Brazil.
- abrupt**, *adv.* Steep, precipitous. See also BOLD.
- abscissa**, *n.* The horizontal coordinate of a set of rectangular coordinates. Also used in a similar sense in connection with oblique coordinates.
- absolute**. . Pertaining to measurement relative to a universal constant or natural datum.
- absolute accuracy**. . The ability of a navigation or positioning system to define an exact location in relation to a coordinate system.
- absolute gain**. . See ISOTROPIC GAIN (of an antenna).
- absolute humidity**. . The mass of water vapor per unit volume of air.
- absolute motion**. . Motion relative to a fixed point. If the earth were stationary in space, any change in the position of another body, relative to the earth, would be due only to the motion of that body. This would be absolute motion, or motion relative to a fixed point.
- Actual motion is motion of an object relative to the earth.
- absolute temperature**. . Temperature measured from absolute zero which is 0°K on the Kelvin scale, -459.69°F on the Fahrenheit scale, and -273.16°C on the Celsius scale. The sizes of the Kelvin and Celsius degree are equal. The size of a degree on the Fahrenheit scale equals that on the Rankine scale.
- absolute value**. . The value of a real number without regard to sign. Thus, the absolute value of +8 or -8 is |8|. Vertical lines on each side of a number indicate that its absolute value is intended.
- absorption**. . The process by which radiant energy is absorbed and converted to other forms of energy. See ATTENUATION.
- absolute zero**. . The theoretical temperature at which molecular motion ceases, -459.69°F or -273.16°C.
- abys**, *n.* A very deep area of the ocean. The term is used to refer to a particular deep part of the ocean, or to any part below 300 fathoms.
- abysmal plain**. . See under PLAIN.
- accelerate**, *v., t.* To move or cause to move with increasing velocity.
- acceleration**, *n.* 1. The rate of change of velocity. 2. The act or process of accelerating, or the state of being accelerated. Negative acceleration is called DECELERATION.
- acceleration error**. . The error resulting from change in velocity (either speed or direction); specifically, deflection of the apparent vertical, as indicated by an artificial horizon, due to acceleration. Also called BUBBLE ACCELERATION ERROR when applied to an instrument using a bubble as an artificial horizon.
- accelerometer**, *n.* A device used to measure the accelerations of a craft, resulting from the craft's acceleration with respect to the earth, acceleration of gravity, and Coriolis acceleration.
- accidental error**. . See RANDOM ERROR. An error of accidental nature. (Not to be confused with MISTAKE.)
- accretion**, *n.* Accumulation of material on the surface of an object.
- accuracy**, *n.* 1. In navigation, a measure of the difference between the position indicated by measurement and the true position. Some expressions of accuracy are defined in terms of probability. 2. A measure of how close the outcome of a series of observations or measurements approaches the true value of a desired quantity. The degree of exactness with which the true value of the quantity is determined from observations is limited by the presence of both systematic and random errors. Accuracy should not be confused with PRECISION, which is a measure of the repeatability of the observations. Observations may be of high precision due to the quality of the observing instrument, the skill of the observer and the resulting small random errors, but inaccurate due to the presence of large systematic errors. Accuracy implies precision, but precision does not imply accuracy. See also ERROR, RADIAL ERROR, ABSOLUTE ACCURACY, PREDICTABLE ACCURACY, RELATIVE ACCURACY, REPEATABLE ACCURACY.
- achromatic lens**. . See under ABERRATION, definition 2.
- acinal**, *adj.* Without dip; horizontal.
- acclinic**, *adj.* Without magnetic dip.
- acclinic line**. . The magnetic equator; the line on the surface of the earth connecting all points of zero magnetic dip.
- acoustic depth finder**. . See ECHO SOUNDER.
- acoustic navigation**. . See SONIC NAVIGATION.
- acoustics**, *n.* 1. That branch of physics dealing with sound. 2. The sound characteristics of a room, auditorium, etc., which determine its quality with respect to distinct hearing.
- acoustic sounding**. . See ECHO SOUNDING.
- acquisition**, *n.* The selection of those targets or satellites requiring a tracking procedure and the initiation of their tracking.
- acre**, *n.* A unit of area equal to 43,560 square feet.



## LIGHT AIR.

- air almanac.** . 1. A periodical publication of astronomical data designed primarily for air navigation, but often used in marine navigation. 2. *Air Almanac*, a joint publication of the U.S. Naval Observatory and H. M. Nautical Almanac Office, Royal Greenwich Observatory, designed primarily for air navigation. In general the information is similar to that of the *Nautical Almanac*, but is given to a precision of 1' of arc and 1 second of time, at intervals of 10 meters (values for the sun and Aries are given to a precision of 0.1').
- air defense identification zone (ADIZ).** . Airspace of defined dimensions within which the ready identification, location, and control of aircraft are required.
- air mass.** . An extensive body of air with fairly uniform (horizontal) physical properties, especially temperature and humidity. In its incipient stage the properties of the air mass are determined by the characteristics of the region in which it forms. It is a cold or warm air mass if it is colder or warmer than the surrounding air.
- air-mass classification.** . Air masses are classified according to their source regions. Four such regions are generally recognized - equatorial (E), the doldrum area between the north and south trades; tropical (T), the trade wind and lower temperate regions; polar (P), the higher temperate latitudes; and Arctic or Antarctic (A), the north or south polar regions of ice and snow. This classification is a general indication of relative temperature, as well as latitude of origin. Air masses are further classified as maritime (m) or continental (c), depending upon whether they form over water or land. This classification is an indication of the relative moisture content of the air mass. A third classification sometimes applied to tropical and polar air masses indicates whether the air mass is warm (w) or cold (k) relative to the underlying surface. The w and k classifications are primarily indications of stability, cold air being more stable.
- air temperature correction.** . A correction due to nonstandard air temperature, particularly the sextant altitude correction due to changes in refraction caused by difference between the actual temperature and the standard temperature used in the computation of the refraction table. The *Nautical Almanac* refraction table is based upon an air temperature of 50°F (10°C) at the surface of the earth. Refraction is greater at lower temperatures, and less at higher temperatures. The correction for air temperature varies with the temperature of the air and the altitude of the celestial body, and applies to all celestial bodies, regardless of the method of observation. It is not applied in normal navigation.
- AIS.** . *n.* See AUTOMATED INFORMATION SYSTEM.
- alarm.** . . In ECDIS a device or system which alerts by audible means, or audible and visual means, a condition requiring attention.
- Alaska Current.** . A North Pacific Ocean current flowing counterclockwise in the Gulf of Alaska. It is the northward flowing division of the Aleutian Current.
- Alaska-Hawaii standard time.** . See STANDARD TIME.
- albedo.** . *n.* The ratio of radiant energy reflected to that received by a surface, usually expressed as a percentage; reflectivity. The term generally refers to energy within a specific frequency range, as the visible spectrum. Its most frequent application in navigation is to the light reflected by a celestial body.
- alert.** . *n.* See ALERT TIME CALCULATIONS.
- alert time calculations.** . Computations of times and altitudes of available satellite passes in a given period of time at a given location, based on orbital data transmitted from satellite memory. Sometimes called ALERT.
- Aleutian Current.** . An eastward flowing North Pacific Ocean current which lies north of the North Pacific Current. As it approaches the coast of North America it divides to form the northward-flowing ALASKA CURRENT, and the southward-flowing CALIFORNIA CURRENT. Also called SUBARCTIC CURRENT.
- alga.** (*pl. algae*), *n.* A plant of simple structure which grows chiefly in water, such as the various forms of seaweed. It ranges in size from a microscopic plant, large numbers of which sometimes cause discoloration of water, to the giant kelp which may extend for more than 600 feet in length. The Red Sea owes its name to red algae, as does the "red tide."
- algorithm.** . A defined procedure or routine used for solving a specific mathematical problem.
- alidade.** . *n.* The part of an optical measuring instrument comprising the optical system, indicator, vernier, etc. In modern practice the term is used principally in connection with a bearing circle fitted with a telescope to facilitate observation of bearings. Also called TELESCOPIC ALIDADE.
- align.** . *v., t.* To place objects in line.
- alignment.** . *n.* 1. The placing of objects in a line. 2. The process of orienting the measuring axes of the inertial components of inertial navigation equipment with respect to the coordinate system in which the equipment is to be used.
- Allard's law.** . A formula relating the illuminance produced on a normal surface at a given distance from a point source of light, the intensity of the light, and the degree of transparency of the atmosphere, assumed to be uniform. See OMNIDIRECTIONAL LIGHT.
- allision.** . In the context of maritime law, the term allision means the act of striking of a moving vessel against a stationary object. Allision is different from collision. The term collision signifies the running of two vessels against each other.
- all other information.** . In ECDIS used to describe information additional to the STANDARD DISPLAY. Also called ON-DEMAND INFORMATION.
- all-weather.** . *adj.* Designed or equipped to perform by day or night under any weather conditions.
- almanac.** . *n.* A periodical publication of ephemeral astronomical data. If information is given in a form and to a precision suitable for marine navigation, it is called a nautical almanac. See also NAUTICAL ALMANAC; if designed primarily for air navigation, it is called an AIR ALMANAC. See also EPHEMERIS, ASTRONOMICAL ALMANAC.
- almucantar.** . *n.* A small circle on the celestial sphere paralleled to the horizon. Also called CIRCLE OF EQUAL ALTITUDE, PARALLEL OF ALTITUDE.
- almucantar staff.** . An ancient instrument formerly used for amplitude observations.
- alnico.** . *n.* An alloy composed principally of aluminum, nickel, cobalt, and iron; used for permanent magnets.
- aloft.** . Up in the rigging of a ship.
- alongshore current.** . See LONGSHORE CURRENT.
- alphanumeric.** . Referring to a set of computer characters consisting of alphabetic and numeric symbols.
- alphanumeric grid.** . See ATLAS GRID.
- alternate blanking.** . See under DUAL-RATE BLANKING.
- alternating current.** . An electric current that continually changes in magnitude and periodically reverses polarity.
- alternating.** . Referring to periodic changes in color of a lighted aid to navigation.
- alternating fixed and flashing light.** . A fixed light varied at regular intervals by a single flash of greater luminous intensity, with color variations in either the fixed light or flash, or both. See ALTERNATING LIGHT.
- alternating fixed and group flashing light.** . A fixed light varied at regular intervals by a group of two or more flashes of greater luminous intensity, with color variations in either the fixed light or flashes or both.
- alternating flashing light.** . A light showing a single flash with color variations at regular intervals, the duration of light being shorter than that of darkness. See also FLASHING LIGHT.
- alternating group flashing light.** . A group flashing light which shows periodic color change.
- alternating group occulting light.** . A group occulting light which shows periodic color change.
- alternating occulting light.** . A light totally eclipsed at regular intervals, the duration of light always being longer than the duration of darkness, which shows periodic color change. See also ALTERNATING LIGHT.
- alternating light.** . A light showing different colors alternately.
- altitude.** . *n.* Angular distance above the horizon; the arc of a vertical circle between the horizon and a point on the celestial sphere, measured upward from the horizon. Angular distance below the horizon is called negative altitude or depression. Altitude indicated by a sextant is called sextant altitude. Sextant altitude corrected only for inaccuracies in the reading (instrument, index, and personal errors, as applicable) and inaccuracies in the reference level (principally dip) is called apparent or rectified altitude. After all corrections are applied, it is called corrected sextant altitude or observed altitude. An altitude taken directly from a table, before interpolation, is called tabulated altitude. After interpolation, or if deter-

mined by calculation, mechanical device, or graphics, it is called computed altitude. If the altitude of a celestial body is computed before observation, and sextant altitude corrections are applied with reversed sign, the result is called precomputed altitude. The difference between computed and observed altitudes (corrected sextant altitudes), or between precomputed and sextant altitudes, is called altitude intercept or altitude difference. An altitude determined by inexact means, as by estimation or star finder, is called an approximate altitude. The altitude of a celestial body on the celestial meridian is called meridian altitude. The expression *ex-meridian* altitude is applied to the altitude of a celestial body near the celestial meridian, to which a correction is to be applied to determine the meridian altitude. A parallel of altitude is a circle of the celestial sphere parallel to the horizon, connecting all points of equal altitude. See also EQUAL ALTITUDES.

**altitude azimuth.** . An azimuth determined by solution of the navigational triangle with altitude, declination, and latitude given. A time azimuth is computed with meridian angle, declination, and latitude given. A time and altitude azimuth is computed with meridian angle, declination, and altitude given.

**altitude circle.** . See PARALLEL OF ALTITUDE.

**altitude difference.** . 1. See ALTITUDE INTERCEPT. 2. The change in the altitude of a celestial body occurring with change in declination, latitude, or hour angle, for example the *first difference* between successive tabulations of altitude in a latitude column of *Pub. No. 229, Sight Reduction Tables for Marine Navigation*.

**altitude intercept.** . The difference in minutes of arc between the computed and the observed altitude (corrected sextant altitude), or between precomputed and sextant altitudes. It is labeled T (toward) or A (away) as the observed (or sextant) altitude is greater or smaller than the computed (or precomputed) altitude. Also called ALTITUDE DIFFERENCE, INTERCEPT.

**altitude intercept method.** . See ST. HILAIRE METHOD.

**altitude of the apogee.** . As defined by the International Telecommunication Union (ITU), the altitude of the apogee above a specified reference surface serving to represent the surface of the earth.

**altitude of the perigee.** . As defined by the International Telecommunication Union (ITU), the altitude of the perigee above a specified reference surface serving to represent the surface of the earth.

**altitude tints.** . See HYPOMETRIC TINTING.

**alto-** . A prefix used in cloud classification to indicate the middle level (mean height 6,500-20,000 ft.). See also CIRRO-

**altocumulus.** , *n.* Clouds within the middle level composed of flattened globular masses, the smallest elements of the regularly arranged layers being fairly thin, with or without shading. These elements are arranged in groups, in lines, or waves, following one or two directions, and are sometimes so close together that their edges join. See also CLOUD CLASSIFICATION.

**altostratus.** , *n.* A sheet of gray or bluish cloud within the middle level. Sometimes the sheet is composed of a compact mass of dark, thick, gray clouds of fibrous structure; at other times the sheet is thin and through it the sun or moon can be seen dimly. See also CLOUD CLASSIFICATION.

**A.M.** . Abbreviation for Ante Meridian; before noon in zone time.

**ambient temperature.** . The temperature of the air or other medium surrounding an object. See also FREE-AIR TEMPERATURE.

**ambiguity.** , *n.* In navigation, the condition obtained when a given set of observations defines more than one point, direction, line of position, or surface of position.

**ambiguous.** , *adj.* Having two or more possible meanings or values.

**American Ephemeris and Nautical Almanac.** . See ASTRONOMICAL ALMANAC.

**American Practical Navigator, The.** . A navigational text and reference book published by the National Geospatial-Intelligence Agency (NGA); originally by Nathaniel Bowditch (1773-1838). Popularly called BOWDITCH.

**amidships.** , *adv.* At, near, or toward the middle of a ship.

**ampere.** , *n.* The base unit of electric current in the International System of Units; it is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to  $2 \times 10^{-7}$  newton per meter of length.

**ampere per meter.** . The derived unit of magnetic field strength in the International System of Units.

**amphidromic point.** . Point on a tidal chart where the cotidal lines meet.

**amphidromic region.** . An area surrounding a no-tide point from which the radiating cotidal lines progress through all hours of the tidal cycle.

**amplification.** , *n.* 1. An increase in signal magnitude from one point to another, or the process causing this increase. 2. Of a transducer, the scalar ratio of the signal output to the signal input.

**amplifier.** , *n.* A device which enables an input signal to control power from a source independent of the signal and thus be capable of delivering an output which is greater than the input signal.

**amplitude.** , *n.* 1. Angular distance of a celestial body north or south of the prime vertical circle; the arc of the horizon or the angle at the zenith between the prime vertical circle and a vertical circle through the celestial body measured north or south from the prime vertical to the vertical circle. The term is customarily used only with reference to bodies whose centers are on the celestial horizon, and is prefixed E or W, as the body is rising or setting, respectively; and suffixed N or S to agree with the declination. The prefix indicates the origin and the suffix the direction of measurement. Amplitude is designated as true, magnetic, compass, or grid as the reference direction is true, magnetic, compass, or grid east or west, respectively. 2. The maximum value of the displacement of a wave, or other periodic phenomenon, from the zero position. 3. One-half the range of a constituent tide. By analogy, it may be applied also to the maximum speed of a constituent current.

**amplitude compass.** . A compass intended primarily for measuring amplitude. It is graduated from 0° at east and west to 90° at north and south. Seldom used on modern vessels.

**amplitude distortion.** . Distortion occurring in an amplifier or other device when the output amplitude is not a linear function of the input amplitude.

**amplitude modulation.** . The process of changing the amplitude of a carrier wave in accordance with the variations of a modulating wave. See also MODULATION.

**AMVER System.** . See Automated Mutual-assistance Vessel Rescue System.

**anabatic wind.** . Any wind blowing up an incline. A KATABATIC WIND blows down an incline.

**analemma.** , *n.* A graduated scale of the declination of the sun and the equation of time for each day of the year located in the Torrid Zone on the terrestrial globe.



analemma

**analog.** , *adj.* Referring to the processing and/or transfer of information via physical means such as waves, fluids, or mechanical devices.

**analog computer.** . A computer in which quantities are represented by physical variables. Problem parameters are translated into equivalent mechanical or electrical circuits as an analog for the physical phenomenon being investigated without the use of a machine language. An analog computer measures continuously; a digital computer counts discretely. See DIGITAL.

**anchorage.** , *n.* An area where vessels may anchor, either because of suitability or designation.

**anchorage buoy.** . A buoy which marks the limits of an anchorage; not to be confused with a MOORING BUOY.

**anchorage chart.** . A nautical chart showing prescribed or recommended anchorages.

**anchorage mark.** . A navigation mark which indicates an anchorage area or defines its limits.

**anchor.** , *n.* A device used to secure a ship to the sea floor.

**anchor.** , *v.t.* To use the anchor to secure a ship to the sea floor. If more than one anchor is used the ship is moored.

**anchor buoy.** . A buoy marking the position of an anchor on the bottom, usually painted green for the starboard anchor and red for the port anchor, and secured to the crown of the anchor by a buoy rope.

**anchor ice.** . Submerged ice attached or anchored to the bottom, irrespec-

- ...tive of the nature of its formation.
- anchor light**. . A light shown from a vessel or aircraft to indicate its position when riding at anchor. Also called RIDING LIGHT.
- anemometer**. . *n.* An instrument for measuring the speed of the wind. Some instruments also indicate the direction from which it is blowing. See also VANE, definition 1; WIND INDICATOR.
- aneroid barometer**. . An instrument which determines atmospheric pressure by the effect of such pressure on a thin-metal cylinder from which the air has been partly exhausted. See also MERCURIAL BAROMETER.
- angel**. . A radar echo caused by a physical phenomenon which cannot be seen.
- angle**. . *n.* The inclination to each other of two intersecting lines, measured by the arc of a circle intercepted between the two lines forming the angle, the center of the circle being the point of intersection. An acute angle is less than  $90^\circ$ ; a right angle,  $90^\circ$ ; an obtuse angle, more than  $90^\circ$  but less than  $180^\circ$ ; a straight angle  $180^\circ$ ; a reflex angle, more than  $180^\circ$  but less than  $360^\circ$ ; a perigon,  $360^\circ$ . Any angle not a multiple of  $90^\circ$  is an oblique angle. If the sum of two angles is  $90^\circ$ , they are complementary angles; if  $180^\circ$ , supplementary angles; if  $360^\circ$ , complementary angles. Two adjacent angles have a common vertex and lie on opposite sides of a common side. A dihedral angle is the angle between two intersecting planes. A spherical angle is the angle between two intersecting great circles.
- angle of cut**. . The smaller angular difference of two bearings or lines of position.
- angle of depression**. . The angle in a vertical plane between the horizontal and a descending line. Also called DEPRESSION ANGLE. See ANGLE OF ELEVATION.
- angle of deviation**. . The angle through which a ray is bent by refraction.
- angle of elevation**. . The angle in a vertical plane between the horizontal and an ascending line, as from an observer to an object. A negative angle of elevation is usually called an ANGLE OF DEPRESSION. Also called ELEVATION ANGLE.
- angle of incidence**. . The angle between the line of motion of a ray of radiant energy and the perpendicular to a surface, at the point of impingement. This angle is numerically equal to the ANGLE OF REFLECTION.
- angle of reflection**. . The angle between the line of motion of a ray of reflected radiant energy and the perpendicular to a surface, at the point of reflection. This angle is numerically equal to the ANGLE OF INCIDENCE.
- angle of refraction**. . The angle between a refracted ray and the perpendicular to the refracting surface.
- angle of roll**. . The angle between the transverse axis of a craft and the horizontal. Also called ROLL ANGLE.
- angle of uncertainty**. . The horizontal angle of the region of indefinite characteristic near the boundaries of a sector of a sector light. Also called ARC OF UNCERTAINTY.
- angstrom**. . *n.* A unit of length, used especially in expressing the length of light waves, equal to one ten-thousandth of a micron or one hundred millionth of a centimeter.
- angular**. . *adj.* Of or pertaining to an angle or angles.
- angular distance**. . 1. The angular difference between two directions, numerically equal to the angle between two lines extending in the given directions. 2. The arc of the great circle joining two points, expressed in angular units. 3. Distance between two points, expressed in angular units of a specified frequency. It is equal to the number of waves between the points multiplied by  $2\pi$  if expressed in radians, or multiplied by  $360^\circ$  if measured in degrees.
- angular distortion**. . Distortion in a map projection because of non-conformity.
- angular momentum**. . The quantity obtained by multiplying the moment of inertia of a body by its angular speed.
- angular rate**. . See ANGULAR SPEED.
- angular rate of the earth's rotation**. . Time rate of change of angular displacement of the earth relative to the fixed stars equal to  $0.729211 \times 10^{-4}$  radian per second.
- angular resolution**. . See BEARING RESOLUTION.
- angular speed**. . Change of direction per unit time. Also called ANGULAR RATE. See also LINEAR SPEED.
- anneal**. . *v., t.* To heat to a high temperature and then allow to cool slowly, for the purpose of softening, making less brittle, or removing permanent magnetism. When Flinders bars or quadrant correctors acquire permanent magnetism which decreases their effectiveness as compass correctors, they are annealed.
- annotation**. . *n.* Any marking on illustrative material for the purpose of clarification such as numbers, letters, symbols, and signs.
- annual**. . *adj.* Of or pertaining to a year; yearly.
- annual aberration**. . See under ABERRATION, definition 1.
- annual inequality**. . Seasonal variation in water level or tidal current speed, more or less periodic due chiefly to meteorological causes.
- annual parallax**. . See HELIOCENTRIC PARALLAX.
- annular**. . *adj.* Ring-shaped.
- annular eclipse**. . An eclipse in which a thin ring of the source of light appears around the obscuring body. Annular solar eclipses occur, but never annular lunar eclipses.
- annulus**. . *n.* A ring-shaped band.
- anode**. . *n.* 1. A positive electrode; the plate of a vacuum tube; the electrode of an electron tube through which a principal stream of electrons leaves the inter-electrode space. 2. The positive electrode of an electrochemical device, such as a primary or secondary cell, toward which the negative ions are drawn. See also CATHODE.
- anomalous**. . *adj.* Pertaining to the periodic return of the moon to its perigee, or of the earth to its perihelion.
- anomalous month**. . The average period of revolution of the moon from perigee to perigee, a period of 27 days, 13 hours, 18 minutes, and 33.2 seconds in 1900. The secular variation does not exceed a few hundredths of a second per century.
- anomalous period**. . The interval between two successive passes of a satellite through perigee. Also called PERIGEE-TO-PERIGEE PERIOD and RADIAL PERIOD. See also ORBITAL PERIOD.
- anomalous year**. . The period of one revolution of the earth around the sun, from perihelion to perihelion, averaging 365 days, 6 hours, 13 minutes, 53.0 seconds in 1900, and increasing at the rate of 0.26 second per century.
- anomaly**. . *n.* 1. Departure from the strict characteristics of the type, pattern, scheme, etc. 2. An angle used in the mathematical description of the orbit of one body about another. It is the angle between the radius vector of the body and the line of apsides and is measured from pericenter in the direction of motion. When the radius vector is from the center of the primary to the orbiting body, the angle is called true anomaly. When the radius vector is from the center of the primary to a fictitious body moving with a uniform angular velocity in such a way that its period is equal to that of the actual body, the angle is called mean anomaly. When the radius vector is from the center of the elliptical orbit to the point of intersection of the circle defined by the semimajor axis with the line perpendicular to the semimajor axis and passing through the orbiting body, the angle is called eccentric anomaly or eccentric angle. 3. Departure of the local mean value of a meteorological element from the mean value for the latitude. See also MAGNETIC ANOMALY.
- antarctic**. . *adj.* referring to the Antarctic region.
- Antarctic**. . *n.* The region within the Antarctic Circle, or, loosely, the extreme southern regions of the earth.
- antarctic air**. . A type of air whose characteristics are developed in an arctic region. Antarctic air appears to be colder at the surface in all seasons, and at all levels in fall and winter, than ARCTIC AIR.
- Antarctic Circle**. . The parallel of latitude at about  $66^\circ 33'S$ , marking the northern limit of the south Frigid Zone. This latitude is the complement of the sun's greatest southerly declination, and marks the approximate northern limit at which the sun becomes circumpolar. The actual limit is extended somewhat by the combined effect of refraction, semidiameter of the sun, parallax, and the height of the observer's eye above the surface of the earth. A similar circle marking the southern limit of the north Frigid Zone is called ARCTIC or NORTH POLAR CIRCLE. Also called SOUTH POLAR CIRCLE.
- Antarctic Circumpolar Current**. . See WEST WIND DRIFT.
- antarctic front**. . The semi-permanent, semi-continuous front between the antarctic air of the antarctic continent and the polar air of the southern oceans; generally comparable to the ARCTIC FRONT of the Northern Hemisphere.
- antarctic whiteout**. . The obliteration of contrast between surface features in the Antarctic when a covering of snow obscuring all landmarks is accompanied by an overcast sky, resulting in an absence of shadows and an unrelieved expanse of white, the earth and sky blending so that the horizon is not distinguishable. A similar occurrence in the Arctic is called ARCTIC WHITEOUT.
- ante meridian (A.M.)**. . Before noon in zone time, or the period of time

- between midnight (0000) and noon (1200). The period between noon and midnight is called POST MERIDIAN or P.M.
- antenna**, *n.* A structure or device used to collect or radiate electromagnetic waves.
- antenna array**. A combination of antennas with suitable spacing and with all elements excited to make the radiated fields from the individual elements add in the desired direction, i.e., to obtain directional characteristics.
- antenna assembly**. The complete equipment associated with an antenna, including, in addition to the antenna, the base, switches, lead-in wires, revolving mechanism, etc.
- antenna bearing**. The generated bearing of the antenna of a radar set, as delivered to the indicator.
- antenna coupler**. 1. A radio-frequency transformer used to connect an antenna to a transmission line or to connect a transmission line to a radio receiver. 2. A radio-frequency transformer, link circuit, or tuned line used to transfer radio-frequency energy from the final plate-tank circuit of a transmitter to the transmitter to the transmission line feeding the antenna.
- antenna directivity diagram**. See DIRECTIVITY DIAGRAM.
- antenna effect**. A spurious effect, in a loop antenna, resulting from the capacitance of the loop to ground.
- antenna feed**. The component of an antenna of mirror or lens type that irradiates, or receives energy from, the mirror or lens. See also HORN ANTENNA.
- antenna radiation pattern**. See RADIATION PATTERN.
- anthelion**, *n.* A rare kind of halo, which appears as a bright spot at the same altitude as the sun and  $180^\circ$  from it in azimuth. See also PARHELION.
- anti-clutter gain control**. See SENSITIVITY TIME CONTROL.
- anti-clutter rain**. See FAST TIME CONSTANT CIRCUIT.
- anti-clutter sea**. See SENSITIVITY TIME CONTROL.
- anticorona**, *n.* A diffraction phenomenon very similar to but complementary to the corona, appearing at a point directly opposite to the sun or moon from the observer. Also called BROKEN BOW, GLORY.
- anti-crepuscular arch**. See ANTITWILIGHT.
- anti-crepuscular rays**. Extensions of crepuscular rays, converging toward a point  $180^\circ$  from the sun.
- anticyclone**, *n.* An approximately circular portion of the atmosphere, having relatively high atmospheric pressure and winds which blow clockwise around the center in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. An anticyclone is characterized by good weather. Also called HIGH. See also CYCLONE.
- anticyclonic winds**. The winds associated with a high pressure area and constituting part of an anticyclone.
- Antilles Current**. This current originates in the vicinity of the Leeward Islands as part of the Atlantic North Equatorial Current. It flows along the northern side of the Greater Antilles. The Antilles Current eventually joins the Florida Current (north of Grand Bahama Island) to form the Gulf Stream.
- antilogarithm**, *n.* The number corresponding to a given logarithm. Also called INVERSE LOGARITHM.
- antinode**, *n.* Either of the two points on an orbit where a line in the orbit plane, perpendicular to the line of nodes, and passing through the focus, intersects the orbit.
- antipodal effects**. See as LONG PATH INTERFERENCE under MULTIPATH ERROR.
- antipode**, *n.* Anything exactly opposite to something else. Particularly, that point on the earth  $180^\circ$  from a given place.
- antisolar point**. The point on the celestial sphere  $180^\circ$  from the sun.
- antitrades**, *n., pl.* The prevailing western winds which blow over and in the opposite direction to the trade winds. Also called COUNTER-TRADES.
- anti-TR tube**. See TR TUBE.
- antitwilight**, *n.* The pink or purplish zone of illumination bordering the shadow of the earth in the dark part of the sky opposite the sun after sunset or before sunrise. Also called ANTI-CREPUSCULAR ARCH.
- anvil cloud**. Heavy cumulus or cumulonimbus having an anvil-like upper part.
- apastron**, *n.* The point of the orbit of one member of a double star system at which the stars are farthest apart. That point at which they are nearest together is called PERIASTRON.
- aperiodic**, *adj.* Without a period; of irregular occurrence.
- aperiodic compass**. Literally “a compass without a period,” or a compass that, after being deflected, returns by one direct movement to its proper reading without oscillation. Also called DEADBEAT COMPASS.
- aperture**, *n.* 1. An opening; particularly, the opening in the front of a camera through which light rays pass when a picture is taken. 2. The diameter of the objective of a telescope or other optical instrument, usually expressed in inches, but sometimes as the angle between lines from the principal focus to opposite ends of a diameter of the objective. 3. Of a directional antenna, that portion of nearby plane surface that is perpendicular to the direction of maximum radiation and through which the major part of the radiation passes.
- aperture antenna**. An antenna in which the beam width is determined by the dimensions of a horn, lens, or reflector.
- aperture ratio**. The ratio of the diameter of the objective to the focal length of an optical instrument.
- apex**, *n.* The highest point of something, as of a cone or triangle, or the maximum latitude (vertex) of a great circle.
- aphelion**, *n.* That point in the elliptical orbit of a body about the sun farthest from the sun. That point nearest the sun is called PERIHELION.
- aphylactic map projection**. A map projection which is neither conformal nor equal area. Also called ARBITRARY MAP PROJECTION.
- aplanatic lens**. See under ABERRATION, definition 2.
- apoaopsis**, *n.* See APOCENTER.
- apocenter**, *n.* In an elliptical orbit, the point in the orbit which is the farthest distance from the focus, where the attracting mass is located. The apocenter is at one end of the major axis of the orbital ellipse. The opposite is PERICENTER, PERIFOCUS, PERIAPSIS. Also called APOAPSIS, APOFOCUS.
- apofocus**, *n.* See APOCENTER.
- apogean range**. The average semidiurnal range of the tide occurring at the time of apogean tides. It is smaller than the mean range, where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal.
- apogean tidal currents**. Tidal currents of decreased speed occurring monthly as the result of the moon being at apogee (farthest from the earth).
- apogean tides**. Tides of decreased range occurring monthly as the result of the moon being at apogee (farthest from the earth).
- apogee**, *n.* That orbital point of a non-circular orbit farthest from the center of attraction. Opposite is PERIGEE. See APOCENTER, PERICENTER.
- app**, *n.* an application, typically a small, specialized program downloaded onto mobile devices. See APPLICATION PROGRAM.
- apparent altitude**. Sextant altitude corrected for inaccuracies in the reading (instrument, index, and personal errors) and inaccuracies in the reference level (principally dip or Coriolis/acceleration), but not for other errors. Apparent altitude is used in obtaining a more accurate refraction correction than would be obtained with an uncorrected sextant altitude. Also called RECTIFIED ALTITUDE. See also OBSERVED ALTITUDE, SEXTANT ALTITUDE.
- apparent horizon**. See VISIBLE HORIZON.
- apparent motion**. Motion relative to a specified or implied reference point which may itself be in motion. The expression usually refers to movement of celestial bodies as observed from the earth. Usually called RELATIVE MOVEMENT when applied to the motion of one vessel relative to that of another. Also called RELATIVE MOTION.
- apparent noon**. Twelve o'clock apparent time, or the instant the apparent sun is over the upper branch of the meridian. Apparent noon may be either local or Greenwich depending upon the reference meridian. High noon is local apparent noon.
- apparent place**. The position on the celestial sphere at which a celestial body would be seen if the effects of refraction, diurnal aberration, and geocentric parallax were removed; the position at which the object would actually be seen from the center of the earth. Also called APPARENT POSITION.
- apparent position**. See APPARENT PLACE.
- apparent precession**. Apparent change in the direction of the axis of rotation of a spinning body, such as a gyroscope, due to rotation of the earth. As a result of gyroscopic inertia or rigidity in space, to an observer on the rotating earth a gyroscope appears to turn or precess.

- apparent secular trend.** . The non-periodic tendency of sea level to rise, fall and/or remain stationary with time. Technically, it is frequently defined as the slope of a least-squares line of regression through a relatively long series of yearly mean sea level values. The word apparent is used since it is often not possible to know whether a trend is truly non-periodic or merely a segment of a very long oscillation.
- apparent shoreline.** . A line drawn on the chart in lieu of the mean high water line or the mean water level line in areas where either may be obscured by marsh, mangrove, cypress, or other marine vegetation. This line represents the intersection of the appropriate datum with the outer limits of vegetation and appears to the navigator as the shoreline.
- apparent sidereal time.** . See under SIDEREAL TIME.
- apparent solar day.** . The duration of one rotation of the earth on its axis, with respect to the apparent sun. It is measured by successive transits of the apparent sun over the lower branch of a meridian. The length of the apparent solar day is 24 hours of apparent time and averages the length of the mean solar day, but varies somewhat from day to day.
- apparent sun.** . The actual sun as it appears in the sky. Also called TRUE SUN. See also MEAN SUN, DYNAMICAL MEAN SUN.
- apparent time.** . Time based upon the rotation of the earth relative to the apparent or true sun. This is the time shown by a sun dial. Apparent time may be designated as either local or Greenwich, as the local or Greenwich meridian is used as the reference. Also called TRUE SOLAR TIME. See also EQUATION OF TIME.
- apparent wind.** . The speed and direction from which the wind appears to blow with reference to a moving point. Sometimes called RELATIVE WIND. See also TRUE WIND.
- application profile.** . In ECDIS used in reference to data structure. An application profile is defined for a specific purpose, such as the transfer of ENC DATA.
- application program.** . A computer program designed to do a specific task or group of tasks. See APP.
- applier.** . In ECDIS used for an entity controlling the application of the UPDATE INFORMATION, e.g. the mariner keying in update information, or software inside ECDIS automatically processing the ENC update information.
- approach chart.** . A chart used to approach a harbor. See CHART CLASSIFICATION BY SCALE.
- approximate altitude.** . An altitude determined by inexact means, as by estimation or by a star finder or star chart.
- approximate coefficients.** . The six coefficients used in the analysis of the magnetic properties of a vessel in the course of magnetic compass adjustment. The values of these coefficients are determined from deviations of an unadjusted compass. See also COEFFICIENT A, COEFFICIENT B, COEFFICIENT C, COEFFICIENT D, COEFFICIENT E, COEFFICIENT J.
- appulse.** , *n.* 1. The near approach of one celestial body to another on the celestial sphere, as in occultation, conjunction, etc. 2. The penumbral eclipse of the moon.
- apron.** , *n.* 1. On the sea floor a gentle slope, with a generally smooth surface, particularly as found around groups of islands or sea mounts. Sometimes called ARCHIPELAGIC APRON. 2. The area of wharf or quay for handling cargo. 3. A sloping underwater extension of an iceberg. 4. An outwash plain along the front of a glacier.
- apse line.** . See LINE OF APSIDES.
- apsis.** (*pl. apsides*), *n.* Either of the two orbital points nearest or farthest from the center of attraction, the perihelion and aphelion in the case of an orbit about the sun, and the perigee and apogee in the case of an orbit about the earth. The line connecting these two points is called LINE OF APSIDES.
- aqueduct.** , *n.* A conduit or artificial channel for the conveyance of water, often elevated, especially one for the conveyance of a large quantity of water that flows by gravitation.
- arbitrary map projection.** . See APHYLACTIC MAP PROJECTION.
- arc.** , *n.* 1. A part of a curved line, as of a circle. See also ANGULAR DISTANCE. 2. The semi-circular graduated scale of an instrument for measuring angles. See also EXCESS OF ARC.
- arched squall.** . A squall which is relatively high in the center, tapering off on both sides.
- archipelagic apron.** . See APRON, definition 1.
- archipelago.** , *n.* 1. A sea or broad expanse of water containing many islands or groups of islands. 2. A group of such islands.
- arc of uncertainty.** . See ANGLE OF UNCERTAINTY.
- arc of visibility.** . The arc of a light sector, designated by its limiting bearings as observed from seaward.
- Arcs of Lowitz.** . Oblique, rare, downward extensions of the parhelia of 22°, concave toward the sun, and with red inner borders. They are formed by refraction by ice crystals oscillating about the vertical, such as with snowflakes.
- arctic.** , *adj.* Of or pertaining to the arctic, or intense cold.
- Arctic.** , *n.* The region within the Arctic Circle, or, loosely, northern regions in general, characterized by very low temperatures.
- arctic air.** . A type of air which develops mostly in winter over the Arctic. Arctic air is cold aloft and extends to great heights, but the surface temperatures are often higher than those of POLAR AIR. For two or three months in summer, arctic air masses are shallow and rapidly lose the characteristics as they move southward. See also ANTARCTIC AIR.
- Arctic Circle.** . The parallel of latitude at about 66°33'N, marking the southern limit of the north Frigid Zone. This latitude is the complement of the sun's greatest northerly declination and marks the approximate southern limit at which the sun becomes circumpolar. The actual limit is extended somewhat by the combined effect of refraction, semi-diameter of the sun, parallax, and the height of the observer's eye above the surface of the earth. A similar circle marking the northern limit of the south Frigid Zone is called ANTARCTIC or SOUTH POLAR CIRCLE. Also called NORTH POLAR CIRCLE.
- arctic front.** . The semi-permanent, semi-continuous front between the deep, cold arctic air and the shallower, generally less cold polar air of northern latitudes; generally comparable to the ANTARCTIC FRONT of the Southern Hemisphere.
- arctic sea smoke.** . Steam fog, but often specifically applied to steam fog rising from small areas of open water within sea ice. See also FROST SMOKE.
- arctic smoke.** . See STEAM FOG.
- arctic whiteout.** . The obliteration of contrast between surface features in the Arctic when a covering of snow obscuring all landmarks is accompanied by an overcast sky, resulting in an absence of shadows and an unrelieved expanse of white, the earth and sky blending so that the horizon is not distinguishable. A similar occurrence in the Antarctic is called ANTARCTIC WHITEOUT.
- arc to chord correction.** . See CONVERSION ANGLE.
- area.** . In ECDIS the 2-dimensional GEOMETRIC PRIMITIVE of an OBJECT that specifies location.
- area to be avoided.** . A ship routing measure comprising an area with defined limits which should be avoided by all ships, or certain classes of ships; instituted to protect natural features or to define a particularly hazardous area for navigation. See also PRECAUTIONARY AREA, ROUTING SYSTEM.
- areal feature.** . A topographic feature, such as sand, swamp, vegetation, etc., which extends over an area. It is represented on the published map or chart by a solid or screened color, by a prepared pattern of symbols, or by a delimiting line.
- argument.** , *n.* One of the values used for entering a table or diagram.
- argument of latitude.** . The angular distance measured in the orbital plane from the ascending node to the orbiting body; the sum of the argument of pericenter and the true anomaly.
- argument of pericenter.** . The angle at the center of attraction from the ascending node to the pericenter point, measured in the direction of motion of the orbiting body. Also called ARGUMENT OF PERIFOCUS.
- argument of perifocus.** . See ARGUMENT OF PERICENTER.
- argument of perigee.** . The angle at the center of attraction from the ascending node to the perigee point, measured in the direction of motion of the orbiting body.
- Aries.** , *n.* 1. Vernal equinox. Also called FIRST POINT OF ARIES. 2. The first sign of the zodiac.
- arithmetic mean.** . See MEAN.
- arm.** , *v., t.* To place tallow or other substance in the recess at the lower end of a sounding lead for obtaining a sample of the bottom.
- Armco.** , *n.* The registered trade name for a high purity, low carbon iron, used for Flinders bars, quadrantal correctors, etc., to correct magnetic compass errors resulting from induced magnetism.
- arming.** , *n.* Tallow or other substance placed in the recess at the lower end of a sounding lead, for obtaining a sample of the bottom.
- array.** , *n.* See ANTENNA ARRAY.

- articulated light.** . An offshore aid to navigation consisting of a pipe attached to a mooring by a pivoting or universal joint; more accurate in position than a buoy but less than a fixed light.
- artificial antenna.** . See DUMMY ANTENNA.
- artificial asteroid.** . A man-made object placed in orbit about the sun.
- artificial earth satellite.** . A man-made earth satellite, as distinguished from the moon. Often shortened to ARTIFICIAL SATELLITE.
- artificial harbor.** . A harbor where the desired protection from wind and sea is obtained from breakwaters, moles, jetties, or other man-made works. See also NATURAL HARBOR.
- artificial horizon.** . A device for indicating the horizontal, such as a bubble, gyroscope, pendulum, or the surface of a liquid.
- artificial magnet.** . A magnet produced by artificial means, either by placing magnetic material in the field of another magnet or by means of an electric current, as contrasted with a NATURAL MAGNET occurring in nature.
- artificial range.** . A range formed by two objects such as buildings, towers, etc., not designed as aids to navigation. See also NATURAL RANGE.
- artificial satellite.** . See ARTIFICIAL EARTH SATELLITE.
- ascending node.** . That point at which a planet, planetoid, or comet crosses the ecliptic from south to north, or a satellite crosses the plane of the equator of its primary from south to north. Also called NORTHBOUND NODE. The opposite is called DESCENDING NODE.
- ASCII.** . Acronym for American Standard Code for Information Interchange, a standard method of representing alphanumeric characters with numbers in a computer.
- ash breeze.** . Expression referring to rowing a sailing vessel in a calm, usually from ship's boats which tow the ship. (Oars are commonly made of ash wood.)
- ashore.** , *adj.* & *adv.* On the shore; on land; aground. See also AFLOAT.
- aspect.** , *n.* The relative bearing of own ship from the target ship, measured 0° to 180° port (red) or starboard (green). See also TARGET ANGLE.
- aspects.** , *n., pl.* The apparent positions of celestial bodies relative to one another; particularly the apparent positions of the moon or a planet relative to the sun.
- assigned frequency.** . The center of the frequency band assigned to a radio station. Sometimes called CENTER FREQUENCY.
- assigned frequency band.** . The frequency band whose center coincides with the frequency assigned to the station and whose width equals the necessary bandwidth plus twice the absolute value of the frequency tolerance.
- assumed latitude.** . The latitude at which an observer is assumed to be located for an observation or computation, as the latitude of an assumed position or the latitude used for determining the longitude of time sight.
- assumed longitude.** . The longitude at which an observer is assumed to be located for an observation or computation, as the longitude of an assumed position or the longitude used for determining the latitude by meridian altitude.
- assumed position.** . A point at which a craft is assumed to be located, particularly one used as a preliminary to establishing certain navigational data, as that point on the surface of the earth for which the computed altitude is determined in the solution of a celestial observation.
- astern.** , *adv.* Bearing approximately 180° relative. The term is often used loosely for DEAD ASTERN, or bearing exactly 180° relative. The opposite is AHEAD.
- asteroid.** , *n.* A MINOR PLANET, one of the many small celestial bodies revolving around the sun, most of the orbits being between those of Mars and Jupiter. Also called PLANETOID. See under PLANET.
- astigmatism.** , *n.* A defect of a lens which causes the image of a point to appear as a line, rather than a point.
- astigmatizer.** , *n.* A lens which introduces astigmatism into an optical system. Such a lens is so arranged that it can be placed in or removed from the optical path at will. In a sextant, an astigmatizer may be used to elongate the image of a celestial body into a horizontal line.
- astre fictif.** . Any of several fictitious stars which are assumed to move along the celestial equator at uniform rates corresponding to the speeds of the several harmonic constituents of the tide producing force. Each astre fictif crosses the meridian at a time corresponding to the maximum of the constituent that it represents.
- astro.** . A prefix meaning *star* or *stars* and sometimes used as the equivalent of *celestial*.
- astrodynamics.** , *n.* The practical application of celestial mechanics, astroballistics, propulsion theory, and allied fields to the problem of planning and directing the trajectories of space vehicles.
- astrograph.** , *n.* A device for projecting a set of precomputed altitude curves onto a chart, the curves moving with time such that if they are properly adjusted, they will remain in the correct position on the chart.
- astrolabe.** , *n.* An instrument which measures altitudes of celestial bodies, used for determining an accurate astronomical position, usually while ashore in survey work. Originally, the astrolabe consisted of a disk with an arm pivoted at the center, the whole instrument being hung by a ring at the top to establish the vertical.
- astrometry.** , *n.* The branch of astronomy dealing with the geometrical relations of the celestial bodies and their real and apparent motions.
- astronomical.** , *adj.* Of or pertaining to astronomy.
- Astronomical Almanac, The.** . An annual publication prepared jointly by the Nautical Almanac Office, U.S. Naval Observatory, and H.M. Nautical Almanac Office, Royal Greenwich Observatory. With the exception of certain introductory pages, the publication as printed in the United Kingdom is identical to that printed in the United States. This ephemeris gives high precision, detailed information on a large number of celestial bodies. It is arranged to suit the convenience of the astronomer for whom it is primarily intended and is not intended for ordinary purposes of navigation. But it does contain some information of general interest to the navigator, such as various astronomical constants, details of eclipses, information on planetary configurations, and miscellaneous phenomena. Prior to 1981 this publication was entitled *American Ephemeris and Nautical Almanac*. See also NAUTICAL ALMANAC.
- astronomical day.** . Prior to January 1, 1925, a mean solar day which began at mean noon, 12 hours later than the beginning of the calendar day of the same date. Since 1925 the astronomical day agrees with the civil day.
- astronomical equator.** . A line connecting points having 0° astronomical latitude. Because the deflection of the vertical varies from point to point, the astronomical equator is not a plane curve. But since the verticals through all points on it are parallel, the zenith at any point on the astronomical equator lies in the plane of the celestial equator. When the astronomical equator is corrected for station error, it becomes the GEODETIC EQUATOR. Sometimes called TERRESTRIAL EQUATOR.
- astronomical latitude.** . Angular distance between the plumb line at a station and the plane of the celestial equator. It is the latitude which results directly from observations of celestial bodies, uncorrected for deflection of the vertical which, in the United States, may amount to as much as 25". Astronomical latitude applies only to positions on the earth, and is reckoned from the astronomical equator (0°), north and south through 90°. Also called ASTRONOMIC LATITUDE and sometimes GEOGRAPHIC LATITUDE. See also GEODETIC LATITUDE.
- astronomical longitude.** . Angular distance between the plane of the celestial meridian at a station and the plane of the celestial meridian at Greenwich. It is the longitude which results directly from observations of celestial bodies, uncorrected for deflection of the vertical, the prime vertical component of which, in the United States, may amount to more than 18". Astronomical longitude applies only to positions on the earth, and is reckoned from the Greenwich meridian (0°) east and west through 180°. Also called ASTRONOMIC LONGITUDE and sometimes GEOGRAPHIC LONGITUDE. See also GEODETIC LONGITUDE.
- astronomical mean sun.** . See MEAN SUN.
- astronomical meridian.** . A line connecting points having the same astronomical longitude. Because the deflection of the vertical (station error) varies from point to point, the astronomical meridian is not a plane curve. When the astronomical meridian is corrected for station error, it becomes the GEODETIC MERIDIAN. Also called TERRESTRIAL MERIDIAN and sometimes called GEOGRAPHIC MERIDIAN.
- astronomical parallel.** . A line connecting points having the same astronomical latitude. Because the deflection of the vertical varies from point to point, the astronomical parallel is an irregular line not lying in a single plane. When the astronomical parallel is corrected for station error, it becomes the GEODETIC PARALLEL. Sometimes





degree-of-freedom of movement.

**azimuth**, *n.* The horizontal direction or bearing of a celestial point from a terrestrial point, expressed as the angular distance from a reference direction. It is usually measured from 000° at the reference direction clockwise through 360°. An azimuth is often designated as true, magnetic, compass grid, or relative as the reference direction is true, magnetic, compass, or grid north, or heading, respectively. Unless otherwise specified, the term is generally understood to apply to true azimuth, which may be further defined as the arc of the horizon, or the angle at the zenith, between the north part of the celestial meridian or principal vertical circle and a vertical circle, measured from 000° at the north part of the principal vertical circle clockwise through 360°. Azimuth taken directly from a table, before interpolation, is called tabulated azimuth. After interpolation, or, if determined by calculation, mechanical device, or graphics, it is called computed azimuth. When the angle is measured in either direction from north or south, and labeled accordingly, it is properly called azimuth angle; when measured either direction from east or west, and labeled accordingly, it is called amplitude. An azimuth determined by solution of the navigational triangle with altitude, declination, and latitude then is called an altitude azimuth; if meridian angle, declination, and latitude are given, it is called a time azimuth; if meridian angle, declination and altitude are given, it is called a time and altitude azimuth. See also BACK AZIMUTH, BEARING.

**azimuthal**, *adj.* Of or pertaining to azimuth.

**azimuthal chart**. . A chart on an azimuthal map projection. Also called ZENITHAL CHART.

**azimuthal equidistant chart**. . A chart on the azimuthal equidistant map projection.

**azimuthal equidistant map projection**. . An azimuthal map projection on which straight lines radiating from the center or pole of projection represent great circles in their true azimuths from that center, and lengths along those lines are of exact scale. This projection is neither equal-area nor conformal. If a geographic pole is the pole of projection, meridians appear as radial straight lines and parallels of latitude as equally spaced concentric circles.

**azimuthal map projection**. . A map projection on which the azimuths or directions of all lines radiating from a central point or pole are the same as the azimuths or directions of the corresponding lines on the ellipsoid. This classification includes the gnomonic, stereographic, orthographic, and the azimuthal equidistant map projections. Also called ZENITHAL MAP PROJECTION.

**azimuthal orthomorphic projection**. . See STEREOGRAPHIC MAP PROJECTION.

**azimuth angle**. . Azimuth measured from 0° at the north or south reference direction clockwise or counterclockwise through 90° or 180°. It is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix. When azimuth angle is measured through 180°, it is labeled N or S to agree with the latitude and E or W to agree with the meridian angle.

**azimuth bar**. . An instrument for measuring azimuths, particularly a device consisting of a slender bar with a vane at each end, and designed to fit over a central pivot in the glass cover of a magnetic compass. See also BEARING BAR.

**azimuth circle**. . A ring designed to fit snugly over a compass or compass repeater, and provided with means for observing compass bearings and azimuths. A similar ring without the means for observing azimuths of the sun is called a BEARING CIRCLE.

**azimuth instrument**. . An instrument for measuring azimuths, particularly a device which fits over a central pivot in the glass cover of a magnetic compass. See also BEARING BAR.

**azimuth stabilized display**. . See as STABILIZED IN AZIMUTH under STABILIZATION OF RADARSCOPE DISPLAY.

**azimuth tables**. . Publications providing tabulated azimuths or azimuth angles of celestial bodies for various combinations of declination, latitude and hour angle. Great circle course angles can also be obtained by substitution of values.

**Azores Current**. . A slow but fairly constant southeast branch of the North Atlantic Current and part of the Gulf Stream System. Its mean speed is only 0.4 knot, and the mean maximum speed computed from all observations above 1 knot in the prevailing direction is 1.3 knots. There is no discernible seasonal fluctuation. The speed and direction of the current is easily influenced for short periods by changing winds. The Azores Current is an inner part of

the general clockwise oceanic circulation of the North Atlantic Ocean. Also called SOUTHEAST DRIFT CURRENT.

## B

**back**, *adj.* Reciprocal.

**back**, *v., i.* 1. A change in wind direction in reverse of the normal pattern, or counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Change in the opposite direction is called VEER. See also HAUL. 2. To go stern first, or to operate the engines in reverse. 3. To brace the yard of a square sail so as to bring the wind on the forward side.

**back azimuth**. . An azimuth 180° from a given azimuth.

**back echo**. . The effect on a radar display produced by a back lobe of a radar antenna. See also SIDE ECHO.

**backlash**, *n.* 1. The amount which a gear or other part of a machine, instrument, etc., can be moved without moving an adjoining part, resulting from loose fit. See also LOST MOTION. 2. The tangle resulting when a reel of line or cable revolves faster than line is being stripped off.

**back lobe**. . The lobe of the radiation pattern of a directional antenna which makes an angle of approximately 180° with the direction of the axis of the main lobe.

**back range**. . A range observed astern, particularly one used as guidance for a craft moving away from the objects forming the range.

**backrush**, *n.* The seaward return of water following the uprush onto the foreshore. See also RIP CURRENT, UNDERTOW.

**backshore**, *n.* That part of a beach which is usually dry, being reached only by the highest tides, and by extension, a narrow strip of relatively flat coast bordering the sea. See also FORESHORE.

**back sight**. . A marine sextant observation of a celestial body made by facing away from the body, measuring an angle of more than 90°.

**backstaff**, *n.* A forerunner of the sextant, consisting essentially of a graduated arc and a single mirror. To use the instrument it was necessary to face away from the body being observed. Also called QUADRANT WITH TWO ARCS, SEA QUADRANT.

**backstays of the sun**. . Crepuscular rays extending downward toward the horizon.

**back-up arrangement**. . In ECDIS, facilities enabling safe take-over of ECDIS functions and measures facilitating means for safe navigation of the remaining part of the voyage in case of ECDIS failure.

**backwash**, *n.* Water or waves thrown back by an obstruction such as a seawall, breakwater, cliff, etc.

**backwater**, *n.* Water held back from the main flow, as that which overflows the land and collects in low places or that forms an inlet approximately parallel to the main body and connected thereto by a narrow outlet.

**bad-bearing sector**. . Relative to a radio direction finder station or radiobeacon, a sector within which bearings are known to be liable to significant errors of unknown magnitudes.

**baguio**, *n.* Local term in the Philippines for a tropical cyclone.

**balancer**, *n.* A device used with a radio direction finder to balance out antenna effect and thus produce a sharper reading.

**balancing**, *n.* The process of neutralizing antenna effect in order to improve the definition of the observed bearing. See also BALANCER.

**Bali wind**. . A strong east wind at the eastern end of Java.

**ball**, *n.* 1. A spherical identifying mark placed at the top of a perch. 2. A time ball.

**ballast ground**. . A designated area for discharging solid ballast before entering a harbor.

**ballistic damping error**. . A temporary oscillatory error of a gyrocompass introduced during changes of course or speed as a result of the means used to damp the oscillations of the spin axis.

**ballistic deflection error**. . A temporary oscillatory error of a gyrocompass introduced when the north-south component of the speed changes, as by speed or course change. An accelerating force acts upon the compass, causing a surge of mercury from one part of the system to another in the case of the non pendulous compass, or a deflection (along the meridian) of a mass in the case of a pendulous compass. In either case, a precessing force introduces a temporary ballistic deflection error in the reading of the compass unless it is corrected.



- risen above the surface.
- baud.** . A measure of the speed of computer data transmission in bits per second.
- bay.** , *n.* A recess in the shore, on an inlet of a sea or lake between two capes or headlands, that may vary greatly in size but is usually smaller than a gulf but larger than a cove.
- bayamo.** , *n.* A violent blast of wind, accompanied by vivid lightning, blowing from the land on the south coast of Cuba, especially near the Bight of Bayamo.
- Bayer's letter.** . The Greek (or Roman) letter used in a BAYER'S NAME.
- Bayer's name.** . The Greek (or Roman) letter and the possessive form of the Latin name of a constellation, used as a star name.
- baymouth bar.** . A bar extending partially or entirely across the mouth of a bay.
- bayou.** , *n.* A minor, sluggish waterway or estuaries creek, generally tidal or with a slow or imperceptible current, and with its course generally through lowlands or swamps, tributary to or connecting with other bodies of water. Various specific meanings have been implied in different parts of the southern United States. Sometimes called SLOUGH.
- beach.** , *n.* The zone of unconsolidated material that extends landward from the low water line to the place where there is a marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves). A beach includes foreshore and backshore. The beach along the margin of the sea may be called SEABEACH. Also called STRAND, especially when the beach is composed of sand. See also TIDELAND.
- beach.** , *v., t. & i.* To intentionally run a craft ashore.
- beach berm.** . See BERM.
- beach erosion.** . The carrying away of beach materials by wave action, tidal or littoral currents, or wind.
- beacon.** , *n.* A fixed artificial navigation mark. See also MARK, definition 1; DAYBEACON; DAYMARK; LIGHTED BEACON; RADIOBEACON.
- beaconage.** , *n.* A system of fixed aids to navigation comprised of beacons and minor lights. See also BUOYAGE.
- beacon buoy.** . See PILLAR BUOY.
- beacon tower.** . A beacon which is a major structure, having a support as distinctive as the topmark. See also LATTICE BEACON, REFUGE BEACON.
- beam.** , *n.* 1. A directed flow of electromagnetic radiation from an antenna. See also MAIN BEAM under LOBE, BEAM WIDTH. 2. A group of nearly parallel rays, as a *light beam*.
- beam compass.** . Compass for drawing circles of large diameter. In its usual form it consists of a bar with sliding holders for points, pencils, or pens which can be set at any desired position.
- beam sea.** . Waves moving in a direction approximately 90° from the vessel's heading. Those moving in a direction approximately opposite to the heading are called HEAD SEA, those moving in the general direction of the heading are called FOLLOWING SEA, and those moving in a direction approximately 135° from the heading (striking the quarter) are called QUARTERING SEA. See also CROSS SEA.
- beam tide.** . A tidal current setting in a direction approximately 90° from the heading of a vessel. One setting in a direction approximately 90° from the course is called a CROSS TIDE. In common usage, these two expressions are usually used synonymously. One setting in a direction approximately opposite to the heading is called a HEAD TIDE. One setting in such a direction as to increase the speed of a vessel is called a FAIR TIDE.
- beam width.** . The angular measure of the transverse section of a beam (usually in the main lobe). Lying within directions corresponding to specified values of field strength relative to the maximum (e.g., half field strength beam width and half power beam width). The beam width is usually measured in one or more specified planes containing the axis of the beam. See also HORIZONTAL BEAM WIDTH, VERTICAL BEAM WIDTH.
- beam-width error.** . An azimuth or bearing distortion on a radar display caused by the width of the radar beam. See also BEAM WIDTH, PULSE LENGTH ERROR.
- beam wind.** . Wind blowing in a direction approximately 90° from the heading. One blowing in a direction approximately 90° from the course is called a CROSS WIND. In common usage these two expressions are usually used synonymously, BEAM WIND being favored by mariners and CROSS WIND by aviators. One blowing from ahead is called a HEAD WIND. One blowing from astern is called a FOLLOWING WIND by mariners and a TAIL WIND by aviators. See also FAIR WIND, FAVORABLE WIND, UNFAVORABLE WIND.
- bear.** , *v., i.* To be situated as to direction, as, the light bears 165°.
- bear down.** . To approach from windward.
- bearing.** , *n.* The horizontal direction of one terrestrial point from another, expressed as the angular distance from a reference direction. It is usually measured from 000° at the reference direction clockwise through 360°. The terms BEARING and AZIMUTH are sometimes used interchangeably, but in navigation the former customarily applies to terrestrial objects and the latter to the direction of a point on the celestial sphere from a point on the earth. A bearing is often designated as true, magnetic, compass, grid, or relative as the reference direction is true, magnetic, compass, or grid north, or heading, respectively. The angular distance between a reference direction and the initial direction of a great circle through two terrestrial points is called great circle bearing. The angular distance between a reference direction and the rhumb line through two terrestrial points is called rhumb or Mercator bearing. A bearing differing by 180°, or one measured in the opposite direction, from a given bearing is called a reciprocal bearing. The maximum or minimum bearing of a point for safe passage of an off-lying danger is called a danger bearing. A relative bearing of 045° or 315° is sometimes called a four-point bearing. Successive relative bearings (right or left) of 45° and 90° taken on a fixed object to obtain a running fix are often called bow and beam bearings. Two or more bearings used as intersecting lines of position for fixing the position of a craft are called cross bearings. The bearing of a radio transmitter from a receiver, as determined by a radio direction finder, is called a radio bearing. A bearing obtained by radar is called a radar bearing. A bearing obtained by visual observation is called a visual bearing. A constant bearing maintained while the distance between two craft is decreasing is called a collision bearing. See also CURVE OF EQUAL BEARING.
- bearing angle.** . Bearing measured from 0° at the reference direction clockwise or counterclockwise through 90° or 180°. It is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix. Thus, bearing angle N37°W is 37° west of north, or true bearing 323°.
- bearing bar.** . An instrument for measuring bearings, particularly a device consisting of a slender bar with a vane at each end, and designed to fit over a central pivot in the glass cover of a magnetic compass. See also AZIMUTH BAR.
- bearing book.** . A log for the recording of visual bearings.
- bearing calibration.** . The determination of bearing corrections of a radio direction finder by observations of a radiobeacon, particularly a calibration radiobeacon, of known visual bearing, observations being taken over 360° of swing of the observing vessel.
- bearing circle.** . A ring designed to fit snugly over a compass or compass repeater, and provided with vanes for observing compass bearings. A similar ring provided with means for observing azimuths of the sun is called an AZIMUTH CIRCLE.
- bearing compass.** . A compass intended primarily for use in observing bearings.
- bearing cursor.** . The radial line on a radar set inscribed on a transparent disk which can be rotated manually about an axis coincident with the center of the Planned Position Indicator. It is used for bearing determination. Also called MECHANICAL BEARING CURSOR.
- bearing light.** . A navigation light using two superimposed optical systems which provides an approximate bearing without the use of a compass.
- bearing line.** . A line extending in the direction of a bearing.
- bearing repeater.** . A compass repeater used primarily for observing bearings.
- bearing resolution.** . See as RESOLUTION IN BEARING under RESOLUTION, definition 2. Also called ANGULAR RESOLUTION.
- beat frequency.** . Either of the two additional frequencies obtained when signals of two frequencies are combined, equal to the sum or difference, respectively, of the original frequencies.
- Beaufort wind scale.** . A numerical scale for indicating wind speed, devised by Admiral Sir Francis Beaufort in 1805. Beaufort numbers (or forces) range from force 0 (calm) to force 12 (hurricane).
- bed.** , *n.* The ground upon which a body of water rests. The term is usually used with a modifier to indicate the type of water body, as river bed





- boxing the compass.** . Stating in order the names of the points (and sometimes the half and quarter points) of the compass.
- brackish.** , *adj.* Containing salt to a moderate degree, such as sea water which has been diluted by fresh water, such as near the mouth of a river. The salinity values of brackish water range from approximately 0.50 to 17.00 parts per thousand.
- branch.** , *n.* 1. A creek or brook, as used locally in the southern U.S. 2. One of the bifurcations of a stream.
- brash ice.** . Accumulations of floating ice made up of fragments not more than 2 meters across, the wreckage of other forms of ice.
- brave west winds.** . The strong, often stormy, winds from the west-northwest and northwest which blow at all seasons of the year between latitudes 40°S and 60°S. See also ROARING FORTIES.
- Brazil Current.** . The ocean current flowing southwestward along the Brazilian coast. Its origin is in the westward flowing Atlantic South Equatorial Current, part of which turns south and flows along the South American coast as the Brazil Current. The mean speed of the current along its entire length is about 0.6 knots. Off Uruguay at about 35° S, it meets the Falkland Current, the two turning eastward to join the South Atlantic Current.
- break-circuit chronometer.** . A chronometer equipped with an electrical contact assembly and program wheel which automatically makes or breaks an electric circuit at precise intervals, the sequence and duration of circuit-open circuit-closed conditions being recorded on a chronograph. The program sequence is controlled by the design of the program wheel installed. Various programs of make or break sequence, up to 60 seconds, are possible. In some chronometers the breaks occur every other second, on the even seconds, and a break occurs also on the 59th second to identify the beginning of the minute; in other chronometers, breaks occur every second except at the beginning of the minute. By recording the occurrence of events (such as star transits) on a chronograph sheet along with the chronometer breaks, the chronometer times of those occurrences are obtained.
- breaker.** , *n.* A wave which breaks, either because it becomes unstable, usually when it reaches shallow water, or because it dashes against an obstacle. Instability is caused by an increase in wave height and a decrease in the speed of the trough of the wave in shallow water. The momentum of the crest, often aided by the wind, causes the upper part of the wave to move faster than the lower part. The crest of a wave which becomes unstable in deep water and topples over or "breaks" is called a WHITECAP.
- breakwater.** , *n.* A line of rocks, concrete, pilings, or other material which breaks the force of the sea at a particular place, forming a protected area. Often an artificial embankment built to protect the entrance to a harbor or to form an artificial harbor. See also JETTY.
- breasting float.** . See CAMEL.
- breeze.** , *n.* 1. Wind of force 2 to 6 (4-31 miles per hour or 4-27 knots) on the Beaufort wind scale. Wind of force 2 (4-7 miles per hour or 4-6 knots) is classified as a light breeze; wind of force 3 (8-12 miles per hour or 7-10 knots), a gentle breeze; wind of force 4 (13-18 miles per hour or 11-16 knots), a moderate breeze; wind of force 5 (19-24 miles per hour or 17-21 knots), a fresh breeze; and wind of force 6 (25-31 miles per hour or 22-27 knots), a strong breeze. See also LIGHT AIR. 2. Any light wind.
- bridge.** , *n.* 1. An elevated structure extending across or over the weather deck of a vessel, or part of such a structure. The term is sometimes modified to indicate the intended use, such as *navigating bridge* or *signal bridge*. 2. A structure erected over a depression or an obstacle such as a body of water, railroad, etc. to provide a roadway for vehicles or pedestrians. See also CAUSEWAY, VIADUCT.
- bridge resource management.** The study of the resources available to the navigator and the exploitation of them in order to achieve the goal of safe and efficient voyages.
- Briggsian logarithm.** . See COMMON LOGARITHM.
- bright display.** . A radar display capable of being used under relatively high ambient light levels.
- brisa, briza.** , *n.* 1. A northeast wind which blows on the coast of South America or an east wind which blows on Puerto Rico during the trade wind season. 2. The northeast monsoon in the Philippines.
- brisote.** , *n.* The northeast trade wind when it is blowing stronger than usual on Cuba.
- Broadcast Notice to Mariners.** . Notices to mariners disseminated by radio broadcast, generally of immediate interest to navigators.
- broad on the beam.** . Bearing 90° relative (*broad on the starboard beam*) or 270° relative (*broad on the port beam*). If the bearings are approximate, the expression ON THE BEAM or ABEAM should be used.
- broad on the bow.** . Bearing 45° relative (*broad on the starboard bow*) or 315° relative (*broad on the port bow*). If the bearings are approximate, the expression ON THE BOW should be used.
- broad on the quarter.** . Bearing 135° relative (*broad on the starboard quarter*) or 225° relative (*broad on the port quarter*). If the bearings are approximate, the expression ON THE QUARTER should be used.
- broadside on.** . Beam on, such as to the wind or sea.
- broad tuning.** . Low selectivity, usually resulting in simultaneous reception of signals of different frequencies (spill-over). The opposite is SHARP TUNING.
- Broken bow.** . See ANTICORONA.
- broken water.** . An area of small waves and eddies occurring in what otherwise is a calm sea.
- brook.** , *n.* A very small natural stream; a rivulet. Also called RUN, RUNNEL. See also CREEK, definition 2.
- brubu.** , *n.* A name for a squall in the East Indies.
- B-trace.** . The second trace of an oscilloscope having more than one displayed.
- bubble acceleration error.** . The error of a bubble sextant observation caused by displacement of the bubble by acceleration or deceleration resulting from motion of a craft. Also called ACCELERATION ERROR.
- bubble horizon.** . An artificial horizon parallel to the celestial horizon, established by means of a bubble level.
- bubble sextant.** . A sextant with a bubble or spirit level to indicate the horizontal.
- bucket temperature.** . Temperature of surface sea water trapped and measured in a bucket or similar receptacle.
- buffer.** . In computers, a temporary storage area used when incoming data cannot be processed as fast as it is transmitted.
- building.** , *n.* A label on a nautical chart which is used when the entire structure is the landmark, rather than an individual feature of it. Also labeled HOUSE.
- bull's eye squall.** . A squall forming in fair weather, characteristic of the ocean off the coast of South Africa. It is named for the peculiar appearance of the small isolated cloud marking the top of the invisible vortex of the storm.
- bull the buoy.** . To bump into a buoy.
- bummock.** , *n.* A downward projection from the underside of an ice field; the counterpart of a HUMMOCK.
- bund.** , *n.* An embankment or embanked thoroughfare along a body of water. The term is used particularly for such structures in the Far East.
- buoy.** , *n.* An unmanned floating device moored or anchored to the bottom as an aid to navigation. Buoys may be classified according to shape, as spar, cylindrical or can, conical, nun, spherical, barrel, or pillar buoy. They may also be classified according to the color scheme as a red, green, striped, banded, or checkered buoy. A buoy fitted with a characteristic shape at the top to aid in its identification is called a topmark buoy. A sound buoy is one equipped with a characteristic sound signal, and may be further classified according to the manner in which the sound is produced, as a bell, gong, horn, trumpet, or whistle buoy. A lighted buoy is one with a light having definite characteristics for detection and identification during darkness. A buoy equipped with a marker radiobeacon is called a radiobeacon buoy. A buoy with equipment for automatically transmitting a radio signal when triggered by an underwater sound signal is called a sonobuoy. A combination buoy has more than one means of conveying information; it may be called a lighted sound buoy if it is a lighted buoy provided with a sound signal. Buoys may be classified according to location, as channel, mid channel, middle ground, turning, fairway junction, junction, or sea buoy. A bar buoy marks the location of a bar. A buoy marking a hazard to navigation may be classified according to the nature of the hazard, such as obstruction, wreck, telegraph, cable, fish net, dredging, or spoil ground buoys. Buoys used for particular purposes may be classified according to their use, as anchor, anchorage, quarantine, mooring, marker, station, watch, or position buoy. A light-weight buoy especially designed to withstand strong currents is called a river buoy. An ice buoy is a sturdy one used to replace a more easily damaged buoy during a period when heavy ice is anticipated.

**buoyage**, *n.* A system of buoys. One in which the buoys are assigned shape, color, and number distinction in accordance with location relative to the nearest obstruction is called a cardinal system. One in which buoys are assigned shape, color, and number distinction as a means of indicating navigable waters is called a lateral system. See also IALA MARITIME BUOYAGE SYSTEM.

**buoy station**. . The established (charted) location of a buoy.

**buoy tender**. . A vessel designed for, and engaged in, servicing aids to navigation, particularly buoys.

**butte**, *n.* An isolated flat-topped hill, similar to but smaller than a MESA.

**Buys Ballot's Law**. . A rule useful in locating the center of cyclones and anticyclones. It states that, facing away from the wind in the northern hemisphere, the low pressure lies to the left. Facing away from the wind in the southern hemisphere, it is to the right; named after Dutch meteorologist C. H. D. Buys Ballot, who published it in 1857.

**byte**. . Basic unit of measurement of computer memory. A byte usually consists of 8 BITS; each ASCII character is represented by 1 byte.

**by the head**. . See DOWN BY THE HEAD.

**by the stern**. . See DOWN BY THE STERN.

## C

**C/A code**, *n.* The coarse acquisition, or "civilian code," modulated on the GPS L1 signal.

**cable**, *n.* 1. A unit of distance equal to one-tenth of a nautical mile. Sometimes called CABLE LENGTH. 2. A chain or very strong fiber or wire rope used to anchor or moor vessels or buoys. 3. A stranded conductor or an assembly of two or more electric conductors insulated from each other, but laid up together with a strong, waterproof covering. A coaxial cable consists of two concentric conductors insulated from each other.

**cable buoy**, *n.* 1. A buoy used to mark one end of a cable being worked by a cable ship. 2. A floating support of a submarine cable.

**cable length**. . See CABLE, definition 1.

**cage**, *n.* The upper part of the buoy built on top of the body of the buoy and used as a daymark or part thereof, usually to support a light, topmark and/or radar reflector. Also called SUPERSTRUCTURE.

**cage**, *v., t.* To erect a gyro or lock it in place by means of a caging mechanism.

**caging mechanism**. . A device for erecting a gyroscope or locking it in position.

**cairn**, *n.* A mound of rough stones or concrete, particularly one intended to serve as a landmark or message location. The stones are customarily piled in a pyramidal or beehive shape.

**caisson**, *n.* A watertight gate for a lock, basin, etc.

**calcareous**, *adj.* Containing or composed of calcium or one of its compounds.

**calculated altitude**. . See under COMPUTED ALTITUDE, definition 2.

**calculator**. . A device for mathematical computations; originally mechanical, modern ones are exclusively electronic, and able to run simple programs, as compared to a computer, which can be used for many other applications and run complex programs. A navigational calculator contains ephemeral data and algorithms for the solution of navigation problems.

**caldera**, *n.* A volcanic crater.

**calendar**, *n.* A graphic or printed record of time, usually of days, weeks, months, etc., used to refer to future events. The Gregorian calendar is in common use today. See also JULIAN DAY.

**calendar day**. . The period from midnight to midnight. The calendar day is 24 hours of mean solar time in length and coincides with the civil day unless a time change occurs during a day.

**calendar line**. . *British terminology.* See DATE LINE.

**calendar month**. . The month of the calendar, varying from 28 to 31 days in length.

**calendar year**. . The year of the calendar. Common years have 365 days and leap years 366 days. Each year exactly divisible by 4 is a leap year, except century years (1800, 1900, etc.), which must be exactly divisible by 400 (2000, 2400, etc.) to be leap years. The calendar year is based on the TROPICAL YEAR. Also called CIVIL YEAR.

**calibrate**, *n.* To determine or rectify the scale graduations of an instrument.

**calibration card**. . See under CALIBRATION TABLE.

**calibration correction**. . The value to be added to or subtracted from the reading of an instrument to obtain the correct reading.

**calibration error**. . The error in an instrument due to imperfection of calibration or maladjustment of its parts. Also called SCALE ERROR.

**calibration radiobeacon**. . A special radiobeacon operated primarily for calibrating shipboard radio direction finders. These radiobeacons transmit either continuously during scheduled hours or upon request.

**calibration table**. . A list of calibration corrections or calibrated values. A card having such a table on it is called a CALIBRATION CARD.

**California Current**. . A North Pacific Ocean current flowing southeastward along the west coast of North America from a point west of Vancouver Island to the west of Baja (Lower) California where it gradually widens and curves southward and southwestward, to continue as the westerly flowing PACIFIC NORTH EQUATORIAL CURRENT. The California Current is the southern branch of the Aleutian Current, augmented by the North Pacific Current, and forms the eastern part of the general clockwise oceanic circulation of the North Pacific Ocean. Although usually described as a permanent ocean current, the California Current is actually a poorly defined and variable flow easily influenced by the winds. See also MEXICO CURRENT.

**California Norther**. . See NORTHER.

**Callipic cycle**. . A period of four Meteoric cycles equal to 76 Julian years or 27,759 days. Devised by Callipus, a Greek astronomer, about 350 B.C., as a suggested improvement on the Meteoric cycle for a period in which new and full moon would recur on the same day of the year. Taking the length of the synodical month as 29.530588 days, there are 940 lunations in the Callipic cycle with about 0.25 days remaining.

**calm**, *adj.* In a state of calm; without motion.

**calm**, *n.* 1. Absence of appreciable wind; specifically, force 0 (less than 1 mile per hour or 1 knot) on the Beaufort wind scale. 2. The state of the sea when there are no waves.

**calm belt**. . 1. The doldrum sides of the trade winds, called calms of Cancer and calms of Capricorn.

**calving**, *n.* The breaking away of a mass of ice from an ice wall, ice front, or iceberg.

**camanchaca**, *n.* See GARUA.

**camel**, *n.* A float used as a fender. Also called BREASTING FLOAT.

**canal**, *n.* 1. An artificial waterway for navigation. 2. A long, fairly straight natural channel with steep sloping sides. 3. Any watercourse or channel. 4. A sluggish coastal stream, as used locally on the Atlantic coast of the U.S.

**Canary Current, Canaries Current**. . The southern branch of the North Atlantic Current (which divides on the eastern side of the ocean); it moves south past Spain and southwestward along the Northwest coast of Africa and past the Canary islands. In the vicinity of the Cape Verde Islands, it divides into two branches, the western branch augmenting the Atlantic North Equatorial Current and the Eastern branch curving southward and continuing as the GUINEA CURRENT. The Canary Current forms the southeastern part of the general clockwise oceanic circulation of the North Atlantic Ocean. Also called the Canaries Current.

**can buoy**. . An unlighted buoy of which the upper part of the body (above the waterline), or the larger part of the superstructure has the shape of a cylinder or nearly so. Also called CYLINDRICAL BUOY.

**candela**, *n.* The base unit of luminous intensity in the International System of Units. It is the luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square meter of a blackbody at the temperature of freezing platinum, under a pressure of 101,325 newtons per square meter. The definition was adopted by the Thirteenth General Conference on Weights and Measures (1967).

**candela per square meter**. . The derived unit of luminance in the International System of Units.

**candlepower**, *n.* Luminous intensity expressed in candelas.

**canyon**, *n.* On the sea floor, a relatively narrow, deep depression with steep sides, the bottom of which generally has a continuous slope.

**cap cloud**. . 1. A cloud resting on the top of an isolated mountain peak. The cloud appears stationary, but actually is being continually formed to windward and dissipated to leeward. A similar cloud over a mountain ridge is called a CREST CLOUD. See also BANNER CLOUD. 2. False cirrus over a towering cumulus, in the form of a cap or hood. See also SCARF CLOUD.

**cape**, *n.* A relatively extensive land area jutting seaward from a continent,

or large island, which prominently marks a change in or interrupts notably the coastal trend.

**Cape Breton Current.** . Originating in the Gulf of St. Lawrence, the Cape Breton Current flows southeastward in the southwestern half of Cabot Strait, and merges with the Labrador Current Extension. It may be augmented by a branch of the constant but tide influenced Gaspe Current to the northwest.

**cape doctor.** . The strong southeast wind which blows on the South African coast. Also called DOCTOR.

**Cape Horn Current.** . An ocean current that flows continuously eastward close to the tip of South America. It enters Drake Passage, at about longitude 70°W, in a 150-mile-wide band, with observed surface speeds to 2.4 knots. The current veers north-northeastward; when it crosses longitude 65°W, the current has narrowed to a width of about 85 miles, and its speed has decreased considerably. The current continues as the FALKLAND CURRENT.

**card.** . An element of a computer consisting of the hard surface on which components are mounted. A completed card performs one or more specific functions, such as graphics.

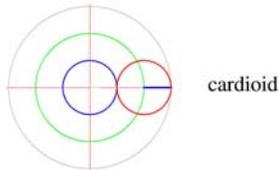
**cardinal heading.** . A heading in the direction of any of the cardinal points of the compass. See also INTERCARDINAL HEADING.

**cardinal mark.** . An IALA aid to navigation intended to show the location of a hazard to navigation based on its position relative to the danger. Its distinguishing features are black double-cone topmarks and black and yellow horizontal bands.

**cardinal point.** . Any of the four principal directions; north, east, south, or west. Directions midway between cardinal points are called INTERCARDINAL POINTS.

**cardinal system.** . A system of aids to navigation in which the shape, color, and number distinction are assigned in accordance with location relative to the nearest hazard to navigation. The cardinal points delineate the sectors for aid location. The cardinal system is particularly applicable to a region having numerous small islands and isolated dangers. In a LATERAL SYSTEM, such as is used in U.S. waters, the aids are assigned shape, color, and number distinction as a means of indicating navigable waters.

**cardioid.** , *n.* The figure traced by a point on a circle which rolls around an equal fixed circle.



**cargo transfer area.** . See under CARGO TRANSSHIPMENT AREAS.

**cargo transshipment area.** . An area generally outside port limits that is specifically designated as suitable for the transshipment of oil or other materials from large ships to smaller ones. As the purpose of transshipment is usually to reduce the draft of the larger vessel to allow her to proceed to port, the operation is often known as lightening and the area may be called lightening area or cargo transfer area.

**Caribbean Current.** . An ocean current flowing westward through the Caribbean Sea to the Yucatan Channel. It is formed by the comingling of part of the waters of the Atlantic North Equatorial Current with those of the Guiana Current.

**carrier.** , *n.* 1. A radio wave having at least one characteristic which may be varied from a known reference value by modulation. 2. The part of a modulated wave that corresponds in a specified manner to the unmodulated wave. 3. In a frequency stabilized system, the sinusoidal component of a modulated wave; or the output of a transmitter when the modulating wave is made zero; or a wave generated at a point in the transmitting system and subsequently modulated by the signal; or a wave generated locally at the receiving terminal which, when combined with the sidebands in a suitable detector, produces the modulating wave. Also called CARRIER WAVE.

**carrier frequency.** . 1. The frequency of the unmodulated fundamental output of a radio transmitter. 2. In a periodic carrier, the reciprocal of its period. The frequency of a periodic pulse carrier often is called PULSE REPETITION FREQUENCY.

**carrier power.** . See under POWER (OF A RADIO TRANSMITTER).

**carrier wave.** . See CARRIER.

**cartesian coordinates.** . Magnitudes defining a point relative to two intersecting lines, called AXES. The magnitudes indicate the distance from each axis, measured along a parallel to the other axis. If the axes are perpendicular, the coordinates are rectangular; if not perpendicular, they are oblique coordinates.

**cartographer.** , *n.* One who designs and constructs charts or maps.

**cartographic feature.** . A natural or cultural object shown on a map or chart by a symbol or line. See also TOPOGRAPHY.

**cartographic object.** , *n.* In ECDIS, a FEATURE OBJECT which contains information about the cartographic representation (including text of real world entities).

**cartography.** , *n.* The art and science of making charts or maps.

**cartometer.** , *n.* A device consisting of a small wheel and a calibrated dial used to measure distances on a map by following the desired route.

**cartouche.** , *n.* A panel of a map, often with decoration enclosing the title, scale, publishing information, and other notes.

**cask buoy.** . A buoy in the shape of a cask.

**Cassegrainian telescope.** . A reflecting telescope in which the incoming light is reflected from the primary mirror onto a secondary mirror and back through a small central aperture in the primary mirror. See also NEWTONIAN TELESCOPE.

**cast.** , *v., t.* 1. To turn a ship in her own length. 2. To turn a ship to a desired direction without gaining headway or sternway. 3. To take a sounding with the lead.

**catamaran.** , *n.* 1. A double-hulled vessel. 2. A raft consisting of a rectangular frame attached to two parallel cylindrical floats and which may be used for working alongside a ship. See also CAMEL.

**catenary.** , *n.* The curve formed by a uniform cable supported only at its ends. Navigators are concerned with the catenary of overhead cables which determines clearance underneath, and the catenary of the anchor rode, which in part determines holding power and swing circle.

**cathode.** , *n.* 1. The electrode through which a primary stream of electrons enters the interelectrode space. 2. The general term for a negative electrode. See also ANODE.

**cathode ray.** . A stream of electrons emitted from the cathode of any vacuum tube, but normally used in reference to special purpose tubes designed to provide a visual display.

**cathode-ray tube (CRT).** . A vacuum tube in which the instantaneous position of a sharply focused electron beam, deflected by means of electrostatic or electromagnetic fields, is indicated by a spot of light produced by impact of the electrons on a fluorescent screen at the end of the tube opposite the cathode. Used in radar displays.

**catoptric light.** . A light concentrated into a parallel beam by means of one or more reflectors. One so concentrated by means of refracting lenses or prisms is a DIOPTRIC LIGHT.

**cat's paw.** . A puff of wind; a light breeze affecting a small area, as one that causes patches of ripples on the surface of the water.

**causeway.** , *n.* A raised earthen road across wet ground or water. See also BRIDGE definition 2; VIADUCT.

**cautionary characteristic.** . Of a light, a unique characteristic which can be recognized as imparting a special cautionary significance e.g., a quick flashing characteristic phase indicating a sharp turn in a channel.

**cautionary note.** . Information calling special attention to some fact, usually a danger area, shown on a map or chart.

**caver, kaver.** , *n.* A gentle breeze in the Hebrides.

**cavitation.** . The formation of bubbles in a liquid which occurs when the static pressure becomes less than the fluid vapor pressure; it usually occurs from rotating propellers and is acoustically very noisy.

**cay, kay.** , *n.* A low, flat, tropical or sub-tropical island of sand and coral built up on a reef lying slightly above high water. Also called KEY.

**C-band.** . A radiofrequency band of 3,900 to 6,200 megahertz. This band overlaps the S- and X-bands. See also FREQUENCY.

**ceiling.** , *n.* The height above the earth's surface of the lowest layer of generally solid clouds, not classified as thin or partial.

**celestial.** , *adj.* Of or pertaining to the heavens.

**celestial body.** . Any aggregation of matter in space constituting a unit for astronomical study, as the sun, moon, a planet, comet, star, nebula, etc. Also called HEAVENLY BODY.

**celestial concave.** . See CELESTIAL SPHERE.

**celestial coordinates.** . Any set of coordinates used to define a point on the celestial sphere. The horizon, celestial equator, and the ecliptic systems of celestial coordinates are based on the celestial horizon,

- celestial equator, and the ecliptic, respectively, as the primary great circle.
- celestial equator.** . The primary great circle of the celestial sphere, everywhere 90° from the celestial poles; the intersection of the extended plane of the equator and the celestial sphere. Also called EQUINOCTIAL.
- celestial equator system of coordinates.** . A set of celestial coordinates based on the celestial equator as the primary great circle. Also called EQUINOCTIAL SYSTEM OF COORDINATES.
- celestial fix.** . A fix established by means of two or more celestial bodies.
- celestial globe.** . See STAR GLOBE.
- celestial horizon.** . That circle of the celestial sphere formed by the intersection of the celestial sphere and a plane through the center of the earth and perpendicular to the zenith-nadir line. Also called RATIONAL HORIZON. See also HORIZON.
- celestial latitude.** . Angular distance north or south of the ecliptic; the arc of a circle of latitude between the ecliptic and a point on the celestial sphere, measured northward or southward from the ecliptic through 90°, and labeled N or S indicate the direction of measurement.
- celestial line of position.** . A line of position determined by means of a celestial body.
- celestial longitude.** . Angular distance east of the vernal equinox, along the ecliptic; the arc of the ecliptic or the angle at the ecliptic pole between the circle of latitude of the vernal equinox at the circle of latitude of a point on the celestial sphere, measured eastward from the circle of latitude of the vernal equinox, through 360°.
- celestial mechanics.** . The study of the motions of celestial bodies under the influence of gravitational fields.
- celestial meridian.** . A great circle of the celestial sphere, through the celestial poles and the zenith. The expression usually refers to the upper branch, that half from pole to pole which passes through the zenith; the other half being called the lower branch. The celestial meridian coincides with the hour circle through the zenith and the vertical circle through the elevated pole.
- celestial navigation.** . Navigation by celestial bodies.
- celestial observation.** . Observation of celestial phenomena. The expression is applied in navigation principally to the measurement of the altitude of a celestial body, and sometimes to measurement of azimuth, or to both altitude and azimuth. The expression may also be applied to the data obtained by such measurement. Also called SIGHT in navigation usage.
- celestial parallel.** . See PARALLEL OF DECLINATION.
- celestial pole.** . Either of the two points of intersection section of the celestial sphere and the extended axis of the earth, labeled N or S to indicate whether the north celestial pole or the south celestial pole.
- celestial sphere.** . An imaginary sphere of infinite radius concentric with the earth, on which all celestial bodies except the earth are imagined to be projected.
- celestial triangle.** . A spherical triangle on the celestial sphere, especially the navigational triangle.
- cell.** . In ECDIS the basic unit of ENC DATA covering a defined geographical area bounded by two meridians and two parallels.
- Celsius temperature.** . The designation given to the temperature measured on the International Practical Temperature Scale with the zero taken as 0.01° below the triple point of water. Normally called CENTIGRADE TEMPERATURE, but the Ninth General Conference of Weights and Measures, held in October 1948, adopted the name *Celsius* in preference to *Centigrade*, to be consistent with naming other temperature scales after their inventors, and to avoid the use of different names in different countries. On the original Celsius scale, invented in 1742 by a Swedish astronomer named Andres Celsius, the numbering was the reverse of the modern scale, 0°C representing the boiling point of water, and 100°C its freezing point.
- center frequency.** . See ASSIGNED FREQUENCY.
- centering control.** . On a radar indicator, a control used to place the sweep origin at the center of the plan position indicator.
- centering error.** . Error in an instrument due to inaccurate pivoting of a moving part, as the index arm of a marine sextant. Also called ECCENTRIC ERROR.
- center line.** . 1. The locus of points equidistant from two reference points or lines. 2. (*Usually centerline*) The line separating the port and starboard sides of a vessel, center of buoyancy. The geometric center of the immersed portion of the hull and appendages of a floating vessel. All buoyant forces may be resolved into one resultant force acting upwards at this point.
- center of gravity.** . The point in any body at which the force of gravity may be considered to be concentrated. Same as CENTER OF MASS in a uniform gravitational field.
- center of mass.** . The point at which all the given mass of a body or bodies may be regarded as being concentrated as far as motion is concerned. Commonly called CENTER OF GRAVITY.
- Centesimal system.** , *n.* Used chiefly in France, a system of dividing a circle into 400 centesimal degrees (sometimes called grades) each of which is divided into 100 centesimal minutes of 100 centesimal seconds each.
- centi-** . A prefix meaning one-hundredth.
- centibar.** , *n.* One-hundredth of a bar; 10 millibars.
- centigrade temperature.** . See under CELSIUS TEMPERATURE.
- centimeter.** , *n.* One-hundredth of a meter.
- centimeter-gram-second system.** . A system of units based on the centimeter as the unit of length, the gram as the unit of mass, and the mean solar second as the unit of time. Its units with special names include the erg, the dyne, the gauss, and the oersted. See also INTERNATIONAL SYSTEM OF UNITS.
- centimetric wave.** . A super high frequency radio wave, approximately 0.01 to 0.1 meter in length (3 to 30 gigahertz). See also ULTRA SHORT WAVE.
- central force.** . A force which for purposes of computation can be considered to be concentrated at one central point with its intensity at any other point being a function of the distance from the central point. Gravitation is considered as a central force in celestial mechanics.
- central force field.** . The spatial distribution of the influence of a central force.
- central force orbit.** . The theoretical orbit achieved by a particle of negligible mass moving in the vicinity of a point mass with no other forces acting; an unperturbed orbit.
- central processing unit (CPU).** . The computer chip which is the brain of a computer, which runs PROGRAMS and processes DATA; also the container in which the CPU is located, along with many other associated devices such as the power supply, disk drives, etc., distinct from the MONITOR and other peripherals.
- central standard time.** . See STANDARD TIME.
- centrifugal force.** . The force acting on a body or part of a body moving under constraint along a curved path, tending to force it outward from the center of revolution or rotation. The opposite is CENTRIFUGAL FORCE.
- centripetal force.** . The force directed toward the center of curvature, which constrains a body to move in a curved path. The opposite is CENTRIFUGAL FORCE.
- chain.** , *n.* A group of associated stations of a radionavigation system.
- chain node.** . In ECDIS the data structure in which the geometry is described in terms of EDGES, ISOLATED NODES and CONNECTED NODES. Edges and connected nodes are topologically linked. NODES are explicitly coded in the DATA STRUCTURE.
- chains.** . The platform or station from which soundings are taken with a hand lead.
- chain signature.** . See under GROUP REPETITION INTERVAL.
- chalk.** , *n.* Soft earthy sandstone of marine origin, composed chiefly of minute shells. It is white, gray, or buff in color. Part of the ocean bed and shores and composed of chalk, notably the "white cliffs of Dover," England.
- challenge.** , *n.* A signal transmitted by an interrogator.
- challenge.** , *v. t.* To cause an interrogator to transmit a signal which puts a transponder into operation.
- challenger.** , *n.* See INTERROGATOR.
- chance error.** . See RANDOM ERROR.
- change of the moon.** . The time of new moon. See also PHASES OF THE MOON.
- change of tide.** . A reversal of the direction of motion (rising or falling) of a tide. The expression is also sometimes applied somewhat loosely to a reversal in the set of a tidal current. Also called TURN OF THE TIDE.
- channel.** , *n.* 1. The part of a body of water deep enough for navigation through an area otherwise not suitable. It is usually marked by a single or double line of buoys and sometimes by ranges. 2. The deepest part of a stream, bay, or strait, through which the main current flows. 3. A name given to certain large straits, such as the English Channel. 4. A hollow bed through which water may run. 5. A band of radio frequencies within which a radio station must

- maintain its modulated carrier frequency to prevent interference with stations on adjacent channels. Also called FREQUENCY CHANNEL.
- channel buoy.** . A buoy marking a channel.
- channel light.** . A light either on a fixed support or on a buoy, marking the limit of a navigable channel. In French, the term "feu de rive" is commonly used for a channel light on a fixed support.
- characteristic.** , *n.* 1. The color and shape of a daymark or buoy or the color and period of a light used for identifying the aid. See also CHARACTERISTIC COLOR, CHARACTERISTIC PHASE. 2. The identifying signal transmitted by a radiobeacon. 3. That part of a logarithm (base 10) to the left of the decimal point. That part of a logarithm (base 10) to the right of the decimal point is called the MANTISSA. 4. A quality, attribute, or distinguishing property of anything.
- characteristic color.** . The unique identifying color of a light.
- characteristic frequency.** . A frequency which can be easily identified and measured in a given emission.
- characteristic phase.** . Of a light, the sequence and length of light and dark periods and the color or colors by which a navigational light is identified, i.e., fixed, flashing, interrupted quick flashing, etc. See also CAUTIONARY CHARACTERISTIC.
- characteristics of a light.** . The sequence and length of light and dark periods and the color or colors by which a navigational light is identified.
- character of the bottom.** . See BOTTOM CHARACTERISTICS.
- chart.** , *n.* A map or geospatial database intended primarily for navigation of aircraft or vessels.
- chart amendment patch.** . See CHARTLET.
- chart catalog.** . A list or enumeration of navigational charts, sometimes with index charts indicating the extent of coverage of the various navigational charts.
- chart cell.** . See CELL.
- chart classification by scale.** . 1. Charts are constructed on many different scales, ranging from about 1:14,000,000 (and even smaller for some world charts) to 1:2,500. Small-scale charts are used for voyage planning and offshore navigation and may contain generalized soundings and minimal detail. Charts of larger scale are used as the vessel approaches land and contain greater detail and specificity. Several methods of classifying charts according to scale are in use in various nations. 2. The following classifications of nautical charts are used by the National Ocean Survey: Sailing, General, Coast, and Harbor. Sailing charts are the smallest scale charts used for planning, fixing position at sea, and for plotting while proceeding on a long voyage; the scale is generally smaller than 1:600,000. The shoreline and topography are generalized and only offshore soundings, the principal navigational lights, outer buoys, and landmarks visible at considerable distances are shown. General charts are intended for coastwise navigation outside of outlying reefs and shoals; scales range from about 1:600,000 to 1:150,000. Coast (coastal) charts are intended for inshore coastwise navigation where the course may lie inside outlying reefs and shoals, for entering or leaving bays and harbors of considerable width, and for navigating large inland waterways; scales range from about 1:150,000 to 1:50,000. Harbor charts are intended for navigation and anchorage in harbors and small waterways; the scale is generally larger than 1:50,000. 3. The classification system used by the National Geospatial-Intelligence Agency differs from the system in definition 2 above in that the Sailing-scale charts are incorporated in the General-scale classification (smaller than about 1:150,000); those Coastal-scale charts especially useful for approaching more confined waters (bays, harbors) are classified as Approach charts. DNC libraries are based on the following scales: General: (<1:500K), Coastal: (1:500K - 1:75K), Approach: (1:75K - 1:25K), Harbor: (>1:50K).
- chart comparison unit.** . An optical device used to superimpose the plan position indicator radar picture on a navigational chart.
- chart convergence.** . Convergence of the meridians as shown on a chart.
- chart datum.** . See CHART SOUNDING DATUM.
- chart desk.** . A flat surface on which charts are spread out, usually with stowage space for charts and other navigating equipment below the plotting surface. One without stowage space is called a CHART TABLE.
- charted depth.** . The vertical distance from the chart sounding datum to the bottom.
- charthouse.** . A room, usually adjacent to or on the bridge, where charts and other navigational equipment are stored, and where navigational computations, plots, etc., may be made. Also called CHARTROOM.
- chartlet.** , *n.* A corrected reproduction of a small area of a nautical chart which is pasted to the chart for which it is issued. These chartlets are disseminated in *Notice to Mariners* when the corrections are too numerous or of such detail as not to be feasible in printed form. Also called BLOCK, BLOCK CORRECTION, CHART AMENDMENT PATCH.
- chart portfolio.** . A systematic grouping of nautical charts covering a specific geographical area.
- chart projection.** . See MAP PROJECTION.
- chart reading.** . Interpretation of the symbols, lines, abbreviations, and terms appearing on charts. May be called MAP READING when applied to maps generally.
- chartroom.** , *n.* See CHARTHOUSE.
- chart scale.** . The ratio between a distance on a chart and the corresponding distance represented as a ratio such as 1:80,000 (natural scale), or 30 miles to an inch (numerical scale). May be called MAP SCALE when applied to any map. See also REPRESENTATIVE FRACTION.
- chart sounding datum.** . The tidal datum to which soundings and drying heights on a chart are referred. It is usually taken to correspond to a low water stage of the tide. Often shortened to CHART DATUM, especially when it is clear that reference is not being made to a geodetic datum.
- chart symbol.** . A character, letter, or similar graphic representation used on a chart to indicate some object, characteristic, etc. May be called MAP SYMBOL when applied to any map.
- chart table.** . A flat surface on which charts are spread out, particularly one without stowage space below the plotting surface. One provided with stowage space is usually called a CHART DESK.
- Charybdis.** , *n.* See GALOFARO.
- chasm.** , *n.* A deep breach in the earth's surface; an abyss; a gorge; a deep canyon.
- check bearing.** . An additional bearing, using a charted object other than those used to fix the position, observed and plotted in order to insure that the fix is not the result of a blunder.
- cheese antenna.** . An antenna consisting of a mirror in the shape of part of a parabolic cylinder bounded by two parallel plates normal to the cylinder axis, and of an antenna feed placed on or near the focal point.
- Chile Current.** . See under PERU CURRENT.
- chimney.** , *n.* A label on a nautical chart which indicates a relatively small smokestack.
- chip.** , *n.* 1. An integrated circuit. 2. The length of time to transmit a "0" or "1" in a binary pulse code.
- chip log.** . A historical speed measuring device consisting of a weighted wooden quadrant (quarter of a circle) attached to a bridle in such a manner that it will float in a vertical position, and a line with equally spaced knots, usually each 47 feet 3 inches apart. Speed is measured by casting the quadrant overboard and counting the number of knots paid out in a unit of time, usually 28 seconds.
- chip rate.** , *n.* The number of chips per second. See CHIP.
- chopped response.** . See CHOPPING.
- chopping.** , *n.* The rapid and regular on and off switching of a transponder, for recognition purposes.
- choppy.** , *adj.* description of short, breaking waves.
- chord.** , *n.* A straight line connecting two points on a curve.
- chromatic aberration.** . See under ABERRATION, definition 2.
- chromosphere.** , *n.* A thin layer of relatively transparent gases above the photosphere of the sun.
- chromospheric eruption.** . See SOLAR FLARE.
- chronograph.** , *n.* An instrument for producing a graphical record of time as shown by a clock or other device. The chronograph produces a double record: the first is made by the associated clock and forms a continuous time scale with significant marks indicating periodic beats of the time keepers; the second is made by some external agency, human or mechanical, and records the occurrence of an event or a series of events. The time interval of such occurrences are read on the time scale made by the clock. See also BREAK-CIRCUIT CHRONOMETER.
- chronogram.** , *n.* The record of a chronograph.
- chronometer.** , *n.* A timepiece with a nearly constant rate. It is customar-

- ily used for comparison of watches and clocks to determine their errors. A chronometer is usually set approximately to Greenwich mean time and not reset as the craft changes time zones. A hack chronometer is one which has failed to meet the exacting requirements of a standard chronometer, and is used for timing observations of celestial bodies. Hack chronometers are seldom used in modern practice, any chronometer failing to meet the requirements being rejected. See also CHRONOMETER WATCH.
- chronometer correction.** . The amount that must be added algebraically to the chronometer time to obtain the correct time. Chronometer correction is numerically equal to the chronometer error, but of opposite sign.
- chronometer error.** . The amount by which chronometer time differs from the correct time to which it was set, usually Greenwich mean time. It is usually expressed to an accuracy of 1s and labeled fast (F) or slow (S) as the chronometer time is later or earlier, respectively, than the correct time. CHRONOMETER ERROR and CHRONOMETER CORRECTION are numerically the same, but of opposite sign. See also WATCH ERROR.
- chronometer rate.** . The amount gained or lost by a chronometer in a unit of time. It is usually expressed in seconds per 24 hours, to an accuracy of 0.1s, and labeled gaining or losing, as appropriate, when it is sometimes called DAILY RATE.
- chronometer time.** . The hour of the day as indicated by a chronometer. Shipboard chronometers are generally set to Greenwich mean time. Unless the chronometer has a 24-hour dial, chronometer time is usually expressed on a 12-hour cycle and labeled A.M. or P.M.
- chronometer watch.** . A small chronometer, especially one with an enlarged watch-type movement.
- chubasco.** , *n.* A very violent wind and rain squall attended by thunder and vivid lightning often encountered during the rainy season along the west coast of Central America.
- churada.** , *n.* A severe rain squall in the Mariana Islands during the northeast monsoon. It occurs from November to April or May, especially from January through March.
- cierzo.** , *n.* See MISTRAL.
- cinders.** , *n., pl.* See SCORIAE.
- circle.** , *n.* 1. A plane closed curve all points of which are equidistant from a point within, called the center. A great circle is the intersection of a sphere and a plane through its center; it is the largest circle that can be drawn on a sphere. A small circle is the intersection of a sphere and a plane which does not pass through its center. See also PARALLEL OF ALTITUDE, PARALLEL OF DECLINATION, PARALLEL OF LATITUDE; AZIMUTH CIRCLE, BEARING CIRCLE, DIURNAL CIRCLE, EQUATOR, HOUR CIRCLE, PARASELENIC CIRCLES, POSITION CIRCLE, SPEED CIRCLE, VERTICAL CIRCLE. 2. A section of a plane, bounded by a curve all points of which are equidistant from a point within, called the center.
- circle of declination.** . See HOUR CIRCLE.
- circle of equal altitude.** . A circle on the surface of the earth, on every point of which the altitude of a given celestial body is the same at a given instant. The center of this circle is the geographical position of the body, and the great circle distance from this pole to the circle is the zenith distance of the body. See PARALLEL OF ALTITUDE.
- circle of equal declination.** . See PARALLEL OF DECLINATION.
- circle of equivalent probability.** . A circle with the same center as an error ellipse of specified probability and of such radius that the probability of being located within the circle is the same as the probability of being located within the ellipse. See also CIRCULAR ERROR PROBABLE.
- circle of latitude.** . A great circle of the celestial sphere through the ecliptic poles and along which celestial latitude is measured.
- circle of longitude.** . See PARALLEL OF LATITUDE, definition 2.
- circle of perpetual apparition.** . The circle of the celestial sphere, centered on the polar axis and having a polar distance from the elevated pole approximately equal to the latitude of the observer, within which celestial bodies do not set. The circle within which bodies do not rise is called the CIRCLE OF PERPETUAL OCCULTATION.
- circle of perpetual occultation.** . The circle of the celestial sphere, centered on the polar axis and having a polar distance from the depressed pole approximately equal to the latitude of the observer, within which celestial bodies do not rise. The circle within which bodies do not set is called the CIRCLE OF PERPETUAL APPARITION.
- circle of position.** . A circular line of position. The expression is most frequently used with reference to the circle of equal altitude surrounding the geographical position of a celestial body. Also called POSITION CIRCLE.
- circle of right ascension.** . See HOUR CIRCLE.
- circle of uncertainty.** . A circle having as its center a given position and as its radius the maximum likely error of the position—a circle within which a vessel is considered to be located. See also CIRCLE OF EQUAL PROBABILITY, CIRCLE OF POSITION, POSITION CIRCLE.
- circle of visibility.** . The circle surrounding an aid to navigation in which the aid is visible. See also VISUAL RANGE OF A LIGHT.
- circle sheet.** . A chart with curves enabling a graphical solution of the three-point problem rather than using a three-arm protractor. Also called SEXTANT CHART, STANDARD CIRCLE SHEET.
- circuit.** , *n.* 1. An electrical path between two or more points. 2. Conductors connected together for the purpose of carrying an electric current. 3. A connected assemblage of electrical components, such as resistors, capacitors, and inductors.
- circular error probable.** . 1. In a circular normal distribution (the magnitudes of the two one-dimensional input errors are equal and the angle of cut is 90°), the radius of the circle containing 50 percent of the individual measurements being made, or the radius of the circle inside of which there is a 50 percent probability of being located. 2. The radius of a circle inside of which there is a 50 percent probability of being located even though the actual error figure is an ellipse. That is, it is the radius of a circle of equivalent probability when the probability is specified as 50 percent. See also ERROR ELLIPSE, CIRCLE OF EQUIVALENT PROBABILITY. Also called CIRCULAR PROBABLE ERROR.
- circular fix.** . The designation of any one of the erroneous fix positions obtained with a revolver or swinger.
- circularly polarized wave.** . An electromagnetic wave which can be resolved into two plane polarized waves which are perpendicular to each other and which propagate in the same direction. The amplitudes of the two waves are equal and in time-phase quadrature. The tip of the component of the electric field vector in the plane normal to the direction of propagation describes a circle. See also ELLIPTICALLY POLARIZED WAVE.
- circular normal distribution.** . A two-dimensional error distribution defined by two equal single axis normal distributions, the axes being perpendicular. The error figure is a circle.
- circular probable error.** . See CIRCULAR ERROR PROBABLE.
- circular radiobeacon.** . See under RADIOBEACON.
- circular velocity.** . The magnitude of the velocity required of a body at a given point in a gravitational field which will result in the body following a circular orbital path about the center of the field. With respect to circular velocities characteristic of the major bodies of the solar system, this is defined for a circular orbit at the surface of the body in question. Circular velocity equals escape velocity divided by the square root of 2.
- circumference.** , *n.* 1. The boundary line of a circle or other closed plane curve or the outer limits of a sphere or other round body. 2. The length of the boundary line of a circle or closed plane curve or of the outer limits of a sphere or other rounded body. The circumference of a sphere is the circumference of any great circle on the sphere.
- circumlunar.** , *adj.* Around the moon, generally applied to trajectories.
- circummeridian altitude.** . See EX-MERIDIAN ALTITUDE.
- circumpolar.** , *adj.* Revolving about the elevated pole without setting. A celestial body is circumpolar when its polar distance is approximately equal to or less than the latitude of the observer. The actual limit is extended somewhat by the combined effect of refraction, semidiameter parallax, and the height of the observer's eye above the horizon.
- circumscribed halo.** . A halo formed by the junction of the upper and lower tangent arcs of the halo of 22°.
- circumzenithal arc.** . A brilliant rainbow-colored arc of about a quarter of a circle with its center at the zenith and about 46° above the sun. It is produced by refraction and dispersion of the sun's light striking the top of prismatic ice crystals in the atmosphere. It usually lasts for only a few minutes. See also HALO.
- cirriiform.** , *adj.* Like cirrus; more generally, descriptive of clouds

composed of small particles, mostly ice crystals, which are fairly widely dispersed, usually resulting in relative transparency and whiteness, and often producing halo phenomena not observed with other cloud forms. Irisation may also be observed. Cirriform clouds are high clouds. As a result, when near the horizon, their reflected light traverses a sufficient thickness of air to cause them often to take on a yellow or orange tint even during the midday period. On the other hand, cirriform clouds near the zenith always appear whiter than any other clouds in that part of the sky. With the sun on the horizon, this type of cloud is whitish, while other clouds may be tinted with yellow or orange; when the sun sets a little below the horizon, cirriform clouds become yellow, then pink or red and when the sun is well below the horizon, they are gray. All species and varieties of cirrus, cirrocumulus, and cirrostratus clouds are cirriform in nature. See also CUMULIFORM, STRATIFORM.

**cirro-**. . A prefix used in cloud classification to indicate the highest of three levels generally recognized. See also ALTO-

**cirrocumulus**, . *n.* A principal cloud type (cloud genus), appearing as a thin, white patch of cloud without shadows, composed of very small elements in the form of grains, ripples, etc. The elements may be merged or separate, and more or less regularly arranged; they subtend an angle of less than 1° when observed at an angle of more than 30° above the horizon. Holes or rifts often occur in a sheet of cirrocumulus. Cirrocumulus may be composed of highly super cooled water droplets, as well as small ice crystals, or a mixture of both; usually, the droplets are rapidly replaced by ice crystals. Sometimes corona or irisation may be observed. Mamma may appear. Small virga may fall, particularly from cirrocumulus castellanus and floccus. Cirrocumulus, as well as altocumulus, often forms in a layer of cirrus and/or cirrostratus. In middle and high latitudes, cirrocumulus is usually associated in space and time with cirrus and/or cirrostratus; this association occurs less often in low latitudes. Cirrocumulus differs from these other cirriform clouds in that it is not on the whole fibrous, or both silky and smooth; rather, it is rippled and subdivided into little cloudlets. Cirrocumulus is most often confused with altocumulus. It differs primarily in that its constituent elements are very small and are without shadows. The term cirrocumulus is not used for incompletely developed small elements such as those on the margin of a sheet of altocumulus, or in separate patches at that level. See also CIRRIFORM, CLOUD CLASSIFICATION.

**cirrostratus**, . *n.* A principal cloud type (cloud genus), appearing as a whitish veil, usually fibrous but sometimes smooth, which may totally cover the sky, and which often produces halo phenomena, either partial or complete. Sometimes a banded aspect may appear, but the intervals between the bands are filled with thinner cloud veil. The edge of a veil of cirrostratus may be straight and clear-cut, but more often it is irregular and fringed with cirrus. Some of the ice crystals which comprise the cloud are large enough to fall, and thereby produce a fibrous aspect. Cirrostratus occasionally may be so thin and transparent as to render it nearly indiscernible, especially through haze or at night. At such times, the existence of a halo may be the only revealing feature. The angle of incidence of illumination upon a cirrostratus layer is an important consideration in evaluating the identifying characteristics. When the sun is high (generally above 50° altitude), cirrostratus never prevents the casting of shadows by terrestrial objects, and a halo might be completely circular. At progressively lower altitudes of the sun, halos become fragmentary and light intensity noticeably decreases. Cirrostratus may be produced by the merging of elements of cirrus; from cirrocumulus; from the thinning of altostratus; or from the anvil of cumulonimbus. Since cirrostratus and altostratus form from each other, it frequently is difficult to delineate between the two. In general, altostratus does not cause halo phenomena, is thicker than cirrostratus, appears to move more rapidly, and has a more even optical thickness. When near the horizon, cirrostratus may be impossible to distinguish from cirrus. See also CIRRIFORM, CLOUD CLASSIFICATION.

**cirrus**, . *n.* A principal cloud type (cloud genus) composed of detached cirriform elements in the form of delicate filaments or white (or mostly white) patches, or of narrow bands. These clouds have a fibrous aspect and/or a silky sheen. Many of the ice crystal particles of cirrus are sufficiently large to acquire an appreciable speed of fall; therefore, the cloud elements have a considerable vertical extent. Wind shear and variations in particle size usually cause these

fibrous trails to be slanted or irregularly curved. For this reason, cirrus does not usually tend, as do other clouds, to appear horizontal when near the horizon. Because cirrus elements are too narrow, they do not produce a complete circular halo. Cirrus often evolves from virga of cirrocumulus or altocumulus, or from the upper part of cumulonimbus. Cirrus may also result from the transformation of cirrostratus of uneven optical thickness, the thinner parts of which dissipate. It may be difficult at times to distinguish cirrus from cirrostratus (often impossible when near the horizon); cirrostratus has a much more continuous structure, and if subdivided, its bands are wider. Thick cirrus (usually cirrus spissatus) is differentiated from patches of altostratus by its lesser extension and white color. The term *cirrus* is frequently used for all types of cirriform clouds. See also CIRRIFORM, CLOUD CLASSIFICATION.

**cirrus spissatus**. . See FALSE CIRRUS.

**cislunar**, . *adj.* Of or pertaining to phenomena, projects, or activity in the space between the earth and moon, or between the earth and the moon's orbit.

**civil day**. . A mean solar day beginning at midnight. See also CALENDAR DAY.

**civil noon**. . U.S. terminology from 1925 through 1952. See MEAN NOON.

**civil time**. . U.S. terminology from 1925 through 1952. See MEAN TIME.

**civil twilight**. . The period of incomplete darkness when the upper limb of the sun is below the visible horizon, and the center of the sun is not more than 6° below the celestial horizon.

**civil year**. . A year of the Gregorian calendar of 365 days in common years, or 366 days in leap years. See CALENDAR YEAR.

**clamp screw**. . A screw for holding a moving part in place, as during an observation or reading, particularly such a device used in connection with the tangent screw of a marine sextant.

**clamp screw sextant**. . A marine sextant having a clamp screw for controlling the position of the tangent screw.

**clapper**, . *n.* A heavy pendulum suspended inside a bell which sounds the bell by striking it.

**Clarke ellipsoid of 1866**. . The reference ellipsoid adopted by the U.S. Coast and Geodetic Survey (now the National Geodetic Survey) in 1880 for charting North America. This ellipsoid is not to be confused with the Clarke ellipsoid of 1880, which was the estimate of the size and shape of the earth at that time by the English geodesist Alexander Ross Clarke. For the Clarke ellipsoid of 1866, the semimajor axis is 6,378,206.4 meters, the semiminor axis is 6,356,583.8 meters, and the flattening or ellipticity is 1/294.98. Also called CLARKE SPHEROID OF 1866.

**Clarke ellipsoid of 1880**. . The reference ellipsoid of which the semimajor axis is 6,378,249.145 meters, the semiminor axis is 6,356,514.870 meters and the flattening or ellipticity is 1/293.65. This ellipsoid should not be confused with the CLARKE ELLIPSOID OF 1866. Also called CLARKE SPHEROID OF 1880.

**Clarke spheroid of 1866**. . See CLARKE ELLIPSOID OF 1866.

**Clarke spheroid of 1880**. . See CLARKE ELLIPSOID OF 1880.

**classification of radar echoes**. . When observing a radarscope having a stabilized relative motion display, the echoes (targets) may be classified as follows as an aid in rapid predictions of effects of evasive action on the compass direction of relative movement: an up-the-scope echo is an echo whose direction of relative movement differs by less than 90° from own ship's heading; a down-the-scope echo is an echo whose direction of relative movement differs by more than 90° from own ship's heading; an across-the-scope (limbo) echo is an echo whose direction of relative movement differs by 90° from own ship's heading, i.e., the echo's tail is perpendicular to own ship's heading flasher.

**clay**, . *n.* See under MUD.

**clean**, . *adj.* Free from obstructions, unevenness, imperfections, as a clean anchorage.

**clear**, . *v., t.* To leave port or pass safely by an obstruction.

**clearance**, . *n.* The clear space between two objects, such as the nearest approach of a vessel to a navigational light, hazard to navigation, or other vessel.

**clear berth**. . A berth in which a vessel may swing at anchor without striking or fouling another vessel or an obstruction. See also FOUL BERTH.

**cliff**, . *n.* Land arising abruptly for a considerable distance above water or surrounding land. See also BLUFF.

**climate**, . *n.* The prevalent or characteristic meteorological conditions of a

- place or region, in contrast with weather, the state of the atmosphere at any time. A marine climate is characteristic of coastal areas, islands, and the oceans, the distinctive features being small annual and daily temperature range and high relative humidity, in contrast with continental climate, which is characteristic of the interior of a large land mass, and the distinctive features of which are large annual and daily temperature range and dry air with few clouds.
- climatology**, *n.* 1. The study of climate. 2. An account of the climate of a particular place or region.
- clinometer**, *n.* An instrument for indicating the degree of the angle of heel, roll, or pitch of a vessel; may be of the pivot arm or bubble type, usually indicating in whole degrees.
- clock**, *n.* A timepiece not meant to be carried on the person. See also CHRONOMETER.
- clock speed**. The speed with which a computer performs operations, commonly measured in mega- or gigahertz.
- clockwise**, *adv.* In the direction of rotation of the hands of a clock.
- close**, *v., i.* To move or appear to move together. An order is sometimes given by a flagship for a vessel to close to yards, or miles. When a craft moves onto a range, the objects forming the range appear to move closer together, or close. The opposite is OPEN.
- close aboard**. Very near.
- closed**, *adj.* Said of a manned aid to navigation that has been temporarily discontinued for the winter season. See also COMMISSIONED, WITHDRAWN.
- closed sea**. 1. A part of the ocean enclosed by headlands, within narrow straits, etc. 2. A part of the ocean within the territorial jurisdiction of a country. The opposite is OPEN SEA. See also HIGH SEAS, INLAND SEA.
- close pack ice**. Pack ice in which the concentration is 7/10 to 8/10, composed of floes mostly in contact.
- closest approach**. 1. The event that occurs when two planets or other bodies are nearest to each other as they orbit about the primary body. 2. The place or time of the event in definition 1. 3. The time or place where an orbiting earth satellite is closest to the observer. Also called CLOSEST POINT OF APPROACH.
- cloud**, *n.* 1. A hydrometeor consisting of a visible aggregate of minute water and/or ice particles in the atmosphere above the earth's surface. Cloud differs from fog only in that the latter is, by definition, in contact with the earth's surface. Clouds form in the free atmosphere as a result of condensation of water vapor in rising currents of air, or by the evaporation of the lowest stratum of fog. For condensation to occur at the point of saturation or a low degree of supersaturation, there must be an abundance of condensation nuclei for water clouds, or ice nuclei for ice-crystal clouds. The size of cloud drops varies from one cloud to another, and within any given cloud there always exists a finite range of sizes. In general, cloud drops range between 1 and 100 microns in diameter and hence are very much smaller than rain drops. See also CLOUD CLASSIFICATION. 2. Any collection of particulate matter in the atmosphere dense enough to be perceptible to the eye, such as a dust cloud or smoke cloud.
- cloud bank**. A fairly well defined mass of clouds observed at a distance; it covers an appreciable portion of the horizon sky, but does not extend overhead.
- cloud base**. For a given cloud or cloud layer, that lowest level in the atmosphere at which the air contains a perceptible quantity of cloud particles.
- cloudburst**, *n.* In popular terminology, any sudden and heavy fall of rain. An unofficial criterion sometimes used specifies a rate of fall equal to or greater than 100 millimeters (3.94 inches) per hour. Also called RAIN GUSH, RAIN GUST.
- cloud classification**. 1. A scheme of distinguishing and grouping clouds according to their appearance and, where possible, to their process of formation. The one in general use, based on a classification system introduced by Luke Howard in 1803, is that adopted by the World Meteorological Organization and published in the *International Cloud Atlas*. This classification is based on the determination of (a) genera, the main characteristic forms of clouds; (b) species, the peculiarities in shape and differences in internal structure of clouds; (c) varieties, special characteristics of arrangement and transparency of clouds; (d) supplementary features and accessory clouds, appended and associated minor cloud forms; and (e) mother-clouds, the origin of clouds if formed from other clouds. The ten cloud genera are cirrus, cirrocumulus, cirrostratus, altocumulus, altostratus, nimbostratus, stratocumulus, stratus, cumulus, and cumulonimbus. The fourteen cloud species are fibratus, uncinus, spissatus, castellanus, floccus, stratiformis, nebulosus, lenticularis, fractus, humilis, mediocris, congestus, calvus, and capillatus. The nine cloud varieties are intortus, vertebratus, undulatus, radiatus, lacunosus, duplicatus, translucidus, perlucidus, and opacus. The nine supplementary features and accessory clouds are inclus, mamma, virga, praecipitatio, arcus, tuba, pileus, velum, and pannus. Note that although these are Latin words, it is proper convention to use only the singular endings, e.g., more than one cirrus cloud are, collectively, cirrus, not cirri. 2. A scheme of classifying clouds according to their usual altitudes. Three classes are distinguished: high, middle, and low. High clouds include cirrus, cirrocumulus, cirrostratus, occasionally altostratus and the tops of cumulonimbus. The middle clouds are altocumulus, altostratus, nimbostratus, and portions of cumulus and cumulonimbus. The low clouds are stratocumulus, stratus, most cumulus and cumulonimbus bases, and sometimes nimbostratus. 3. A scheme of classifying clouds according to their particulate composition; namely water clouds, ice-crystal clouds, and mixed clouds. The first are composed entirely of water droplets (ordinary and/or super cooled), the second entirely of ice crystals, and the third a combination of the first two. Of the cloud genera, only cirrostratus and cirrus are always ice-crystal clouds; cirrocumulus can also be mixed; and only cumulonimbus is always mixed. Altostratus nearly always is mixed, but occasionally can be ice-crystal. All the rest of the genera are usually water clouds, occasionally mixed: altocumulus, cumulus, nimbostratus and stratocumulus.
- cloud cover**. That portion of the sky cover which is attributed to clouds, usually measured in tenths of sky covered.
- cloud deck**. The upper surface of a cloud.
- cloud height**. In weather observations, the height of the cloud base above local terrain.
- cloud layer**. An array of clouds, not necessarily all of the same type, whose bases are at approximately the same level. It may be either continuous or composed of detached elements.
- club**, *v., i.* To drift in a current with an anchor dragging to provide control. Usually used with the word down, ie. club down.
- clutter**, *n.* 1. Unwanted radar echoes reflected from heavy rain, snow, waves, etc., which may obscure relatively large areas on the radar scope. See also RAIN CLUTTER, SEA RETURN. 2. In ECDIS excess information or noise data on a DISPLAY or CHART, reducing legibility.
- co-**. A prefix meaning 90° minus the value with which it is used. Thus, if the latitude is 30° the colatitude is 90° - 30° = 60°. The cofunction of an angle is the function of its complement.
- coalsack**, *n.* Any of several dark areas in the Milky Way, especially, when capitalized, a prominent one near the Southern Cross.
- coalitude**, *n.* Ninety degrees minus the altitude. The term has significance only when used in connection with altitude measured from the celestial horizon, when it is synonymous with ZENITH DISTANCE.
- coast**, *n.* The general region of indefinite width that extends from the sea inland to the first major change in terrain features. Sometimes called SEACOAST. See also SEABOARD.
- coastal aid**. See COASTAL MARK.
- coastal area**. The land and sea area bordering the shoreline.
- coastal boundary**. A general term for the boundary defined as the line (or measured from the line or points thereon) used to depict the intersection of the ocean surface and the land at an elevation of a particular datum, excluding one established by treaty or by the U.S. Congress.
- coastal chart**. See under CHART CLASSIFICATION BY SCALE.
- coastal current**. An ocean current flowing roughly parallel to a coast, outside the surf zone. See also LONGSHORE CURRENT.
- coastal mark**. A navigation mark placed on the coast to assist coastal navigation. Particularly used with reference to marks placed on a long straight coastline devoid of many natural landmarks. Also called COASTAL AID.
- coastal marsh**. An area of salt-tolerant vegetation in brackish and/or salt-water habitats subject to tidal inundation.
- coastal plain**. Any plain which has its margin on the shore of a large body of water, particularly the sea, and generally represents a strip of recently emerged sea bottom.
- coastal refraction**. The bending of the wave front of a radio wave trav-

- eling parallel to a coastline or crossing it at an acute angle due to the differences in the conducting and reflective properties of the land and water over which the wave travels. This refraction affects the accuracy of medium frequency radio direction finding systems. Also called COAST REFRACTION.
- Coast and Geodetic Survey.** . Name of the mapping, charting, and surveying arm of the National Ocean Service (NOS), a component of the National Oceanic and Atmospheric Administration (NOAA), which has reorganized and renamed at various times. The organization was known as: The Survey of the Coast from its founding in 1807 to 1836, Coast Survey from 1836 to 1878, and Coast and Geodetic Survey from 1878 to 1970, when it became the Office of Charting and Geodetic Services under the newly formed NOAA. In 1991 the name Coast and Geodetic Survey was reinstated. In 1995 the topographic and hydrographic parts of the Coast and Geodetic Survey were split and became the National Geodetic Survey (NGS) and the Office of Coast Survey (OCS). The Center for Operational Oceanographic Products and Services (CO-OPS) was also established. All three of these organizations are now part of NOS. Today OCS compiles onto nautical charts, and also maintains the National Geodetic Reference System. CO-OPS provides tides, water levels, currents and other oceanographic information that are used directly by mariners, as well as part of the hydrographic surveys and chart production processes that OCS carries out.
- Coast Earth Station (CES).** . A station which receives communications from an earth orbiting satellite for retransmission via landlines, and vice versa.
- coast chart.** . See under CHART CLASSIFICATION BY SCALE.
- coasting.** , *n.* Proceeding approximately parallel to a coastline (headland to headland) in sight of land, or sufficiently often in sight of land to fix the ship's position by observations of land features.
- coasting lead.** . A light deep sea lead (30 to 50 pounds), used for sounding in water 20 to 60 fathoms.
- coastline.** , *n.* The configuration made by the meeting of land and sea.
- Coast Pilot.** . See UNITED STATES COAST PILOT.
- coast refraction.** . See COASTAL REFRACTION.
- coastwise.** , *adv. & adj.* By way of the coast; moving along the coast. coastwise navigation. Navigation in the vicinity of a coast, in contrast with OFFSHORE NAVIGATION at a distance from a coast. See also COASTING.
- coastwise navigation.** . Navigation in the vicinity of a coast, in contrast with OFFSHORE NAVIGATION at a distance from a coast. See also COASTING.
- coaxial cable.** . A transmission cable consisting of two concentric conductors insulated from each other.
- cobble.** , *n.* A stone particle between 64 and 256 millimeters (about 2.5 to 10 inches) in diameter. See also STONE.
- cocked hat.** . Error triangle formed by lines of position which do not cross at a common point.
- cockeyed bob.** . A colloquial term in western Australia for a squall, associated with thunder, on the northwest coast in Southern Hemisphere summer.
- code beacon.** . A beacon that flashes a characteristic signal by which it may be recognized.
- codeclination.** , *n.* Ninety degrees minus the declination. When the declination and latitude are of the same name, codeclination is the same as POLAR DISTANCE measured from the elevated pole.
- coding delay.** . An arbitrary time delay in the transmission of pulse signals. In hyperbolic radionavigation systems of the pulse type, the coding delay is inserted between the transmission of the master and secondary signals to prevent zero or small readings, and thus aid in distinguishing between master and secondary station signals.
- coefficient.** , *n.* 1. A number indicating the amount of some change under certain specified conditions, often expressed as a ratio. For example, the coefficient of linear expansion of a substance is the ratio of its change in length to the original length for a unit change of temperature, from a standard. 2. A constant in an algebraic equation. 3. One of several parts which combine to make a whole, as the maximum deviation produced by each of several causes. See also APPROXIMATE COEFFICIENTS.
- coefficient A.** . A component of magnetic compass deviation of constant value with compass heading resulting from mistakes in calculations, compass and pelorus misalignment, and unsymmetrical arrangements of horizontal soft iron. See also APPROXIMATE COEFFICIENTS.
- coefficient B.** . A component of magnetic compass deviation, varying with the sine function of the compass heading, resulting from the fore-and-aft component of the craft's permanent magnetic field and induced magnetism in unsymmetrical vertical iron forward or abaft the compass. See also APPROXIMATE COEFFICIENTS.
- coefficient C.** . A component of magnetic compass deviation, varying with the cosine function of the compass heading, resulting from the athwartship component of the craft's permanent magnetic field and induced magnetism in unsymmetrical vertical iron port or starboard of the compass. See also APPROXIMATE COEFFICIENTS.
- coefficient D.** . A component of magnetic compass deviation, varying with the sine function of twice the compass heading, resulting from induced magnetism in all symmetrical arrangements of the craft's horizontal soft iron. See also APPROXIMATE COEFFICIENTS.
- coefficient E.** . A component of magnetic compass deviation, varying with the cosine function of twice the compass heading, resulting from induced magnetism in all unsymmetrical arrangements of the craft's horizontal soft iron. See also APPROXIMATE COEFFICIENTS.
- coefficient J.** . A change in magnetic compass deviation, varying with the cosine function of the compass heading for a given value of J, where J is the change of deviation for a heel of 1° on compass heading 000°. See also APPROXIMATE COEFFICIENTS.
- coercive force.** . The opposing magnetic intensity that must be applied to a magnetic substance to remove the residual magnetism.
- COGARD.** , *n.* Acronym for U.S. Coast Guard usually used in radio messages.
- coherence.** , *n.* The state of there being correlation between the phases of two or more waves, as is necessary in making phase comparisons in radionavigation.
- coincidence.** , *n.* The condition of occupying the same position as regards location, time, etc.
- col.** , *n.* 1. A neck of relative low pressure between two anticyclones. 2. A depression in the summit line of a mountain range. Also called PASS.
- colatitude.** , *n.* Ninety degrees minus the latitude, the angle between the polar axis and the radius vector locating a point.
- cold air mass.** . An air mass that is colder than surrounding air. The expression implies that the air mass is colder than the surface over which it is moving.
- cold core system.** . A cyclonic system where at any given level of atmosphere, the center of the low is colder than the environment surrounding it. Extra-tropical cyclones and winter lows are examples of normally cold core weather systems.
- cold front.** . Any non-occluded front, or portion thereof, that moves so that the colder air replaces the warmer air, i.e., the leading edge of a relatively cold air mass. While some occluded fronts exhibit this characteristic, they are more properly called COLD OCCLUSIONS.
- cold occlusion.** . See under OCCLUDED FRONT.
- cold wave.** . Unseasonably low temperatures extending over a period of a day or longer, particularly during the cold season of the year.
- collada.** , *n.* A strong wind (35 to 50 miles per hour or stronger) blowing from the north or northwest in the northern part of the Gulf of California and from the northeast in the southern part of the Gulf of California.
- collection object.** . In ECDIS a FEATURE OBJECT describing the RELATIONSHIP between other OBJECTS.
- collimate.** , *v., t.* 1. To render parallel, as rays of light. 2. To adjust the line of sight of an optical instrument, such as a theodolite, in proper relation to other parts of the instrument.
- collimation error.** . The angle by which the line of sight of an optical instrument differs from its collimation axis. Also called ERROR OF COLLIMATION.
- collimator.** , *n.* An optical device which renders rays of light parallel. One of the principal navigational uses of a collimator is to determine the index error of a bubble sextant.
- collision bearing.** . A constant bearing maintained while the distance between two craft is decreasing.
- collision course.** . A course which, if followed, will bring two craft together.
- cologarithm.** , *n.* The logarithm of the reciprocal of a number, or the negative logarithm. The sum of the logarithm and cologarithm of the same number is zero. The addition of a cologarithm accomplishes the same result as the subtraction of a logarithm.

- colored light.** . An aid to navigation exhibiting a light of a color other than white.
- color calibration.** . In ECDIS, in order to reproduce the standard colors for ECDIS, a color calibration at the monitor must be performed to transform the CIE-specified colors for ECDIS into the color coordinate system of the screen. Calibration will ensure correct color transfer at the time a DISPLAY leaves the manufacturer's plant.
- color differentiation test diagrams.** . In ECDIS - screen diagrams supplied in the PRESENTATION LIBRARY for use by the mariner to check brightness and contrast settings and to find out whether the screen still has the capability of distinguishing the important colors.
- color fill.** . 1. In ECDIS the use of color to fill the interior area of a chart symbol to make it more readily recognizable. 2. In ECDIS a method of distinguishing different area features by filling areas with color. "Transparent" color fill is used to allow information to show through the fill, e.g., soundings in a traffic separation zone.
- color gradients.** . See HYPOMETRIC TINTING.
- COLREGS.** , *n.* Acronym for International Regulations for Prevention of Collisions at Sea.
- COLREGS Demarcation Lines.** . Lines delineating the waters upon which mariners must comply with the International Regulations for Preventing Collisions at Sea 1972 (72 COLREGS) and those waters upon which mariners must comply with the Navigation Rules for Harbors, Rivers, and Inland Waters (Inland Rules). The waters outside the lines are COLREGS waters. For specifics concerning COLREGS Demarcation Lines, see *U.S. Code of Federal Regulations*, Title 33, Navigation and Navigable Waters; Part 82, COLREGS Demarcation Lines.
- column.** , *n.* A vertical line of anything, such as a column of air, a column of figures in a table, etc.
- colure.** , *n.* A great circle of the celestial sphere through the celestial poles and either the equinoxes or solstices, called, respectively, the equinoctial colure or the solstitial colure.
- coma.** , *n.* The foggy envelope surrounding the nucleus of a comet.
- combat chart.** . A special-purpose chart of a land-sea area using the characteristics of a map to represent the land area and a chart to represent the sea area, with special features to make the chart useful in naval operations, particularly amphibious operations. Also called MAP CHART.
- comber.** , *n.* A deep water wave whose crest is pushed forward by a strong wind and is much larger than a whitecap. A long spilling breaker. See ROLLER.
- comet.** , *n.* A luminous member of the solar system composed of a head or coma, at the center of which a nucleus of many small solid particles is sometimes situated, and often with a spectacular gaseous tail extending a great distance from the head. The orbits of comets are highly elliptical and present no regularity as to their angle to the plane of the ecliptic.
- command and control.** . The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, locating, directing, and controlling operations of assigned forces pursuant to the missions assigned. In many cases, a locating or position fixing capability exists in, or as a by-product to, command and control systems.
- commissioned.** , *adj.* Officially placed in operation. In navigation, most commonly used to describe seasonal aids to navigation, which are *decommissioned* in the fall or winter, *commissioned* in spring.
- Commission on the Promulgation of Radio Navigation Warnings.** . International commission that monitors and guides the Worldwide Navigation Warning Service (WWNWS). Facilitates major changes and or studies to enhance navigational warning dissemination, encourages bilateral agreements, prepares and reviews WWNWS guidance documents.
- common establishment.** . See under ESTABLISHMENT OF THE PORT.
- common logarithm.** . A logarithm to the base 10. Also called BRIGGSIAN LOGARITHM.
- common-user.** , *adj.* Having the characteristics of being planned, operated or used to provide services for both military and civil applications. The availability of a system having such characteristics is not dependent on tactical military operations or use.
- common year.** . A calendar year of 365 days. One of 366 days is called a LEAP YEAR.
- communication.** , *n.* The transfer of intelligence between entities. If by wire, radio, or other electromagnetic means, it may be called telecommunication; if by radio, radiocommunication.
- commutation.** , *n.* A method by means of which the transmissions from a number of stations of a radionavigation system are time shared on the same frequency.
- compact disk.** . A type of computer storage media which records data using bubbles melted into the surface of a disk.
- compacted ice edge.** . A close, clear-cut ice edge compacted by wind or current. It is usually on the windward side of an area of pack ice.
- compacting.** , *adj.* Pieces of sea ice are said to be compacting when they are subjected to a converging motion, which increases ice concentration and/or produces stresses which may result in ice deformations.
- compact pack ice.** . Pack ice in which the concentration is 10/10 and no water is visible.
- comparing watch.** . A watch used for timing observations of celestial bodies. Generally its error is determined by comparison with a chronometer, hence its name. A comparing watch normally has a large sweep second hand to facilitate reading time to the nearest second. Sometimes called HACK WATCH. See also SPLIT-SECOND TIMER.
- comparison frequency.** . In the Decca Navigator System, the common frequency to which the incoming signals are converted in order that their phase relationships may be compared.
- comparison of simultaneous observations.** . A reduction process in which a short series of tide or tidal current observations at any place is compared with simultaneous observations at a control station where tidal or tidal current constants have previously been determined from a long series of observations. For tides, it is usually used to adjust constants from a subordinate station to the equivalent of that which would be obtained from a 19-year series.
- compass.** , *adj.* Of or pertaining to a compass or related to compass directions.
- compass.** , *n.* An instrument for indicating a horizontal reference direction relative to the earth. Compasses used for navigation are equipped with a graduated compass card for direct indication of any horizontal direction. A magnetic compass depends for its directive force upon the attraction of the magnetism of the earth for a magnet free to turn in any horizontal direction. A compass having one or more gyroscopes as the directive element, and tending to indicate true north is called a gyrocompass. A compass intended primarily for use in observing bearings is called a bearing compass; one intended primarily for measuring amplitudes, an amplitude compass. A directional gyro is a gyroscopic device used to indicate a selected horizontal direction for a limited time. A remote-indicating compass is equipped with one or more indicators, called compass repeaters, to repeat at a distance the readings of a master compass. A compass designated as the standard for a vessel is called a standard compass; one by which a craft is steered is called a steering compass. A liquid, wet, or spirit compass is a magnetic compass having a bowl completely filled with liquid; a magnetic compass without liquid is called a dry compass. An aperiodic or deadbeat compass, after being deflected, returns by one direct movement to its proper reading, without oscillation. A small compass mounted in a box for convenient use in small water craft is called a boat compass. A pelorus is sometimes called a dumb compass. A radio direction finder was formerly called a radio compass.
- compass adjustment.** . The process of neutralizing undesired magnetic effects on a magnetic compass. Permanent magnets and soft iron correctors are arranged about the binnacle so that their effects are about equal and opposite to the magnetic material in the craft, thus reducing the deviations and eliminating the sectors of sluggishness and unsteadiness. See also COMPASS COMPENSATION.
- compass adjustment buoy.** . See SWINGING BUOY.
- compass amplitude.** . Amplitude relative to compass east or west.
- compass azimuth.** . Azimuth relative to compass north.
- compass bearing.** . Bearing relative to compass north.
- compass bowl.** . The housing in which the compass card is mounted, usually filled with liquid.
- compass card.** . The part of a compass on which the direction graduations are placed. It is usually in the form of a thin disk or annulus graduated in degrees, clockwise from 000° at the reference direction to 360°, and sometimes also in compass points. A similar card on a pelorus is called a PELORUS CARD.
- compass card axis.** . The line joining 000° and 180° on a compass card. Extended, this line is sometimes called COMPASS MERIDIAN.

- compass compensation.** . The process of neutralizing the effects of degaussing currents on a marine magnetic compass. The process of neutralizing the magnetic effects the vessel itself exerts on a magnetic compass is properly called COMPASS ADJUSTMENT, but the expression compass compensation is often used for this process, too.
- compass course.** . Course relative to compass north.
- compass direction.** . Horizontal direction expressed as angular distance from compass north.
- compass error.** . The angle by which a compass direction differs from the true direction; the algebraic sum of variation and deviation; the angle between the true meridian and the compass card axis, expressed in degrees east or west to indicate the direction of compass north with respect to true north. See also ACCELERATION ERROR, GAUSSIN ERROR, GYRO ERROR, HEELING ERROR, LUBBER'S LINE ERROR, QUADRANTAL ERROR, RETENTIVE ERROR, SWIRL ERROR.
- compasses.** , *n.* An instrument for drawing circles. In its most common form it consists of two legs joined by a pivot, one leg carrying a pen or pencil and the other leg being pointed. An instrument for drawing circles of large diameter, usually consisting of a bar with sliding holders for points, pencils, or pens is called beam compasses. If both legs are pointed, the instrument is called DIVIDERS and is used principally for measuring distances or coordinates.
- compass heading.** . Heading relative to compass north.
- compass meridian.** . A line through the north-south points of a magnetic compass. The COMPASS CARD AXIS lies in the compass meridian.
- compass north.** . The direction north as indicated by a magnetic compass; the reference direction for measurement of compass directions.
- compass points.** . The 32 divisions of a compass, at intervals of 11.25°. Each division is further divided into quarter points. Stating in order the names of the points (and sometimes the half and quarter points) is called BOXING THE COMPASS.
- compass prime vertical.** . The vertical circle through the compass east and west points of the horizon.
- compass repeater.** . That part of a remote-indicating compass system which repeats at a distance the indications of the master compass. One used primarily for observing bearings may be called a bearing repeater. Also called REPEATER COMPASS. See also GYRO REPEATER.
- compass rose.** . A circle graduated in degrees, clockwise from 000° at the reference direction to 360°, and sometimes also in compass points. Compass roses are placed at convenient locations on the Mercator chart or plotting sheet to facilitate measurement of direction. See also PROTRACTOR.
- compass track.** . The direction of the track relative to compass north.
- compass transmitter.** . The part of a remote-indicating compass system which sends the direction indications to the repeater compass.
- compensate.** , *v., t.* To counteract an error; to counterbalance.
- compensated loop radio direction finder.** . A loop antenna radio direction finder for bearing determination, which incorporates a second antenna system designed to reduce the effect of polarization and radiation error.
- compensating coils.** . The coils placed near a magnetic compass to neutralize the effect of the vessel's degaussing system on the compass. See also COMPASS COMPENSATION.
- compensating error.** . An error that tends to offset a companion error and thus obscure or reduce the effect of each.
- compensator.** , *n.* 1. A corrector used in the compensation of a magnetic compass. 2. The part of a radio direction finder which applies all or part of the necessary correction to the direction indication.
- compilation scale.** . In ECDIS the SCALE at which the DATA was compiled.
- compilation update.** . In ECDIS the CORRECTION INFORMATION which has been issued since the last new edition of the ENC or since the last OFFICIAL UPDATE applied to the SENC, compiled into a single, comprehensive ENC UPDATE.
- compile.** . To assemble various elements of a system into a whole.
- compiler.** . 1. One who compiles. 2. Computer software which translates programs into machine language which a computer can use.
- complement.** , *n.* An angle equal to 90° minus a given angle. See also EXPLEMENT, SUPPLEMENT.
- complementary angles.** . Two angles whose sum is 90°.
- component.** , *n.* 1. See CONSTITUENT. 2. The part of a tidal force of tidal current velocity which, by resolution into orthogonal vectors, is found to act in a specified direction. 3. One of the parts into which a vector quantity can be divided. For example, the earth's magnetic force at any point can be divided into *horizontal* and *vertical components*.
- composite.** , *adj.* Composed of two or more separate parts.
- composite group flashing light.** . A light similar to a group flashing light except that successive groups in a single period have different numbers of flashes.
- composite group occulting light.** . A group occulting light in which the occultations are combined in successive groups of different numbers of occultations.
- composite sailing.** . A modification of great circle sailing used when it is desired to limit the highest latitude. The composite track consists of a great circle from the point of departure and tangent to the limiting parallel, a course line along the parallel, and a great circle tangent to the limiting parallel to the destination. Composite sailing applies only when the vertex lies between the point of departure and destination.
- composite track.** . A modified great circle track consisting of an initial great circle track from the point of departure with its vertex on a limiting parallel of latitude, a parallel-sailing track from this vertex along the limiting parallel to the vertex of a final great circle track to the destination.
- composition of vectors.** . See VECTOR ADDITION.
- compound harmonic motion.** . The projection of two or more uniform circular motions on a diameter of the circle of such motion. The projection of a simple uniform circular motion is called SIMPLE HARMONIC MOTION.
- compound tide.** . A tidal constituent with a speed equal to the sum or difference of the speeds of two or more elementary constituents. Compound tides are usually the result of shallow water.
- compressed-air horn.** . See DIAPHRAGM HORN.
- compression.** , *n.* See FLATTENING.
- computed altitude.** . 1. Tabulated altitude interpolated for increments of latitude, declination, or hour angle. If no interpolation is required, the tabulated altitude and computed altitude are identical. 2. Altitude determined by computation, table, mechanical computer, or graphics, particularly such an altitude of the center of a celestial body measured as an arc on a vertical circle of the celestial sphere from the celestial horizon. Also called CALCULATED ALTITUDE.
- computed azimuth.** . Azimuth determined by computation, table, mechanical device, or graphics for a given place and time. See also TABULATED AZIMUTH.
- computed azimuth angle.** . Azimuth angle determined by computation, table, mechanical device, or graphics for a given place and time. See also TABULATED AZIMUTH ANGLE.
- computed point.** . In the construction of the line of position by the Marcq St. Hilaire method, the foot of the perpendicular from the assumed position to the line of position. Also called SUMNER POINT.
- concave.** , *adj.* Curving and hollow, such as the inside of a circle or sphere. The opposite is CONVEX.
- concave.** , *n.* A concave line or surface.
- concentration.** , *n.* The ratio, expressed in tenths, of the sea surface actually covered by ice to the total area of sea surface, both ice-covered and ice-free, at a specific location or over a defined area.
- concentration boundary.** . The transition between two areas of pack ice with distinctly different concentrations.
- concentric.** , *adj.* Having the same center. The opposite is ECCENTRIC.
- concurrent line.** . A line on a map or chart passing through places having the same current hour.
- condensation.** , *n.* The physical process by which a vapor becomes a liquid or solid. The opposite is EVAPORATION.
- conduction.** , *n.* Transmission of electricity, heat, or other form of energy from one point to another along a conductor, or transference of heat from particle to particle through a substance, such as air, without any obvious motion. Heat is also transferred by CONVECTION and RADIATION.
- conductivity.** , *n.* The ability to transmit, as electricity, heat, sound, etc. Conductivity is the opposite of RESISTIVITY.
- conductor.** , *n.* A substance which transmits electricity, heat, sound, etc.
- cone.** , *n.* 1. A solid having a plane base bounded by a closed curve and a surface formed by lines from every point on the circumference of the base to a common point or apex. 2. A surface generated by a

straight line of indefinite length, one point of which is fixed and another point of which follows a fixed curve. Also called a CONICAL SURFACE.

**configuration**, *n.* 1. The position or disposition of various parts, or the figure or pattern so formed. 2. A geometric figure, usually consisting principally of points and connecting lines.

**conformal**, *adj.* Having correct angular representation.

**conformal chart**. . A chart using a conformal map projection; also called orthomorphic chart.

**conformal map projection**. . A map projection in which all angles around any point are correctly represented. In such a projection the scale is the same in all directions about any point. Very small shapes are correctly represented, resulting in an orthomorphic projection. The terms *conformal* and *orthomorphic* are used synonymously since neither characteristic can exist without the other.

**confusion region**. . The region surrounding a radar target within which the radar echo from the target cannot be distinguished from other echoes.

**conic**, *adj.* Pertaining to a cone.

**conical buoy**. . See NUN BUOY.

**conical surface**. . See CONE, definition 2.

**conic chart**. . A chart on a conic map projection.

**conic chart with two standard parallels**. . A chart on the conic map projection with two standard parallels. Also called SECANT CONIC CHART. See also LAMBERT CONFORMAL CHART.

**conic map projection**. . A map projection in which the surface of a sphere or spheroid, such as the earth, is conceived as projected onto a tangent or secant cone which is then developed into a plane. In a simple conic map projection the cone is tangent to the sphere or spheroid, in a conic map projection with two standard parallels the cone intersects the sphere or spheroid along two chosen parallels, and in a polyconic map projection a series of cones are tangent to the sphere or spheroid. See also LAMBERT CONFORMAL CONIC MAP PROJECTION, MODIFIED LAMBERT CONFORMAL MAP PROJECTION.

**conic map projection with two standard parallels**. . A conic map projection in which the surface of a sphere or spheroid is conceived as developed on a cone which intersects the sphere or spheroid along two standard parallels, the cone being spread out to form a plane. The Lambert conformal map projection is an example. Also called SECANT CONIC MAP PROJECTION.

**conic section**. . *n.* Any plane curve which is the locus of a point which moves so that the ratio of its distance from a fixed point to its distance from a fixed line is constant. The ratio is called the eccentricity; the fixed point is the focus; the fixed line is the directrix. When the eccentricity is equal to unity, the conic section is a parabola; when less than unity an ellipse; and when greater than unity, a hyperbola. They are so called because they are formed by the intersection of a plane and a right circular cone.

**conjunction**. . *n.* The situation of two celestial bodies having either the same celestial longitude or the same sidereal hour angle. A planet is at superior conjunction if the sun is between it and the earth; at inferior conjunction if it is between the sun and the earth. The situation of two celestial bodies having either celestial longitudes or sidereal hour angles differing by 180° is called OPPOSITION.



conjunction

**conn**, *v., t.* 1. To direct the course and speed of a vessel. The person giving orders to the helmsman (not just relaying orders) is said to have the conn or to be conning the ship. 2. *n.* Control of the maneuvering of a ship.

**connected node**. . In ECDIS a NODE referred to as a beginning and/or end node by one or more EDGE. Connected nodes are defined only in the CHAIN-NODE, PLANAR GRAPH and FULL TOPOLOGY data structures.

**Consol**. . *n.* A long range, obsolete azimuthal radionavigation system of low accuracy operated primarily for air navigation.

**console**. . *n.* The housing of the main operating unit of electronic equipment, in which indicators and general controls are located. The term is popularly limited to large housings resting directly on the deck, as contrasted with smaller cabinets such as rack or bracket-mounted units.

**consolidated pack ice**. . Pack ice in which the concentration is 10/10 and the floes are frozen together.

**consolidated ridge**. . A line or wall of ice forced up by pressure in which the base has frozen together.

**Consol station**. . A short baseline directional antenna system used to generate Consol signals.

**constant**. . *n.* A fixed quantity; one that does not change.

**constant bearing, decreasing range**. . See STEADY BEARING.

**constant deviation**. . Deviation which is the same on any heading, as that which may result from certain arrangements of asymmetrical horizontal soft iron.

**constant error**. . A systematic error of unchanging magnitude and sign throughout a given series of observations. Also called BIAS ERROR.

**constant of aberration**. . The measure of the maximum angle between the true direction and the apparent direction of a celestial body as observed from earth due to aberration. It has a value of 20.496 seconds of arc. The aberration angle depends upon the ratio of the velocity of the earth in its orbit and the velocity of light in addition to the angle between the direction of the light and the direction of motion of the observing telescope. The maximum value is obtained when the celestial body is at the pole of the ecliptic. Also called ABERRATION CONSTANT.

**constant of the cone**. . The chart convergence factor for a conic projection. See also CONVERGENCE FACTOR.

**constant-pressure chart**. . The synoptic chart for any constant-pressure surface, usually containing plotted data and analyses of the distribution of, e.g., height of the surface, wind, temperature, and humidity. Constant-pressure charts are most commonly known by their pressure value; for example the 1000-millibar chart. Also called ISOBARIC CHART.

**constant-pressure surface**. . In meteorology, an imaginary surface along which the atmospheric pressure is everywhere equal at a given instant. Also called ISOBARIC SURFACE.

**constellation**. . *n.* A group of stars which appear close together, regardless of actual distances, particularly if the group forms a striking configuration. Among astronomers a constellation is now considered a region of the sky having precise boundaries so arranged that all of the sky is covered, without overlap. The ancient Greeks recognized 48 constellations covering only certain groups of stars. Modern astronomers recognize 88 constellations.

**constituent**. . *n.* One of the harmonic elements in a mathematical expression for the tide-producing force and in corresponding formulas for the tide or tidal current. Each constituent represents a periodic change or variation in the relative positions of the earth, moon, and sun. Also called HARMONIC CONSTITUENT, TIDAL CONSTITUENT, COMPONENT.

**constituent day**. . The duration of one rotation of the earth on its axis, with respect to an astre fictif, a fictitious star representing one of the periodic elements in tidal forces. It approximates the length of a lunar or solar day. The expression is not applicable to a long period.

**constituent, constituent hour**. . One twenty-fourth part of a constituent day.

**contact**. . *n.* Any echo detected on the radarscope and not evaluated as clutter or as a false echo. Although the term *contact* is often used interchangeably with *target*, the latter term specifically indicates that the echo is from an object about which information is being sought.

**conterminous U.S.**. . Forty-eight states and the District of Columbia, i.e., the United States before January 3, 1959 (excluding Alaska and Hawaii).

**contiguous zone**. . The band of water outside or beyond the territorial sea in which a coastal nation may exercise customs control and enforce public health and other regulations.

**continent**. . *n.* An expanse of continuous land constituting one of the major divisions of the land surface of the earth.

**continental borderland**. . A region adjacent to a continent, normally occupied by or bordering a shelf, that is highly irregular with depths well in excess of those typical of a shelf. See also INSULAR BORDERLAND.

- continental climate.** . The type of climate characteristic of the interior of a large land mass, the distinctive features of which are large annual and daily temperature range and dry air with few clouds, in contrast with MARINE CLIMATE.
- continental polar air.** . See under AIR-MASS CLASSIFICATION.
- continental rise.** . A gentle slope rising from oceanic depths toward the foot of a continental slope.
- continental shelf.** . A zone adjacent to a continent that extends from the low water line to a depth at which there is usually a marked increase of slope towards oceanic depths. See also INSULAR SHELF.
- continental tropical air.** . See under AIR-MASS CLASSIFICATION.
- Continental United States.** . United States territory, including the adjacent territorial waters, located within the North American continent between Canada and Mexico. See also CONTERMINOUS U.S.
- continuous carrier radiobeacon.** . A radiobeacon whose carrier wave is unbroken but which is modulated with the identification signal. The continuous carrier wave signal is not audible to the operator of an aural null direction finder not having a beat frequency oscillator. The use of the continuous carrier wave improves the performance of automatic direction finders. The marine radiobeacons on the Atlantic and Pacific coasts of the U.S. are of this type. See also DUAL CARRIER RADIOBEACON.
- continuous quick light.** . A quick flashing light (flashing 50-80 times per minute) which operates continuously with no eclipses.
- continuous system.** . A classification of a navigation system with respect to availability. A continuous system gives the capability to determine position at any time.
- continuous ultra quick light.** . An ultra quick light (flashing not less than 160 flashes per minute) with no eclipses.
- continuous very quick light.** . A very quick light (flashing 80-160 times per minute) with no eclipses.
- continuous wave.** . 1. Electromagnetic radiation of a constant amplitude and frequency. 2. Radio waves, the successive sinusoidal oscillations of which are identical under steady-state conditions.
- contour.** , *n.* The imaginary line on the ground or seafloor, all points of which are at the same elevation above or below a specified datum.
- contour interval.** . The difference in elevation between two adjacent contours.
- contour line.** . A line connecting points of equal elevation or equal depth. One connecting points of equal depth is usually called a depth contour, but if depth is expressed in fathoms, it may be called a fathom curve or fathom line. See also FORM LINES.
- contour map.** . A topographic map showing relief by means of contour lines.
- contrary name.** . A name opposite or contrary to that possessed by something else, as declination has a name *contrary* to that of latitude if one is north and the other south. If both are north or both are south, they are said to be of SAME NAME.
- contrasts.** , *n., pl.* Winds a short distance apart blowing from opposite quadrants, frequent in the spring and fall in the western Mediterranean.
- contrast threshold.** . The minimum contrast at the eye of a given observer at which an object can be detected. The contrast threshold is a property of the eye of the individual observer. See METEOROLOGICAL VISIBILITY, VISUAL RANGE.
- control.** , *n.* 1. The coordinated and correlated dimensional data used in geodesy and cartography to determine the positions and elevations of points on the earth's surface or on a cartographic representation of that surface. 2. A collective term for a system of marks or objects on the earth or on a map or a photograph, whose positions and/or elevations have been or will be determined.
- control current station.** . A current station at which continuous velocity observations have been made over a minimum of 29 days. Its purpose is to provide data for computing accepted values of the harmonic and nonharmonic constants essential to tidal current predictions and circulatory studies. The data series from this station serves as the control for the reduction of relatively short series from subordinate current stations through the method of comparison of simultaneous observations. See also CURRENT STATION, SUBORDINATE CURRENT STATION.
- controlled air space.** . An airspace of defined dimensions within which air traffic control service is provided.
- controlling depth.** . 1. The least depth in the approach or channel to an area, such as a port or anchorage, governing the maximum draft of vessels that can enter. 2. The least depth within the limits of a channel; it restricts the safe use of the channel to drafts of less than that depth. The center line controlling depth of a channel applies only to the channel center line; lesser depths may exist in the remainder of the channel. The mid-channel controlling depth of a channel is the controlling depth of only the middle half of the channel. See also FEDERAL PROJECT DEPTH.
- control station.** . See PRIMARY CONTROL TIDE STATION, SECONDARY CONTROL TIDE STATION, CONTROL CURRENT STATION.
- convection.** , *n.* Circulation in a fluid of nonuniform temperature, due to the differences in density and the action of gravity. In the atmosphere, convection takes place on a large scale. It is essential to the formation of many clouds, especially those of the cumulus type. Heat is transferred by convection and also by ADVECTION, CONDUCTION, and RADIATION.
- convention.** , *n.* A body of regulations adopted by the International Maritime Organization (IMO) which regulate an aspect of maritime affairs. See also GEOGRAPHIC SIGN CONVENTIONS.
- conventional direction of buoyage.** . 1. The general direction taken by the mariner when approaching a harbor, river, estuary or other waterway from seaward, or 2. The direction determined by the proper authority. In general it follows a clockwise direction around land masses.
- converge.** , *v., i.* To tend to come together.
- converged beam.** . See under FAN BEAM.
- convergence constant.** . The angle at a given latitude between meridians 1° apart. Sometimes loosely called CONVERGENCY. On a map or chart having a convergence constant of 1.0, the true direction of a straight line on the map or chart changes 1° for each 1° of longitude that the line crosses; the true direction of a straight line on a map or chart having a convergence constant of 0.785 changes 0.785° for each 1° of longitude the line crosses. Also called CONVERGENCE FACTOR. See also CONVERGENCE OF MERIDIANS.
- convergence factor.** . See CONVERGENCE CONSTANT.
- convergence of meridians.** . The angular drawing together of the geographic meridians in passing from the Equator to the poles. At the Equator all meridians are mutually parallel; passing from the Equator, they converge until they meet at the poles, intersecting at angles that are equal to their differences of longitude. See also CONVERGENCE CONSTANT.
- convergency.** , *n.* See under CONVERGENCE CONSTANT.
- conversion.** , *n.* Determination of the rhumb line direction of one point from another when the initial great circle direction is known, or vice versa. The difference between the two directions is the conversion angle, and is used in great circle sailing.
- conversion angle.** . The angle between the rhumb line and the great circle between two points. Also called ARC TO CHORD CORRECTION. See also HALF-CONVERGENCY.
- conversion scale.** . A scale for the conversion of units of one measurement to equivalent units of another measurement. See NOMOGRAM.
- conversion table.** . A table for the conversion of units of one measurement to equivalent units of another measurement. See NOMOGRAM.
- convex.** , *adj.* Curving away from, such as the outside of a circle or sphere. The opposite is CONCAVE.
- convex.** , *n.* A convex line or surface.
- coordinate.** , *n.* One of a set of magnitudes defining a point in space. If the point is known to be on a given line, only one coordinate is needed; if on a surface, two are required; if in space, three. Cartesian coordinates define a point relative to two intersecting lines, called AXES. If the axes are perpendicular, the coordinates are rectangular; if not perpendicular, they are oblique coordinates. A three-dimensional system of Cartesian coordinates is called space coordinates. Polar coordinates define a point by its distance and direction from a fixed point called the POLE. Direction is given as the angle between a reference radius vector and a radius vector to the point. If three dimensions are involved, two angles are used to locate the radius vector. Space-polar coordinates define a point on the surface of a sphere by (1) its distance from a fixed point at the center, called the POLE (2) the COLATITUDE or angle between the POLAR AXIS (a reference line through the pole) and the RADIUS VECTOR (a straight line connecting the pole and the point)- and (3) the LONGITUDE or angle between a reference plane through the polar axis and a plane through the radius vector and the polar axis. Spherical coordinates define a point on a sphere or spheroid by its

- angular distances from a primary great circle and from a reference secondary great circle. Geographical or terrestrial coordinates define a point on the surface of the earth. Celestial coordinates define a point on the celestial sphere. The horizon, celestial equator and the ecliptic systems of celestial coordinates are based on the celestial horizon, celestial equator, and the ecliptic, respectively, as the primary great circle.
- coordinate conversion.** . Changing the coordinate values from one system to those of another.
- Coordinated Universal Time (UTC).** . The time scale that is available from most broadcast time signals. It differs from International Atomic Time (TAI) by an integral number of seconds. UTC is maintained within 1 second of UT1 by the introduction of 1-second steps (leap seconds) when necessary, normally at the end of December. DUT1, an approximation to the difference UT1 minus UTC, is transmitted in code on broadcast time signals.
- coordinate paper.** . Paper ruled with lines to aid in the plotting of coordinates. In its most common form, it has two sets of parallel lines, usually at right angles to each other, when it is also called CROSS-SECTION PAPER. A type ruled with two sets of mutually-perpendicular, parallel lines spaced according to the logarithms of consecutive numbers is called logarithmic coordinate paper or semilogarithmic coordinate paper as both or only one set of lines is spaced logarithmically. A type ruled with concentric circles and radial lines from the common center is called polar coordinate paper. Also called GRAPH PAPER.
- coplanar.** , *adj.* Lying in the same plane.
- coprocessor.** . A microprocessor chip which performs numerical functions for the Central Processing Unit (CPU), freeing it for other tasks.
- coral.** , *n.* The hard skeleton of certain tiny sea animals or the stony, solidified mass of a number of such skeletons.
- coral head.** . A large mushroom or pillar shaped coral growth.
- coral reef.** . A reef made up of coral, fragments of coral and other organisms, and the limestone resulting from their consolidation. Coral may constitute less than half of the reef material.
- corange line.** . A line passing through places of equal tidal range.
- cordillera.** , *n.* On the sea floor, an entire mountain system including all the subordinate ranges, interior plateaus, and basins.
- cordonazo.** , *n.* The "Lash of St. Francis." Name applied locally to southerly hurricane winds along the west coast of Mexico. The cordonazo is associated with tropical cyclones in the southeastern North Pacific Ocean. These storms may occur from May to November, but ordinarily affect the coastal areas most severely near or after the Feast of St. Francis, on October 4.
- Coriolis acceleration.** . An acceleration of a body in motion in a relative (moving) coordinate system. The total acceleration of the body, as measured in an inertial coordinate system, may be expressed as the sum of the acceleration within the relative system, the acceleration of the relative system itself, and the Coriolis acceleration. In the case of the earth, moving with angular velocity  $\Omega$ , a body moving relative to the earth with velocity  $V$  has the Coriolis acceleration  $2\Omega \times V$ . If Newton's laws are to be applied in the relative system, the Coriolis acceleration and the acceleration of the relative system must be treated as forces. See also CORIOLIS FORCE.
- Coriolis correction.** . 1. A correction applied to an assumed position, celestial line of position, celestial fix, or to a computed or observed altitude to allow for Coriolis acceleration. 2. In inertial navigation equipment, an acceleration correction which must be applied to measurements of acceleration with respect to a coordinate system in translation to compensate for the effect of any angular motion of the coordinate system with respect to inertial space.
- Coriolis force.** . An inertial force acting on a body in motion, due to rotation of the earth, causing deflection to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. It affects air (wind), water (current), etc. and introduces an error in bubble sextant observations made from a moving craft due to the liquid in the bubble being deflected, the effect increasing with higher latitude and greater speed of the craft.
- corner reflector.** . A radar reflector consisting of three mutually perpendicular flat reflecting surfaces designed to return incident electromagnetic radiation toward its source. The reflector is used to render objects such as buoys and sailboats more conspicuous to radar observations. Since maximum effectiveness is obtained when the incident beam coincides with the axis of symmetry of the reflector, clusters of reflectors are sometimes used to insure that the object will be a good reflector in all directions. See also RADAR REFLECTOR. Also called TRIHEDRAL REFLECTOR.
- coromell.** , *n.* A night land breeze prevailing from November to May at La Paz, near the southern extremity of the Gulf of California.
- corona.** , *n.* 1. The luminous envelope surrounding the sun but visible only during a total eclipse. 2. A luminous discharge due to ionization of the air surrounding an electric conductor. 3. A set of one or more rainbow-colored rings of small radii surrounding the sun, moon, or other source of light covered by a thin cloud veil. It is caused by diffraction of the light by tiny droplets in the atmosphere, and hence the colors are in the reverse order to those of a HALO caused by refraction. 4. A circle of light occasionally formed by the apparent convergency of the beams of the aurora.
- corona discharge.** . Luminous and often audible discharge of electricity intermediate between a spark and a point discharge. See ST. ELMO'S FIRE.
- corposant.** , *n.* See CORONA DISCHARGE, ST. ELMO'S FIRE.
- corrasion.** , *n.* The wearing away of the earth's surface by the abrasive action of material transported by glacier, water, or air; a process of erosion.
- corrected compass course.** . Compass course with deviation applied; magnetic course.
- corrected compass heading.** . Compass heading with deviation applied; magnetic heading.
- corrected current.** . A relatively short series of current observations from a subordinate station to which a factor is applied to adjust the current to a more representative value, based on a relatively long series from a nearby control station. See also CURRENT, TOTAL CURRENT.
- corrected establishment.** . See under ESTABLISHMENT OF THE PORT.
- corrected sextant altitude.** . Sextant altitude corrected for index error, height of eye, parallax, refraction, etc. Also called OBSERVED ALTITUDE, TRUE ALTITUDE.
- correcting.** , *n.* The process of applying corrections, particularly the process of converting compass to magnetic direction, or compass, magnetic, or gyro to true direction. The opposite is UNCORRECTING.
- correction.** , *n.* That which is added to or subtracted from a reading, as of an instrument, to eliminate the effect of an error, or to reduce an observation to an arbitrary standard.
- correction information.** . See UPDATE INFORMATION.
- correction of soundings.** . The adjustment of soundings for any departure from true depth because of the method of sounding or any fault in the measuring apparatus. See also REDUCTION OF SOUNDINGS.
- corrector.** , *n.* A magnet, piece of soft iron, or device used in the adjustment of a magnetic compass. See also FLINDERS BAR, HEELING MAGNET, QUADRANTAL CORRECTORS.
- corrosion.** , *n.* The wearing or wasting away by chemical action, usually by oxidation. A distinction is usually made between corrosion and EROSION, the latter referring to the wearing away of the earth's surface primarily by non-chemical action. See also CORRASION.
- coscant.** , *n.* The ratio of the hypotenuse of a plane right triangle to the side opposite one of the acute angles of the triangle, equal to  $1/\sin$ . The expression NATURAL COSECANT is sometimes used to distinguish the cosecant from its logarithm (called LOGARITHMIC COSECANT).
- cosine.** , *n.* The ratio of the side adjacent to an acute angle of a plane right triangle to the hypotenuse. The expression NATURAL COSINE is sometimes used to distinguish the cosine from its logarithm (called LOGARITHMIC COSINE).
- COSPAS/SARSAT.** . A cooperative search and rescue satellite system operated by the U.S. and Russia which provides worldwide coverage by sensing the signals of Emergency Position Indicating Radiobeacons (EPIRBs).
- cotangent.** , *n.* The ratio of the shorter side adjacent to an acute angle of a plane right triangle to the side opposite the same angle, equal to  $1/\tan$ . The expression NATURAL COTANGENT is sometimes used to distinguish the cotangent from its logarithm (called LOGARITHMIC COTANGENT).
- cotidal.** , *adj.* Having tides occurring at the same time.
- cotidal chart.** . A chart showing COTIDAL lines.
- cotidal hour.** . The average interval between the moon's transit over the

- meridian of Greenwich and the time of the following high water at any place, expressed in either mean solar or lunar time units. When expressed in solar time, it is the same as the Greenwich high water interval. When expressed in lunar time, it is equal to the Greenwich high water interval multiplied by the factor 0.966.
- cotidal line.** . A line on a map or chart passing through places having the same cotidal hour.
- coulomb.** , *n.* A derived unit of quantity of electricity in the International System of Units; it is the quantity of electricity carried in 1 second by a current of 1 ampere.
- counterclockwise.** , *adv.* In a direction of rotation opposite to that of the hands of a clock.
- countercurrent.** , *n.* A current usually setting in a direction opposite to that of a main current.
- counterglow.** , *n.* See GEGENSCHIEIN.
- countertrades.** , *n., pl.* See ANTITRADES.
- coupler.** , *n.* See as ANTENNA COUPLER.
- course.** , *n.* The direction in which a vessel is steered or intended to be steered, expressed as angular distance from north, usually from 000° at north, clockwise through 360°. Strictly, the term applies to direction through the water, not the direction intended to be made good over the ground. The course is often designated as true, magnetic, compass, or grid as the reference direction is true, magnetic compass, or grid north, respectively. TRACK MADE GOOD is the single resultant direction from the point of departure to point of arrival at any given time. The use of this term to indicate a single resultant direction is preferred to the use of the misnomer course made good. A course line is a line, as drawn on a chart, extending in the direction of a course. See also COURSE ANGLE, COURSE OF ADVANCE, COURSE OVER GROUND, HEADING, TRACK.
- course angle.** . Course measured from 0° at the reference direction clockwise or counterclockwise through 90° or 180°. It is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix.
- course beacon.** . A directional radiobeacon which gives an "on course" signal in the receiver of a vessel which is on, or in close proximity to, the prescribed course line and "off course" signals in sectors adjacent to this line.
- course board.** . A board located on the navigation bridge used to display the course to steer, track, drift angle, leeway angle, compass error, etc.
- course line.** . 1. The graphic representation of a ship's course, usually with respect to true north. 2. A line of position approximately parallel to the course line (definition 1), thus providing a check as to deviating left or right of the track. See also SPEED LINE.
- course made good.** . A misnomer indicating the resultant direction from a point of departure to a point of arrival at any given time. See also COURSE, COURSE OVER GROUND, TRACK MADE GOOD.
- course of advance.** . An expression sometimes used to indicate the direction intended to be made good over the ground. The preferred term is TRACK, definition 1. This is a misnomer in that courses are directions steered or intended to be steered through the water with respect to a reference meridian. See also COURSE, COURSE OVER GROUND.
- course over ground.** . The direction of the path over the ground actually followed by a vessel. The preferred term is TRACK, definition 1. It is normally a somewhat irregular line. This is a misnomer in that courses are directions steered or intended to be steered through the water with respect to a reference meridian. See also COURSE, COURSE MADE GOOD.
- course recorder.** . A device which makes an automatic graphic record of the headings of a vessel vs. time. See also DEAD RECKONING TRACER.
- course up.** . See BASE COURSE UP.
- course up display.** . In ECDIS (or radar) the information shown on the DISPLAY with the direction of the vessel's course upward.
- cove.** , *n.* A small sheltered recess or indentation in a shore or coast, generally inside a larger embayment.
- crab.** , *v., t.* To drift sideways while in forward motion.
- crack line.** , *n.* Any fracture (in ice) which has not parted.
- creek.** , *n.* 1. A stream of less volume than a river but larger than a brook. 2. A small tidal channel through a coastal marsh. 3. A wide arm of a river or bay, as used locally in Maryland and Virginia.
- crepuscular rays.** . Literally, "twilight rays," alternating lighter and darker bands (rays and shadows) which appear to diverge in fan-like array from the sun's position at about twilight. This term is applied to two quite different phenomena: a. It refers to shadows cast across the purple light, a true twilight phenomenon, by cloud tops that are high enough and far enough away from the observer to intercept some of the sunlight that would ordinarily produce the purple light. b. A more common occurrence is that of shadows and rays made visible by haze in the lower atmosphere. Towering clouds produce this effect also, but they may be fairly close to the observer and the sun need not be below the horizon. The apparent divergence of crepuscular rays is merely a perspective effect. When they continue across the sky to the antisolar point, these extensions are called ANTI-CREPUSCULAR RAYS. Also called SHADOW BANDS.
- crescent.** , *adj.* Bounded by a convex and a concave curve. Originally, the term applied only to the "increasing" moon, from which the word was derived. By extension, it is now generally applied to the moon between last quarter and new as well as between new and first quarter, and to any other celestial body presenting a similar appearance, or any similarly shaped object. See also PHASES OF THE MOON.
- crest.** , *n.* The highest part of a wave or swell; or terrestrially, a hill or ridge.
- crest cloud.** . A type of cloud over a mountain ridge, similar to a cap cloud over an isolated peak. The cloud is apparently stationary, but actually is continually being formed to windward and dissipated to leeward.
- crevasse.** , *n.* A deep fissure or rift in a glacier.
- critical angle.** . 1. The maximum angle at which a radio wave may be emitted from an antenna, in respect to the plane of the earth, and still be returned to the earth by refraction or reflection by an ionospheric layer. 2. The angle at which radiation, about to pass from a medium of greater density into one of lesser density, is refracted along the surface of the denser medium.
- critical table.** . A single entering argument table in which values of the quantity to be found are tabulated for limiting values of the entering argument. In such a table interpolation is avoided through dividing the argument into intervals so chosen that successive intervals correspond to successive values of the required quantity, called the respondent. For any value of the argument within these intervals, the respondent can be extracted from the table without interpolation. The lower and upper limits (critical values) of the argument correspond to half-way values of the respondent and, by convention, are chosen so that when the argument is equal to one of the critical values, the respondent corresponding to the preceding (upper) interval is to be used.
- critical temperature.** . The temperature above which a substance cannot exist in the liquid state, regardless of pressure.
- cross-band Racon.** . A Racon which transmits at a frequency not within the marine radar frequency band. To be able to use this type of Racon, the ship's radar receiver must be capable of being tuned to the frequency of the crossband Racon, or special accessory equipment is required. In either case, normal radar echoes will not be painted on the radarscope. This is an experimental type of Racon. See also INBAND RACON.
- cross-band transponder.** . A transponder which responds on a frequency different from that of the interrogating signal.
- cross bearings.** . Two or more bearings used as intersecting lines of position for fixing the position of a craft.
- cross hair.** . A hair, thread, or wire constituting part of a reticle.
- cross sea.** . A series of waves imposed across the prevailing waves. It is called CROSS SWELL when the imposed waves are the longer swell waves.
- cross-section paper.** . Paper ruled with two sets of parallel lines, useful as an aid in plotting Cartesian coordinates. Usually, the two sets are mutually perpendicular. See also COORDINATE PAPER.
- cross-staff.** , *n.* A forerunner of the modern sextant used for measuring altitudes of celestial bodies, consisting of a wooden rod with one or more perpendicular cross pieces free to slide along the main rod. Also called FORESTAFF, JACOB'S STAFF.
- cross swell.** . See under CROSS SEA.
- cross tide.** . A tidal current setting in a direction approximately 90° from the course of a vessel. One setting in a direction approximately 90° from the heading is called a BEAM TIDE. In common usage these two expressions are usually used synonymously. One setting from ahead is called a HEAD TIDE. One setting from aft is called a FAIR

- TIDE.**
- cross wind.** . See under BEAM WIND.
- cruising radius.** . The distance a craft can travel at cruising speed without refueling. Also called CRUISING RANGE.
- cruising range.** . See CRUISING RADIUS.
- cryogenics.** , *n.* 1. The study of the methods of producing very low temperatures. 2. The study of the behavior of materials and processes at cryogenic temperatures.
- cryogenic temperature.** . In general, a temperature range below the boiling point of nitrogen (-320.4°F or -195.8°C); more particularly, temperatures within a few degrees of absolute zero.
- crystal.** , *n.* A crystalline substance which allows electric current to pass in only one direction.
- crystal clock.** . See QUARTZ CRYSTAL CLOCK.
- cube.** , *n.* 1. A solid bounded by six equal square sides. 2. The third power of a quantity.
- cubic meter.** . The derived unit of volume in the International System of Units.
- cul-de-sac.** , *n.* An inlet with a single small opening.
- culmination.** , *n.* See MERIDIAN TRANSIT.
- culture.** , *n.* 1. The man-made features of a map or chart, including roads, rails, cables, etc.; boundary lines, latitude and longitude lines, isogonic lines, etc. are also properly classified as culture.
- cumulative update.** . In ECDIS, the collection of all sequential CORRECTION INFORMATION which has been issued since the last new edition of the ENC or since the last OFFICIAL UPDATE applied to the SENC.
- cumuliform.** , *adj.* Like cumulus; generally descriptive of all clouds, the principal characteristic of which is vertical development in the form of rising mounds, domes, or towers. This is the contrasting form to the horizontally extended STRATIFORM types. See also CIRRIFORM.
- cumulonimbus.** , *n.* An exceptionally dense cloud of great vertical development, occurring either as an isolated cloud or one of a line or wall of clouds with separated upper portions. These clouds appear as mountains or huge towers, at least a part of the upper portions of which are usually smooth, fibrous, striated, and almost flattened. This part often spreads out in the form of an anvil or plume. Under the base of cumulonimbus, which often is very dark, there frequently exists virga, precipitation, and low, ragged clouds, either merged with it or not. Its precipitation is often heavy and always of a showery nature. The usual occurrence of lightning and thunder within or from this cloud leads to its being popularly called THUNDERCLOUD and THUNDERHEAD. The latter term usually refers to only the upper portion of the cloud. See also CLOUD CLASSIFICATION.
- cumulus.** , *n.* A cloud type in the form of individual, detached elements which are generally dense and possess sharp non-fibrous outlines. These elements develop vertically, appearing as rising mounds, domes, or towers, the upper parts of which often resemble a cauliflower. The sunlit parts of these clouds are mostly brilliant white; their bases are relatively dark and nearly horizontal. Near the horizon the vertical development of cumulus often causes the individual clouds to appear merged. If precipitation occurs, it is usually of a showery nature. Various effects of wind, illumination, etc. may modify many of the above characteristics. Strong winds may shred the clouds, often tearing away the cumulus tops to form the species *fractus*. See also CLOUD CLASSIFICATION.
- cupola.** , *n.* A label on a nautical chart which indicates a small dome-shaped tower or turret rising from a building.
- current.** , *n.* A horizontal movement of water. Currents may be classified as tidal and nontidal. Tidal currents are caused by gravitational interactions between the sun, moon, and earth and are a part of the same general movement of the sea that is manifested in the vertical rise and fall, called TIDE. Tidal currents are periodic with a net velocity of zero over the tidal cycle. Nontidal currents include the permanent currents in the general circulatory systems of the sea as well as temporary currents arising from more pronounced meteorological variability. The SET of a current is the direction toward which it flows; the DRIFT is its speed. In British usage, tidal current is called TIDAL STREAM, and nontidal current is called current.
- current chart.** . A chart on which current data are graphically depicted. See also TIDAL CURRENT CHARTS.
- current constants.** . Tidal current relations that remain practically constant for any particular locality. Current constants are classified as harmonic and nonharmonic. The harmonic constants consist of the amplitudes and epochs of the harmonic constituents, and the nonharmonic constants include the velocities and intervals derived directly from the current observations.
- current curve.** . A graphic representation of the flow of the current. In the reversing type of tidal current, the curve is referred to rectangular coordinates with time represented by the abscissas and the speed of the current by the ordinates, the flood speeds being considered as positive and the ebb speeds as negative. In general, the current curve for a reversing tidal current approximates a cosine curve.
- current cycle.** . A complete set of tidal current conditions, as those occurring during a tidal day, lunar month, or Metonic cycle.
- current diagram.** . A graphic table showing the speeds of the flood and ebb currents and the times of slack and strength over a considerable stretch of the channel of a tidal waterway, the times being referred to tide or tidal current phases at some reference station.
- current difference.** . The difference between the time of slack water (or minimum current) or strength of current in any locality and the time of the corresponding phase of the tidal current at a reference station, for which predictions are given in the *Tidal Current Tables*.
- current direction.** . The direction toward which a current is flowing, called the SET of the current.
- current ellipse.** . A graphic representation of a rotary current in which the velocity of the current at different hours of the tidal cycle is represented by radius vectors and vectorial angles. A line joining the extremities of the radius vectors will form a curve roughly approximating an ellipse. The cycle is completed in one half tidal day or in a whole tidal day according to whether the tidal current is of the semidiurnal or the diurnal type. A current of the mixed type will give a curve of two unequal loops each tidal day.
- current hour.** . The mean interval between the transit of the moon over the meridian of Greenwich and the time of strength of flood, modified by the times of slack water (or minimum current) and strength of ebb. In computing the mean current hour an average is obtained of the intervals for the following phases: flood strength, slack (or minimum) before flood increased by 3.10 hours (one-fourth of tidal cycle), slack (or minimum) after flood decreased by 3.10 hours, and ebb strength increased or decreased by 6.21 hours (one-half of tidal cycle). Before taking the average, the four phases are made comparable by the addition or rejection of such multiples of 12.42 hours as may be necessary. The current hour is usually expressed in solar time, but if the use of lunar time is desired the solar hour should be multiplied by the factor 0.966.
- current line.** . A graduated line attached to a CURRENT POLE, used in measuring the velocity of the current. The line is marked so that the speed of the current, expressed in knots and tenths, is indicated directly by the length of line carried out by the current pole in a specified interval of time. When marked for a 60 second run, the principal divisions for the whole knots are spaced 101.33 feet and the subdivisions for tenths of knots are spaced at 10.13 feet. Also called LOG LINE.
- current meter.** . An instrument for measuring the speed and direction or just speed of a current. The measurements are usually Eulerian since the meter is most often fixed or moored at a specific location.
- current pole.** . A pole used in observing the velocity of the current. In use, the pole, which is weighted at one end so as to float upright, is attached to the current line but separated from the graduated portion by an ungraduated section of approximately 100 feet, known as the *stray line*. As the pole is carried out from an observing vessel by the current, the amount of line passing from the vessel during a specific time interval indicates the speed of the current. The set is obtained from a bearing from the vessel to the pole.
- current rips.** . See RIPS.
- current sailing.** . The process of allowing for current when predicting the track to be made good or of determining the effect of a current on the direction of motion of a vessel. The expression is better avoided, as the process is not strictly a sailing.
- current station.** . The geographic location at which current observations are conducted. Also, the facilities used to make current observations. These may include a buoy, ground tackle, current meters, recording mechanism, and radio transmitter. See also CONTROL CURRENT STATION, SUBORDINATE CURRENT STATION.
- current tables.** . See TIDAL CURRENT TABLES.
- cursor.** , *n.* A device used with an instrument to provide a movable reference. A symbol indicating the location in a file of the data entry

point of a computer.

**cursor-pick**, . *n.* In ECDIS, the process of querying a point, symbol, line or area for further information from the database which is not represented by the SYMBOL.

**curve of constant bearing**, . See CURVE OF EQUAL BEARING.

**curve of equal bearing**, . A curve connecting all points at which the great circle bearing of a given point is the same. Also called CURVE OF CONSTANT BEARING.

**curvilinear**, . *adj.* Consisting of or bounded by a curve.

**curvilinear triangle**, . A closed figure having three curves as sides.

**cusp**, . *n.* One of the horns or pointed ends of the crescent moon or other luminary.

**cut**, . *n.* 1. A notch or depression produced by excavation or erosion. 2. The intersection of lines of position, constituting a fix, with particular reference to the angle of intersection.

**cut in**, . To observe and plot lines of position locating an object or craft, particularly by bearings.

**cut-off**, . *n.* 1. A new and relatively short channel formed when a stream cuts through the neck of an oxbow or horseshoe bend. 2. An artificial straightening or short-cut in a channel.

**cycle**, . *n.* One complete train of events or phenomena that recur sequentially. When used in connection with sound or radio the term refers to one complete wave, or to a frequency of one wave per second. See also KILOCYCLE, MEGACYCLE, CALLIPIC CYCLE, CURRENT CYCLE, DUTY CYCLE, LUNAR CYCLE, METONIC CYCLE, TIDAL CYCLE.

**cycle match**, . The comparison, in time difference, between corresponding carrier cycles contained in the rise times of a master and secondary station pulse. The comparison is refined to a determination of the phase difference between these two cycles. See also ENVELOPE MATCH.

**cyclic**, . *adj.* Of or pertaining to a cycle or cycles.

**cyclogenesis**, . *n.* A development or strengthening of cyclonic circulation in the atmosphere. The opposite is CYCLOLYSIS. The term is applied to the development of cyclonic circulation where previously it did not exist, as well as to the intensification of existing cyclonic flow. While cyclogenesis usually occurs with a deepening (a decrease in atmospheric pressure), the two terms should not be used synonymously.

**cyclolysis**, . *n.* Any weakening of cyclonic circulation in the atmosphere. The opposite is CYCLOGENESIS. While cyclolysis usually occurs with a filling (an increase in atmospheric pressure), the two terms should not be used synonymously.

**cyclone**, . *n.* 1. A meteorological phenomena characterized by relatively low atmospheric pressure and winds which blow counterclockwise around the center in the Northern Hemisphere and clockwise in the Southern Hemisphere. 2. The name by which a tropical storm having winds of 34 knots or greater is known in the South Indian Ocean. See TROPICAL CYCLONE.

**cyclonic storm**, . See under TROPICAL CYCLONE.

**cyclonic winds**, . The winds associated with a low pressure area and constituting part of a CYCLONE.

**cylinder**, . *n.* 1. A solid figure having two parallel plane bases bounded by closed congruent curves, and a surface formed by parallel lines connecting similar points on the two curves. 2. A surface formed by a straight line moving parallel to itself and constantly intersecting a curve. Also called CYLINDRICAL SURFACE.

**cylindrical**, . *adj.* Of or pertaining to a cylinder.

**cylindrical buoy**, . See CAN BUOY.

**cylindrical chart**, . A chart on a CYLINDRICAL MAP PROJECTION.

**cylindrical map projection**, . A map projection in which the surface of a sphere or spheroid, such as the earth, is conceived as developed on a tangent cylinder, which is then spread out to form a plane. See also MERCATOR MAP PROJECTION, RECTANGULAR MAP PROJECTION, EQUATORIAL MAP PROJECTION, OBLIQUE MAP PROJECTION, OBLIQUE MERCATOR MAP PROJECTION, TRANSVERSE MAP PROJECTION.

**cylindrical surface**, . A surface formed by a straight line moving parallel to itself and constantly intersecting a curve. Also called a CYLINDER.

## D

**daily aberration**, . See under ABERRATION, definition 1.

**Daily Memorandum**, . An electronic file of the National Geospatial-Intelligence Agency's Maritime Safety Information System web site, containing HYDROLANTS, HYDROPACS, HYDROARCS and NAVAREAS IV and XII Warnings issued during the last 24 hours or since the last Daily Memorandum was issued.

**daily rate**, . See CHRONOMETER RATE, WATCH RATE.

**dale**, . *n.* A vale or small valley.

**dam**, . *n.* A barrier to check or confine anything in motion; particularly a bank of earth, masonry, etc., across a watercourse to keep back moving water.

**damped wave**, . 1. A wave such that, at every point, the amplitude of each sinusoidal component is a decreasing function of time. 2. A wave in which the amplitudes of successive peaks (crests) progressively diminish.

**damp haze**, . See under HAZE.

**damping**, . *n.* 1. The reduction of energy in a mechanical or electrical system by absorption or radiation. 2. The act of reducing the amplitude of the oscillations of an oscillatory system; hindering or preventing oscillation or vibration; diminishing the sharpness of resonance of the natural frequency of a system.

**damping error**, . See BALLISTIC DAMPING ERROR.

**dan buoy**, . A buoy consisting of a ballasted float carrying a staff which supports a flag or light. Dan buoys are used principally in mine-sweeping, and by fisherman to mark the position of deepsea fishing lines or nets.

**danger angle**, . The maximum or minimum angle between two points, as observed from a craft indicating the limit of safe approach to an offlying danger. A horizontal danger angle is measured between points shown on the chart. A vertical danger angle is measured between the top and bottom of an object of known height.

**danger area**, . A specified area above, below, or within which there may exist potential danger. See also PROHIBITED AREA, RESTRICTED AREA.

**danger bearing**, . The maximum or minimum bearing of a point for safe passage of an off-lying danger. As a vessel proceeds along a coast, the bearing of a fixed point on shore, such as a lighthouse, is measured frequently. As long as the bearing does not exceed the limit of the predetermined danger bearing, the vessel is on a safe course.

**danger buoy**, . A buoy marking an isolated danger to navigation, such as a rock, shoal or sunken wreck.

**danger line**, . 1. A line drawn on a chart to indicate the limits of safe navigation for a vessel of specific draft. 2. A line of small dots used to draw the navigator's attention to a danger which would not stand out clearly enough if it were represented on the chart solely by the specific symbols. This line of small dots is also used to delimit areas containing numerous dangers, through which it is unsafe to navigate.

**dangerous semicircle**, . The half of a cyclonic storm in which the rotary and forward motions of the storm reinforce each other and the winds tend to blow a vessel into the storm track. In the Northern Hemisphere this is to the right of the storm center (when facing the direction the storm is moving) and in the Southern Hemisphere it is to the left. The opposite is the LESS DANGEROUS or NAVIGABLE SEMICIRCLE.

**danger sounding**, . A minimum sounding chosen for a vessel of specific draft in a given area to indicate the limit of safe navigation.

**dark nilas**, . NILAS which is under 5 centimeters in thickness and is very dark in color.

**dark-trace tube**, . A cathode-ray tube having a specially coated screen which changes color but does not necessarily luminesce when struck by the electron beam. It shows a dark trace on a bright background.

**data**, . Factual information.

**data-acquisition station**, . A ground station used for performing the various functions necessary to control satellite operations and to obtain data from the satellite.

**database**, . A uniform, organized set of data.

**data dictionary**, . In ECDIS, conveys the meaning of entities and ATTRIBUTES, the RELATIONSHIP between entities and attributes and

- the relationship between attribute and value domains.
- data model.** . In ECDIS a conceptual specification of the sets of components and the RELATIONSHIPS among the components pertaining to the specific phenomena defined by the model reality. A data model is independent of specific systems or DATA STRUCTURES.
- data processing.** . Changing data from one form or format to another by application of specified routines or algorithms.
- data quality indicator.** . In ECDIS an indication of reliability and ACCURACY of surveys of a particular area provided through relevant ATTRIBUTE of the quality of data META OBJECT in the IHO TRANSFER STANDARD.
- data reduction.** . The process of transforming raw data into more ordered data.
- data smoothing.** . The process of fitting dispersed data points to a smooth or uniform curve or line.
- data structure.** . In ECDIS a computer interpretable format used for storing, accessing, transferring, and archiving data.
- date.** . *n.* A designated mark or point on a time scale.
- date line.** . The line coinciding approximately with the 180th meridian, at which each calendar day first begins; the boundary between the -12 and +12 time zones. The date on each side of this line differs by 1 day, but the time is the same in these two zones. When crossing this line on a westerly course, the date must be advanced 1 day; when crossing on an easterly course, the date must be put back 1 day. Sometimes called INTERNATIONAL DATE LINE.
- datum.** . *n.* Any numerical or geometrical quantity or set of such quantities which may serve as reference or base for other quantities. In navigation, two types of datums are used: horizontal and vertical. See also HORIZONTAL GEODETIC DATUM, VERTICAL GEODETIC DATUM. CHART SOUNDING DATUM, VERTICAL DATUM.
- datum-centered ellipsoid.** . The reference ellipsoid that gives the best fit to the astrogeodetic network of a particular datum, and hence does not necessarily have its center at the center of the earth.
- datum plane.** . A misnomer for collection of datums used in mapping, charting, and geodesy which are not strictly planar. This term should not be used.
- datum transformation.** . The systematic elimination of discrepancies between adjoining or overlapping triangulation networks from different datums by moving the origins, rotating, and stretching the networks to fit each other.
- Davidson Current.** . A seasonal North Pacific Ocean countercurrent flowing northwestward along the west coast of North America from north of 32°N to at least latitude 48°N, inshore of the southeasterly-flowing California Current. This current occurs generally between November and April, but is best established in January. Strong opposing winds may cause the current to reverse. Also called WINTER COASTAL COUNTERCURRENT.
- Davidson Inshore Current.** . See DAVIDSON CURRENT.
- dawn.** . *n.* The first appearance of light in the eastern sky before sunrise; DAYBREAK. See also DUSK, TWILIGHT.
- day.** . *n.* 1. The duration of one rotation of a celestial body on its axis. It is measured by successive transits of a reference point on the celestial sphere over the meridian, and each type takes its name from the reference used. Thus, for a solar day on earth the reference is the sun; a mean solar day uses the mean sun; and an apparent solar day uses the apparent sun. For a lunar day the reference is the moon; for a sidereal day the vernal equinox; for a constituent day an *astre fictiv* or fictitious star representing one of the periodic elements in the tidal forces. The expression lunar day refers also to the duration of one rotation of the moon with respect to the sun. A JULIAN DAY begins at Greenwich mean noon and the days are consecutively numbered from January 1, 4713 B.C. 2. A period of 24 hours beginning at a specified time, as the civil day beginning at midnight, or the astronomical day beginning at noon, which was used up to 1925 by astronomers. 3. A specified time or period, usually of approximately 24-hours duration. A CALENDAR DAY extends from midnight to midnight, and is of 24-hours duration unless a time change occurs during the day. A tidal day is either the same as a lunar day (on the earth), or the period of the daily cycle of the tides, differing slightly from the lunar day because of priming and lagging. 4. The period of daylight, as distinguished from night.
- daybeacon.** . *n.* An unlighted beacon. A daybeacon is identified by its color and the color, shape and number of its daymark. The simplest form of daybeacon consists of a single pile with a daymark affixed at or near its top. See also DAYMARK.
- daybreak.** . *n.* See DAWN.
- daylight control.** . A photoelectric device that automatically lights and extinguishes a navigation light, usually lighting it at or about sunset and extinguishing it at or about sunrise. Also called SUN RELAY, SUN SWITCH, SUN VALVE.
- daylight saving meridian.** . The meridian used for reckoning daylight saving time. This is generally 15° east of the ZONE or STANDARD MERIDIAN.
- daylight saving noon.** . Twelve o'clock daylight saving time, or the instant the mean sun is over the upper branch of the daylight saving meridian. Also called SUMMER NOON, especially in Europe. See also MEAN NOON.
- daylight saving time.** . A variation of standard time in order to make better use of daylight. In the U.S. the *Energy Policy Act of 2005* (Public Law 109-58) establishes the annual advancement and retardation of standard time by 1 hour at 2 A.M. on the second Sunday of March and first Sunday of November, respectively, except in those states which have by law exempted themselves from the observance of daylight saving time. This change from previous policy went into effect in 2007. Also called SUMMER TIME, especially in Europe.
- daylight signal light.** . A signal light exhibited by day and also, usually with reduced intensity by night. The reduction of intensity is made in order to avoid glare. Daylight signals may be used to indicate whether or not the entrance to a lock is free.
- daymark.** . *n.* 1. The daytime identifying characteristics of an aid to navigation. See also DAYBEACON. 2. An unlighted navigation mark. 3. The shaped signals used to identify vessels engaged in special operations during daytime, more properly known as day shapes.
- day's run.** . The distance traveled by a vessel in 1 day, usually reckoned from noon to noon.
- dead ahead.** . Bearing exactly 000° relative. If the bearing is approximate, the term AHEAD should be used.
- dead astern.** . Bearing 180° relative. If the bearing is approximate, the term ASTERN should be used. Also called RIGHT ASTERN.
- deadbeat.** . *adj.* APERIODIC, or without a period.
- deadbeat compass.** . See APERIODIC COMPASS.
- deadhead.** . *n.* 1. A block of wood used as an anchor buoy. 2. A bollard, particularly one of wood set in the ground.
- deadman.** . Timber or other long sturdy object buried in ice or ground to which a ship's mooring lines are attached.
- dead reckoning.** . Determining the position of a vessel by adding to the last fix the ship's course and speed for a given time. The position so obtained is called a DEAD RECKONING POSITION. Comparison of the dead reckoning position with the fix for the same time indicates the sum of currents, winds, and other forces acting on the vessel during the intervening period.
- dead reckoning equipment.** . A device that continuously indicates the dead reckoning position of a vessel. It may also provide, on a dead reckoning tracer, a graphical record of the dead reckoning. See also COURSE RECORDER.
- dead reckoning plot.** . The graphic plot of the dead reckoning, suitably labeled with time, direction, and speed. See also NAVIGATIONAL PLOT.
- dead reckoning position.** . See under DEAD RECKONING.
- dead reckoning tracer.** . A device that automatically provides a graphic record of the dead reckoning. It may be part of dead reckoning equipment. See also COURSE RECORDER.
- dead water.** . The water carried along with a ship as it moves through the water. It is maximum at the waterline and decreases with depth. It increases in a direction towards the stern.
- deca-** . A prefix meaning ten.
- decameter.** . *n.* Ten meters.
- Decca.** . *n.* See as DECCA NAVIGATOR SYSTEM.
- Decca chain.** . A group of associated stations of the Decca Navigator System. A Decca chain normally consists of one master and three secondary stations. Each secondary station is called by the color of associated pattern of hyperbolic lines as printed on the chart, i.e., red secondary station, green secondary station, purple secondary station. See also CHAIN.
- Decca Navigator System.** . A short to medium range low frequency (70-130 kilohertz) radionavigation system which yields a hyperbolic line of position of high accuracy. The system is an arrangement of

- fixed, phase locked, continuous wave transmitters operating on harmonically related frequencies and special receiving and display equipment carried on a vessel or other craft. The operation of the system depends on phase comparison of the signals from the transmitters brought to a common comparison frequency within the receiver.
- decelerate**, *v., t.* To cause to move slower. *v. i.* To decrease speed.
- deceleration**, *n.* Negative acceleration.
- December solstice**. Winter solstice in the Northern Hemisphere.
- deci-**. A prefix meaning one-tenth. *decibar, n.* One-tenth of a bar; 100 millibars.
- decibar**, *n.* One-tenth of a bar; 100 millibars.
- decibel**, *n.* A dimensionless unit used for expressing the ratio between widely different powers. It is 10 times the logarithm to the base 10 of the power ratio.
- decimeter**, *n.* One-tenth of a meter.
- deck log**. See LOG, definition 2.
- declination**, *n.* 1. Angular distance north or south of the celestial equator; the arc of an hour circle between the celestial equator and a point on the celestial sphere, measured northward or southward from the celestial equator through 90°, and labeled N or S (+ or -) to indicate the direction of measurement. 2. Short for MAGNETIC DECLINATION.
- declinational inequality**. See DIURNAL INEQUALITY.
- declinational reduction**. A processing of observed high and low waters or flood and ebb tidal currents to obtain quantities depending upon changes in the declination of the moon; such as tropic ranges or speeds, height or speed inequalities, and tropic intervals.
- declination difference**. The difference between two declinations, particularly between the declination of a celestial body and the value used as an argument for entering a table.
- declinometer**, *n.* An instrument for measuring magnetic declination. See also MAGNETOMETER.
- Decimeter**. A phase meter used in the Decca Navigator System.
- decrement**, *n.* 1. A decrease in the value of a variable. 2. *v.* To decrease a variable in steps. See also INCREMENT.
- deep**, *n.* 1. An unmarked fathom point on a lead line. 2. A relatively small area of exceptional depth found in a depression of the ocean floor. The term is generally restricted to depths greater than 3,000 fathoms. If it is very limited in area, it is referred to as a HOLE. 3. A relatively deep channel in a strait or estuary.
- deepening**, *n.* Decrease in atmospheric pressure, particularly within a low. Increase in pressure is called FILLING. See also CYCLOGENESIS.
- deep sea lead**. A heavy sounding lead (about 30 to 100 pounds), usually having a line 100 fathoms or more in length. A light deep sea lead is sometimes called a COASTING LEAD. Sometimes called DIPSEY LEAD.
- deep water route**. A route for deep draft vessels within defined limits which has been accurately surveyed for clearance of sea bottom and submerged obstacles as indicated on the chart. See also ROUTING SYSTEM.
- definition**, *n.* The clarity and fidelity of the detail of radar images on the radarscope. A combination of good resolution and focus is required for good definition.
- definitive orbit**. An orbit that is defined in a highly precise manner with due regard taken for accurate constants and observational data, and precision computational techniques including perturbations.
- deflection of the plumb line**. See under DEFLECTION OF THE VERTICAL.
- deflection of the vertical**. The angular difference at any place, between the direction of a plumb line (the vertical) and the perpendicular to the reference ellipsoid. This difference seldom exceeds 30". Often expressed in two components, meridian and prime vertical. Also called STATION ERROR.
- deflection of the vertical correction**. The correction due to deflection of the vertical resulting from irregularities in the density and form of the earth. Deflection of the vertical affects the accuracy of sextant altitudes.
- deflector**, *n.* An instrument for measuring the directive force acting on a magnetic compass. It is used for adjusting a compass when ordinary methods of determining deviation are not available, and operates on the theory that when the directive force is the same on all cardinal headings, the compass is approximately adjusted.
- deformed ice**. A general term for ice which has been squeezed together and in places forced forwards (and downwards). Subdivisions are RAFTED ICE, RIDGED ICE, and HUMMOCKED ICE.
- degaussing**, *n.* Neutralization of the strength of the magnetic field of a vessel, using electric coils permanently installed in the vessel. See also DEPERMING.
- degaussing cable**. A cable carrying an electric current for degaussing a vessel.
- degaussing range**. An area for determining magnetic signatures of ships and other marine craft. Such signatures are used to determine required degaussing coil current settings and other required corrective actions. Sensing instruments and cables are installed on the sea bed in the range, and there are cables leading from the range to a control position ashore.
- degree**, *n.* 1. A unit of circular measure equal to 1/360th of a circle. 2. A unit of measurement of temperature.
- degree-of-freedom**. The number of orthogonal axes of a gyroscope about which the spin axis is free to rotate, the spin axis freedom not being counted. This is not a universal convention. For example, the free gyro is frequently referred to as a three-degree-of-freedom gyro, the spin axis being counted.
- deka-**. A prefix meaning ten.
- delayed plan position indicator**. A plan position indicator on which the start of the sweep is delayed so that the center represents a selected range. This allows distant targets to be displayed on a larger-scale presentation.
- delayed sweep**. Short for DELAYED TIME BASE SWEEP.
- delayed time base**. Short for DELAYED TIME BASE SWEEP.
- delayed time base sweep**. A sweep, the start of which is delayed, usually to provide an expanded scale for a particular part. Usually shortened to DELAYED SWEEP, and sometimes to DELAYED TIME BASE.
- delta**, *n.* 1. The low alluvial land, deposited in a more or less triangular form, as the Greek letter delta, at the mouth of a river, which is often cut by several distributaries of the main stream. 2. A change in a variable quantity, such as a change in the value of the declination of a celestial body.
- demagnetize**, *v., t.* To remove magnetism. The opposite is MAGNETIZE.
- demodulation**, *n.* The process of obtaining a modulating wave from a modulated carrier. The opposite is MODULATION.
- density**. Quantity of mass per unit of volume.
- departure**, *n.* 1. The distance between two meridians at any given parallel of latitude, expressed in linear units, usually nautical miles; the distance to the east or west made good by a craft in proceeding from one point to another. 2. The point at which reckoning of a voyage begins. It is usually established by bearings of prominent landmarks as the vessel clears a harbor and proceeds to sea. When a navigator establishes this point, he is said to take departure. Also called POINT OF DEPARTURE. 3. Act of departing or leaving. 4. The amount by which the value of a meteorological element differs from the normal value.
- dependent surveillance**. Position determination requiring the cooperation of the tracked craft.
- deperming**, *n.* The process of changing the magnetic condition of a vessel by wrapping a large conductor around it a number of times in a vertical plane, athwartships, and energizing the coil thus formed. If a single coil is placed horizontally around the vessel and energized, the process is called FLASHING if the coil remains stationary, and WIPING if it is moved up and down. See also DEGAUSSING.
- depressed pole**. The celestial pole below the horizon, of opposite name to the latitude. The celestial pole above the horizon is called ELEVATED POLE.
- depression**, *n.* 1. See NEGATIVE ALTITUDE. 2. A developing cyclonic area, or low pressure area.
- depression angle**. See ANGLE OF DEPRESSION.
- depth**, *n.* The vertical distance from a given water level to the sea bottom. The charted depth is the vertical distance from the tidal datum to the bottom. The least depth in the approach or channel to an area, such as a port or anchorage, governing the maximum draft of vessels that can enter is called the controlling depth. See also CHART SOUNDING DATUM.
- depth contour**. A line connecting points of equal depth below the sounding datum. It may be called FATHOM CURVE or FATHOM LINE if depth is expressed in fathoms. Also called DEPTH

- CURVE, ISOBATH.**
- depth curve.** . See DEPTH CONTOUR.
- depth finder.** . See ECHO SOUNDER.
- depth of water.** . The vertical distance from the surface of the water to the bottom. See also SOUNDING.
- depth perception.** . The ability to estimate depth or distance between points in the field of vision.
- derelict.** , *n.* Any property abandoned at sea, often large enough to constitute a menace to navigation; especially an abandoned vessel. See also JETTISON, WRECK.
- derived units.** . See under INTERNATIONAL SYSTEM OF UNITS.
- descending node.** . The point at which a planet, planetoid, or comet crosses the ecliptic from north to south, or a satellite crosses the plane of the equator of its primary from north to south. Also called SOUTHBOUND NODE. The opposite is ASCENDING NODE.
- destination.** , *n.* The port of intended arrival. Also called POINT OF DESTINATION. See also POINT OF ARRIVAL.
- detection.** , *n.* 1. The process of extracting information from an electromagnetic wave. 2. In the use of radar, the recognition of the presence of a target.
- detritus.** , *n.* An accumulation of the fragments resulting from the disintegration of rocks.
- developable.** , *adj.* Capable of being flattened without distortion. The opposite is UNDEVELOPABLE.
- developable surface.** . A curved surface that can be spread out in a plane without distortion, e.g., the cone and the cylinder.
- deviascope.** , *n.* A device for demonstration of various forms of deviation and compass adjustment, or compass compensation.
- deviation.** , *n.* 1. The angle between the magnetic meridian and the axis of a compass card, expressed in degrees east or west to indicate the direction in which the northern end of the compass card is offset from magnetic north. Deviation is caused by disturbing magnetic influences in the immediate vicinity of the compass. Semicircular deviation changes sign (E or W) approximately each 180° change of heading; quadrantal deviation changes sign approximately each 90° change of heading; constant deviation is the same on any heading. Deviation of a magnetic compass after adjustment or compensation is RESIDUAL DEVIATION. Called MAGNETIC DEVIATION when a distinction is needed to prevent possible ambiguity. 2. Given a series of observations or measurements of a given quantity, the deviation of a single observation is the algebraic difference between the single observation and the mean or average value of the series of observations. See also RANDOM ERROR.
- deviation table.** . A table of the deviation of a magnetic compass on various headings, magnetic or compass. Also called MAGNETIC COMPASS TABLE. See also NAPIER DIAGRAM.
- dew point.** . The temperature to which air must be cooled at constant pressure and constant water vapor content to reach saturation. Any further cooling usually results in the formation of dew or frost.
- DGPS.** . Differential Global Positioning System; a method of increasing the accuracy of GPS positions by transmitting corrections generated by precisely surveyed reference stations.
- diagram on the plane of the celestial equator.** . See TIME DIAGRAM.
- diagram on the plane of the celestial meridian.** . A theoretical orthographic view of the celestial sphere from a point outside the sphere and over the celestial equator. The great circle appearing as the outer limit is the local celestial meridian; other celestial meridians appear as ellipses. The celestial equator appears as a diameter 90° from the poles. Parallels of declination appear as straight lines parallel to the equator. The celestial horizon appears as a diameter 90° from the zenith.
- diagram on the plane of the equinoctial.** . See TIME DIAGRAM.
- diameter.** , *n.* Any chord passing through the center of a figure, as a circle, ellipse, sphere, etc., or the length of such chord. See also RADIUS.
- diaphone.** , *n.* A sound signal emitter operating on the principle of periodic release of compressed air controlled by the reciprocating motion of a piston operated by compressed air. The diaphone usually emits a powerful sound of low pitch which often concludes with a brief sound of lowered pitch called the GRUNT. The emitted signal of a TWO-TONE DIAPHONE consists of two tones of different pitch, in which case the second tone is of lower pitch.
- diaphragm horn.** . A sound signal emitter comprising a resonant horn excited at its throat by impulsive emissions of compressed air regulated by an elastic diaphragm. Duplex or triplex horn units of different pitch produce a chime signal. Also called COMPRESSED-
- AIR HORN.**
- diatom.** , *n.* A microscopic alga with an external skeleton of silica, found in both fresh and salt water. Part of the ocean bed is composed of a sedimentary ooze consisting principally of large collections of the skeletal remains of diatoms.
- dichroic mirror.** . A glass surface coated with a special metallic film that permits some colors of light to pass through the glass while reflecting certain other colors of light. Also called SEMIREFLECTING MIRROR.
- dichroism.** , *n.* The optical property of exhibiting two colors, as one color in transmitted light and another in reflected light. See also DICHROIC MIRROR.
- dielectric reflector.** . A device composed of dielectric material which returns the greater part of the incident electromagnetic waves parallel to the direction of incidence. See also RADAR REFLECTOR.
- difference of latitude.** . The shorter arc of any meridian between the parallels of two places, expressed in angular measure.
- difference of longitude.** . The smaller angle at the pole or the shorter arc of a parallel between the meridians of two places, expressed in angular measure.
- difference of meridional parts.** . See MERIDIONAL DIFFERENCE.
- differential.** . Relating to the technology of increasing the accuracy of an electronic navigation system by monitoring the system error from a known, fixed location and transmitting corrections to vessels using the system. Differential GPS is in operation. Differential Loran has been in an experimental phase.
- differentiator.** , *n.* See FAST TIME CONSTANT CIRCUIT.
- diffraction.** , *n.* 1. The bending of the rays of radiant energy around the edges of an obstacle or when passing near the edges of an opening, or through a small hole or slit, resulting in the formation of a spectrum. See also REFLECTION REFRACTION. 2. The bending of a wave as it passes an obstruction.
- diffuse ice edge.** . A poorly defined ice edge limiting an area of dispersed ice. It is usually on the leeward side of an area of pack ice.
- diffuse reflection.** . A reflection process in which the reflected radiation is sent out in many directions usually bearing no simple relationship to the angle of incidence. It results from reflection from a rough surface with small irregularities. See also SPECULAR REFLECTION.
- diffusion.** , *n.* See DIFFUSE REFLECTION.
- digit.** , *n.* A single character representing an integer.
- digital.** . Referring to the use of discreet expressions to represent variables. See ANALOG.
- digital calculator.** . In navigation, a small electronic device which does arithmetical calculations by applying mathematical formulas (ALGORITHMS) to user-entered values. A navigational calculator has preloaded programs to solve navigational problems.
- digital nautical chart (DNC).** . The electronic chart data base used in the U.S. Navy's Navigation Sensor System Interface (NAVSSI).
- digital selective calling (DSC).** . A communications technique using coded digitized signals which allows transmitters and receivers to manage message traffic, accepting or rejecting messages according to certain variables.
- digital tide gage.** . See AUTOMATIC TIDE GAGE.
- digitize.** . To convert analog data to digital data.
- digitizing conventions.** . See ENCODING CONVENTIONS.
- dihedral angle.** . The angle between two intersecting planes.
- dihedral reflector.** . A radar reflector consisting of two flat surfaces intersecting mutually at right angles. Incident radar waves entering the aperture so formed with a direction of incidence perpendicular to the edge, are returned parallel to their direction of incidence. Also called RIGHT ANGLE REFLECTOR.
- dike.** , *n.* A bank of earth or stone used to form a barrier, which restrains water outside of an area that is normally flooded. See LEVEE.
- dioptic light.** . A light concentrated into a parallel beam by means of refracting lenses or prisms. One so concentrated by means of a reflector is a CATOPTRIC LIGHT.
- dip.** , *n.* 1. The vertical angle, at the eye of an observer, between the horizontal and the line of sight to the visible horizon. Altitudes of celestial bodies measured from the visible sea horizon as a reference are too great by the amount of dip. Since dip arises from and varies with the elevation of the eye of the observer above the surface of the earth, the correction for dip is sometimes called HEIGHT OF EYE CORRECTION. Dip is smaller than GEOMETRICAL DIP by the

- amount of terrestrial refraction. Also called **DIP OF THE HORIZON**. 2. The angle between the horizontal and the lines of force of the earth's magnetic field at any point. Also called **MAGNETIC DIP**, **MAGNETIC LATITUDE**, **MAGNETIC INCLINATION**. 3. The first detectable decrease in the altitude of a celestial body after reaching its maximum altitude on or near meridian transit.
- dip**, *v., i.* To begin to descend in altitude after reaching a maximum on or near meridian transit.
- dip circle**. . An instrument for measuring magnetic dip. It consists of a **DIP NEEDLE**, or magnetic needle, suspended in such manner as to be free to rotate about a horizontal axis.
- dip correction**. . The correction to sextant altitude due to dip of the horizon. Also called **HEIGHT OF EYE CORRECTION**.
- dip needle**. . A magnetic needle suspended so as to be free to rotate about a horizontal axis. An instrument using such a needle to measure magnetic dip is called a **DIP CIRCLE**. A dip needle with a sliding weight that can be moved along one of its arms to balance the magnetic force is called a **HEELING ADJUSTER**.
- dip of the horizon**. . See **DIP**, *n.*, definition 1.
- dipole antenna**. . *n.* A straight center-fed one-half wavelength antenna. Horizontally polarized it produces a figure eight radiation pattern, with maximum radiation at right angles to the plane of the antenna. Also called **DOUBLET ANTENNA**.
- dip pole**. . See **MAGNETIC POLE**, definition 1.
- dipse lead**. . See **DEEP SEA LEAD**.
- direct indicating compass**. . A compass in which the dial, scale, or index is carried on the sensing element.
- direction**. . *n.* The position of one point in space relative to another without reference to the distance between them. Direction may be either three-dimensional or two-dimensional, the horizontal being the usual plane of the latter. Direction is not an angle but is often indicated in terms of its angular distance from a reference directions. Thus, a horizontal direction may be specified as compass, magnetic, true, grid or relative. A Mercator or rhumb direction is the horizontal direction of a rhumb line, expressed as angular distance from a reference direction, while great circle direction is the horizontal direction of a great circle, similarly expressed. See also **CURRENT DIRECTION**, **SWELL DIRECTION**, **WAVE DIRECTION**, **WIND DIRECTION**.
- directional antenna**. . An antenna designed so that the radiation pattern is largely concentrated in a single lobe.
- directional gyro**. . A gyroscopic device used to indicate a selected horizontal direction for a limited time.
- directional gyro mode**. . The mode of operation of a gyrocompass in which the compass operates as a free gyro with the spin axis oriented to grid north.
- directional radiobeacon**. . See under **RADIOBEACON**. Also see **COURSE BEACON**.
- direction finder**. . See **RADIO DIRECTION FINDER**.
- direction finder deviation**. . The angular difference between a bearing observed by a radio direction finder and the correct bearing, caused by disturbances due to the characteristics of the receiving craft or station.
- direction finder station**. . See **RADIO DIRECTION FINDER STATION**.
- direction light**. . A light illuminating a sector of very narrow angle and intended to mark a direction to be followed. A direction light bounded by other sectors of different characteristics which define its margins with small angles of uncertainty is called a **SINGLE STATION RANGE LIGHT**.
- direction of current**. . The direction toward which a current is flowing, called the **SET** of the current.
- direction of force of gravity**. . The direction indicated by a plumb line. It is perpendicular (normal) to the surface of the geoid. Also called **DIRECTION OF GRAVITY**.
- direction of gravity**. . See **DIRECTION OF FORCE OF GRAVITY**.
- direction of relative movement**. . The direction of motion relative to a reference point, itself usually in motion.
- direction of waves or swell**. . The direction from which waves or swell are moving.
- direction of wind**. . The direction from which a wind is blowing.
- directive force**. . The force tending to cause the directive element of a compass to line up with the reference direction. Also, the value of this force. Of a magnetic compass, it is the intensity of the horizontal component of the earth's magnetic field.
- directive gain**. . Four times the ratio of the radiation intensity of an antenna for a given direction to the total power radiated by the antenna. Also called **GAIN FUNCTION**.
- directivity**. . *n.* 1. The characteristic of an antenna which makes it radiate or receive more efficiently in some directions than in others. 2. An expression of the value of the directive gain of an antenna in the direction of its maximum gain. Also called **POWER GAIN (OF AN ANTENNA)**.
- directivity diagram**. . See **RADIATION PATTERN**.
- direct motion**. . The apparent motion of a planet eastward among the stars. Apparent motion westward is called **RETROGRADE MOTION**. The usual motion of planets is direct.
- directory**. . A list of files in a computer.
- direct wave**. . *l.* A radio wave that travels directly from the transmitting to the receiving antenna without reflections from any object or layer of the ionosphere. The path may be curved as a result of refraction. 2. A radio wave that is propagated directly through space; it is not influenced by the ground. Also called **SPACE WAVE**.
- discontinued**. . *adj.* Said of a previously authorized aid to navigation that has been removed from operation (permanent or temporary).
- discontinuity**. . *n.* 1. A zone of the atmosphere within which there is a comparatively rapid transition of any meteorological element. 2. A break in sequence of continuity of anything.
- discrepancy**. . *n.* 1. Failure of an aid to navigation to maintain its position or function exactly as prescribed in the *List of Lights*. 2. The difference between two or more observations or measurements of a given quantity.
- discrepancy buoy**. . An easily transportable buoy used to temporarily replace a buoy which is missing, damaged or otherwise not working properly.
- disk**. . A type of computer data storage which consists of a plastic or metallic disk which rotates to provide access to the stored data. Data is stored in discreet areas of the disk known as tracks and sectors.
- dismal**. . *n.* A swamp bordering on, or near the sea. Also called **POCOSIN**.
- dispersion**. . *n.* The separation of light into its component colors by its passage through a diffraction grating or by refraction such as that provided by a prism.
- display**. . *n.* 1. The visual presentation of radar echoes or electronic charts. 2. The equipment for the visual display.
- display base**. . See **DISPLAY CATEGORY**.
- display category**. . *l.* In ECDIS, three categories for **SENC** objects are established in the **ECDIS PERFORMANCE STANDARDS**: display base, permanently retained on the display; standard display, displayed at switch-on, recalled by single operator action; **ALL OTHER INFORMATION**, displayed individually (by class) on demand.
- display generator**. . In ECDIS the manufacturer's software which takes an **OBJECT** from the **SENC**, assigns a symbol and color, and presents it appropriately on the **DISPLAY**, using the tools and procedures provided in the **PRESENTATION LIBRARY**.
- display priority**. . In ECDIS, detailed rules to decide which line or point **SYMBOL** is to be shown when two **OBJECTS** overlap. Priority 2 overwrites priority 1. Display priority is given in the **LOOKUP TABLE**.
- display priority layer**. . *n.* In ECDIS, layers to establish the priority of information on the **DISPLAY**. Lower priority information must not obscure higher priority information.
- display scale**. . *n.* In ECDIS the ratio between a distance on the display and a distance on the ground, normalized and expressed for example 1/10,000 or 1:10,000.
- disposal area**. . Area designated by the U.S. Army Corps of Engineers for depositing dredged material where existing depths indicate that the intent is not to cause sufficient shoaling to create a danger to surface navigation. Disposal areas are shown on nautical charts. See also **DUMPING GROUND**, **DUMP SITE**, **SPOIL AREA**.
- disposition of lights**. . The arrangement, order, etc., of navigational lights in an area.
- distance circles**. . Circles concentric to the center of a formation of ships, designated by their radii in thousands of yards.
- distance finding station**. . An attended light station or lightship emitting simultaneous radio and sound signals as a means of determining distance from the source of sound, by measuring the difference in the time of reception of the signals. The sound may be transmitted through either air or water or both and either from the same location

- as the radio signal or a location remote from it. Very few remain in use.
- distance of relative movement.** . The distance traveled relative to a reference point, itself usually in motion.
- distance resolution.** . See RANGE RESOLUTION.
- Distances Between Ports.** . See PUB. 151.
- Distances Between United States Ports.** . A reference published by the National Ocean Service (NOS) which provides distances in nautical miles over water areas between U.S. ports. A similar publication published by the National Geospatial-Intelligence Agency for foreign waters is entitled *Pub. No. 151, Distances Between Ports.*
- diurnal.** , *adj.* Having a period or cycle of approximately 1 day. The tide is said to be diurnal when only one high water and one low water occur during a tidal day, and the tidal current is said to be diurnal when there is a single flood and single ebb period in the tidal day. A rotary current is diurnal if it changes its direction through 360° once each tidal day. A diurnal constituent is one which has a single period in the constituent day. See also STATIONARY WAVE THEORY, TYPE OF TIDE.
- diurnal aberration.** . See under ABERRATION, definition 1.
- diurnal age.** . See AGE OF DIURNAL INEQUALITY.
- diurnal circle.** . The apparent daily path of a celestial body, approximating a PARALLEL OF DECLINATION.
- diurnal current.** . Tidal current in which the tidal day current cycle consists of one flood current and one ebb current, separated by slack water; or a change in direction of 360° of a rotary current. A SEMIDIURNAL CURRENT is one in which two floods and two ebbs, or two changes of 360°, occur each tidal day.
- diurnal inequality.** . The difference in height of the two high waters or of the two low waters of each tidal day; the difference in speed between the two flood tidal currents or the two ebb tidal currents of each tidal day. The difference changes with the declination of the moon and to a lesser extent with declination of the sun. In general, the inequality tends to increase with an increasing declination, either north or south. Mean diurnal high water inequality is one-half the average difference between the two high waters of each day observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). It is obtained by subtracting the mean of all high waters from the mean of the higher high waters. Mean diurnal low water inequality is one-half the average difference between the two low waters of each day observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). It is obtained by subtracting the mean of the lower low waters from the mean of all low waters. Tropic high water inequality is the average difference between the two high waters of the day at the times of the tropic tides. Tropic low water inequality is the average difference between the two low waters of the day at the times of the tropic tides. Mean and tropic inequalities as defined above are applicable only when the type of tide is either semidiurnal or mixed. Sometimes called DECLINATIONAL INEQUALITY.
- diurnal motion.** . The apparent daily motion of a celestial body.
- diurnal parallax.** . See GEOCENTRIC PARALLAX.
- diurnal range.** . See GREAT DIURNAL RANGE.
- diurnal tide.** . See under TYPE OF TIDE; DIURNAL, *adj.*
- dive.** , *n.* Submergence with one end foremost.
- dive.** , *v., i.* To submerge with one end foremost.
- diverged beam.** . See under FAN BEAM.
- dividers.** , *n.* An instrument consisting of two pointed legs joined by a pivot, used principally for measuring distances or coordinates on charts. If the legs are pointed at both ends and provided with an adjustable pivot in the middle of the legs, the instrument is called proportional dividers. An instrument having one pointed leg and one leg carrying a pen or pencil is called COMPASSES.



dividers

**D-layer.** , *n.* The lowest of the ionized layers in the upper atmosphere, or ionosphere. It is present only during daylight hours, and its density

is proportional to the altitude of the sun. The D-layer's only significant effect upon radio waves is its tendency to absorb their energy, particularly at frequencies below 3 megahertz. High angle radiation and signals of a frequency greater than 3 megahertz may penetrate the D-layer and be refracted or reflected by the somewhat higher E-layer.

**DNC Library.** , *n.* The working unit of a geographic area on a Digital Nautical Chart (DNC). DNC is divided into scale-based libraries that fall into one of four (4) categories: General (1:500,000 and smaller), Coastal (1:75,000 to 1:500,000), Approach (1:25,000 to 1:100,000), and Harbor (1:50,000 and larger). The geographic limits and scale of the library are determined by the Regional Data Manager based on U.S. Navy Requirements.

**dock.** , *n.* 1. The slip or waterway between two piers, or cut into the land for the berthing of ships. A PIER is sometimes erroneously called a DOCK. Also called SLIP. See also JETTY; LANDING, definition 1; QUAY; WHARF. 2. A basin or enclosure for reception of vessels, provided with means for controlling the water level. A wet dock is one in which water can be maintained at various levels by closing a gate when the water is at the desired level. A dry dock is a dock providing support for a ship, and means of removing the water so that the bottom of the ship can be exposed. A dry dock consisting of an artificial basin is called a graving dock; one consisting of a floating structure is called a floating dock. 3. Used in the plural, a term used to describe area of the docks, wharves, basins, quays, etc.

**dock.** , *v., t.* To place in a dock.

**docking signals.** . See TRAFFIC CONTROL SIGNALS.

**dock sill.** . The foundation at the bottom of the entrance to a dry dock or lock against which the caisson or gates close. The depth of water controlling the use of the dock or lock is measured from the sill to the surface.

**dockyard.** , *n.* *British terminology.* Shipyard.

**doctor.** , *n.* 1. A cooling sea breeze in the Tropics. 2. See HARMATTAN. 3. The strong southeast wind which blows on the south African coast. Usually called CAPE DOCTOR.

**dog days.** . The period of greatest heat in the summer.

**doldrums.** , *n., pl.* The equatorial belt of calms or light variable winds, lying between the two trade wind belts. Also called EQUATORIAL CALMS.

**dolphin.** , *n.* A post or group of posts, used for mooring or warping a vessel. The dolphin may be in the water, on a wharf, or on the beach. See PILE DOLPHIN.

**dome.** , *n.* A label on a nautical chart which indicates a large, rounded, hemispherical structure rising from a building or a roof.

**dome-shaped iceberg.** . A solid type iceberg with a large, round, smooth top.

**doppler effect.** . First described by Christian Johann Doppler in 1842, an effect observed as a frequency shift which results from relative motion between a transmitter and receiver or reflector of acoustic or electromagnetic energy. The effect on electromagnetic energy is used in doppler satellite navigation to determine an observer's position relative to a satellite. The effect on ultrasonic energy is used in doppler sonar speed logs to measure the relative motion between the vessel and the reflective sea bottom (for bottom return mode) or suspended particulate matter in the seawater itself (for volume reverberation mode). The velocity so obtained and integrated with respect to time is used in doppler sonar navigators to determine position with respect to a start point. The doppler effect is also used in docking aids which provide precise speed measurements. Also called DOPPLER SHIFT.

**doppler navigation.** . The use of the doppler effect in navigation. See also DOPPLER SONAR NAVIGATION, DOPPLER SATELLITE NAVIGATION.

**doppler radar.** . Any form of radar which detects radial motion of a distant object relative to a radar apparatus by means of the change of the radio frequency of the echo signal due to motion.

**doppler satellite navigation.** . The use of a navigation system which determines positions based on the doppler effect of signals received from an artificial satellite.

**doppler shift.** . See DOPPLER EFFECT.

**doppler sonar navigation.** . The use of the doppler effect observed as a frequency shift resulting from relative motion between a transmitter and receiver of ultrasonic energy to measure the relative motion between the vessel and the reflective sea bottom (for bottom return

- mode) or suspended particulate matter in the seawater itself (for volume reverberation mode) to determine the vessel's velocity. The velocity so obtained by a doppler sonar speed log may be integrated with respect to time to determine distance traveled. This integration of velocity with time is correlated with direction of travel in a doppler sonar navigator to determine position with respect to a start point. The doppler effect is also used in docking aids to provide precise speed measurements.
- double**, , *v.*, *t.* To travel around with a near reversal of course. See also ROUND.
- double altitudes**. . See EQUAL ALTITUDES.
- double ebb**. . An ebb tidal current having two maxima of speed separated by a lesser ebb speed.
- double flood**. . A flood tidal current having two maxima of speed separated by a lesser flood speed.
- double interpolation**. . Interpolation when there are two arguments or variables.
- double sextant**. . A sextant designed to enable the observer to simultaneously measure the left and right horizontal sextant angles of the three-point problem.
- double stabilization**. . See under STABILIZATION OF RADARSCOPE DISPLAY.
- double star**. . Two stars appearing close together. If they appear close because they are in nearly the same line of sight but differ greatly in distance from the observer, they are called an optical double star; if in nearly the same line of sight and at approximately the same distance from the observer, they are called a physical double star. If they revolve about their common center of mass, they are called a binary star.
- double summer time**. . See under SUMMER TIME.
- doublet antenna**. . See DIPOLE ANTENNA.
- double tide**. . A high water consisting of two maxima of nearly the same height separated by a relatively small depression, or a low water consisting of two minima separated by a relatively small elevation. Sometimes called AGGER. See also GULDER.
- doubling the angle on the bow**. . A method of obtaining a running fix by measuring the distance a vessel travels on a steady course while the relative bearing (right or left) of a fixed object doubles. The distance from the object at the time of the second bearing is equal to the run between bearings, neglecting drift.
- doubly stabilized**. . See under STABILIZATION OF RADARSCOPE DISPLAY.
- doubtful**, , *adj.* Of questionable accuracy. Approximate or second class may be used with the same meaning.
- doubtful sounding**. . Of uncertain depth. The expression, as abbreviated, is used principally on charts to indicate a position where the depth may be less than indicated, the position not being in doubt.
- down**, , *n.* 1. See DUNE. 2. An area of high, treeless ground, usually undulating and covered with grass.
- down by the head**. . Having greater draft at the bow than at the stern. The opposite is DOWN BY THE STERN or BY THE STERN. Also called BY THE HEAD.
- down by the stern**. . Having greater draft at the stern than at the bow. The opposite is DOWN BY THE HEAD or BY THE HEAD. Also called BY THE STERN. See DRAG *n.*, definition 3.
- downstream**, , *adj.* & *adv.* In the direction of flow of a current or stream. The opposite is UPSTREAM.
- down-the-scope echo**. . See CLASSIFICATION OF RADAR ECHOES.
- downwind**, , *adj.* & *adv.* In the direction toward which the wind is blowing. The term applies particularly to the situation of moving in this direction, whether desired or not. BEFORE THE WIND implies assistance from the wind in making progress in a desired direction. LEEWARD applies to the direction toward which the wind blows, without implying motion. The opposite is UPWIND.
- draft**, , *n.* The depth to which a vessel is submerged. Draft is customarily indicated by numerals called DRAFT MARKS at the bow and stern. It may also be determined by means of a DRAFT GAUGE.
- draft gauge**. . A hydrostatic instrument installed in the side of a vessel, below the light load line, to indicate the depth to which a vessel is submerged.
- drafting machine**. . See PARALLEL MOTION PROTRACTOR.
- draft marks**. . Numerals placed on the sides of a vessel, customarily at the bow and stern, to indicate the depth to which a vessel is submerged.
- drag**, , *n.* 1. See SEA ANCHOR. 2. Short for WIRE DRAG. 3. The designed difference between the draft forward and aft when a vessel is down by the stern. See also TRIM, definition 1. 4. The retardation of a ship when in shallow water. 5. Short for ATMOSPHERIC DRAG.
- drag**, , *v.*, *t.* 1. To tow a line or object below the surface, to determine the least depth in an area or to ensure that a given area is free from navigational dangers to a certain depth. DRAG and SWEEP have nearly the same meanings. DRAG refers particularly to the location of obstructions, or the determination that obstructions do not exist. SWEEP may include, additionally, the removal of any obstructions located. 2. To pull along the bottom, as in dragging anchor.
- dragging**, , *n.* 1. The process of towing a wire or horizontally set bar below the surface, to determine the least depth in an area or to insure that a given area is free from navigational dangers to a certain depth. 2. The process of pulling along the bottom, as in dragging anchor.
- draw**, , *v.*, *i.* 1. To be immersed to a specified draft. 2. To change relative bearing forward or aft, or to port or starboard.
- drawing sequence**, , . In ECDIS the implementation of DISPLAY PRIORITY.
- dredge**, , *n.* A vessel used to dredge an area.
- dredge**, , *v.*, *t.* To remove solid matter from the bottom of a water area.
- dredging area**. . An area where dredging vessels may be encountered dredging material for construction. Channels dredged to provide an adequate depth of water for navigation are not considered as dredging areas.
- dredging buoy**. . A buoy marking the limit of an area where dredging is being performed. See also SPOIL GROUND BUOY.
- dried ice**. . Sea ice from the surface of which meltwater has disappeared after the formation of cracks and thaw holes. During the period of drying, the surface whitens.
- drift**, , *n.* 1. The speed of a current as defined in CURRENT. 2. The distance a craft is moved by current and wind. 3. Downwind or downcurrent motion of airborne or waterborne objects due to wind or current. 4. Material moved from one place and deposited in another, as sand by a river, rocks by a glacier, material washed ashore and left stranded, snow or sand piled up by wind. Rock material deposited by a glacier is also called ERRATIC. 5. The horizontal component of real precession or apparent precession, or the algebraic sum of the two. When it is desired to differentiate between the sum and its components, the sum is called total drift.
- drift**, , *v.*, *i.* To move by action of wind or current without control.
- drift angle**. . 1. The angle between the tangent-to the turning circle and the centerline of the vessel during a turn. 2. The angular difference between a vessel's ground track and the water track. See also LEEWAY ANGLE.
- drift axis**. . On a gyroscope, the axis about which drift occurs. In a directional gyro with the spin axis mounted horizontally the drift axis is the vertical axis. See also SPIN AXIS, TOPPLE AXIS.
- drift bottle**. . An identifiable float allowed to drift with ocean currents to determine their sets and drifts.
- drift current**. . A wide, slow-moving ocean current principally caused by prevailing winds.
- drifting snow**. . Snow raised from the ground and carried by the wind to such a height that the horizontal visibility is considerably reduced but the vertical visibility is not materially diminished. The expression BLOWING SNOW is used when both the horizontal and vertical visibility are considerably reduced.
- drift lead**. . A lead placed on the bottom to indicate movement of a vessel. At anchor the lead line is usually secured to the rail with a little slack and if the ship drags anchor, the line tends forward. A drift lead is also used to indicate when a vessel coming to anchor is dead in the water or when it is moving astern. A drift lead can be used to indicate current if a ship is dead in the water.
- drilling rig**. . A term used solely to indicate a mobile drilling structure. A drilling rig is not charted except in the rare cases where it is converted to a permanent production platform.
- drizzle**, , *n.* Very small, numerous, and uniformly dispersed water drops that may appear to float while following air currents. Unlike fog droplets, drizzle falls to the ground. It usually falls from low stratus clouds and is frequently accompanied by low visibility and fog. See also MIST.
- drogue**, , *n.* 1. See SEA ANCHOR. 2. A current measuring assembly consisting of a weighted parachute and an attached surface buoy.
- drought**, , *n.* A protracted period of dry weather.
- droxtal**, , *n.* A very small ice particle (about 10 to 20 microns in diameter) formed by the direct freezing of supercooled water droplets at tem-

- peratures below  $-30^{\circ}\text{C}$ . Droxtals cause most of the restriction to visibility in ice fog.
- dry-bulb temperature.** . The temperature of the air, as indicated by the dry-bulb thermometer of a PSYCHROMETER.
- dry-bulb thermometer.** . A thermometer with an uncovered bulb, used with a wet-bulb thermometer to determine atmosphere humidity. The two thermometers constitute the essential parts of a PSYCHROMETER.
- dry compass.** . A compass without a liquid-filled bowl, particularly a magnetic compass having a very light compass card. Such a magnetic compass is seldom, if ever, used in marine applications. See also LIQUID COMPASS.
- dry dock.** . A dock providing support for a vessel, and means for removing the water so that the bottom of the vessel can be exposed. A dry dock consisting of an artificial basin is called a graving dock; one consisting of a floating structure is called a floating dock. See also MARINE RAILWAY.
- dry-dock.** , *v.*, *t.* To place in a dry dock.
- drydock iceberg.** . An iceberg eroded in such manner that a large U-shaped slot is formed with twin columns. The slot extends into or near the waterline.
- dry fog.** . A fog that does not moisten exposed surfaces.
- dry harbor.** . A small harbor which either dries at low water or has insufficient depths to keep vessels afloat during all states of the tide. Vessels using it must be prepared to take the ground on the falling tide.
- dry haze.** . See under HAZE.
- drying heights.** . Heights above chart sounding datum of those features which are periodically covered and exposed by the rise and fall of the tide.
- dual-carrier radiobeacon.** . A continuous carrier radiobeacon in which identification is accomplished by means of a keyed second carrier. The frequency difference between the two carriers is made equal to the desired audio frequency. The object of the system is to reduce the bandwidth of the transmission.
- duct.** , *n.* See as TROPOSPHERIC RADIO DUCT.
- dumb compass.** . See PELORUS.
- dummy antenna.** . A substantially non-radiating device used to simulate an antenna with respect to input impedance over some specified range of frequencies. Also called ARTIFICIAL ANTENNA.
- dumping ground.** . An area used for the disposal of dredge spoil. Although shown on nautical charts as dumping grounds in U.S. waters, the Federal regulations for these areas have been revoked and their use for dumping discontinued. These areas will continue to be shown on nautical charts until they are no longer considered to be a danger to navigation. See also DUMP SITE, SPOIL AREA, DISPOSAL AREA.
- dump site.** . Area established by Federal regulation in which dumping of dredged and fill material and other nonbuoyant objects is allowed with the issuance of a permit. Dump sites are shown on nautical charts. See also DISPOSAL AREA, DUMPING GROUND, SPOIL AREA.
- dune.** , *n.* A mound, ridge, or hill of sand piled up by the wind on the shore or in a desert. Also called SAND DUNE.
- duplex.** . Concurrent transmission and reception of radio signals, electronic data, or other information.
- duplexer.** , *n.* A device which permits a single antenna system to be used for both transmitting and receiving.
- duration of flood, duration of ebb.** . Duration of flood is the interval of time in which a tidal current is flooding, and the duration of ebb is the interval in which it is ebbing; these intervals being reckoned from the middle of the intervening slack waters or minimum currents. Together they cover, on an average, a period of 12.42 hours for a semidiurnal tidal current or a period of 24.84 hours for a diurnal current. In a normal semidiurnal tidal current, the duration of flood and duration of ebb will each be approximately equal to 6.21 hours, but the times may be modified greatly by the presence of a nontidal flow. In a river, the duration of ebb is usually longer than the duration of flood because of the fresh water discharge, especially during the spring months when snow and ice melt are the predominant influences. See also DURATION OF RISE, DURATION OF FALL.
- duration of rise, duration of fall.** . Duration of rise is the interval from low water to high water, and duration of fall is the interval from high water to low water. Together they cover, on an average, a period of 12.42 hours for a semidiurnal tide or a period of 24.84 hours for a diurnal tide. In a normal semidiurnal tide, the duration of rise and duration of fall will each be approximately equal to 6.21 hours, but in shallow waters and in rivers there is a tendency for a decrease in the duration of rise and a corresponding increase in the duration of fall. See also DURATION OF FLOOD, DURATION OF EBB.
- dusk.** , *n.* The darker part of twilight; that part of twilight between complete darkness and the darker limit of civil twilight, both morning and evening.
- dust devil.** . A well-developed dust whirl, a small but vigorous whirlwind, usually of short duration, rendered visible by dust, sand, and debris picked up from the ground. Diameters of dust devils range from about 10 feet to greater than 100 feet; their average height is about 600 feet, but a few have been observed as high as several thousand feet. They have been observed to rotate anticyclonically as well as cyclonically. Dust devils are best developed on a hot, calm afternoon with clear skies, in a dry region when intense surface heating causes a very steep lapse rate of temperature in the lower few hundred feet of the atmosphere.
- dust storm.** , *n.* An unusual, frequently severe weather condition characterized by strong winds and dust-filled air over an extensive area. Prerequisite to a dust storm is a period of drought over an area of normally arable land, thus providing very fine particles of dust which distinguish it from the much more common SANDSTORM.
- dust whirl.** . A rapidly rotating column of air, or WHIRLWIND, over a dry and dusty or sandy area, carrying dust, leaves, and other light material picked up from the ground. When well developed it is called a DUST DEVIL.
- Dutchman's log.** . A buoyant object thrown overboard to determine the speed of a vessel. The time required for a known length of the vessel to pass the object is measured.
- duty cycle.** . An expression of the fraction of the total time of pulse radar that radio-frequency energy is radiated. It is the ratio of pulse length to pulse repetition time.
- dynamical mean sun.** . A fictitious sun conceived to move eastward along the ecliptic at the average rate of the apparent sun. The dynamical mean sun and the apparent sun occupy the same position when the earth is at perihelion in January. See also MEAN SUN.
- dyne.** , *n.* A force which imparts an acceleration of 1 centimeter per second to a mass of 1 gram. The dyne is the unit of force in the CENTIMETER-GRAM-SECOND SYSTEM. It corresponds to  $10^{-5}$  newton in the International System of Units.

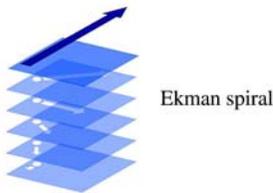
## E

- earth-centered ellipsoid.** . A reference ellipsoid whose geometric center coincides with the earth's center of gravity and whose semiminor axis coincides with the earth's rotational axis.
- earth-fixed coordinate system.** . Any coordinate system in which the axes are stationary with respect to the earth. See also INERTIAL COORDINATE SYSTEM.
- earthlight.** , *n.* The faint illumination of the dark part of the moon by sunlight reflected from the earth. Also called EARTHSHINE.
- earth rate.** . The angular velocity or rate of the earth's rotation. See also EARTH-RATE CORRECTION, HORIZONTAL EARTH RATE, VERTICAL EARTH RATE.
- earth-rate correction.** . A rate applied to a gyroscope to compensate for the apparent precession of the spin axis caused by the rotation of the earth. See also EARTH RATE, HORIZONTAL EARTH RATE, VERTICAL EARTH RATE.
- earth satellite.** . A body that orbits about the earth. See also ARTIFICIAL EARTH SATELLITE.
- earthshine.** , *n.* See EARTHLIGHT.
- earth tide.** . Periodic movement of the earth's crust caused by the gravitational interactions between the sun, moon, and earth.
- east.** , *n.* The direction  $90^{\circ}$  to the right of NORTH. See also CARDINAL POINT.
- East Africa Coastal Current.** . An Indian Ocean current which originates mainly from the part of the Indian South Equatorial Current which turns northward off the northeast coast of Africa in the vicinity of latitude  $10^{\circ}\text{S}$ . The current appears to vary considerably in speed and direction from month to month. The greatest changes

- coincide with the period of the opposing northeast monsoon during November through March. This coastal current is most persistent in a north or northeast direction and strongest during the southwest monsoon from May through September, particularly during August. Speed and frequency begin to decrease during the transition month of October. In November at about latitude 4°N a part of the current begins to reverse; this part expands northward and southward until February. The region of reverse flow begins to diminish in March and disappear in April, when the northward set again predominates. Also called SOMALI CURRENT. See also MONSOON.
- East Australia Current.** . A South Pacific Ocean current flowing southward along the east coast of Australia, from the Coral Sea to a point northeast of Tasmania, where it turns to join the northeastward flow through the Tasman Sea. It is formed by that part of the Pacific South Equatorial Current that turns south east of Australia. In the southern hemisphere summer, a small part of this current flows westward along the south coast of Australia into the Indian Ocean. The East Australia Current forms the western part of the general counterclockwise oceanic circulation of the South Pacific Ocean.
- eastern standard time.** . See STANDARD TIME.
- East Greenland Current.** . An ocean current flowing southward along the east coast of Greenland carrying water of low salinity and low temperature. The East Greenland Current is joined by most of the water of the Irminger Current. The greater part of the current continues through Denmark Strait between Iceland and Greenland, but one branch turns to the east and forms a portion of the counterclockwise circulation in the southern part of the Norwegian Sea. Some of the East Greenland Current curves to the right around the tip of Greenland, flowing northward into Davis Strait as the WEST GREENLAND CURRENT. The main discharge of the Arctic Ocean is via the East Greenland Current.
- easting.** , *n.* The distance a craft makes good to the east. The opposite is WESTING.
- East Siberian Coastal Current.** . An ocean current in the Chukchi Sea which joins the northward flowing Bering Current north of East Cape.
- ebb.** , *n.* Tidal current moving away from land or down a tidal stream. The opposite is FLOOD. Sometimes the terms ebb and flood are also used with reference to vertical tidal movement, but for this vertical movement the expressions FALLING TIDE and RISING TIDE are preferable. Also called EBB CURRENT.
- ebb axis.** . The average direction of current at strength of ebb.
- ebb current.** . The movement of a tidal current away from shore or down a tidal river or estuary. In the mixed type of reversing tidal current, the terms *greater ebb* and *lesser ebb* are applied respectively to the ebb tidal currents of greater and lesser speed of each day. The terms *maximum ebb* and *minimum ebb* are applied to the maximum and minimum speeds of a current running continuously. Maximum ebb is also applicable to any ebb current at the time of greatest speed. The opposite is FLOOD CURRENT.
- ebb interval.** . Short for STRENGTH OF EBB INTERVAL. The interval between the transit of the moon over the meridian of a place and the time of the following strength of ebb. See also LUNICURRENT INTERVAL.
- ebb strength.** . Phase of the ebb tidal current at the time of maximum velocity. Also, the velocity at this time. Also called STRENGTH OF EBB.
- eccentric.** , *adj.* Not having the same center. The opposite is CONCENTRIC.
- eccentric angle.** . See under ANOMALY, definition 2.
- eccentric anomaly.** . See under ANOMALY, definition 2.
- eccentric error.** . See CENTERING ERROR.
- eccentricity.** , *n.* 1. Degree of deviating from a center. 2. The ratio of the distance between foci of an ellipse to the length of the major axis, or the ratio of the distance between the center and a focus to the length of the semimajor axis. 3. The ratio of the distances from any point of a conic section to a focus and the corresponding directrix.
- eccentricity component.** . That part of the equation of time due to the ellipticity of the orbit and known as the eccentricity component is the difference, in mean solar time units, between the hour angles of the apparent (true) sun and the dynamical mean sun. It is also the difference in the right ascensions of these two suns.
- ECDIS.** . See ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM.
- ECDIS Chart 1.** . An ECDIS version of IHO INT 1, including all SYMBOLS, line styles and color coding used for chart and navigation symbols, contained in the PRESENTATION LIBRARY.
- echo.** , *n.* 1. A wave which has been reflected or otherwise returned with sufficient magnitude and delay to be perceived. 2. A signal reflected by a target to a radar antenna. Also called RETURN. 3. The deflection or indication on a radarscope representing a target. Also called PIP, BLIP, RETURN.
- echo box.** . A resonant cavity, energized by part of the transmitted pulse of a radar set, which produces an artificial target signal for tuning or testing the overall performance of a radar set. Also called PHANTOM TARGET.
- echo box performance monitor.** . See under PERFORMANCE MONITOR.
- echogram.** , *n.* A graphic record of depth measurements obtained by an echo sounder. See also FATHOGRAM.
- echo ranging.** . The determination of distance by measuring the time interval between transmission of a radiant energy signal and the return of its echo. Since echo ranging equipment is usually provided with means for determining direction as well as distance, both functions are generally implied. The expression is customarily applied only to ranging by utilization of the travel of sonic or ultrasonic signals through water. See also RADIO ACOUSTIC RANGING, SONAR.
- echo sounder.** . An instrument used to determine water depth by measuring the time interval for sound waves to go from a source of sound near the surface to the bottom and back again. Also called DEPTH FINDER, ACOUSTIC DEPTH FINDER.
- echo sounding.** . Determination of the depth of water by measuring the time interval between emission of a sonic or ultrasonic signal and the return of its echo from the bottom. The instrument used for this purpose is called an ECHO SOUNDER. Also called ACOUSTIC SOUNDING.
- eclipse.** , *n.* 1. Obscuring of a source of light by the intervention of an object. When the moon passes between the earth and the sun, casting a shadow on the earth, a SOLAR ECLIPSE takes place within the shadow. A solar eclipse is partial if the sun is partly obscured, total if the entire surface is obscured, or annular if a thin ring of the sun's surface appears around the obscuring body. When the moon enters the earth's shadow, a LUNAR ECLIPSE occurs. When the moon enters only the penumbra of the earth's shadow, a PENUMBRAL LUNAR ECLIPSE occurs. A lunar eclipse can be either total or partial. 2. An interval of darkness between flashes of a navigation light.
- eclipse year.** . The interval between two successive conjunctions of the sun with the same node of the moon's orbit, averaging 346 days, 14 hours, 52 minutes 50.7 seconds in 1900, and increasing at the rate of 2.8 seconds per century.
- ecliptic.** , *n.* The apparent annual path of the sun among the stars; the intersection of the plane of the earth's orbit with the celestial sphere. This is a great circle of the celestial sphere inclined at an angle of about 23°27' to the celestial equator. See also ZODIAC.
- ecliptic diagram.** . A diagram of the ZODIAC, indicating the positions of certain celestial bodies in this region.
- ecliptic pole.** . On the celestial sphere, either of the two points 90° from the ecliptic.
- ecliptic system of coordinates.** . A set of celestial coordinates based on the ecliptic as the primary great circle; celestial latitude and celestial longitude.
- eddy.** , *n.* A quasi-circular movement of water whose area is relatively small in comparison to the current with which it is associated. Eddies may be formed between two adjacent currents flowing counter to each other and where currents pass obstructions, especially on the downstream side. See also WHIRLPOOL.
- edge.** . In ECDIS, a one-dimensional SPATIAL OBJECT, located by two or more coordinate pairs (or two CONNECTED NODES) and optional interpolation parameters. If the parameters are missing, the interpolation is defaulted to straight line segments between the coordinate pairs. In the CHAIN-NODE, PLANAR GRAPH and FULL TOPOLOGY data structures, an edge must reference a connected node at both ends and must not reference any other NODES.
- effective radiated power.** . The power supplied to the antenna multiplied by the relative gain of the antenna in a given direction.
- effective radius of the earth.** . The radius of a hypothetical earth for which the distance to the radio horizon, assuming rectilinear prop-

agation, is the same as that for the actual earth with an assumed uniform vertical gradient of a refractive index. For the standard atmosphere, the effective radius is 4/3 that of the actual earth.

**Ekman spiral.** . A logarithmic spiral (when projected on a horizontal plane) formed by current velocity vectors at increasing depth intervals. The current vectors become progressively smaller with depth. They spiral to the right (looking in the direction of flow) in the Northern Hemisphere and to the left in the Southern Hemisphere with increasing depth. Theoretically, the surface current vector sets 45° from the direction toward which the wind is blowing. Flow opposite to the surface current occurs at the depth of frictional resistance. The phenomenon occurs in wind drift currents in which only the Coriolis and frictional forces are significant. Named for Vagn Walfrid Ekman who, assuming a constant eddy viscosity, steady wind stress, and unlimited depth and extent, published the effect in 1905.



**E-layer.** , *n*. From the standpoint of its effect upon radio wave propagation, the lowest useful layer of the Kennelly-Heaviside radiation region. Its average height is about 70 miles, and its density is greatest about local apparent noon. For practical purposes, the layer disappears during the hours of darkness.

**elbow.** , *n*. A sharp change in direction of a coast line, a channel, river, etc.

**electrical distance.** . A distance expressed in terms of the duration of travel of an electromagnetic wave in a given medium between two points.

**electrically suspended gyro.** . A gyroscope in which the main rotating element is suspended by a magnetic field or any other similar electrical phenomenon. See also GYRO, ELECTROSTATIC GYRO.

**electrical storm.** . See THUNDERSTORM.

**electric field.** . That region in space which surrounds an electrically charged object and in which the forces due to this charge are detectable. See also ELECTRIC VECTOR.

**electric tape gage.** . A tide gage consisting of a monel metal tape on a metal reel (with supporting frame), voltmeter, and battery. The tape is graduated with numbers increasing toward the unattached end. Tidal heights can be measured directly by unreeling the tape into its stilling well. When contact is made with the water's surface, the circuit is completed and the voltmeter needle moves. At that moment, the length of tape is read against an index mark, the mark having a known elevation relative to the tidal bench marks. Used at many long term control stations in place of the tide staff.

**electric vector.** . The component of the electromagnetic field associated with electromagnetic radiation which is of the nature of an electric field. The electric vector is considered to coexist with, but to act at right angles to, the magnetic vector.

**electrode.** , *n*. A terminal at which electricity passes from one medium into another. The positive electrode is called the ANODE; the negative electrode is called the CATHODE.

**electromagnetic.** , *adj*. Of, pertaining to, or produced by electromagnetism.

**electromagnetic energy.** . All forms of radiant energy, such as radio waves, light waves, X-rays, heat waves, gamma rays, and cosmic rays.

**electromagnetic field.** . 1. The field of influence which an electric current produces around the conductor through which it flows. 2. A rapidly moving electric field and its associated magnetic field located at right angles to both electric lines of force and to their direction of motion. 3. The magnetic field resulting from the flow of electricity.

**electromagnetic log.** . A log containing an electromagnetic sensing element extended below the hull of the vessel, which produces a voltage directly proportional to speed through the water.

**electromagnetic waves.** . Waves of associated electric and magnetic fields characterized by variations of the fields. The electric and magnetic fields are at right angles to each other and to the direction of propagation. The waves are propagated at the speed of light and

are known as radio (Hertzian) waves, infrared rays, light, ultraviolet rays, X-rays, etc., depending on their frequencies.

**electromagnetism.** , *n*. 1. Magnetism produced by an electric current. 2. The science dealing with the physical relations between electricity and magnetism.

**electron.** , *n*. A negatively-charged particle of matter constituting a part of an atom. Its electric charge is the most elementary unit of negative electricity.

**electron gun.** . A group of electrodes which produces an electron beam of controllable intensity. By extension, the expression is often used to include, also, the elements which focus and deflect the beam.

**electronic aid to navigation.** . An aid to navigation using electronic equipment. If the navigational information is transmitted by radio waves, the device may be called a RADIO AID TO NAVIGATION.

**electronic bearing cursor.** . The bright rotatable radial line on the display of a marine radar set, used for bearing determination.

**electronic chart (EC).** . A chart displayed on a video terminal, usually integrated with other navigational aids.

**electronic chart data base (ECDB).** . The master electronic chart data base for the electronic navigation chart held in digital form by the hydrographic authority.

**electronic chart display and information system (ECDIS).** . An electronic chart system which complies with IMO guidelines and is the legal equivalent of a paper chart. ECDIS is the only equipment on the bridge that provides an overall view of all navigational sensors simultaneously with nautical charts. Displaying multiple information feeds on one screen enhances the navigating officer's situational awareness.

**Electronic Chart System (ECS).** . Navigation information system that electronically displays vessel position and relevant nautical chart data and information from the ECS database on a display screen, but does not meet all IMO requirements for ECDIS, and does not satisfy SOLAS Chapter V requirements to carry a navigational chart.

**Electronic Navigational Chart (ENC).** . The data base, standardized as to content, structure and format, issued for use with ECDIS on the authority of government authorized hydrographic offices. The ENC contains all the chart information necessary for safe navigation and may contain supplementary information in addition to that contained in the paper chart (e.g. sailing directions) which may be considered necessary for safe navigation.

**electronic cursor.** . Short for ELECTRONIC BEARING CURSOR.

**electronic distance measuring devices.** . Instruments that measure the phase differences between transmitted and reflected or retransmitted electromagnetic waves of known frequency, or that measure the round-trip transit time of a pulsed signal, from which distance is computed.

**electronic navigation.** . Navigation by means of electronic equipment. The expression electronic navigation is more inclusive than RADIO NAVIGATION, since it includes navigation involving any electronic device or instrument.

**electronics.** , *n*. The science and technology relating to the emission, flow, and effects of electrons in a vacuum or through a semiconductor such as a gas, and to systems using devices in which this action takes place.

**electronic telemeter.** . An electronic device that measures the phase difference or transit time between a transmitted electromagnetic impulse of known frequency and speed and its return.

**electrostatic gyro.** . A gyroscope in which a small ball rotor is electrically suspended within an array of electrodes in a vacuum inside a ceramic envelope. See also GYRO, ELECTRICALLY SUSPENDED GYRO.

**elements of a fix.** . The specific values of the coordinates used to define a position.

**elephanta.** , *n*. A strong southerly or southeasterly wind which blows on the Malabar coast of India during the months of September and October and marks the end of the southwest monsoon.

**elevated duct.** . A TROPOSPHERIC RADIO DUCT of which the lower boundary is above the surface of the earth.

**elevated pole.** . The celestial pole above the horizon, agreeing in name with the latitude. The celestial pole below the horizon is called DEPRESSED POLE.

**elevation.** , *n*. 1. Vertical distance of a point above a datum, usually mean sea level. Elevation usually applies to a point on the surface of the

- earth. The term HEIGHT is used for points on or above the surface. See also SPOT ELEVATION. 2. An area higher than its surroundings, as a hill.
- elevation angle.** . See ANGLE OF ELEVATION.
- elevation tints.** . See HYPOMETRIC TINTING.
- elimination.** , *n.* One of the final processes in the harmonic analysis of tides in which preliminary values of the harmonic constants of a number of constituents are cleared of residual effects of each other.
- E-link.** . A bracket attached to one of the arms of a binnacle to permit the mounting of a quadrantal corrector in an intermediate position between the fore-and-aft and athwartship lines through a magnetic compass.
- ellipse.** , *n.* A plane curve constituting the locus of all points the sum of whose distances from two fixed points called FOCI is constant; an elongated circle. The orbits of planets, satellites, planetoids, and comets are ellipses with the center of attraction at one focus. See also CONIC SECTION, CURRENT ELLIPSE.
- ellipsoid.** , *n.* A surface whose plane sections (cross-sections) are all ellipses or circles, or the solid enclosed by such a surface. Also called ELLIPSOID OF REVOLUTION, SPHEROID.
- ellipsoidal height.** . The height above the reference ellipsoid, measured along the ellipsoidal outer normal through the point in question. Also called GEODETIC HEIGHT.
- ellipsoid of reference.** . See REFERENCE ELLIPSOID.
- ellipsoid of revolution.** . A term used for an ellipsoid which can be formed by revolving an ellipse about one of its axes. Also called ELLIPSOID OF ROTATION.
- ellipsoid of rotation.** . See ELLIPSOID OF REVOLUTION.
- elliptically polarized wave.** . An electromagnetic wave which can be resolved into two plane polarized waves which are perpendicular to each other and which propagate in the same direction. The amplitudes of the waves may be equal or unequal and of arbitrary time-phase. The tip of the component of the electric field vector in the plane normal to the direction of propagation describes an ellipse. See also CIRCULARLY POLARIZED WAVE.
- ellipticity.** , *n.* The amount by which a spheroid differs from a sphere or an ellipse differs from a circle, found by dividing the difference in the lengths of the semi-axes of the ellipse by the length of the semimajor axis. See also FLATTENING.
- elongation.** , *n.* The angular distance of a body of the solar system from the sun; the angle at the earth between lines to the sun and another celestial body of the solar system. The greatest elongation is the maximum angular distance of an inferior planet from the sun before it starts back toward conjunction. The direction of the body east or west of the sun is usually specified, as greatest elongation east (or west).
- embayed.** , *adj.* 1. Formed into or having bays. 2. Unable to put to sea safely because of wind, current, or sea conditions.
- embayment.** , *n.* Any indentation of a coast regardless of width at the entrance or depth of penetration into the land. See also ESTUARY.
- emergency light.** . A light put into service in an emergency when the permanent or standby light has failed. It often provides reduced service in comparison with the permanent light.
- Emergency Position Indicating Radiobeacon (EPIRB).** . A small portable radiobeacon carried by vessels, aircraft, or personnel which transmits radio signals which can be used by search and rescue authorities to locate a marine emergency.
- emergency position indicating radiobeacon station.** . As defined by the International Telecommunication Union, a station in the mobile service whose emissions are intended to facilitate search and rescue operations.
- emission delay.** . A delay in the transmission of a pulse signal from a secondary station of a hyperbolic radionavigation system, introduced as an aid in distinguishing between master and secondary station signals.
- empirical.** , *adj.* Derived by observation or experience rather than by rules or laws.
- e-Navigation.** , *n.* The harmonized collection, integration, exchange, presentation and analysis of maritime information on board and ashore by electronic means to enhance berth-to-berth navigation and related services for safety and security at sea and protection of the marine environment.
- ENC.** . See ELECTRONIC NAVIGATIONAL CHART.
- ENC cell structure.** . See CELL.
- ENC product specification.** . In ECDIS the IHO Standard which specifies the content, structure and other mandatory aspects of an ENC.
- ENC test data set.** . In ECDIS a standardized data set supplied on behalf of the INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) that is necessary to accomplish all IEC testing requirements for ECDIS.
- encapsulation.** . In ECDIS the identification of FIELDS and RECORDS and the grouping of fields and records and the data syntax rules used.
- encoding conventions.** . In ECDIS a set of rules to be followed when encoding data for a particular purpose.
- endless tangent screw.** . A tangent screw which can be moved over its entire range without resetting.
- endless tangent screw sextant.** . A marine sextant having an endless tangent screw for controlling the position of the index arm and the vernier or micrometer drum. The index arm may be moved over the entire arc without resetting, by means of the endless tangent screw.
- enhanced group call (EGC).** . A global automated satellite communications service capable of addressing messages to specific areas or specific groups of vessels.
- ensonify.** , **insonify.** . To fill the ocean or any fluid medium with acoustic radiation, which is then observed and analyzed to study the medium or to locate or image objects with it.
- entrance.** , *n.* The seaward end of a channel, harbor, etc.
- entrance lock.** . A lock between the tideway and an enclosed basin when their water levels vary. By means of the lock, which has two sets of gates vessels can pass either way at all states of the tide. Also called TIDAL LOCK. See also NONTIDAL BASIN.
- ephemeris.** (*pl. ephemerides*), *n.* 1. A periodical publication tabulating the predicted positions of celestial bodies at regular intervals, such as daily, and containing other data of interest to astronomers and navigators. The *Astronomical Almanac* is an ephemeris. See also ALMANAC. 2. A statement, not necessarily in a publication, presenting a correlation of time and position of celestial bodies or artificial satellites.
- ephemeris day.** . See under EPHEMERIS SECOND.
- ephemeris second.** . The ephemeris second is defined as  $1/31,556,925.9747$  of the tropical year for 1900 January 0<sup>d</sup> 12<sup>h</sup> ET. The ephemeris day is 86,400 ephemeris seconds. See also EPHEMERIS TIME.
- Ephemeris Time.** . The time scale used by astronomers as the tabular argument of the precise fundamental ephemerides of the sun, moon and planets. It is the independent variable in the gravitational theories of the solar system. It is determined in arrears from astronomical observations and extrapolated into the future, based on International Atomic Time.
- epicenter.** , *n.* The point on the earth's surface directly above the focus of an earthquake.
- epoch.** , *n.* 1. A particular instant of time or a date for which values of data, which vary with time, are given. 2. A given period of time during which a series of related acts or events takes place. 3. Angular retardation of the maximum of a constituent of the observed tide behind the corresponding maximum of the same constituent of the hypothetical equilibrium. Also called PHASE LAG, TIDAL EPOCH. 4. As used in tidal datum determinations, a 19-year Metonic cycle over which tidal height observations are meaned in order to establish the various datums.
- equal altitudes.** . Two altitudes numerically the same. The expression applies particularly to the practice of determining the instant of local apparent noon by observing the altitude of the sun a short time before it reaches the meridian and again at the same altitude after transit, the time of local apparent noon being midway between the times of the two observations, if the second is corrected as necessary for the run of the ship. Also called DOUBLE ALTITUDES.
- equal-area map projection.** . A map projection having a constant area scale. Such a projection is not conformal and is not used for navigation. Also called AUTHALIC MAP PROJECTION, EQUIVALENT MAP PROJECTION.
- equal interval light.** . A navigation light having equal periods of light and darkness. Also called ISOPHASE LIGHT.
- equation of time.** . The difference at any instant between apparent time and local mean time. It is a measure of the difference of the hour angles of the apparent (true) sun and the mean (fictitious) sun. The curve drawn for the equation of time during a year has two maxima: February 12 (+14.3<sup>m</sup>) and July 27 (+6.3<sup>m</sup>) and two minima: May

- 15 (-3.7<sup>m</sup>) and November 4 (-16.4<sup>m</sup>). The curve crosses the zero line on April 15, June 14, September 1, and December 24. The equation of time is tabulated in the *Nautical Almanac*, without sign, for 00<sup>h</sup> and 12<sup>h</sup> GMT on each day. To obtain apparent time, apply the equation of time to mean time with a positive sign when GHA sun at 00<sup>h</sup> GMT exceeds 180°, or at 12<sup>h</sup> exceeds 0°, corresponding to a meridian passage of the sun before 12<sup>h</sup> GMT; otherwise apply with a negative sign.
- equator**, *n.* The primary great circle of a sphere or spheroid, such as the earth, perpendicular to the polar axis, or a line resembling or approximating such a circle. The terrestrial equator is 90° from the earth's geographical poles, the celestial equator or equinoctial is 90° from the celestial poles. The astronomical equator is a line connecting points having 0° astronomical latitude, the geodetic equator connects points having 0° geodetic latitude. The expression terrestrial equator is sometimes applied to the astronomical equator. The equator shown on charts is the geodetic equator. A fictitious equator is a reference line serving as the origin for measurement of fictitious latitude. A transverse or inverse equator is a meridian the plane of which is perpendicular to the axis of a transverse projection. An oblique equator is a great circle the plane of which is perpendicular to the axis of an oblique projection. A grid equator is a line perpendicular to a prime grid meridian at the origin. The magnetic equator or acclinic line is the line on the surface of the earth connecting all points at which the magnetic dip is zero. The geomagnetic equator is the great circle 90° from the geomagnetic poles of the earth.
- equatorial**, *adj.* Of or pertaining to the EQUATOR.
- equatorial air**. . See under AIR-MASS CLASSIFICATION.
- equatorial bulge**. . The excess of the earth's equatorial diameter over the polar diameter.
- equatorial calms**. . See DOLDRUMS.
- equatorial chart**. . 1. A chart of equatorial areas. 2. A chart on an EQUATORIAL MAP PROJECTION.
- equatorial countercurrent**. . An oceanic current flowing between and counter to the EQUATORIAL CURRENTS. See ATLANTIC EQUATORIAL COUNTERCURRENT, PACIFIC EQUATORIAL COUNTERCURRENT, INDIAN EQUATORIAL COUNTERCURRENT.
- equatorial current**. . See NORTH EQUATORIAL CURRENT, SOUTH EQUATORIAL CURRENT.
- equatorial cylindrical orthomorphic chart**. . See MERCATOR CHART.
- equatorial cylindrical orthomorphic map projection**. . See MERCATOR MAP PROJECTION.
- equatorial gravity value**. . The mean acceleration of gravity at the equator, approximately equal to 978.03 centimeters per second per second.
- equatorial map projection**. . A map projection centered on the equator.
- equatorial node**. . Either of the two points where the orbit of the satellite intersects the equatorial plane of its primary.
- equatorial satellite**. . A satellite whose orbital plane coincides, or almost coincides, with the earth's equatorial plane.
- equatorial tidal currents**. . Tidal currents occurring semimonthly as a result of the moon being over the equator. At these times the tendency of the moon to produce a diurnal inequality in the tidal current is at a minimum.
- equatorial tides**. . Tides occurring semimonthly as the result of the moon being over the equator. At these times the tendency of the moon to produce a diurnal inequality in the tide is at a minimum.
- equiangular**, *adj.* Having equal angles.
- equilateral**, *adj.* Having equal sides.
- equilateral triangle**. . A triangle having all of its sides equal. An equilateral triangle is necessarily equiangular.
- equilibrium**, *n.* A state of balance between forces. A body is said to be in equilibrium when the vector sum or all forces acting upon it is zero.
- equilibrium argument**. . The theoretical phase of a constituent of the equilibrium tide.
- equilibrium theory**. . A model under which it is assumed that the waters covering the face of the earth instantly respond to the tide-producing forces of the moon and sun, and form a surface of equilibrium under the action of these forces. The model disregards friction and inertia and the irregular distribution of the land masses of the earth. The theoretical tide formed under these conditions is called EQUATORIAL TIDE.
- equilibrium tide**. . Hypothetical tide due to the tide producing forces under the equilibrium theory. Also called GRAVITATIONAL TIDE.
- equinoctial**, *adj.* Of or pertaining to an EQUINOX or the equinoxes.
- equinoctial**, *n.* See CELESTIAL EQUATOR.
- equinoctial colure**. . The great circle of the celestial sphere through the celestial poles and the equinoxes; the hour circle of the vernal equinox. See also SOLSTITIAL COLURE.
- equinoctial point**. . One of the two points of intersection of the ecliptic and the celestial equator. Also called EQUINOX.
- equinoctial system of coordinates**. . See CELESTIAL EQUATOR SYSTEM OF COORDINATES.
- equinoctial tides**. . Tides occurring near the times of the equinoxes, when the spring range is greater than average.
- equinoctial year**. . See TROPICAL YEAR.
- equinox**, *n.* 1. One of the two points of intersection of the ecliptic and celestial equator, occupied by the sun when its declination is 0°. The point occupied on or about March 21, when the sun's declination changes from south to north, is called vernal equinox, March equinox, or first point of Aries; the point occupied on or about September 23, when the declination changes from north to south, is called autumnal equinox, September equinox, or first point of Libra. Also called EQUINOCTIAL POINT. 2. The instant the sun occupies one of the equinoctial points.
- equiphase zone**. . The region in space within which there is no difference in phase between two radio signals.
- equipotential surface**. . A surface having the same potential of gravity at every point. See also GEOID.
- equisignal**, *adj.* Pertaining to two signals of equal intensity.
- equisignal zone**. . The region in space within which the difference in amplitude of two radio signals (usually emitted by a signal station) is indistinguishable.
- equivalent echoing area**. . See RADAR CROSS SECTION.
- equivalent map projection**. . See EQUAL-AREA MAP PROJECTION.
- erect image**. . See under IMAGE, definition 1.
- erecting telescope**. . A telescope with which the observer sees objects right side up as opposed to the upside down view provided by the INVERTING TELESCOPE. The eyepiece in the optical system of an erecting telescope usually has four lenses, and the eyepiece in the optical system of an inverting telescope has two lenses.
- erg**, *n.* The work performed by a force of 1 dyne acting through a distance of 1 centimeter. The erg is the unit of energy or work in the centimeter-gram-second system. It corresponds to 10<sup>-7</sup> joule in the International System of Units.
- ergonomics**. . The science of making mechanical and electronic devices easily usable by humans; human factors engineering.
- error**, *n.* The difference between the value of a quantity determined by observation, measurement or calculation and the true, correct, accepted, adopted or standard value of that quantity. Usually, the true value of the quantity cannot be determined with exactness due to insufficient knowledge of the errors encountered in the observations. Exceptions occur (1) when the value is mathematically determinable, or (2) when the value is an adopted or standard value established by authority. In order to analyze the exactness with which the true value of a quantity has been determined from observations, errors are classified into two categories, random and systematic errors. For the purpose of error analysis, blunders or mistakes are not classified as errors. The significant difference between the two categories is that random errors must be treated by means of statistical and probability methods due to their accidental or chance nature whereas systematic errors are usually expressible in terms of a unique mathematical formula representing some physical law or phenomenon. See also ACCURACY.
- error budget**. . A correlated set of individual major error sources with statements of the percentage of the total system error contributed by each source.
- error ellipse**. . The contour of equal probability density centered on the intersection of two straight lines of position which results from the one-dimensional normal error distribution associated with each line. For the 50% error ellipse, there is a 50% probability that a fix will lie within such ellipse. If the angle of cut is 90° and the standard deviations are equal, the error figure is a circle.
- error of collimation**. . See COLLIMATION ERROR.
- error of perpendicularity**. . That error in the reading of a marine sextant

- due to non-perpendicularity of the index mirror to the frame.
- escape velocity**, *n*. The minimum velocity required of a body at a given point in a gravitational field which will permit the body to escape from the field. The orbit followed is a parabola and the body arrives at an infinite distance from the center of the field with zero velocity. With respect to escape velocities characteristic of the major bodies of the solar system, this is defined as escape from the body's gravitational field from the surface of the body in question. Escape velocity equals circular velocity times the square root of 2. Also called PARABOLIC VELOCITY.
- escarpment**, *n*. An elongated and comparatively steep slope separating flat or gently sloping areas. Also called SCARP.
- established direction of traffic flow**. A traffic flow pattern indicating the directional movement of traffic as established within a traffic separation scheme. See also RECOMMENDED DIRECTION OF TRAFFIC FLOW.
- establishment of the port**. Average high water interval on days of the new and full moon. This interval is also sometimes called the COMMON or VULGAR ESTABLISHMENT to distinguish it from the CORRECTED ESTABLISHMENT, the latter being the mean of all high water intervals. The latter is usually 10 to 15 minutes less than the common establishment. Also called HIGH WATER FULL AND CHANGE.
- estimate**, *v, t*. To determine roughly or with incomplete information.
- estimated position**. The most probable position of a craft determined from incomplete data or data of questionable accuracy. Such a position might be determined by applying a correction to the dead reckoning position, as for estimated current; by plotting a line of soundings; or by plotting lines of position of questionable accuracy. If no better information is available, a dead reckoning position is an estimated position, but the expression *estimated position* is not customarily used in this case. The distinction between an estimated position and a fix or running fix is a matter of judgment.
- estimated time of arrival**. The predicted time of reaching a destination or waypoint.
- estimated time of departure**. The predicted time of leaving a place.
- estimation**, *n*. A mathematical method or technique of making a decision concerning the approximate value of a desired quantity when the decision is weighted or influenced by all available information.
- estuarine sanctuary**. A research area which may include any part or all of an estuary, adjoining transitional areas, and adjacent uplands, constituting to the extent feasible a natural unit, set aside to provide scientists and students the opportunity to examine over a period of time the ecological relationships within the area. See also MARINE SANCTUARY.
- estuary**, *n*. 1. An embayment of the coast in which fresh river water entering at its head mixes with the relatively saline ocean water. When tidal action is the dominant mixing agent, it is usually called TIDAL ESTUARY. 2. The lower reaches and mouth of a river emptying directly into the sea where tidal mixing takes place. Sometimes called RIVER ESTUARY. 3. A drowned river mouth due to sinking of the land near the coast.
- etesian**, *n*. A refreshing northerly summer wind of the Mediterranean, especially over the Aegean Sea.
- Eulerian current measurement**. The direct observation of the current speed or direction, or both, during a period of time as it flows past a recording instrument such as the Ekman or Roberts current meter. See also LAGRANGIAN CURRENT MEASUREMENT.
- Eulerian motion**. A slight wobbling of the earth about its axis of rotation, often called POLAR MOTION, and sometimes WANDERING OF THE POLES. This motion, which does not exceed 40 feet from the mean position, produces slight variation of latitude and longitude of places on the earth.
- European Datum**. The origin of this datum is at Potsdam, Germany. Numerous national systems have been joined in a large datum based upon the International Ellipsoid 1924 which was oriented by a modified astrogeodetic method. European, African, and Asian triangulation chains were connected. African arc measurements from Cairo to Cape Town were completed. Thus, all Europe, Africa, and Asia are molded into one great system. Through common survey stations, it was possible to convert data from the Russian Pulkovo 1932 system to the European Datum, and as a result the European Datum includes triangulation as far east as the 84th meridian. Additional ties across the Middle East have permitted connection of the Indian and European Datums.
- evaporation**, *n*. The physical process by which a liquid or solid is transformed to the gaseous state. The opposite is CONDENSATION. In meteorology, the term evaporation is usually restricted in use to the change of water from liquid to gas, while SUBLIMATION is used for the change from solid to gas as well as from gas to solid. Energy is lost by an evaporating liquid, and when no heat is added externally, the liquid always cools. The heat thus removed is called LATENT HEAT OF VAPORIZATION.
- eviction**, *n*. A perturbation of the moon depending upon the alternate increase or decrease of the eccentricity of its orbit, which is always a maximum when the sun is passing the moon's line of apsides and at minimum when the sun is at right angles to it.
- evening star**. The brightest planet appearing in the western sky during EVENING TWILIGHT.
- evening twilight**. The period of time between sunset and darkness.
- everglade**, *n*. 1. A tract of swampy land covered mostly with tall grass. 2. A swamp or inundated tract of low land, as used locally in the southern U.S.
- excess of arc**. That part of a sextant arc beginning at zero and extending in the direction opposite to that part usually considered positive. See also ARC, definition 2.
- exchange format**. In ECDIS a specification for the structure and organization of data to facilitate exchange between computer systems.
- exchange set**. In ECDIS the set of FILES representing a complete, single purpose (i.e. product specific) data transfer. The ENC PRODUCT SPECIFICATION defines an exchange set which contains one Catalogue file and at least one data set file.
- existence doubtful**. Of uncertain existence. The expression is used principally on charts to indicate the possible existence of a rock, shoal, etc., the actual existence of which has not been established.
- ex-meridian altitude**. An altitude of a celestial body near the celestial meridian of the observer to which a correction must be applied to determine the meridian altitude. Also called CIRCUMMERIDIAN ALTITUDE.
- ex-meridian observation**. Measurement of the altitude of a celestial body near the celestial meridian of the observer, for conversion to a meridian altitude; or the altitude so measured.
- expanded center PPI display**. A plan position indicator display on which zero range corresponds to a ring around the center of the display.
- expanded sweep**. Short for EXPANDED TIME BASE SWEEP.
- expanded time base**. A time base having a selected part of increased speed. Particularly an EXPANDED TIME BASE SWEEP.
- expanded time base sweep**. A sweep in which the sweep speed is increased during a selected part of the cycle. Usually shortened to EXPANDED SWEEP, and sometimes to EXPANDED TIME BASE.
- explement**, *n*. An angle equal to 360° minus a given angle. See also COMPLEMENT, SUPPLEMENT.
- explementary angles**. Two angles whose sum is 360°.
- explosive fog signal**. A fog signal consisting of short reports produced by detonating explosive charges.
- exponent**, *n*. A number which indicates the power to which another number is to be raised.
- external noise**. In radio reception, atmospheric radio noise and man-made noise, singly or in combination. Internal noise is produced in the receiver circuits.
- extragalactic nebula**. An aggregation of matter beyond our galaxy, large enough to occupy a perceptible area but which has not been resolved into individual stars.
- extrapolation**, *n*. The process of estimating the value of a quantity beyond the limits of known values by assuming that the rate or system of change between the last few known values continues.
- extratropical cyclone**. Any cyclonic-scale storm that is not a tropical cyclone, usually referring only to the migratory frontal cyclones of middle and high latitudes. Also called EXTRATROPICAL LOW.
- extratropical low**. See EXTRATROPICAL CYCLONE.
- extreme high water**. The highest elevation reached by the sea as recorded by a tide gage during a given period. The National Ocean Survey routinely documents monthly and yearly extreme high waters for its control stations. See also EXTREME LOW WATER.
- extreme low water**. The lowest elevation reached by the sea as recorded by a tide gage during a given period. The National Ocean Survey routinely documents monthly and yearly extreme low water for its control stations. See also EXTREME HIGH WATER.

**extremely high frequency (EHF).** . Radio frequency of 30,000 to 300,000 megahertz.

**eye guard.** . A guard or shield on an eyepiece of an optical system, to protect the eye from stray light, wind, etc., and to maintain proper eye distance. Also called EYE SHIELD, EYE SHADE, SHADE.

**eye of the storm.** . The center of a tropical cyclone marked by relatively light winds, confused seas, rising temperature, lowered relative humidity, and often by clear skies. The general area of lowest atmospheric pressure of a cyclone is called STORM CENTER.

**eye of the wind.** . Directly into the wind; the point or direction from which the wind is blowing.

**eyepiece.** , *n.* In an optical device, the lens group which is nearest the eye and with which the image formed by the preceding elements is viewed.

**eye shade.** . See EYE GUARD.

**eye shield.** . See EYE GUARD.

## F

**face.** , *n.* In ECDIS a two dimensional SPATIAL OBJECT. A face is a continuous area defined by a loop of one or more EDGES which bound it. A face may contain interior holes, defined by closing loops of EDGES. These interior boundaries must be within the outer boundary. No boundary may cross itself or touch itself other than at the beginning/end NODE. None of the boundaries may touch or cross any other boundary. Faces are defined only in the FULL TOPOLOGY data structure.

**facsimile.** , *n.* A system for transmitting images electronically. A fax, or the hard-copy result of a facsimile transmission.

**fading.** , *n.* The fluctuation in intensity or relative phase of any or all of the frequency components of a received radio signal due to changes in the characteristics of the propagation path. See also SELECTIVE FADING.

**Fahrenheit temperature.** . Temperature based on a scale in which, under standard atmospheric pressure, water freezes at 32° and boils at 212° above zero.

**fair.** , *adj.* Not stormy; good; fine; clear.

**fair tide.** . A tidal current setting in such a direction as to increase the speed of a vessel. One setting in a direction approximately opposite to the heading is called a HEAD TIDE. One abeam is called a BEAM TIDE. One approximately 90° from the course is called a CROSS TIDE.

**fairway.** , *n.* 1. The main thoroughfare of shipping in a harbor or channel. 2. The middle of a channel.

**fairway buoy.** . A buoy marking a fairway, with safe water on either side. Its color is red and white vertical stripes. Also called MID-CHANNEL BUOY.

**fair wind.** . A wind which aids a craft in making progress in a desired direction. Used chiefly in connection with sailing vessels, when it refers to a wind which permits the vessel to proceed in the desired direction without tacking. See also FOLLOWING WIND.

**Falkland Current.** . Originating mainly from the Cape Horn Current in the north part of Drake Passage, the Falkland Current flows northward between the continent and the Falkland Islands after passing through the strait. The current follows the coast of South America until it joins the BRAZIL CURRENT at about latitude 36°S near the entrance to Rio de la Plata. Also called MALVIN CURRENT.

**fall.** , *n.* 1. See AUTUMN. 2. Decrease in a value, such as a fall of temperature. 3. Sinking, subsidence, etc., as the rise and fall of the sea due to tidal action or when waves or swell are present. See also WATERFALL.

**fall equinox.** . See AUTUMNAL EQUINOX.

**falling star.** . See METEOR.

**falling tide.** . The portion of the tide cycle between high water and the following low water in which the depth of water is decreasing. Sometimes the term EBB is used as an equivalent, but since ebb refers primarily to horizontal rather than vertical movement, falling tide is considered more appropriate. The opposite is RISING TIDE.

**fall streaks.** . See VIRGA.



fall streaks

**fall wind.** . A cold wind blowing down a mountain slope. It is warmed by its descent, but is still cool relative to surrounding air. A warm wind blowing down a mountain slope is called a FOEHN. The bora, mistral, papagayo, and vardar are examples of fall winds. See also KATABATIC WIND.

**false cirrus.** . A cloud species unique to the genus cirrus, of such optical thickness as to appear grayish on the side away from the sun, and to veil the sun, conceal its outline, or even hide it. These often originate from the upper part of a cumulonimbus, and are often so dense that they suggest clouds of the middle level. Also called THUNDERSTORM CIRRUS, CIRRUS SPISSATUS.

**false echo.** . See INDIRECT ECHO, PHANTOM TARGET.

**false horizon.** . A line resembling the VISIBLE HORIZON but above or below it.

**false light.** . A light which is unavoidably exhibited by an aid to navigation and which is not intended to be a part of the proper characteristic of the light. Reflections from storm panes come under this category.

**false relative motion.** . False indications of the movement of a target relative to own ship on a radar display that is unstabilized in azimuth due to continuous reorientation of the display as own ship's heading changes. See also STABILIZATION OF RADARSCOPE DISPLAY.

**fan.** , *n.* On the sea floor, a relatively smooth feature normally sloping away from the lower termination of a canyon or canyon system.

**fan beam.** . A beam in which the radiant energy is concentrated in and about a single plane. The angular spread in the plane of concentration may be any amount to 360°. This type beam is most widely used for navigational lights. A converged beam is a fan beam in which the angular spread is decreased laterally to increase the intensity of the remaining beam over all or part of its arc; a diverged beam is a fan beam formed by increasing the divergence of a pencil beam in one plane only.

**farad.** , *n.* A derived unit of capacitance in the International System of Units; it is the capacitance of a capacitor between the plates of which there appears a potential difference of 1 volt when it is charged by a quantity of electricity of 1 coulomb.

**far vane.** . That instrument sighting vane on the opposite side of the instrument from the observer's eye. The opposite is NEAR VANE.

**fast ice.** . Sea ice which forms and remains attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. Fast ice may be formed in situ from the sea water or by freezing of pack ice of any age to the shore, and it may extend a few meters or several hundred kilometers from the coast. Fast ice may be more than 1 year old and may then be prefixed with the appropriate age category (old, second-year or multi-year). If it is thicker than about 2 meters above sea level, it is called an ICE SHELF.

**fast-ice boundary.** . The ice boundary at any given time between FAST ICE and PACK ICE.

**fast-ice edge.** . The demarcation at any given time between FAST ICE and open water.

**fast-sweep racon.** . See under SWEEP-FREQUENCY RACON.

**fast time constant circuit.** . A type of coupling circuit, with high pass frequency characteristics used in radar receivers to permit discrimination against received pulses of duration longer than the transmitted pulse. With the fast time constant (FTC) circuit in operation, only the leading edge of an echo having a long time duration is displayed on the radarscope. The use of this circuit tends to reduce saturation of the scope which could be caused by clutter. Also called ANTI-CLUTTER RAIN, or RAIN CLUTTER DIFFERENTIATOR.

**fata morgana.** . A complex mirage, characterized by marked distortion, generally in the vertical. It may cause objects to appear towering, magnified, floating in air, and at times even multiplied.

- fathogram**, *n.* A graphic record of depth measurements obtained by a fathometer. See also ECHOGRAM.
- fathom**, *n.* A unit of length equal to 6 feet. This unit of measure is used principally as a measure of depth of water and the length of lead lines, anchor chains, and cordage.
- fathom curve, fathom line**. A depth contour, with depths expressed in fathoms.
- Fathometer**, *n.* The registered trade name for a widely-used echo sounder.
- favorable current**. A current flowing in such a direction as to increase the speed of a vessel over the ground. The opposite is UNFAVORABLE CURRENT.
- favorable wind**. A wind which aids a craft in making progress in a desired direction. Usually used in connection with sailing vessels. A wind which delays the progress of a craft is called an UNFAVORABLE WIND. Also called FAIR WIND. See also FOLLOWING WIND.
- feasibility orbit**. An orbit that can be rapidly and inexpensively computed on the basis of simplifying assumptions (e.g., two-body motion, circular orbit, rectilinear orbit, three-body motion approximated by two two-body orbits, etc.) and yields an indication of the general feasibility of a system based upon the orbit without having to carry out a full-blown definitive orbit computation.
- feature**. In ECDIS a representation of a real world phenomenon.
- feature object**. In ECDIS an OBJECT which contains the non-locational information about real world entities.
- feature record**. In ECDIS a feature record is the implemented term used in the S-57 data structure for a FEATURE OBJECT (i.e. a feature object as defined in the DATA MODEL is encoded as a feature record in the DATA STRUCTURE). There are four types of feature records: GEO, META, COLLECTION, and CARTOGRAPHIC.
- federal project depth**. The design dredging depth of a channel constructed by the U.S. Army Corps of Engineers; the project depth may or may not be the goal of maintenance dredging after completion of the channel. For this reason federal project depth must not be confused with CONTROLLING DEPTH.
- feel the bottom**. The effect on a ship underway in shallow water which tends to reduce her speed, make her slow in answering the helm, and often make her sheer off course. The speed reduction is largely due to increased wave making resistance resulting from higher pressure differences due to restriction of flow around the hull. The increased velocity of the water flowing past the hull results in an increase in squat. Also called SMELL THE BOTTOM.
- femto-**. A prefix meaning one-quadrillionth ( $10^{-15}$ ).
- fen**, *n.* A low-lying tract of land, wholly or partly covered with water at times.
- fetch**, *n.* 1. An area of the sea surface over which seas are generated by a wind having a constant direction and speed. Also called GENERATING AREA. 2. The length of the fetch area, measured in the direction of the wind, in which the seas are generated.
- fiber optic gyro (FOG)**. A type of compass that senses changes in orientation using the Sagnac effect, thus performing the function of a mechanical gyroscope. However its principle of operation is instead based on the interference of light which has passed through a coil of optical fiber which can be as long as 5 kilometers. The development of diode (semiconductor) lasers and low-loss single-mode optical fiber in the early 1970s for the telecommunications industry enabled Sagnac effect fiber optic gyros to be developed as practical devices. Sometimes call a fiber optic gyro/navigator (FOG-N).
- fictitious equator**. A reference line serving as the origin for measurement of fictitious latitude. A transverse or inverse equator is a meridian the plane of which is perpendicular to the axis of a transverse map projection. An oblique equator is a great circle the plane of which is perpendicular to the axis of an oblique map projection. A grid equator is a line perpendicular to a prime grid meridian, at the origin.
- fictitious graticule**. The network of lines representing fictitious parallels and fictitious meridians on a map, chart, or plotting sheet. It may be either a transverse graticule or an oblique graticule depending upon the kind of projection; a fictitious graticule may also be a GRID. See also OBLIQUE GRATICULE, TRANSVERSE GRATICULE.
- fictitious latitude**. Angular distance from a fictitious equator. It may be called transverse, oblique, or grid latitude depending upon the type of fictitious equator.
- fictitious longitude**. The arc of the fictitious equator between the prime fictitious meridian and any given fictitious meridian. It may be called transverse, oblique, or grid longitude depending upon the type of fictitious meridian.
- fictitious loxodrome**. See FICTITIOUS RHUMB LINE.
- fictitious loxodromic curve**. See FICTITIOUS RHUMB LINE.
- fictitious meridian**. One of a series of great circles or lines used in place of a meridian for certain purposes. A transverse meridian is a great circle perpendicular to a transverse equator; an oblique meridian is a great circle perpendicular to an oblique equator; a grid meridian is one of the grid lines extending in a grid north-south direction. The reference meridian (real or fictitious) used as the origin for measurement of fictitious longitude is called prime fictitious meridian.
- fictitious parallel**. A circle or line parallel to a fictitious equator, connecting all points of equal fictitious latitude. It may be called transverse, oblique, or grid parallel depending upon the type of fictitious equator.
- fictitious pole**. One of the two points  $90^\circ$  from a fictitious equator. It may be called the transverse or oblique pole depending upon the type of fictitious equator.
- fictitious rhumb**. See FICTITIOUS RHUMB LINE.
- fictitious rhumb line**. A line making the same oblique angle with all fictitious meridians. It may be called transverse, oblique, or grid rhumb line depending upon the type of fictitious meridian. The expression OBLIQUE RHUMB LINE applies also to any rhumb line, real or fictitious, which makes an oblique angle with its meridians; as distinguished from parallels and meridians real or fictitious, which may be consider special cases of the rhumb line. Also called FICTITIOUS RHUMB, FICTITIOUS LOXODROME, FICTITIOUS LOXODROMIC CURVE.
- fictitious ship**. An imaginary craft used in the solution of certain maneuvering problems, as when a ship to be intercepted is expected to change course or speed during the interception run.
- fictitious sun**. An imaginary sun conceived to move eastward along the celestial equator at a rate equal to the average rate of the apparent sun or to move eastward along the ecliptic at the average rate of the apparent sun. See also DYNAMICAL MEAN SUN, MEAN SUN.
- fictitious year**. The period between successive returns of the sun to a sidereal hour angle of  $80^\circ$  (about January 1). The length of the fictitious year is the same as that of the tropical year, since both are based upon the position of the sun with respect to the vernal equinox. Also called BESSELIAN YEAR.
- fidelity**, *n.* The accuracy to which an electrical system, such as a radio, reproduces at its output the essential characteristics of its input signal.
- field**. In ECDIS, a named collection of labeled subfield(s). For example, IHO ATTRIBUTE LABEL/CODE and IHO ATTRIBUTE VALUE are collected into a field named Feature Record Attribute.
- field glass**. A telescopic binocular.
- field lens**. A lens at or near the plane of a real image, to collect and redirect the rays into another part of the optical system; particularly, the eyepiece lens nearest the object, to direct the rays into the eye lens.
- field of view**. The maximum angle of vision, particularly of an optical instrument.
- figure of the earth**. See GEOID.
- file**, *n.* In ECDIS, an identified set of S-57 records collected together for a specific purpose. The file content and structure must be defined by a PRODUCT SPECIFICATION.
- filling**, *n.* Increase in atmospheric pressure, particularly within a low. Decrease in pressure is called DEEPENING.
- final diameter**. The diameter of the circle traversed by a vessel after turning through  $360^\circ$  and maintaining the same speed and rudder angle. This diameter is always less than the tactical diameter. It is measured perpendicular to the original course and between the tangents at the points where  $180^\circ$  and  $360^\circ$  of the turn have been completed.
- final great circle course**. The direction, at the destination, of the great circle through that point and the point of departure, expressed as the angular distance from a reference direction, usually north, to that part of the great circle extending beyond the destination. See also INITIAL GREAT CIRCLE COURSE.
- finger rafted ice**. The type of rafted ice in which floes thrust "fingers" alternately over and under the other.
- finger rafting**. A type of rafting whereby interlocking thrusts are formed, each floe thrusting "fingers" alternately over and under the other.

- Finger rafting is common in NILAS and GRAY ICE.
- finite**, *adj.* Having limits. The opposite is INFINITE.
- fireball**, *n.* See BOLIDE.
- firn**, *n.* Old snow which has recrystallized into a dense material. Unlike snow, the particles are to some extent joined together; but, unlike ice, the air spaces in it still connect with each other.
- first estimate-second estimate method**. . The process of determining the value of a variable quantity by trial and error. The expression applies particularly to the method of determining time of meridian transit (especially local apparent noon) at a moving craft. The time of transit is computed for an estimated longitude of the craft, the longitude estimate is then revised to agree with the time determined by the first estimate, and a second computation is made. The process is repeated as many times as necessary to obtain an answer of the desired precision.
- first light**. . The beginning of morning nautical twilight, i.e., when the center of the morning sun is 12° below the horizon.
- first point of Aries**. . See VERNAL EQUINOX.
- first point of Cancer**. . See SUMMER SOLSTICE.
- first point of Capricornus**. . See WINTER SOLSTICE.
- first point of Libra**. . See AUTUMNAL EQUINOX.
- first quarter**. . The phase of the moon when it is near east quadrature, when the western half of it is visible to an observer on the earth. See also PHASES OF THE MOON.
- first-year ice**. . Sea ice of not more than one winter's growth, developing from young ice, with a thickness of 30 centimeters to 2 meters. First-year ice may be subdivided into THIN FIRST-YEAR ICE, WHITE ICE, MEDIUM FIRST-YEAR ICE, and THICK FIRST-YEAR ICE.
- firth**, *n.* A long, narrow arm of the sea.
- Fischer ellipsoid of 1960**. . The reference ellipsoid of which the semimajor axis is 6,378,166.000 meters, the semiminor axis is 6,356,784.298 meters, and the flattening or ellipticity is 1/298.3. Also called FISCHER SPHEROID OF 1960.
- Fischer ellipsoid of 1968**. . The reference ellipsoid of which the semimajor axis is 6,378,150 meters, the semiminor axis is 6,356,768.337 meters, and the flattening or ellipticity is 1/298.3. Also called FISCHER SPHEROID OF 1968.
- Fischer spheroid of 1960**. . See FISCHER ELLIPSOID OF 1960.
- Fischer spheroid of 1968**. . See FISCHER ELLIPSOID OF 1968.
- fish**, *n.* Any towed sensing device.
- fishery conservation zone**. . See under FISHING ZONE.
- fish havens**. . Areas established by private interests, usually sport fishermen, to simulate natural reefs and wrecks that attract fish. The reefs are constructed by dumping assorted junk in areas which may be of very small extent or may stretch a considerable distance along a depth contour. Fish havens are outlined and labeled on charts.
- fishing zone**. . The offshore zone in which exclusive fishing rights and management are held by the coastal nation. The U.S. fishing zone, known as the fishery conservation zone, is defined under P.L. 94-265. The law states, "The inner boundary of the fishery conservation zone is a line conterminous with the seaward boundary of catch of the coastal states, and the outer boundary of such zone is a line drawn in such manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured."
- fish lead**. . A type of sounding lead used without removal from the water between soundings.
- fish stakes**. . Poles or stakes placed in shallow water to outline fishing grounds or to catch fish.
- fish trap areas**. . Areas established by the U.S. Army Corps of Engineers in which traps may be built and maintained according to established regulations. The fish stakes which may exist in these areas are obstructions to navigation and may be dangerous. The limits of fish trap areas and a cautionary note are usually charted.
- fix**, *n.* A position determined without reference to any former position; the common intersection of two or more lines of position obtained from simultaneous observations. Fixes obtained from electronic systems are often given as lat./long. coordinates determined by algorithms in the system software. See also RUNNING FIX.
- fixed**. . A light which is continuously on.
- fixed and flashing light**. . A light in which a fixed light is combined with a flashing light of higher luminous intensity. The aeronautical light equivalent is called UNDLATING LIGHT.
- fixed and group flashing light**. . A fixed light varied at regular intervals by a group of two or more flashes of greater intensity.
- fixed and variable parameters of satellite orbit**. . The fixed parameters are those parameters which describe a satellite's approximate orbit and which are used over a period of hours. The variable parameters describe the fine structure of the orbit as a function of time and are correct only for the time at which they are transmitted by the satellite.
- fixed antenna radio direction finder**. . A radio direction finder whose use does not require the rotation of the antenna system.
- fixed light**. . A light which appears continuous and steady. The term is sometimes loosely used for a light supported on a fixed structure, as distinct from a light on a floating support.
- fixed mark**. . A navigation mark fixed in position.
- fixed satellite**. . See GEOSTATIONARY SATELLITE.
- fixed star**. . A star whose apparent position relative to surrounding stars appears to be unvarying or fixed for long periods of time.
- fjord**, *n.* A long, deep, narrow arm of the sea between high land. A fjord often has a relatively shallow sill across its entrance.



fjord

- flag alarm**. . . A semaphore-type flag in the indicator of an instrument, to serve as a signal, usually to warn that the indications are unreliable.
- flagpole**, *n.* A label on a nautical chart which indicates a single pole from which flags are displayed. The term is used when the pole is not attached to a building. The label flagstaff is used for a flagpole rising from a building.
- flagstaff**, *n.* See under FLAGPOLE.
- Flamsteed's number**. . A number sometimes used with the possessive form of the Latin name of the constellation to identify a star.
- flash**, *n.* A relatively brief appearance of a light, in comparison with the longest interval of darkness in the period of the light. See also OCCULTATION.
- flasher**, *n.* An electrical device which controls the characteristic of a lighted aid to navigation by regulating power to the lamp according to a certain pattern.
- flashing**, *n.* The process of reducing the amount of permanent magnetism in a vessel by placing a single coil horizontally around the vessel and energizing it. If the energized coil is moved up and down along the sides of the vessel, the process is called WIPING. See also DEPERMING.
- flashing light**. . A navigation light in which the total duration of light in a cycle is shorter than the total duration of darkness. The term is commonly used for a SINGLE-FLASHING LIGHT, a flashing light in which a flash is regularly repeated at a rate of less than 50 flashes per minute. See also GROUP FLASHING LIGHT, COMPOSITE GROUP FLASHING LIGHT, LONG FLASHING LIGHT, QUICK LIGHT.
- flat**, *n.* 1. A large flat area attached to the shore consisting usually of mud, but sometimes of sand and rock. Also called TIDAL FLATS. See also SALT MARSH, SLOUGH, TIDAL MARSH. 2. On the sea floor, a small level or nearly level area.
- flattening**, *n.* The ratio of the difference between the equatorial and polar radii of the earth to its equatorial radius. The flattening of the earth is the ellipticity of the spheroid. The magnitude of the flattening is sometimes expressed as the numerical value of the reciprocal of the flattening. Also called COMPRESSION.
- flaw**, *n.* A narrow separation zone between pack ice and fast ice, where the pieces of ice are in a chaotic state. The flaw forms when pack ice shears under the effect of a strong wind or current along the fast-ice boundary. See also SHEARING.
- flaw lead**. . A passage-way between pack ice and fast ice which is navigable by surface vessels.
- flaw polynya**. . A POLYNIA between pack ice and fast ice.
- F-layer**, *n.* The second principal layer of ionization in the Kennelly-Heaviside region (the E-layer is the first principal layer; the D-layer is of minor significance except for a tendency to absorb energy from radio waves in the medium frequency range). Situated about 175 miles above the earth's surface, the F-layer exists as a single layer

- only during the hours of darkness. It divides into two separate layers during daylight hours.
- F1-layer**, *n.* The lower of the two layers into which the F-layer divides during daylight hours. Situated about 140 miles above the earth's surface, it reaches its maximum density at noon. Since its density varies with the extent of the sun's radiation, it is subject to daily and seasonal variations. It may disappear completely at some point during the winter months.
- F2-layer**, *n.* The higher of the two layers into which the F-layer divides during daylight hours. It reaches its maximum density at noon and, over the continental U.S., varies in height from about 185 miles in winter to 250 miles in the summer. The F2-layer normally has a greater influence on radio wave propagation than the F1-layer.
- FleetNET**. . INMARSAT broadcast service for commercial traffic.
- Fleet Guide**. . One of a series of port information booklets for U.S. naval bases prepared for U.S. Navy use only.
- Flinders bar**. . A bar of soft unmagnetized iron placed vertically near a magnetic compass to counteract deviation caused by magnetic induction in vertical soft iron of the craft.
- float chamber**. . A sealed, hollow part attached to the compass card of a magnetic compass as part of the compass card assembly, to provide buoyancy to reduce the friction on the pivot bearing.
- floating aid**. . A buoy serving as an aid to navigation secured in its charted position by a mooring.
- floating breakwater**. . A moored assembly of floating objects used for protection of vessels riding at anchor.
- floating dock**. . A form of dry dock consisting of a floating structure of one or more sections, which can be partly submerged by controlled flooding to receive a vessel, then raised by pumping out the water so that the vessel's bottom can be exposed. See also GRAVING DOCK.
- floating ice**. . Any form of ice found floating in water. The principal kinds of floating ice are lake ice, river ice and sea ice which form by the freezing of water at the surface, and glacier ice (ice of land origin) formed on land or in an ice shelf. The concept includes ice that is stranded or grounded.
- floating mark**. . A navigation mark carried on a floating body such as a lightship or buoy.
- float pipe**. . A pipe used as a float well.
- float well**. . A vertical pipe or box with a relatively small opening (orifice) in the bottom. It is used as a tide gage installation to dampen the wind waves while freely admitting the tide to actuate a float which, in turn, operates the gage. Also called STILLING WELL.
- floe**, *n.* Any relatively flat piece of sea ice 20 meters or more across. Floes are subdivided according to horizontal extent. A giant floe is over 5.4 nautical miles across; a vast floe is 1.1 to 5.4 nautical miles across; a big floe is 500 to 2000 meters across; a medium floe is 100 to 500 meters across; and a small floe is 20 to 100 meters across.
- floeberg**, *n.* A massive piece of sea ice composed of a hummock, or a group of hummocks frozen together, and separated from any ice surroundings. It may float showing up to 5 meters above sea level.
- flood**, *n.* Tidal current moving toward land or up a tidal stream. The opposite is EBB. Also called FLOOD CURRENT.
- flood axis**. . Average direction of tidal current at strength of flood.
- flood current**. . The movement of a tidal current toward the shore or up a tidal river or estuary. In the mixed type of reversing current, the terms *greater flood* and *lesser flood* are applied respectively to the flood currents of greater and lesser speed of each day. The terms *maximum flood* and *minimum flood* are applied to the maximum and minimum speeds of a flood current, the speed of which alternately increases and decreases without coming to a slack or reversing. The expression maximum flood is also applicable to any flood current at the time of greatest velocity. The opposite is EBB CURRENT.
- flooded ice**. . Sea ice which has been flooded by melt-water or river water and is heavily loaded by water and wet snow.
- floodgate**, *n.* A gate for shutting out, admitting, or releasing a body of water; a sluice.
- flood interval**. . Short for STRENGTH OF FLOOD INTERVAL. The interval between the transit of the moon over the meridian of a place and the time of the following strength of flood. See also LUNICURRENT INTERVAL.
- flood plain**. . The belt of low flat ground bordering a stream or river channel that is flooded when runoff exceeds the capacity of the stream channel.
- flood strength**. . Phase of the flood current at time of maximum speed.
- Also, the speed at this time. Also called STRENGTH OF FLOOD.
- floor**, *n.* The ground under a body of water. See also BOTTOM.
- Florida Current**. . A swift ocean current that flows through the Straits of Florida from the Gulf of Mexico to the Atlantic Ocean. It shows a gradual increase in speed and persistency as it flows northeastward and then northward along the Florida coast. In summer, the part of the surface current south of latitude 25°N moves farther south of its mean position, with a mean speed of 2.0 knots and a maximum speed of about 6.0 knots; the part of the current north of latitude 25°N moves farther west of its mean position, with a mean speed of 2.9 knots and a maximum speed of 6.5 knots. In winter the shift of position is in the opposite direction, and speeds are somewhat less by about 0.2 to 0.5 knots. The flow prevails throughout the year, with no significant changes in direction; the speed, however, varies slightly from one season to another. North of Grand Bahama Island, it merges with the Antilles Current to form the GULF STREAM. The Florida Current is part of the GULF STREAM SYSTEM.
- flotsam**, *n.* Floating articles, particularly those that are thrown overboard to lighten a vessel in distress. See also JETSAM, JETTISON, LAGAN.
- flow**, *n.* *British terminology.* Total current or the combination of tidal current and nontidal current. In British usage, tidal current is called TIDAL STREAM and nontidal current is called CURRENT.
- fluorescence**, *n.* Emission of light or other radiant energy as a result of and only during absorption of radiation from some other source.
- fluorescent chart**. . A chart reproduced with fluorescent ink or on fluorescent paper, which enables the user to read the chart under ultraviolet light.
- flurry**, *n.* See SNOW FLURRY.
- flux-gate**. . The magnetic direction-sensitive element of a flux-gate compass. Also called FLUX VALVE.
- flux-gate gyro magnetic compass**. . A directional gyro compass with an input from a flux valve to keep the gyro oriented to magnetic north.
- fluxmeter**, *n.* An instrument for measuring the intensity of a magnetic field.
- flux valve**. . See FLUX-GATE.
- focal length**. . The distance between the optical center of a lens, or the surface of a mirror, and its focus.
- focal plane**. . A plane parallel to the plane of a lens or mirror and passing through the focus.
- focal point**. . See FOCUS.
- focus**. (*pl. foci*), *n.* 1. The point at which parallel rays of light meet after being refracted by a lens or reflected by a mirror. Also called FOCAL POINT. 2. A point having specific significance relative to a geometrical figure. See under ELLIPSE, HYPERBOLA, PARABOLA. 3. The true center of an earthquake, within which the strain energy is first converted to elastic wave energy.
- focus**, *v., t.* The process of adjusting an optical instrument, projector, cathode-ray tube, etc., to produce a clear and well-defined image.
- foehn**, *n.* A warm, dry, wind blowing down the leeward slope of a mountain and across a valley floor or plain.
- fog**, *n.* A visible accumulation of tiny droplets of water, formed by condensation of water vapor in the air, with the base at the surface of the earth. It reduces visibility below 1 kilometer (0.54 nautical miles). If this is primarily the result of movement of air over a surface of lower temperature, it is called advection fog. If this is primarily the result of cooling of the surface of the earth and the adjacent layer of atmosphere by radiational cooling, it is called radiation fog. An advection fog occurring as monsoon circulation transports warm moist air over a colder surface is called a monsoon fog. A fog that hides less than six-tenths of the sky, and does not extend to the base of any clouds is called a ground fog. Fog formed at sea, usually when air from a warm-water surface moves to a cold-water surface, is called sea fog. Fog produced by apparent steaming of a relatively warm sea in the presence of very cold air is called steam fog, steam mist, frost smoke, sea smoke, arctic sea smoke, arctic smoke, or water smoke. A rare simulation of true fog by anomalous atmospheric refraction is called mock fog. A dry fog is a fog that does not moisten exposed surfaces. Ice fog is composed of suspended ice crystals (20-100 microns in diameter) and droxtals (12-20 microns in diameter). In dense ice fog, the lower visibility is chiefly due to the presence of the droxtals, rather than the crystals.
- fog bank**. . A well-defined mass of fog observed at a distance, most commonly at sea.
- fogbound**, *adj.* Surrounded by fog. The term is used particularly with ref-

- erence to vessels which are unable to proceed because of the fog.
- fogbow**, *n.* A faintly colored circular arc similar to a RAINBOW but formed on fog layers containing drops whose diameters are of the order of 100 microns or less. See also BOUGUER'S HALO.
- fog detector**. . A device used to automatically determine conditions of visibility which warrant sounding a fog signal.
- fog signal**. . See under SOUND SIGNAL.
- following sea**. . A sea in which the waves move in the general direction of the heading. The opposite is HEAD SEA. Those moving in a direction approximately 90° from the heading are called BEAM SEA, and those moving in a direction approximately 45° from the heading (striking the quarter) are called QUARTERING SEA.
- following wind**. . Wind blowing in the general direction of a vessel's course. The equivalent aeronautical expression is TAIL WIND. Wind blowing in the opposite direction is called a HEAD WIND. Wind blowing in a direction approximately 90° from the heading is called a BEAM WIND. One blowing in a direction approximately 90° from the course is called a CROSS WIND. See also FAIR WIND, FAVORABLE WIND, UNFAVORABLE WIND.
- foot**, *n.* Twelve inches or 30.48 centimeters. The latter value was adopted in 1959 by Australia, Canada, New Zealand, South Africa, the United Kingdom, and the United States. See also U.S. SURVEY FOOT. 2. The bottom of a slope, grade, or declivity.
- foraminifera**, *n., pl.* Small, single-cell, jellylike marine animals with hard shells of many chambers. In some areas the shells of dead foraminifera are so numerous they cover the ocean bottom.
- Forbes log**. . A log consisting of a small rotator in a tube projecting below the bottom of a vessel, and suitable registering devices.
- forced wave**. . A wave generated and maintained by a continuous force, in contrast with a FREE WAVE that continues to exist after the generating force has ceased to act.
- foreland**, *n.* See PROMONTORY, HEADLAND.
- foreshore**, *n.* That part of the shore or beach which lies between the low water mark and the upper limit of normal wave action. See also BACKSHORE.
- forestaff**, *n.* See CROSS-STAFF.
- fork**, *n.* On the sea floor, a branch of a canyon or valley.
- format**, *v., t.* To prepare a computer disk for data storage; formatting defines tracks and sectors, sets up a directory, and performs other functions before a new disk can be used.
- form lines**. . Broken lines resembling contour lines but representing no actual elevations, which have been sketched from visual observation or from inadequate or unreliable map sources, to show collectively the shape of the terrain rather than the elevation.
- formation axis**. . An arbitrarily selected direction within a formation of ships from which all bearings used in the designation of station are measured; bearings are always expressed in true direction from the center.
- formation center**. . An arbitrary point around which a formation of ships is centered, designated "station zero."
- formation guide**. . A ship designated by the officer of tactical command (OTC) as the reference vessel upon which all ships in a formation maintain position.
- forward**, *adj.* In a direction towards the bow of a vessel. See also AHEAD, ABAFT.
- forward of the beam**. . Any direction between broad on the beam and ahead. See also ABAFT THE BEAM.
- foul berth**. . A berth in which a vessel cannot swing to her anchor or moorings without fouling another vessel or striking an obstruction. See also FOUL GROUND, CLEAR BERTH.
- foul bottom**. . A term used to describe the bottom of a vessel when encrusted with marine growth.
- foul ground**. . An area unsuitable for anchoring or fishing due to rocks, boulders, coral, or other obstructions. See also FOUL BERTH.
- four-point bearing**. . A relative bearing of 045° or 315°. See also BOW AND BEAM BEARINGS.
- fractional scale**. . See REPRESENTATIVE FRACTION.
- fracto-**. . A prefix used with the name of a basic cloud form to indicate a torn, ragged, and scattered appearance caused by strong winds. See also SCUD.
- fracture**, *n.* A break or rupture through very close pack ice, compact pack ice, consolidated pack ice, fast ice, or a single floe resulting from deformation processes. Fractures may contain brash ice and/or be covered with NILAS and/or young ice. The length of a fracture may vary from a few meters to many miles. A large fracture is more than 500 meters wide, a medium fracture is 200 to 500 meters wide, a small fracture is 50 to 200 meters wide, and a very small fracture is up to 50 meters wide.
- fracture zone**. . 1. An extensive linear zone of irregular topography of the sea floor characterized by steep-sided or asymmetrical ridges, troughs, or escarpments. 2. An ice area which has a great number of fractures. See also FRACTURE.
- fracturing**, *n.* The pressure process whereby ice is permanently deformed, and rupture occurs. The term is most commonly used to describe breaking across very close pack ice, compact pack ice, and consolidated pack ice.
- Franklin continuous radar plot technique**. . A method of providing continuous correlation of a small fixed radar-conspicuous object with own ship's position and movement relative to a planned track. Named for QMCM Byron Franklin, USN.
- Franklin piloting technique**. . A method of finding the most probable position of a ship from three lines of position which do not intersect in a point.
- frazil ice**. . Fine spicules or plates of ice, suspended in water.
- free-air temperature**. . Temperature of the atmosphere, obtained by a thermometer located so as to avoid as completely as practicable the effects of extraneous heating. See also AMBIENT TEMPERATURE, WET-BULB TEMPERATURE.
- freeboard**, *n.* The vertical distance from the uppermost complete, watertight deck of a vessel to the surface of the water, usually measured amidships. Minimum permissible freeboards may be indicated by LOAD LINE MARKS.
- free gyro**. . A two-degree-of-freedom gyro or a gyro the spin axis of which may be oriented in any specified altitude. The rotor of this gyro has freedom to spin on its axis, freedom to tilt about its horizontal axis, and freedom to turn about its vertical axis. Also called FREE GYROSCOPE. See also DEGREE-OF-FREEDOM.
- free gyroscope**. . See FREE GYRO.
- free wave**. . A wave that continues to exist after the generating force has ceased to act, in contrast with a FORCED WAVE that is generated and maintained by a continuous force.
- freezing drizzle**. . Drizzle that falls in liquid form but freezes upon impact to form a coating of glaze upon the ground and exposed objects.
- freezing fog**. . A fog whose droplets freeze upon contact with exposed objects and form a coating of rime and/or glaze. See also FREEZING PRECIPITATION.
- freezing precipitation**. . Precipitation which falls to the earth in a liquid state and then freezes to exposed surfaces. Such precipitation is called freezing rain if it consists of relatively large drops of water, and freezing drizzle if of smaller drops. See also GLAZE.
- freezing rain**. . Rain that falls in liquid form but freezes upon impact to form a coating of ice on the ground and exposed objects.
- frequency**, *n.* The rate at which a cycle is repeated. See also AUDIO FREQUENCY, RADIO FREQUENCY.
- frequency band**. . 1. A specified segment of the frequency spectrum. 2. One of two or more segments of the total frequency coverage of a radio receiver or transmitter, each segment being selectable by means of a band change switch. 3. Any range of frequencies extending from a specified lower to a specified upper limit. See ASSIGNED FREQUENCY BAND.
- frequency channel**. . The assigned frequency band commonly referred to by number, letter, symbol, or some salient frequency within the band.
- frequency-modulated radar**. . A type of radar in which the radiated wave is frequency modulated and the frequency of an echo is compared with the frequency of the transmitted wave at the instant of reception, thus enabling range to be measured.
- frequency modulation**. . Angle modulation of a sinewave carrier in which the instantaneous frequency of the modulated wave differs from the carrier frequency by an amount proportional to the instantaneous value of the modulating.
- frequency tolerance**. . The maximum permissible departure by the center frequency of the frequency band occupied by an emission from the assigned frequency, or by the characteristic frequency of an emission from the reference frequency. The frequency tolerance is expressed in parts per million or in hertz.
- fresh breeze**. . Wind of force 5 (17 to 21 knots or 19 to 24 miles per hour) on the Beaufort wind scale.
- freshen**, *v., i.* To become stronger, applied particularly to wind.
- Freshet**, *n.* A sudden increased flow of fresh water, as from a flood,

emptying from a river into a larger body of salt or brackish water.

**fresh gale.** . A term once used by seamen for what is now called GALE on the Beaufort wind scale.

**fresh-water marsh.** . A tract of low, wet ground, usually miry and covered with rank vegetation.

**friction.** , *n.* Resistance to motion due to interaction between the surface of a body and anything in contact with it.

**friction error.** . The error of an instrument reading due to friction in the moving parts of the instrument.

**friction layer.** . See SURFACE BOUNDARY LAYER.

**friendly ice.** . From the point of view of the submariner, an ice canopy containing many large skylights or other features which permit a submarine to surface. There must be more than 10 such features per 30 nautical miles along the submarine's track.

**frigid zones.** . Either of the two zones between the polar circles and the poles, called the north frigid zone and the south frigid zone.

**fringing reef.** . A reef attached directly to the shore of an island or continental landmass. Its outer margin is submerged and often consists of algal limestone, coral rock, and living coral. See also BARRIER REEF.

**front.** , *n.* Generally, the interface or transition zone between two air masses of different density. Since the temperature distribution is the most important regulator of atmospheric density, a front almost invariably separates air masses of different temperature. Along with the basic density criterion and the common temperature criterion, many other features may distinguish a front, such as a pressure trough, a change in wind direction, a moisture discontinuity, and certain characteristic cloud and precipitation forms. The term front is used ambiguously for: frontal zone, the three-dimensional zone or layer of large horizontal density gradient, bounded by frontal surfaces across which the horizontal density gradient is discontinuous (frontal surface usually refers specifically to the warmer side of the frontal zone); and surface front, the line of intersection of a frontal surface or frontal zone with the earth's surface or less frequently, with a specified constant-pressure surface. See also POLAR FRONT, ARCTIC FRONT, COLD FRONT, WARM FRONT, OCCLUDED FRONT.

**frontal.** , *adj.* Of or pertaining to a front.

**frontal cyclone.** . In general, any cyclone associated with a front; often used synonymously with WAVE CYCLONE or with EXTRA-TROPICAL CYCLONE (as opposed to tropical cyclones, which are non-frontal).

**frontal occlusion.** . See OCCLUDED FRONT; OCCLUSION, definition 2.

**frontal surface.** . See under FRONT.

**frontal zone.** . See under FRONT.

**front light.** . The closer of two range lights. It is the lowest of the lights of an established range. Also called LOW LIGHT.

**frontogenesis.** , *n.* 1. The initial formation of a front or frontal zone. 2. In general, an increase in the horizontal gradient of an air mass property, principally density, and the development of the accompanying features of the wind field that characterize a front.

**frontolysis.** , *n.* 1. The dissipation of a front or frontal zone. 2. In general, a decrease in the horizontal gradient of an air mass property, principally density, and the dissipation of the accompanying features of the wind field.

**frost.** , *n.* 1. A deposit of interlocking ice crystals formed by direct sublimation on objects, usually those of small diameter freely exposed to the air. The deposition is similar to the process in which dew is formed, except that the temperature of the object must be below freezing. It forms when air with a dew point below freezing is brought to saturation by cooling. It is more fluffy and feathery than rime which in turn is lighter than glaze. Also called HOAR, HOAR-FROST. 2. The condition which exists when the temperature of the earth's surface and earthbound objects falls below 0°C or 32°F. Temperatures below the freezing point of water are sometimes expressed as "degrees of frost."

**frost smoke.** . 1. Fog-like clouds due to contact of cold air with relatively warm water, which can appear over openings in the ice, or leeward of the ice edge, and which may persist while ice is forming. 2. A rare type of fog formed in the same manner as a steam fog but at lower temperatures. It is composed of ice particles or droplets instead of liquid water as is steam fog. Thus, it is a type of ice fog. Sometimes called BARBER. 3. See STEAM FOG.

**frozen precipitation.** . Any form of precipitation that reaches the ground in frozen form; i.e., snow, snow pellets, snow grains, ice crystals, ice pellets, and hail.

**frustum.** , *n.* That part of a solid figure between the base and a parallel intersecting plane; or between any two intersecting planes, generally parallel.

**full depiction of detail.** . Since even on charts of the largest scale full depiction of detail is impossible because all features are symbolized to an extent which is partly determined by scale and partly by the conventions of charting practice, the term *full depiction of detail* is used to indicate that over the greater part of a chart nothing essential to navigation is omitted. See also GENERALIZATION, MINIMAL DEPICTION OF DETAIL.

**full moon.** . The moon at opposition, when it appears as a round disk to an observer on the earth because the illuminated side is toward him. See also PHASES OF THE MOON.

**full topology.** . In ECDIS a 2-dimensional DATA STRUCTURE in which the geometry is described in terms of NODES, EDGES and FACES which are all TOPOLOGICALLY linked. A PLANAR GRAPH with faces.

**fully automatic updating.** . In ECDIS the application of corrections to ENC DATA in the SENC in a fully integrated state, without human intervention.

**function.** , *n.* A magnitude so related to another magnitude that for any value of one there is a corresponding value of the other. See also TRIGONOMETRIC FUNCTIONS.

**fundamental circle.** . See PRIMARY GREAT CIRCLE.

**fundamental frequency.** . In the Decca Navigator System, the frequency from which other frequencies in a chain are derived by harmonic multiplication.

**funnel cloud.** . A cloud column or inverted cloud cone, pendant from a cloud base. This supplementary feature occurs mostly with cumulus and cumulonimbus; when it reaches the earth's surface, it constitutes a tornado or waterspout. Also called TUBA, TORNADO CLOUD.

**furrow.** , *n.* On the sea floor, a closed, linear, narrow, shallow depression.

**fusion.** , *n.* The phase transition of a substance passing from the solid to the liquid state; melting. In meteorology, fusion is almost always understood to refer to the melting of ice, which, if the ice is pure and subjected to 1 standard atmosphere of pressure, takes place at the ice point of 0°C or 32°F. Additional heat at the melting point is required to fuse any substance. This quantity of heat is called LATENT HEAT OF FUSION; in the case of ice, it is approximately 80 calories per gram.

## G

**G.** , *n.* An acceleration equal to the acceleration of gravity, approximately 32.2 feet per second per second at sea level.

**gain.** , *n.* The ratio of output voltage, current, or power to input voltage, current, or power in electronic instruments.

**gain control.** . See RECEIVER GAIN CONTROL.

**gain function.** . See DIRECTIVE GAIN.

**gain of an antenna.** . An expression of radiation effectiveness, it is the ratio of the power required at the input of a reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field at the same distance. When not specified otherwise, the figure expressing the gain of an antenna refers to the gain in the direction of the radiation main lobe. In services using scattering modes of propagation, the full gain of an antenna may not be realizable in practice and the apparent gain may vary with time.

**gain referred to a short vertical antenna.** . The gain of an antenna in a given direction when the reference antenna is a perfect vertical antenna, much shorter than one quarter of the wavelength, placed on the surface of a perfectly conducting plane earth.

**gal.** , *n.* A special unit employed in geodesy and geophysics to express the acceleration due to gravity. The gal is a unit accepted temporarily for use with the International System of Units; 1 gal is equal to 1 centimeter per second, per second.

**galactic nebula.** . An aggregation of matter within our galaxy but beyond the solar system, large enough to occupy a perceptible area but

which has not been resolved into individual stars.



galactic nebula

**galaxy**, *n.* A vast assemblage of stars, planets, nebulae, and other bodies composing a distinct group in the universe. The sun and its family of planets are part of a galaxy commonly called the MILKY WAY.

**gale**, *n.* Wind of force 8 on the Beaufort wind scale (34 to 40 knots or 39 to 46 miles per hour) is classified as a gale. Wind of force 9 (41 to 47 knots or 47 to 54 miles per hour) is classified as a strong gale. Wind of force 7 (28 to 33 knots or 32 to 38 miles per hour) is classified as a near gale. See also MODERATE GALE, FRESH GALE, WHOLE GALE.

**gallon**, *n.* A unit of volume equal to 4 quarts or 231 cubic inches.

**Galofaro**, *n.* A whirlpool in the Strait of Messina; formerly called CHARYBDIS.

**galvanometer**, *n.* An instrument for measuring the magnitude of a small electric current or for detecting the presence or direction of such a current by means of motion of an indicator in a magnetic field.

**gap**, *n.* On the sea floor, a narrow break in a ridge or rise.

**garua**, *n.* A thick, damp fog on the coasts of Ecuador, Peru, and Chile. Also called CAMANCHACA.

**gas**, *n.* A fluid without shape or volume, which tends to expand indefinitely, or to completely fill a closed container of any size.

**gas buoy**, *n.* A buoy having a gas light. See also LIGHTED BUOY.

**gat**, *n.* A natural or artificial passage or channel extending inland through shoals or steep banks. See also OPENING.

**gather way**, *v.* To begin to move.

**gauge, gage**, *n.* An instrument for measuring the size or state of anything.

**gauge, gage**, *v., t.* To determine the size or state of anything.

**gauss**, *n.* The centimeter-gram-second electromagnetic unit of magnetic induction. It corresponds to  $10^{-4}$  tesla in the International System.

**Gaussian distribution**, *n.* See NORMAL DISTRIBUTION.

**Gaussin error**, *n.* Deviation of a magnetic compass due to transient magnetism caused by eddy currents set up by a changing number of lines of force through soft iron as the ship changes heading. Due to these eddy currents, the induced magnetism on a given heading does not arrive at its normal value until about 2 minutes after change to the heading. This error should not be confused with RETENTIVE ERROR.

**gazeteer**, *n.* An alphabetical list of place names giving geographic coordinates.

**Gegenschein**, *n.* A faint light area of the sky always opposite the position of the sun on the celestial sphere. It is believed to be the reflection of sunlight from particles moving beyond the earth's orbit. Also called COUNTERGLOW.

**general chart**, *n.* See CHART CLASSIFICATION BY SCALE.

**generalization**, *n.* The process of selectively removing less-important features of charts as scale becomes smaller, to avoid over-crowding charts. See also FULL DEPICTION OF DETAIL, MINIMAL DEPICTION OF DETAIL.

**general precession**, *n.* The resultant motion of the components causing precession of the equinoxes westward along the ecliptic at the rate of about 50.3" per year, completing the cycle in about 25,800 years. The effect of the sun and moon, called lunisolar precession, is to produce a westward motion of the equinoxes along the ecliptic. The effect of other planets, called planetary precession, tends to produce a much smaller motion eastward along the ecliptic. The component of general precession along the celestial equator, called precession in right ascension, is about 46.1" per year; and the component along a celestial meridian, called precession in declination, is about 20.0" per year.

**General Prudential Rule**, *n.* Rule 2(b) of the International Rules (COLREGS) as well as the Inland Navigation and Inland Rules. Rule 2(b) states "In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels

involved, which may make a departure from these Rules necessary to avoid immediate danger."

**generating area**, *n.* The area in which ocean waves are generated by the wind. Also called FETCH.

**gentle breeze**, *n.* Wind of force 3 (7 to 10 knots or 8 to 12 miles per hour) on the Beaufort wind scale.

**geo**, *n.* A narrow coastal inlet bordered by steep cliffs. Also called GIO.

**geo-**, *n.* A prefix meaning earth.

**geocentric**, *adj.* Relative to the earth as a center; measured from the center of the earth.

**geocentric latitude**, *n.* The angle at the center of the reference ellipsoid between the celestial equator and a radius vector to a point on the ellipsoid. This differs from the geographic latitude by a maximum of 11.6' of arc at Lat. 45°.

**geocentric parallax**, *n.* The difference in apparent direction of a celestial body from a point on the surface of the earth and from the center of the earth. This difference varies with the body's altitude and distance from the earth. Also called DIURNAL PARALLAX. See also HELIOCENTRIC PARALLAX.

**geodesic**, *adj.* Of or pertaining to geodesy; geodetic.

**geodesic**, *n.* See GEODESIC LINE.

**geodesic line**, *n.* A line of shortest distance between any two points on any mathematically defined surface. A geodesic line is a line of double curvature and usually lies between the two normal section lines which the two points determine. If the two terminal points are in nearly the same latitude, the geodesic line may cross one of the normal section lines. It should be noted that, except along the equator and along the meridians, the geodesic line is not a plane curve and cannot be sighted over directly. Also called GEODESIC, GEODETIC LINE.

**geodesy**, *n.* The science of the determination of the size and shape of the earth.

**geodetic**, *adj.* Of or pertaining to geodesy; geodesic.

**geodetic bench mark**, *n.* See under BENCH MARK.

**geodetic datum**, *n.* See DATUM, HORIZONTAL GEODETIC DATUM, VERTICAL GEODETIC DATUM.

**geodetic equator**, *n.* The line of zero geodetic latitude; the great circle described by the semimajor axis of the reference ellipsoid as it is rotated about the minor axis. See also ASTRONOMICAL EQUATOR.

**geodetic height**, *n.* See ELLIPSOIDAL HEIGHT.

**geodetic latitude**, *n.* The angle which the normal to the ellipsoid at a station makes with the plane of the geodetic equator. It differs from the corresponding astronomical latitude by the amount of the meridional component of the local deflection of the vertical. Also called TOPOGRAPHICAL LATITUDE and sometimes GEOGRAPHIC LATITUDE.

**geodetic line**, *n.* See GEODESIC LINE.

**geodetic longitude**, *n.* The angle between the plane of the geodetic meridian at a station and the plane of the geodetic meridian at Greenwich. A geodetic longitude differs from the corresponding astronomical longitude by the amount of the prime vertical component of the local deflection of the vertical divided by the cosine of the latitude. Sometimes called GEOGRAPHIC LONGITUDE.

**geodetic meridian**, *n.* A line on a reference ellipsoid which has the same geodetic longitude at every point. Sometimes called GEOGRAPHIC MERIDIAN.

**geodetic parallel**, *n.* A line on a reference ellipsoid which has the same geodetic latitude of every point. A geodetic parallel, other than the equator, is not a geodesic line. In form, it is a small circle whose plane is parallel with the plane of the geodetic equator. See also ASTRONOMICAL PARALLEL.

**geodetic position**, *n.* A position of a point on the surface of the earth expressed in terms of geodetic latitude and geodetic longitude. A geodetic position implies an adopted geodetic datum.

**geodetic satellite**, *n.* Any satellite whose orbit and payload render it useful for geodetic purposes.

**geodetic survey**, *n.* A survey that takes into account the shape and size of the earth. It is applicable for large areas and long lines and is used for the precise location of basic points suitable for controlling other surveys.

**geographic, geographical**, *adj.* Of or pertaining to geography.

**geographical coordinates**, *n.* Spherical coordinates defining a point on the surface of the earth, usually latitude and longitude. Also called TERRESTRIAL COORDINATES.

- geographical mile.** . The length of 1 minute of arc of the equator, or 6,087.08 feet. This approximates the length of the nautical mile.
- geographical plot.** . A plot of the movements of one or more vessel relative to the surface of the earth. Also called TRUE PLOT. See also NAVIGATIONAL PLOT.
- geographical pole.** . Either of the two points of intersection of the surface of the earth with its axis, where all meridians meet, labeled N or S to indicate whether the north geographical pole or the south geographical pole.
- geographical position.** . 1. That point on the earth at which a given celestial body is in the zenith at a specified time. The geographical position of the sun is also called the sub solar point, of the moon the sublunar point, and of a star the substellar or subastral point. 2. Any position on the earth defined by means of its geographical coordinates either astronomical or geodetic.
- geographic graticule.** . The system of coordinates of latitude and longitude used to define the position of a point on the surface of the earth with respect to the reference ellipsoid.
- geographic information system.** . An approach to modeling the world that allows for data in a wide variety of forms to be linked to geographic positioning to aid in decision-making, intelligence, and safety of navigation applications. Database, analysis, and display are separate aspects that multiply the power and usefulness in a digital environment.
- geographic latitude.** . A general term applying to astronomic and geodetic latitudes.
- geographic longitude.** . A general term applying to astronomic and geodetic longitudes.
- geographic meridian.** . A general term applying to astronomical and geodetic meridians.
- geographic number.** . The number assigned to an aid to navigation for identification purposes in accordance with the lateral system of numbering.
- geographic parallel.** . A general term applying to astronomical and geodetic parallels.
- geographic range.** . The maximum distance at which the curvature of the earth and terrestrial refraction permit an aid to navigation to be seen from a particular height of eye without regard to the luminous intensity of the light. The geographic range sometimes printed on charts or tabulated in light lists is the maximum distance at which the curvature of the earth and terrestrial refraction permit a light to be seen from a height of eye of 15 feet above the water when the elevation of the light is taken above the height datum of the largest scale chart of the locality. Therefore, this range is a nominal geographic range. See also VISUAL RANGE OF A LIGHT.
- geographic sign conventions.** . In mapping, charting, and geodesy, the inconsistent application of algebraic sign to geographical references and the angular reference of azimuthal systems is a potential trouble area in scientific data collection. The following conventions have wide use in the standardization of scientific notation: Longitude references are positive eastward of the Greenwich meridian to 180°, and negative westward of Greenwich. Latitude references are positive to the north of the equator and negative to the south. Azimuths are measured clockwise, using South as the origin and continuing to 360°. Bearings are measured clockwise, using North as the origin and continuing to 360°. Tabulated coordinates, or individual coordinates, are annotated N, S, E, W, as appropriate.
- geoid.** . *n.* The equipotential surface in the gravity field of the earth; the surface to which the oceans would conform over the entire earth if free to adjust to the combined effect of the earth's mass attraction and the centrifugal force of the earth's rotation. As a result of the uneven distribution of the earth's mass, the geoidal surface is irregular. The geoid is a surface along which the gravity potential is everywhere equal (equipotential surface) and to which the direction of gravity is always perpendicular. Also called FIGURE OF THE EARTH.
- geoidal height.** . The distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid. Also called GEOIDAL SEPARATION, GEOIDAL UNDULATION, UNDULATION OF THE GEOID.
- geoidal horizon.** . The circle of the celestial sphere formed by the intersection of the celestial sphere and a plane through a point on the sea level surface of the earth, and perpendicular to the zenith-nadir line. See also HORIZON.
- geoidal separation.** . See GEOIDAL HEIGHT.
- geoidal undulation.** . See GEOIDAL HEIGHT.
- geological oceanography.** . The study of the floors and margins of the oceans, including description of submarine relief features, chemical and physical composition of bottom materials, interaction of sediments and rocks with air and seawater, and action of various forms of wave energy in the submarine crust of the earth.
- geomagnetic.** . *adj.* Of or pertaining to geomagnetism.
- geomagnetic equator.** . The terrestrial great circle everywhere 90° from the geomagnetic poles. The geomagnetic equator is not the same as the MAGNETIC EQUATOR, the line connecting all points of zero magnetic dip.
- geomagnetic latitude.** . Angular distance from the geomagnetic equator, measured northward or southward on the geomagnetic meridian through 90° and labeled N or S to indicate the direction of measurement. The geomagnetic latitude should not be confused with MAGNETIC LATITUDE.
- geomagnetic pole.** . Either of two antipodal points marking the intersection of the earth's surface with the extended axis of a bar magnet assumed to be located at the center of the earth and approximating the source of the actual magnetic field of the earth. The pole in the Northern Hemisphere (at about 78.5°N 69°W) is designated north geomagnetic pole, and the pole in the Southern Hemisphere (at about 78°S 111°E) is designated south geomagnetic pole. The great circle midway between these poles is called GEOMAGNETIC EQUATOR. The expression GEOMAGNETIC POLE should not be confused with MAGNETIC POLE, which relates to the actual magnetic field of the earth. See also GEOMAGNETIC LATITUDE.
- geomagnetic pole.** . The great circle midway between these poles is called GEOMAGNETIC EQUATOR. The expression GEOMAGNETIC POLE should not be confused with MAGNETIC POLE, which relates to the actual magnetic field of the earth. See also GEOMAGNETIC LATITUDE.
- geomagnetism.** . *n.* Magnetic phenomena, collectively considered, exhibited by the earth and its atmosphere. Also called TERRESTRIAL MAGNETISM.
- geometric dilution.** . See GEOMETRIC DILUTION OF PRECISION.
- geometric dilution of precision.** . All geometric factors that degrade the accuracy of position fixes derived from externally referenced navigation systems. Often shortened to GEOMETRIC DILUTION.
- geometric map projection.** . See PERSPECTIVE MAP PROJECTION.
- geometric primitive.** . In ECDIS one of the three basic geometric units of representation: POINT, LINE, and AREA.
- geometric projection.** . See PERSPECTIVE PROJECTION.
- geometrical dip.** . The vertical angle between the horizontal and a straight line tangent to the surface of the earth. It is larger than DIP by the amount of terrestrial refraction.
- geometrical horizon.** . Originally, the celestial horizon; now more commonly the intersection of the celestial sphere and an infinite number of straight lines tangent to the earth's surface, and radiating from the eye of the observer. If there were no terrestrial refraction, GEOMETRICAL and VISIBLE HORIZONS would coincide. See also RADIO HORIZON.
- geometry.** . *n.* A branch of mathematics dealing with the properties, relations, and measurement of points, lines, surfaces, solids, and angles.
- geomorphology.** . *n.* A branch of both geography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of land forms.
- geo-navigation.** . *n.* Navigation by means of reference points on the earth. The term is obsolete.
- geo object.** . *n.* In ECDIS a FEATURE OBJECT which carries the descriptive characteristics of a real world ENTITY.
- geophysics.** . *n.* The study of the composition and physical phenomena of the earth and its liquid and gaseous envelopes; it embraces the study of terrestrial magnetism, atmospheric electricity, and gravity; and it includes seismology, volcanology, oceanography, meteorology, and related sciences.
- geopotential.** . *n.* The gravity potential of the actual earth. It is the sum of the gravitational (attraction) potential and the potential of the centrifugal force.
- Georef.** . *n.* See WORLD GEOGRAPHIC REFERENCE SYSTEM.
- geosphere.** . *n.* The portion of the earth, including land (lithosphere) and water (hydrosphere), but excluding the atmosphere.
- geostationary satellite.** . An earth satellite moving eastward in an equatorial, circular orbit at an altitude (approximately 35,900 kilometers)

- such that its period of revolution is exactly equal to and synchronous with the rotational period of the earth. Such a satellite will remain fixed over a point on the earth's equator. Although geostationary satellites are frequently called GEOSYNCHRONOUS or SYNCHRONOUS SATELLITES, the orbit of an eastward moving synchronous satellite must be equatorial if the satellite is to remain fixed over a point on the equator. Otherwise, the satellite moves daily in a figure eight pattern relative to the earth. Also called FIXED SATELLITE. See also STATIONARY ORBIT.
- geostrophic equilibrium.** , *n.* The state of motion in which the Coriolis force exactly balances the horizontal pressure force. Also called geostrophic balance. See also GEOSTROPHIC WIND, GRADIENT CURRENT.
- geostrophic wind.** . The horizontal wind velocity for which the Coriolis force exactly balances the horizontal pressure force. See also GRADIENT WIND.
- geosynchronous satellite.** . An earth satellite whose period of rotation is equal to the period of rotation of the earth about its axis. The orbit of a geosynchronous satellite must be equatorial if the satellite is to remain fixed over a point on the earth's equator. Also called TWENTY-FOUR HOUR SATELLITE. See also SYNCHRONOUS SATELLITE, GEOSTATIONARY SATELLITE.
- ghost.** , *n.* 1. An unwanted image appearing on a radarscope caused by echoes which experience multiple reflections before reaching the receiver. See also SECOND-TRACE ECHO, MULTIPLE ECHOES, INDIRECT ECHO. 2. An image appearing on a radarscope the origin of which cannot readily be determined.
- giant floe.** . See under FLOE.
- gibbous.** , *adj.* Bounded by convex curves. The term is used particularly in reference to the moon when it is between first quarter and full or between full and last quarter, or to other celestial bodies when they present a similar appearance. See also PHASES OF THE MOON.
- giga-** . A prefix meaning one billion ( $10^9$ ).
- gigahertz.** , *n.* One thousand megahertz, or one billion cycles per second.
- gimbal freedom.** . The maximum angular displacement of a gyro about the output axis of a gimbal.
- gimballess inertial navigation equipment.** . See STRAPPED-DOWN INERTIAL NAVIGATION EQUIPMENT.
- gimballing error.** . That error introduced in a gyro-compass by the tilting of the gimbal mounting system of the compass due to horizontal acceleration caused by motion of the vessel, such as rolling.
- gimbal lock.** . A condition of a two-degree-of-freedom gyro wherein the alignment of the spin axis with an axis of freedom deprives the gyro of a degree-of-freedom and therefore its useful properties.
- gimbals.** , *n., pl.* A device for supporting anything, such as an instrument, in such a manner that it will remain horizontal when the support tilts. It consists of a ring inside which the instrument is supported at two points  $180^\circ$  apart, the ring being similarly supported at two points  $90^\circ$  from the instrument supports.
- gio.** , *n.* See GEO.
- glacial.** , *adj.* Of or pertaining to a glacier.
- glacier.** , *n.* A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. The principal forms of glaciers are ICE SHELVES, ICE STREAMS, ICE CAPS, inland ice sheets, ice piedmonts, cirque glaciers, and various types of mountain (valley) glaciers.
- glacier berg.** . An irregularly shaped iceberg. Also called WEATHERED BERG.
- glacier ice.** . Ice in, or originating from, a glacier, whether on land or floating on the sea as icebergs, bergy bits, or growlers.
- glacier tongue.** . The seaward projecting extension of a glacier, usually afloat. In the Antarctic, glacier tongues may extend many tens of kilometers.
- glare.** , *n.* Dazzling brightness of the atmosphere caused by excessive reflection and scattering of light by particles in the line of sight.
- glaze.** , *n.* A coating of ice, generally clear and smooth but usually containing some air pockets, formed on exposed objects by the freezing of a film of super cooled water deposited by rain, drizzle, fog, or possibly condensed from super cooled water vapor. Glaze is denser, harder and more transparent than either rime or hoarfrost. Also called GLAZE ICE, GLAZED FROST VERGLAS.
- glazed frost.** . See GLAZE.
- glaze ice.** . See GLAZE.
- glint.** , *n.* The pulse-to-pulse variation in amplitude of reflected radar signals due to rapid change of the reflecting surface, as in the case of the propeller of an aircraft in flight.
- Global Navigation Satellite System (GNSS).** . A system of satellites that provides time-referenced position information that can be received by particular radio systems, and used to calculate the position of the receiver in latitude, longitude, and elevation. One such GNSS system used in the United States is known as GPS.
- Global Positioning System (GPS).** . A satellite navigation system developed by the U.S. Department of Defense. The system provides highly accurate position and velocity information in three dimensions and precise time and time intervals on a global basis continuously, to an unlimited number of users. It is unaffected by weather and provides a worldwide common grid reference system. The objective of the program is to provide very precise position information for a wide spectrum of military missions, although its use has expanded broadly in civilian sectors. Also called NAVSTAR GLOBAL POSITIONING SYSTEM.
- globigerina.** (*pl. globigerinae*), *n.* A very small marine animal of the foraminifera order, with a chambered shell; or the shell of such an animal. In large areas of the ocean the calcareous shells of these animals are very numerous, being the principal constituent of a soft mud or globigerina ooze forming the ocean bed.
- GLONASS.** . Stands for Global Navigation Satellite System. A satellite navigation system operated by Russia, analogous to the U.S. Global Positioning System (GPS).
- gloom.** , *n.* The condition existing when daylight is very much reduced by dense cloud or smoke accumulation above the surface, the surface visibility not being materially reduced.
- glory.** , *n.* See ANTICORONA.
- gnomon.** , *n.* Any object the shadow of which serves as an indicator, as the SHADOW PIN on a sun.
- gnomonic.** , *adj.* Of or pertaining to a gnomon.
- gnomonic chart.** . A chart constructed on the gnomonic projection and often used as an adjunct for transferring a great circle to a Mercator chart. Commonly called GREAT CIRCLE CHART.
- gnomonic map projection.** . A perspective azimuthal map projection in which points on the surface of a sphere or spheroid, such as the earth, are conceived as projected by radials from the center to a tangent plane. Great circles project as straight lines. For this reason the projection is used principally for charts for great circle sailing. The projection is neither conformal nor equal area.
- gong.** , *n.* A sound signal produced by the vibration of a resonant disc struck by a clapper.
- gong buoy.** . A buoy fitted with a group of saucer shaped bells of different tones, used as an audible signal.
- goniometer.** , 1. An instrument for measuring angles. 2. A pick-up coil which eliminates the necessity of having to rotate a radio direction finder antenna to determine direction.
- gore.** , *n.* A lune-shaped map which may be fitted to the surface of a globe with a negligible amount of distortion.
- gorge.** , *n.* 1. A narrow opening between mountains, especially one with steep, rocky walls. 2. A collection of solid matter obstructing a channel, river, etc., as *ice gorge*.
- GPS.** . See GLOBAL POSITIONING SYSTEM.
- gradient.** , *n.* 1. A rate of rise or fall of a quantity against horizontal distance expressed as a ratio, decimal, fraction, percentage, or the tangent of the angle of inclination. 2. The rate of increase or decrease of one quantity with respect to another. 3. A term used in radionavigation to refer to the spacing between consecutive hyperbolas. If the gradient is high, a relatively small time-difference error in determining a hyperbolic line of position will result in a relatively high position error. See also GEOMETRIC DILUTION OF PRECISION.
- gradient current.** . An ocean current associated with horizontal pressure gradients in the ocean and determined by the condition that the pressure force due to the distribution of mass balances the Coriolis force due to the earth's rotation. See also OCEAN CURRENT.
- gradient tints.** . See HYPSONOMETRIC TINTING.
- gradient wind.** . Any horizontal wind velocity tangent to the contour line of a constant pressure surface (or to the isobar of a geopotential surface) at the point in question. At such points where the wind is gradient, the Coriolis force and the centrifugal force together exactly balance the horizontal pressure force. See also GEOSTROPHIC WIND.
- graduation error.** . Inaccuracy in the graduations of the scale of an instrument.

- graduations.** , *n., pl.* The marks on a scale.
- grain noise.** . See SNOW, definition 2.
- gram.** , *n.* One one-thousandth of a kilogram.
- granular snow.** . See SNOW GRAINS.
- graph.** , *n.* A diagram indicating the relationship between two or more variables.
- graph.** , *v., t.* To represent by a graph.
- graphic scale.** . See BAR SCALE.
- graticule.** , *n.* 1. The network of lines representing parallels and meridians on a map, chart, or plotting sheet. A fictitious graticule represents fictitious parallels and fictitious meridians. See also GRID, *n.* 2. A scale at the focal plane of an optical instrument to aid in the measurement of objects. See also RETICLE.
- graupel.** , *n.* See SNOW PELLETS.
- gravel.** , *n.* See under STONES.
- graving dock.** . A form of dry dock consisting of an artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessels' bottoms. The term is derived from the term used to describe the process of burning barnacles and other accretions from a ship's bottom. See also FLOATING DOCK.
- gravisphere.** , *n.* The spherical extent in which the force of a given celestial body's gravity is predominant in relation to that of other celestial bodies.
- gravitation.** , *n.* 1. The force of attraction between two bodies. According to Newton, gravitation is directly proportional to the product of the masses of two bodies and inversely proportional to the square of the distance between them. 2. The acceleration produced by the mutual attraction of two masses, directed along the line joining their centers of mass, and of magnitude inversely proportional to the square of the distance between the two centers of mass.
- gravitational disturbance.** . See GRAVITY DISTURBANCE.
- gravitational gradient.** . The change in the gravitational acceleration per unit distance.
- gravitational perturbations.** . Perturbations caused by body forces due to nonspherical terrestrial effects, lunisolar effect, tides, and the effect of relativity.
- gravitational tide.** . See EQUILIBRIUM TIDE.
- gravity.** , *n.* The force of attraction of the earth, or another body, on nearby objects.
- gravity anomaly.** . The difference between the observed gravity value properly reduced to sea level and the theoretical gravity obtained from gravity formula. Also called OBSERVED GRAVITY ANOMALY.
- gravity anomaly map.** . A map showing the positions and magnitudes of gravity anomalies. Also, a map on which contour lines are used to represent points at which the gravity anomalies are equal.
- gravity data.** . Information concerning that acceleration which attracts bodies and is expressed as observations or in the form of gravity anomaly charts or spherical harmonics for spatial representation of the earth and other celestial bodies.
- gravity disturbance.** . The difference between the observed gravity and the normal gravity at the same point (the vertical gradient of the disturbing potential) as opposed to GRAVITY ANOMALY which uses corresponding points on two different surfaces. Because the centrifugal force is the same when both are taken at the same point, it can also be called GRAVITATIONAL DISTURBANCE.
- gravity field of the earth.** . The field of force arising from a combination of the mass attraction and rotation of the earth. The field is normally expressed in terms of point values, mean area values, and/or series expansion for the potential of the field.
- gravity network.** . A network of gravity stations.
- gravity reduction.** . A combination of gravity corrections to obtain reduced gravity on the geoid.
- gravity reference stations.** . Stations which serve as reference values for a gravity survey, i.e., with respect to which the differences at the other stations are determined in a relative survey. The absolute value of gravity may or may not be known at the reference stations.
- gravity station.** . A station at which observations are made to determine the value of gravity.
- gravity wind.** . A wind blowing down an incline. Also called KATABATIC WIND.
- gray ice.** . A subdivision of YOUNG ICE 10 to 15 centimeters thick. Gray ice is less elastic than nilas and breaks in swells. It usually rafts under pressure.
- gray-white ice.** . A subdivision of YOUNG ICE 15 to 30 centimeters thick. Gray-white ice under pressure is more likely to ridge than to raft.
- grease ice.** . Ice at that stage of freezing when the crystals have coagulated to form a soupy layer on the surface. Grease ice is at a later stage of freezing than FRAZIL ICE and reflects little light, giving the sea a matte appearance.
- great circle.** . The intersection of a sphere and a plane through its center. The intersection of a sphere and a plane which does not pass through its center is called a small circle. Also called ORTHODROME, ORTHODROMIC CURVE.
- great circle bearing.** . The initial direction of a great circle through two terrestrial points, expressed as angular distance from a reference direction. It is usually measured from 000° at the reference direction clockwise through 360°. Bearings obtained by any form of radiant energy are great circle bearings.
- great circle chart.** . A chart on which a great circle appears as a straight line or approximately so, particularly a chart on the gnomonic map projection.
- great circle course.** . The direction of the great circle through the point of departure and the destination, expressed as the angular distance from a reference direction, usually north, to the direction of the great circle. The angle varies from point to point along the great circle. At the point of departure it is called initial great circle course; at the destination it is called final great circle course.
- great circle direction.** . Horizontal direction of a great circle, expressed as angular distance from a reference direction.
- great circle distance.** . The length of the shorter arc of the great circle joining two points. It is usually expressed in nautical miles.
- great circle sailing.** . Any method of solving the various problems involving courses, distance, etc., as they are related to a great circle track.
- great circle track.** . The track of a vessel following a great circle, or a great circle which a vessel intends to follow.
- great diurnal range.** . The difference in height between mean higher high water and mean lower low water. Often shortened to DIURNAL RANGE. The difference in height between mean lower high water and mean higher low water is called SMALL DIURNAL RANGE.
- greater ebb.** . See under EBB CURRENT.
- greater flood.** . See under FLOOD CURRENT.
- greatest elongation.** . The maximum angular distance of an inferior planet from the sun before it starts back toward conjunction, as observed from the earth. The direction of the body east or west of the sun is usually specified, as *greatest elongation east* (or *west*). See also ELONGATION.
- great tropic range.** . The difference in height between tropic higher high water and tropic lower low water. Often shortened to TROPIC RANGE. See also MEAN TROPIC RANGE, SMALL TROPIC RANGE.
- great year.** . The period of one complete cycle of the equinoxes around the ecliptic, about 25,800 years. Also called PLATONIC YEAR. See also PRECESSION OF THE EQUINOXES.
- green flash.** . A brilliant green coloring of the upper edge of the sun as it appears at sunrise or disappears at sunset when there is a clear, distinct horizon. It is due to refraction by the atmosphere, which disperses the first (or last) spot of light into a spectrum and causes the colors to appear (or disappear) in the order of refrangibility. The green is bent more than red or yellow and hence is visible sooner at sunrise and later at sunset.
- green house effect.** . The heating phenomenon due to shorter wavelengths of insolation passing through the atmosphere to the earth, which radiates longer wavelength infrared radiation, which is trapped by the atmosphere. Some of this trapped radiation is re-radiated to the earth. This causes a higher earth temperature than would occur from direct insolation alone.
- Greenwich apparent noon.** . Local apparent noon at the Greenwich meridian; 12 o'clock Greenwich apparent time, or the instant the apparent sun is over the upper branch of the Greenwich meridian.
- Greenwich apparent time.** . Local apparent time at the Greenwich meridian; the arc of the celestial equator, or the angle at the celestial pole between the lower branch of the Greenwich celestial meridian and the hour circle of the apparent or true sun, measured westward from the lower branch of the Greenwich celestial meridian through 24 hours; Greenwich hour angle of the apparent or true sun, expressed in time units, plus 12 hours.
- Greenwich civil time.** . United States terminology from 1925 through

1952. See GREENWICH MEAN TIME.
- Greenwich hour angle.** . Angular distance west of the Greenwich celestial meridian; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the Greenwich celestial meridian and the hour circle of a point on the celestial sphere, measured westward from the Greenwich celestial meridian through 360°; local hour angle at the Greenwich meridian.
- Greenwich interval.** . An interval based on the moon's transit of the Greenwich celestial meridian, as distinguished from a local interval based on the moon's transit of the local celestial meridian.
- Greenwich lunar time.** . Local lunar time at the Greenwich meridian; the arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the Greenwich celestial meridian and the hour circle of the moon, measured westward from the lower branch of the Greenwich celestial meridian through 24 hours; Greenwich hour angle of the moon expressed in time units, plus 12 hours.
- Greenwich mean noon.** . Local mean noon at the Greenwich meridian, 12 o'clock Greenwich mean time, or the instant the mean sun is over the upper branch of the Greenwich meridian.
- Greenwich mean time.** . Local mean time at the Greenwich meridian; the arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the Greenwich celestial meridian and the hour circle of the mean sun, measured westward from the lower branch of the Greenwich celestial meridian through 24 hours; Greenwich hour angle of the mean sun expressed in time units, plus 12 hours. Also called UNIVERSAL TIME, or ZULU.
- Greenwich meridian.** . The meridian through Greenwich, England, serving as the reference for Greenwich time, in contrast with LOCAL MERIDIAN. It is accepted almost universally as the PRIME MERIDIAN, or the origin of measurement of longitude.
- Greenwich noon.** . Noon at the Greenwich meridian.
- Greenwich sidereal noon.** . Local sidereal noon at the Greenwich meridian; zero hour Greenwich sidereal time, or the instant the vernal equinox is over the upper branch of the Greenwich meridian.
- Greenwich sidereal time.** . Local sidereal time at the Greenwich meridian; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the Greenwich celestial meridian and the hour circle of the vernal equinox, measured westward from the upper branch of the Greenwich celestial meridian through 24 hours; Greenwich hour angle of the vernal equinox expressed in time units.
- Greenwich time.** . Time based upon the Greenwich meridian as reference.
- gregale.** , *n.* A strong northeast wind of the central Mediterranean.
- Gregorian calendar.** . The calendar now in almost universal use for civil purposes in which each year has 365 days, except leap years which have 366 days. Leap years are those years which are divisible by 4, and in the case of centurial years, those years divisible by 400. This calendar, a modification of the Julian calendar, was not adopted in Great Britain and the English colonies in North America until 1752. The calendar was instituted in 1582 by Pope Gregory XIII to keep calendar days in adjustment with the tropical year for the purpose of regulating the date of Easter and the civil and ecclesiastical calendars.
- gray ice.** . A subdivision of YOUNG ICE 10 to 15 centimeters thick. Gray ice is less elastic than nilas and breaks in swells. It usually rafts under pressure.
- gray-white ice.** . A subdivision of YOUNG ICE 15 to 30 centimeters thick. Gray-white ice under pressure is more likely to ridge than to raft.
- grid.** , *adj.* Pertaining to a grid or related to grid north.
- grid.** , *n.* 1. A series of lines, usually straight and parallel, superimposed on a chart or plotting sheet to serve as a directional reference for navigation. See also FICTITIOUS GRATICULE, GRATICULE, definition 1. 2. Two sets of mutually perpendicular lines dividing a map or chart into squares or rectangles to permit location of any point by a system of rectangular coordinates. Also called REFERENCE GRID. See also MILITARY GRID, UNIVERSAL POLAR STEREOGRAPHIC GRID, UNIVERSAL TRANSVERSE MERCATOR GRID, WORLD GEOGRAPHIC REFERENCE SYSTEM.
- grid amplitude.** . Amplitude relative to grid east or west.
- grid azimuth.** . Azimuth relative to grid north.
- grid bearing.** . Bearing relative to grid north.
- grid convergence.** . The angular difference in direction between grid north and true north. It is measured east or west from true north.
- grid course.** . Course relative to grid north.
- grid declination.** . The angular difference between grid north and true north.
- grid direction.** . Horizontal direction expressed as angular distance from grid north. Grid direction is measured from grid north, clockwise through 360°.
- grid equator.** . A line perpendicular to a prime grid meridian, at the origin. For the usual orientation in polar regions the grid equator is the 90°W - 90°E meridian forming the basic grid parallel, from which grid latitude is measured. See also FICTITIOUS EQUATOR.
- grid heading.** . Heading relative to grid north.
- grid latitude.** . Angular distance from a grid equator. See also FICTITIOUS LATITUDE.
- grid line.** . One of the lines of a grid.
- grid longitude.** . Angular distance between a prime grid meridian and any given grid meridian. See also FICTITIOUS LONGITUDE.
- grid magnetic angle.** . Angular difference in direction between grid north and magnetic north. It is measured east or west from grid north. Grid magnetic angle is sometimes called GRID VARIATION or GRIVATION.
- grid meridian.** . One of the grid lines extending in a grid north-south direction. The reference grid meridian is called prime grid meridian. In polar regions the prime grid meridian is usually the 180° - 0° geographic meridian. See also FICTITIOUS MERIDIAN.
- grid navigation.** . Navigation by the use of grid directions.
- grid north.** . 1. An arbitrary reference direction used with grid navigation. The direction of the 180th geographical meridian from the north pole is used almost universally as grid north. 2. The northerly or zero direction indicated by the grid datum of directional reference.
- grid parallel.** . A line parallel to a grid equator, connecting all points of equal grid latitude. See also FICTITIOUS PARALLEL.
- grid prime vertical.** . The vertical circle through the grid east and west points of the horizon.
- grid rhumb line.** . A line making the same oblique angle with all grid meridians. Grid parallels and meridians may be considered special cases of the grid rhumb line. See also FICTITIOUS RHUMB LINE.
- grid track.** . The direction of the track relative to grid north.
- grid variation.** . See GRID MAGNETIC ANGLE.
- grivation.** , *n.* See GRID MAGNETIC ANGLE.
- groin.** , *n.* A structure (usually one of a group) extending approximately perpendicular from a shore to protect the shore from erosion by tides, currents, or waves or to trap sand for making a beach. See also JETTY, definition 1.
- ground.** , *n.* A conducting connection between an electric circuit and the earth or some other conducting body of zero potential with respect to the earth.
- ground.** , *v., t. & i.* 1. To touch bottom or run aground. *v., t.* 2. To connect an electric circuit with the earth or some other conducting body, such that the earth or body serves as part of the circuit.
- ground absorption.** . The dissipation of energy in radio waves because of absorption by the ground over which the waves are transmitted.
- ground-based duct.** . See SURFACE DUCT.
- ground chain.** . Heavy chain used with permanent moorings and connecting the various legs or bridles.
- grounded hummock.** . Hummocked grounded ice formation. There are single grounded hummocks and lines (or chains) of grounded hummocks. A hummock refers to a mound.
- grounded ice.** . Floating ice which is aground in shoal water. See also STRANDED ICE, FLOATING ICE.
- ground fog.** . A fog that obscures less than six tenths of the sky, and does not extend to the base of any clouds.
- grounding.** , *n.* The touching of the bottom by a vessel. A serious grounding is called a stranding.
- ground log.** . A device for determining the course and speed over the ground in shallow water consisting of a lead or weight attached to a line. The lead is thrown overboard and allowed to rest on the bottom. The course over ground is indicated by the direction the line tends and the speed by the amount of line paid out in a unit of time.
- ground stabilization.** . In ECDIS a display whereby own ship position is referenced to the ground. It is usually performed in conjunction with radar/ARPA, it can be determined by computing set and drift or by the use of GPS/DGPS.
- ground swell.** . A long, deep swell or undulation of the ocean often caused

by a long-continued gale and sometimes a seismic disturbance and felt even at a remote distance. In shallow water the swell rises to a prominent height. See SWELL.

**ground tackle.** . The anchors, anchor chains, fittings etc., used for anchoring a vessel.

**ground track.** . 1. See under TRACK, definition 2. 2. See under TRUE TRACK OF TARGET.

**groundwave.** . A radio wave that is propagated over the earth and is ordinarily influenced by the presence of the ground and the troposphere. Except for ionospheric and tropospheric waves, the groundwave includes all components of a radio wave.

**group flashing light.** . A flashing light in which the flashes are combined in groups, each group having the same number of flashes, and in which the groups are repeated at regular intervals. The eclipses separating the flashes within each group are of equal duration and this duration is clearly shorter than the duration of the eclipse between two successive groups.

**group occulting light.** . An occulting light in which the occultations are combined in groups, each group including the same number of occultations, and in which the groups are repeated at regular intervals. The intervals of light separating the occultations within each group are of equal duration and this duration is clearly shorter than the duration of the interval of light between two successive groups.

**group quick light.** . A quick flashing light in which a specified group of flashes is regularly repeated. See also CONTINUOUS QUICK LIGHT, INTERRUPTED QUICK LIGHT.

**group very quick light.** . A very quick flashing light in which a specified group of flashes is regularly repeated. See also CONTINUOUS VERY QUICK LIGHT, INTERRUPTED VERY QUICK LIGHT.

**growler.** , *n.* A piece of ice smaller than a BERGY BIT or FLOEBERG, often transparent but appearing green or almost black in color. It extends less than 1 meter above the sea surface and its length is less than 20 feet (6 meters). A growler is large enough to be a hazard to shipping but small enough that it may escape visual or radar detection.

**grunt.** , *n.* See under DIAPHONE.

**Guiana Current.** . An ocean current flowing northwestward along the northeast coast of South America. The Guiana Current is an extension of the Atlantic South Equatorial Current, which crosses the equator and approaches the coast of South America. Eventually, it is joined by part of the Atlantic North Equatorial Current and becomes, successively, the CARIBBEAN CURRENT, and the FLORIDA CURRENT. Also called NORTH BRAZIL CURRENT.

**Guinea Current.** . A North Atlantic Ocean current flowing eastward along the south coast of northwest Africa into the Gulf of Guinea. The Guinea Current is the continuation of the Atlantic Equatorial Countercurrent augmented by the eastern branch of the Canary Current.

**gulder.** , *n.* Local name given to double low water occurring on the south coast of England. See DOUBLE TIDE.

**gulf.** , *n.* A major indentation of the sea into the land, usually larger than a bay.

**Gulf Coast Low Water Datum.** . Gulf Coast Low Water Datum (GCLWD) is defined as mean lower low water when the type of tide is mixed, and mean low water when the type of tide is diurnal. GCLWD was used as chart tidal datum from November 14, 1977, to November 28, 1980, for the coastal waters of the gulf coast of the United States.

**Gulf Stream.** . A warm, well defined, swift, relatively narrow ocean current which originates where the Florida Current and the Antilles Current meet north of Grand Bahama Island. It gains its impetus from the large volume of water that flows through the Straits of Florida. Near the edge of the Grand Banks of Newfoundland - extensions of the Gulf Stream and the Labrador Current continue as the NORTH ATLANTIC CURRENT, which fans outward and widens in a northeastward to eastward flow across the ocean. The Florida Current, the Gulf Stream, and the North Atlantic Current together form the GULF STREAM SYSTEM. Sometimes the entire system is referred to as the Gulf Stream. The Gulf Stream forms the western and northwestern part of the general clockwise oceanic circulation of the North Atlantic Ocean.

**Gulf Stream System.** . A system of ocean currents comprised of the Florida Current, the Gulf Stream, and the North Atlantic Current.

**gulfweed.** , *n.* See SARGASSUM.

**gully.** , *n.* 1. A small ravine, especially one cut by running water, but

through which water flows only after a rain. 2. On the sea floor, a small valley-like feature.

**gust.** , *n.* 1. A sudden brief increase in the speed of the wind of more transient character than a squall, and followed by a lull or slackening of the wind. 2. The violet wind or squall that accompanies a thunderstorm.

**gut.** , *n.* A narrow passage or contracted strait connecting two bodies of water.

**guyot.** , *n.* See TABLEMOUNT.

**gyre.** , *n.* A closed circulatory system, but larger than a whirlpool or eddy.

**gyro.** , *n.* Short for GYROSCOPE.

**gyrocompass.** , *n.* A compass having one or more gyroscopes as the directive element, and which is north-seeking. Its operation depends upon four natural phenomena, namely gyroscopic inertia, gyroscopic precession, the earth's rotation, and gravity. When such a compass controls remote indicators, called GYRO REPEATERS, it is called a master gyrocompass. See also DIRECTIONAL GYRO MODE.

**gyro error.** . The error in the reading of the gyrocompass, expressed in degrees east or west to indicate the direction in which the axis of the compass is offset from true north. See also BALLISTIC DAMPING ERROR, BALLISTIC DEFLECTION ERROR, COMPASS ERROR, GIMBALLING ERROR, INTERCARDINAL ROLLING ERROR, LUBBER'S LINE ERROR, SPEED ERROR.

**gyro log.** . A written record of the performance of a gyrocompass.

**Gyro pilot.** , *n.* An automatic device for steering a vessel by means of control signals received from a gyrocompass. Also called AUTO PILOT.

**gyro repeater.** . A device which displays at a different location the indications of the master gyrocompass. See also COMPASS REPEATER.

**gyroscope.** , *n.* A rapidly rotating mass free to move about one or both axes perpendicular to the axis of rotation and to each other. It is characterized by GYROSCOPIC INERTIA and PRECESSION. Usually shortened to GYRO. The term also refers colloquially to the GYROCOMPASS. See also DIRECTIONAL GYRO, FREE GYRO.

**gyroscopic drift.** . The horizontal rotation of the spin axis of a gyroscope about the vertical axis.

**gyroscopic inertia.** . The property of a gyroscope of resisting any force which tends to change its axis of rotation. A gyroscope tends to maintain the direction of its axis of rotation in space. Also called RIGIDITY IN SPACE.

**gyro sextant.** . A sextant provided with a gyroscope to indicate the horizontal.

## H

**haar.** , *n.* A wet sea fog or very fine drizzle which drifts in from the sea in coastal districts of eastern Scotland and northeast England, especially in summer.

**habitat sanctuary.** . A marine sanctuary established for the preservation, protection, and management of essential or specialized habitats representative of important marine systems. See also MARINE SANCTUARY.

**hachures.** , *n. pl.* 1. Short lines on topographic maps or nautical charts to indicate the slope of the ground or the submarine bottom. They usually follow the direction of the slope. 2. Inward-pointing short lines or "ticks" around the circumference of a closed contour indicating a depression or a minimum.

**hack.** , *n.* A chronometer which has failed to meet the exacting requirements of a standard chronometer, and is used for timing observations of celestial bodies, regulating ship's clocks, etc. A comparing watch, which may be of high quality, is normally used for timing celestial observations, the watch being compared with the chronometer, preferably both before and after observations. Sometimes called HACK CHRONOMETER.

**hack chronometer.** . See HACK.

**hack watch.** . See COMPARING WATCH.

**hail.** , *n.* Frozen precipitation consisting of ice balls or irregular lumps of ice of varying size, ranging from that of a raindrop to an inch or considerably more. They are composed of clear ice or of alternate

- layers of ice and snow, and may fall detached or frozen together into irregular lumps. Hail is usually associated with thunderstorms. A hailstone is a single unit of hail. Small hail consists of snow pellets surrounded by a very thin ice covering. See also SNOW PELLETS.
- hailstone**, *n.* See under HAIL.
- hail storm**. See under STORM, definition 2.
- half-power points**. Power ratios used to define the angular width of a radar beam. One convention defines beam width as the angular width between points at which the field strength is 71 percent of its maximum value. Expressed in terms of power ratio, this convention defines beam width as the angular width between half-power points. A second convention defines beam width as the angular width between points at which the field strength is 50 percent of its maximum value. Expressed in terms of power ratio, the latter convention defines beam width as the angular width between quarter-power points.
- half tide**. The condition or time of the tide when midway between high and low.
- half-tide basin**. A lock of very large size and usually of irregular shape, the gates of which are kept open for several hours after high tide so that vessels may enter as long as there is sufficient depth over the sill. Vessels remain in the half-tide basin until the ensuing flood tide before they may pass through the gate to the inner harbor. If entry to the inner harbor is required before this time, water must be admitted to the half-tide basin from some external source. See also TIDAL BASIN, NON-TIDAL BASIN.
- half-tide level**. A tidal datum midway between mean high water and mean low water. Mean sea level may coincide with half-tide level, but seldom does; the variation is generally about 3 centimeters and rarely exceeds 6 centimeters. Also called MEAN TIDE LEVEL. See also MID-EXTREME TIDE.
- halo**, *n.* Any of a group of optical phenomena caused by refraction or reflection of light by ice crystals in the atmosphere. The most common form is a ring of light of radius  $22^\circ$  or  $46^\circ$  around the sun or moon. See also CORONA, PARHELION, CIRCUMSCRIBED HALO, PARHELIC CIRCLE, SUN CROSS, SUN PILLAR, CIRCUMZENITHAL ARC, ANTHELION, PARANTHELION, HAVELIAN HALO, TANGENT ARC.
- halving**, *n.* The process of adjusting magnetic compass correctors so as to remove half of the deviation on the opposite cardinal or adjacent intercardinal headings to those on which adjustment was originally made when all deviation was removed. This is done to equalize the error on opposite headings.
- Handbook of Magnetic Compass Adjustment**. See PUB. NO. 226. (No longer in print, but available on the NGA Maritime Safety Information website)
- hand lead**. A light sounding lead (7 to 14 pounds), usually having a line of not more than 25 fathoms.
- hanging compass**. See INVERTED COMPASS.
- harbor**, *n.* 1. A body of water providing protection for vessels and, generally, anchorage and docking facilities. 2. A haven or space of deep water so sheltered by the adjacent land as to afford a safe anchorage for ships. See also NATURAL HARBOR, ARTIFICIAL HARBOR.
- harbor chart**. See under CHART CLASSIFICATION BY SCALE.
- harbor line**. The line beyond which wharves and other structures cannot be extended.
- harbor reach**. See REACH.
- hard beach**. A portion of a beach especially prepared with a hard surface extending into the water, employed for the purpose of loading or unloading directly into landing ships or landing craft.
- hard iron**. Iron or steel which is not readily magnetized by induction, but which retains a high percentage of the magnetism acquired. The opposite is SOFT IRON.
- hardware**. The physical parts of a computer system; compare with SOFTWARE, the programs which accomplish work.
- harmattan**, *n.* The dry, dusty trade wind blowing off the Sahara Desert across the Gulf of Guinea and the Cape Verde Islands. Sometimes called the DOCTOR, because of its supposed healthful properties.
- harmful interference**. Any emission, radiation, or induction which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio-communication service operating in accordance with the International Telecommunications Union Regulations.
- harmonic**, *n.* 1. A sinusoidal quantity having a frequency that is an integral multiple of the frequency of a periodic quantity to which it is related. 2. A signal having a frequency which is an integral multiple of the fundamental frequency.
- harmonic analysis**. The process by which the observed tide or tidal current at any place is separated into basic harmonic constituents. Also called HARMONIC REDUCTION.
- harmonic analyzer**. A machine designed for the resolution of a periodic curve into its harmonic constituents. Now performed by computer.
- harmonic component**. Any of the simple sinusoidal components into which a periodic quantity may be resolved.
- harmonic constants**. The amplitudes and epochs of the harmonic constituents of the tide or tidal current at any place.
- harmonic constituent**. See CONSTITUENT.
- harmonic expressions**. Trigonometric terms of an infinite series used to approximate irregular curves in two or three dimensions.
- harmonic function**. Any real function that satisfies a certain equation. In its simplest form, as used in tide and tidal current predictions, it is a quantity that varies as the cosine of an angle that increases uniformly with time.
- harmonic motion**. The projection of circular motion on a diameter of the circle of such motion. Simple harmonic motion is produced if the circular motion is of constant speed. The combination of two or more simple harmonic motions results in compound harmonic motion.
- harmonic prediction**. (*tidal*). Method of predicting tides and tidal currents by combining the harmonic constituents into a single tide curve, usually performed by computer.
- harmonic reduction**. See HARMONIC ANALYSIS.
- harmonic tide plane**. See INDIAN SPRING LOW WATER.
- harpoon log**. A log which consists of a rotator and distance registering device combined in a single unit, which is towed through the water. The TAFFRAIL LOG is similar except that the registering device is located at the taffrail, with only the rotator in the water.
- harvest moon**. The full moon occurring nearest the autumnal equinox. See also PHASES OF THE MOON.
- haul**, *v., i.* 1. A counterclockwise change in direction of the wind. 2. A shift in the direction of the wind forward. The opposite is to VEER. 2. *v., t.* To change the course of a sailing vessel to bring the wind farther forward, usually used with up, such as *haul up*.
- haven**, *n.* A place of safety for vessels.
- haze**, *n.* Fine dust or salt particles in the air, too small to be individually apparent but in sufficient number to reduce horizontal visibility and give the atmosphere a characteristic hazy appearance which casts a bluish or yellowish veil over the landscape, subduing its colors. This is sometimes called a dry haze to distinguish it from damp haze, small water droplets or very hygroscopic particles in the air, smaller and more scattered than light fog.
- head**, *n.* See HEADLAND.
- heading**, *n.* The horizontal direction in which a ship actually points or heads at any instant, expressed in angular units from a reference direction, usually from  $000^\circ$  at the reference direction clockwise through  $360^\circ$ . Heading is often designated as true, magnetic, compass, or grid. Heading should not be confused with COURSE, which is the intended direction of movement through the water. At a specific instant the heading may or may not coincide with the course. The heading of a ship is also called SHIP'S HEAD.
- heading angle**. Heading measured from  $0^\circ$  at the reference direction clockwise or counterclockwise through  $90^\circ$  or  $180^\circ$ . It is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix.
- heading flasher**. An illuminated radial line on the radar for indicating own ship's heading on the bearing dial. Also called HEADING MARKER.
- heading line**. The line extending in the direction of a heading.
- heading marker**. See HEADING FLASHER.
- headland**, *n.* A comparatively high promontory having a steep face. Usually called HEAD when coupled with a specific name. Also called FORELAND.
- head sea**. A sea in which the waves move in a direction approximately opposite to the heading. The opposite is FOLLOWING SEA.
- head tide**. A tidal current setting in a direction approximately opposite to the heading of a vessel. One setting in such a direction as to increase the speed of a vessel is called a FAIR TIDE. One abeam is called a BEAM TIDE. One approximately  $90^\circ$  from the course is called a CROSS TIDE.

- head up, heading upward.** . One of the three basic orientations of display of relative or true motion on a radarscope. In the HEAD UP orientation, the target pips are painted at their measured distances and in their directions relative to own ship's heading maintained UP in relation to the display and so indicated by the HEADING FLASHER. See also NORTH UP, BASE COURSE UP.
- head-up display.** . In ECDIS information shown on a display in such a fashion so that the vessel's HEADING is always pointing upward. This ORIENTATION corresponds to the visual view from the bridge in the direction of the ship's heading. This orientation may require frequent rotations of the display contents. Changing the ship's course or yawing of the vessel may render this non stabilized orientation mode unreadable. (See COURSE-UP DISPLAY).
- headwaters.** , *n., pl.* The source of a stream or river.
- headway.** , *n.* Motion in a forward direction. Motion in the opposite direction is called STERNWAY.
- head wind.** . Wind from ahead of the vessel.
- heat lightning.** . A flash of light from an electric discharge, without thunder, believed to be the reflection by haze or clouds of a distant flash of lightning, too far away for the thunder to be audible.
- heat wave.** . Unseasonably high temperatures extending over a period of a day or longer, particularly during the warm season of the year.
- heave.** , *n.* The oscillatory vertical rise and fall due to the entire hull being lifted by the force of the sea. Also called HEAVING. See also SHIP MOTIONS.
- heavenly body.** . See CELESTIAL BODY.
- heave the lead.** . To take a sounding with a lead.
- heaving.** , *n.* See HEAVE.
- Heaviside layer.** . See under KENNELLY-HEAVISIDE REGION.
- hecto-**. . A prefix meaning one hundred ( $10^2$ ).
- hectometer.** , *n.* One hundred meters.
- heel.** , *n.* Lateral inclination of a vessel. See also LIST, *n.*
- heel.** , *v., t., i.* To incline or be inclined to one side. See also LIST, *n.*
- heeling adjuster.** . A dip needle with a sliding weight that can be moved along one of its arms to balance magnetic force, used to determine the correct position of a heeling magnet. Also called HEELING ERROR INSTRUMENT, VERTICAL FORCE INSTRUMENT. See also HEELING ERROR.
- heeling error.** . The change in the deviation of a magnetic compass when a craft heels due to the change in the position of the magnetic influences of the craft relative to the earth's magnetic field and to the compass.
- heeling error instrument.** . Heeling adjuster. Also called VERTICAL FORCE INSTRUMENT.
- heeling magnet.** . A permanent magnet placed vertically in a tube under the center of a marine magnetic compass, to correct for heeling error.
- height.** , *n.* Vertical distance above a datum.
- height of eye correction.** . The correction to sextant altitude due to dip of the horizon. Also called DIP CORRECTION.
- height of tide.** . Vertical distance from the chart sounding datum to the water surface at any stage of the tide. It is positive if the water level is higher than the chart sounding datum. The vertical distance from the chart sounding datum to a high water datum is called RISE OF TIDE.
- heliocentric.** , *adj.* Relative to the sun as a center.
- heliocentric parallax.** . The difference in the apparent direction or positions of a celestial body outside the solar system, as observed from the earth and sun. Also called STELLAR PARALLAX, ANNUAL PARALLAX. See also GEOCENTRIC PARALLAX.
- helm.** , *n.* The apparatus by which a vessel is steered; the tiller or wheel.
- hemisphere.** , *n.* Half of a sphere.
- hemispheric resonating gyro (HRG).** , *n.* Also called wine-glass gyroscope, mushroom gyro or hemispheric resonating gyro/navigator (HRG-N), is made using a thin solid-state hemispherical shell, anchored by a thick stem. This shell is driven to a flexural resonance by electrostatic forces generated by electrodes which are deposited directly onto separate fused-quartz structures that surround the shell. Gyroscopic effect is obtained from the inertial property of the flexural standing waves. HRG has no moving parts and is extremely reliable and accurate.
- henry.** , *n.* A derived unit of electric inductance in the International System of Units; it is the inductance of a closed circuit in which an electromotive force of one volt is produced when the electric current in the circuit varies uniformly at a rate of one ampere per second.
- hertz.** , *n.* The special name for the derived unit of frequency in the International System of Units, it is one cycle per second.
- Hertzian waves.** . See RADIO WAVES.
- heterodyne reception.** . Radio reception in which an audio frequency is derived by beating the signal frequency with that produced by a local oscillator, followed by detection. Also called BEAT RECEPTION.
- Hevelian halo.** . A faint white halo consisting of a ring occasionally seen  $90^\circ$  from the sun, and probably caused by the refraction and internal reflection of the sun's light by bi-pyramidal ice crystals.
- hexagon.** , *n.* A closed plane figure having six sides.
- hibernal.** , *adj.* Pertaining to winter. The corresponding adjectives for spring, summer, and fall are vernal, aestival, and autumnal.
- high.** , *n.* An area of high pressure. Since a high is, on a synoptic chart, always associated with anticyclonic circulation, the term is used interchangeably with ANTICYCLONE. See also LOW.
- high altitude method.** . The establishing of a circular line of position from the observation of the altitude of a celestial body by means of the geographical position and zenith distance of the body. The line of position is a circle having the geographical position as its center and a radius equal to the zenith distance. The method is normally used only for bodies at high altitudes having small zenith distances. See also SAINT HILAIRE METHOD, SUMNER METHOD LONGITUDE METHOD.
- high clouds.** . Types of clouds the mean lower level of which is above 20,000 feet. The principal clouds in this group are cirrus, cirro-cumulus, and cirrostratus.
- higher high water.** . The higher of the two high waters of any tidal day.
- higher high water interval.** . See under LUNITIDAL INTERVAL.
- higher lower water.** . The higher of the two low waters of any tidal day.
- higher low water interval.** . See under LUNITIDAL INTERVAL.
- high fidelity.** . The ability to reproduce modulating waves at various audio frequencies without serious distortion.
- high focal plane buoy.** . A type of lighted buoy in which the light is mounted exceptionally high above the surface of the sea.
- high frequency.** . Radio frequency of 3 to 30 megahertz.
- high light.** . The rear light of a lighted range. See REAR LIGHT.
- high noon.** . See LOCAL APPARENT NOON.
- high sea, high seas.** . All water beyond the outer limit of the territorial sea. Although the high seas are in part coextensive with the waters of the contiguous zone, the fishing zone, and those over the continental shelf, freedom of the seas is not invalidated by the zonal overlap.
- high tide.** . See under HIGH WATER.
- high water.** . The maximum height reached by a rising tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Use of the synonymous term HIGH TIDE is discouraged.
- high water full and change.** . See ESTABLISHMENT OF THE PORT.
- high water inequality.** . The difference between the heights of the two high waters during a tidal day. See under DIURNAL INEQUALITY.
- high water interval.** . See under LUNITIDAL INTERVAL.
- high water line.** . 1. The intersection of the land with the water surface at an elevation of high water. 2. The line along the shore to which the waters normally reach at high water.
- high water mark.** . A line or mark left upon tide flats, beach, or along-shore objects indicating the elevation of the intrusion of high water. It should not be confused with the MEAN HIGH WATER LINE or MEAN HIGHER HIGH WATER LINE.
- high water neaps.** . See under NEAP TIDES.
- high water springs.** . Short for MEAN HIGH WATER SPRINGS.
- high water stand.** . The condition at high water when there is no sensible change in the height of the water. A similar condition at low water is called LOW WATER STAND. See also STAND.
- hill.** , *n.* 1. A relatively low, rounded elevation of the earth's surface. 2. On the sea floor, an elevation rising generally less than 500 meters.
- hillock.** , *n.* A small hill.
- hoar.** , *n.* See FROST, definition 1.
- hoarfrost.** , *n.* See FROST, definition 1.
- HO-information.** , *n.* In ECDIS, the information content of the SENC originated by hydrographic offices. It consists of the ENC content and UPDATES to it.
- holding ground.** . The bottom ground of an anchorage. The expression is

- usually used with a modifying adjective to indicate the quality of the holding power of the material constituting the bottom.
- hole**, *n.* 1. A small depression of the sea floor. 2. An opening through a piece of sea ice, or an open space between ice cakes. 3. A small bay, particularly in New England.
- homing**, *n.* Navigation toward a point by following a signal from that point. Radiobeacons are commonly used for homing.
- homogenous**, *adj.* Uniform throughout, or composed of parts which are similar in every detail.
- hood**, *n.* A shield placed over a radarscope, to eliminate extraneous light and thus make the radar picture appear clearly.
- hook**, *n.* A feature resembling a hook in shape, particularly, a. a spit or narrow cape of sand or gravel which turns landward at the outer end; or b. a sharp bend or curve, as in a stream.
- hooked spit**. See RECURVED SPIT.
- hop**, *n.* Travel of a radio wave to the ionosphere and back to earth. The number of hops a radio signal has experienced is usually designated by the expression one-hop, two-hop, multihop, etc.
- horizon**, *n.* The great circle of the celestial sphere midway between the zenith and nadir, or a line resembling or approximating such a circle. The line where earth and sky appear to meet, and the projection of this line upon the celestial sphere, is called the visible or apparent horizon. A line resembling the visible horizon but above or below it is called a false horizon. The circle of the celestial sphere-formed by the intersection of the celestial sphere and a plane perpendicular to the zenith-nadir line is called a sensible horizon if the plane is through any point, such as the eye of an observer; geoidal horizon if through any sea-level point; and celestial or rational horizon if through the center of the earth. The geometrical horizon was originally considered identical with the celestial horizon, but the expression is now more commonly used to refer to the intersection of the celestial sphere and an infinite number of straight lines tangent to the earth's surface, and radiating from the eye of the observer. If there were no terrestrial refraction, GEOMETRICAL AND VISIBLE HORIZONS would coincide. An artificial horizon is a device for indicating the horizontal. A radio horizon is the line at which direct rays from a transmitting antenna become tangent to the earth's surface. A radar horizon is the radio horizon of a radar antenna.
- horizon glass**. The glass of a marine sextant, attached to the frame, through which the horizon is observed. The half of this glass nearer the frame is silvered to form the HORIZON MIRROR for reflecting the image of a celestial body; the other half is clear.
- horizon mirror**. The mirror part of the horizon glass. The expression is sometimes used somewhat loosely to refer to the horizon glass.
- horizon prism**. A prism which can be inserted in the optical path of an instrument, such as a bubble sextant, to permit observation of the visible horizon.
- horizon system of coordinates**. A set of celestial coordinates based on the celestial horizon as the primary great circle; usually altitude and azimuth or azimuth angle.
- horizontal**, *adj.* Parallel to the plane of the horizon; perpendicular to the direction of gravity.
- horizontal**, *n.* A horizontal line, plane, etc. horizontal beam width. The beam width measured in a horizontal plane.
- horizontal beam width**, *n.* The beam width measured in a horizontal plane.
- horizontal control datum**. See HORIZONTAL GEODETIC DATUM.
- horizontal danger angle**. The maximum or minimum angle between two points on a chart, as observed from a vessel, indicating the limit of safe approach to an off-lying danger. See also DANGER ANGLE.
- horizontal datum**. See HORIZONTAL GEODETIC DATUM.
- horizontal earth rate**. The rate at which the spin axis of a gyroscope must be tilted about the horizontal axis to remain parallel to the earth's surface. Horizontal earth rate is maximum at the equator, zero at the poles, and varies as the cosine of the latitude. See also EARTH RATE, VERTICAL EARTH RATE.
- horizontal force instrument**. An instrument used to make a comparison between the intensity of the horizontal component of the earth's magnetic field and the magnetic field at the compass location on board. Basically, it consists of a magnetized needle pivoted in a horizontal plane, as a dry card compass. It will settle in some position which will indicate the direction of the resultant magnetic field. If the needle is started swinging, it will be damped down with a certain period of oscillation dependent upon the strength of the magnetic field. Also called HORIZONTAL VIBRATING NEEDLE. See also DEFLECTOR.
- horizontal geodetic datum**. The basis for computations of horizontal control surveys in which the curvature of the earth is considered. It consists of the astronomical and geodetic latitude and the astronomical and geodetic longitude of an initial point (origin); an azimuth of a line from this point; the parameters (radius and flattening) of the reference ellipsoid; and the geoidal separation at the origin. A change in any of these quantities affects every point on the datum. For this reason, while positions within a system are directly and accurately related, those points from different datums must be transformed to a common datum for consistency. The horizontal geodetic datum may extend over a continent or be limited to a small area. See also DATUM. Also called HORIZONTAL DATUM, HORIZONTAL CONTROL DATUM.
- horizontal intensity of the earth's magnetic field**. The strength of the horizontal component of the earth's magnetic field.
- horizontally polarized wave**. A plane-polarized electromagnetic wave in which the electric field vector is in a horizontal plane.
- horizontal parallax**. The geocentric parallax when a body is on the horizon. The expression is usually used only in connection with the moon, for which the tabulated horizontal parallax is given for an observer on the equator. The parallax at any altitude is called PARALLAX IN ALTITUDE.
- horizontal vibrating needle**. See HORIZONTAL FORCE INSTRUMENT.
- horn**, *n.* 1. A flared tube designed to match the acoustic impedance to the impedance of the atmosphere; it can behave as a resonator and can influence the directivity; the narrow end is called the throat and the large end the mouth. Also called TRUMPET. 2. See HORN ANTENNA.
- horn antenna**. An antenna consisting of a waveguide, the cross-sectional area of which increases toward the open end. Often shortened to HORN.
- horse latitudes**. The regions of calms and variable winds coinciding with the subtropical high pressure belts on the poleward sides of the trade winds. The expression is generally applied only to the northern of these two regions in the North Atlantic Ocean, or to the portion of it near Bermuda.
- hostile ice**. An ice canopy containing no large sky lights or other features which permit a submarine to surface.
- hour**, *n.* 1. A 24th part of a day. 2. A specified interval. See also COTIDAL HOUR, CURRENT HOUR.
- hour angle**. Angular distance west of a celestial meridian or hour circle; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of a celestial meridian or hour circle and the hour circle of a celestial body or the vernal equinox, measured westward through 360°. It is usually further designated as local, Greenwich, or sidereal as the origin of measurement is the local or Greenwich celestial meridian or the hour circle of the vernal equinox. See also MERIDIAN ANGLE.
- hour angle difference**. See MERIDIAN ANGLE DIFFERENCE.
- hour circle**. On the celestial sphere, a great circle through the celestial poles. An hour circle through the zenith is called a celestial meridian. Also called CIRCLE OF DECLINATION, CIRCLE OF RIGHT ASCENSION.
- hour-glass effect**. A radarscope phenomenon which appears as a constriction or expansion of the display near the center of the plan position indicator, which can be caused by a nonlinear time base or the sweep plot starting on the radar indicator at the same instant as the transmission of the pulse. The phenomenon is most apparent when in narrow rivers or close to shore.
- hug**, *v., t.* To remain close to, as to *hug the land*.
- Humboldt Current**. See PERU CURRENT.
- humidity**, *n.* The amount of water vapor in the air. The mass of water vapor per unit volume of air is called absolute humidity. The mass of water vapor per unit mass of moist air is called specific humidity. The ratio of the actual vapor pressure to the vapor pressure corresponding to saturation at the prevailing temperature is called relative humidity.
- hummock**, *n.* 1. A hillock of broken ice which has been forced upwards by pressure. It may be fresh or weathered. The submerged volume of broken ice under the hummocks, forced downwards by pressure,

is called a **BUMMOCK**; 2. A natural elevation of the earth's surface resembling a hillock, but smaller and lower.

**hummocked ice**. . Sea ice piled haphazardly one piece over another to form an uneven surface. When weathered, hummocked ice has the appearance of smooth hillocks.

**hummocking**, *n.* The pressure process by which sea ice is forced into hummocks. When the floes rotate in the process, it is called **SCREWING**.

**hunter's moon**. . The full moon following the harvest moon. See also **PHASES OF THE MOON**.

**hunting**, *n.* Fluctuation about a mid-point due to instability, as oscillations of the needle of an instrument about the zero point.

**hurricane**, *n.* 1. See under **TROPICAL CYCLONE**. 2. Wind of force 12 (64 knots and higher or 73 miles per hour and higher) on the Beaufort wind scale.

**hydraulic current**. . A current in a channel caused by a difference in the surface level at the two ends. Such a current may be expected in a strait connecting two bodies of water in which the tides differ in time or range. The current in the East River, N.Y., connecting Long Island Sound and New York Harbor, is an example.

**HYDROARC**, *n.* A report containing details about maritime hazards to surface ships and submarines in the international waters of the Arctic Ocean and adjacent northern seas. Any person who physically collects data, or has an interest in data collected in the Arctic region should refer to these reports

**hydrographer**, *n.* One who studies and practices the science of hydrography.

**hydrographic**, *adj.* Of or pertaining to hydrography.

**hydrographic datum**. . A datum used for referencing depths of water or the heights of predicted tides. See also **DATUM**.

**hydrographic sextant**. . A surveying sextant similar to those used for celestial navigation but smaller and lighter, constructed so that the maximum angle that can be read on it is slightly greater than that on the navigating sextant. Usually the angles can be read only to the nearest minute by means of a vernier. It is fitted with a telescope with a large object glass and field of view. Although the ordinary navigating sextant may be used in place of the hydrographic sextant, it is not entirely satisfactory for use in observing objects ashore which are difficult to see. Hydrographic sextants are either not provided with shade glasses or they are removed before use. Also called **SOUNDING SEXTANT**, **SURVEYING SEXTANT**.

**hydrographic survey**. . The survey of a water area, with particular reference to submarine relief, and any adjacent land. See also **OCEANOGRAPHIC SURVEY**.

**hydrography**, *n.* The science that deals with the measurement and description of the physical features of the oceans, seas, lakes, rivers, and their adjoining coastal areas, with particular reference to their use for navigation.

**HYDROLANT**, *n.* A radio message disseminated by the National Geospatial-Intelligence Agency and restricted to important marine incidents or navigational changes which affect navigational safety. The **HYDROLANT** broadcast covers those water areas outside and eastward of **NAVAREA IV** in the Atlantic Ocean. **HYDROLANT** messages constitute part of the U.S. long range radio navigational warning system. The text of effective **HYDROLANT** is available through **NAVINFONET** and printed in the weekly *Notice to Mariners*.

**hydrology**, *n.* The scientific study of the waters of the earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of ground water.

**hydrometeor**, *n.* Any product of the condensation or sublimation of atmospheric water vapor whether formed in the free atmosphere or at the earth's surface; also any water particles blown by the wind from the earth's surface. See also **LITHOMETEOR**.

**HYDROPAC**, *n.* A radio message disseminated by the National Geospatial-Intelligence Agency and restricted to important marine incidents or navigational changes which affect navigational safety. The **HYDROPAC** broadcast covers those water areas outside of **NAVAREA XII** in the Pacific Ocean. **HYDROPAC** messages constitute part of the U.S. long-range radio navigational warning system. The text of effective **HYDROPAC** messages is available through **NAVINFONET** and is printed in the weekly *Notice to Mariners*.

**hydrophone**, *n.* A listening device for receiving underwater sounds.

**hydrosphere**, *n.* The water portion of the earth as distinguished from the

solid part, called the **LITHOSPHERE**, and from the gaseous outer envelope, called the **ATMOSPHERE**.

**hyetal**, *adj.* Of or pertaining to rain.

**hygrometer**, *n.* An instrument for measuring the humidity of the air. The most common type is a psychrometer consisting of drybulb and wet-bulb thermometers.

**hygroscope**, *n.* An instrument which indicates variation in atmospheric moisture.

**hygroscopic**, *adj.* Able to absorb moisture.

**hyperbola**, *n.* An open curve with two parts, all points of which have a constant difference in distance from two fixed points called **FOCI**.

**hyperbolic**, *adj.* Of or pertaining to a hyperbola.

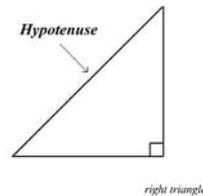
**hyperbolic lattice**. . A pattern formed by two or more families of intersecting hyperbolas.

**hyperbolic line of position**. . A line of position in the shape of a hyperbola, determined by measuring the difference in distance to two fixed points. Those who remember **Loran C** lines of position are familiar with those lines as an example.

**hyperbolic navigation**. . Radionavigation based on the measurement of the time differences in the reception of signals from several pairs of synchronized transmitters. For each pair of transmitters the isochrones are substantially hyperbolic. The combination of isochrones for two or more pairs of transmitters forms a hyperbolic lattice within which position can be determined according to the measured time differences.

**hypersonic**, *adj.* Of or pertaining to high supersonic speed, of the order of five times the speed of sound, or greater.

**hypotenuse**, *n.* The side of a plane right triangle opposite the right angle; the longest side of a plane right triangle.



**hypographic detail**. . The features pertaining to relief or elevation of terrain.

**hypographic map**. . A map showing land or submarine bottom relief in terms of height above, or below, a datum by any method, such as contours, hachures, shading, or hypsometric tinting. Also called **HYPSOMETRIC MAP**, **RELIEF MAP**.

**hypsography**, *n.* 1. The science or art of describing elevations of land surfaces with reference to a datum, usually sea level. 2. That part of topography dealing with relief or elevation of terrain.

**hypsometer**, *n.* An instrument for measuring height by determining the boiling temperature of a liquid. Its operation depends on the principle that boiling temperature is dependent on pressure, which normally varies with height.

**hypsometric map**. . See **HYPSOGRAPHIC MAP**.

**hypsometric tinting**. . A method of showing relief on maps and charts by coloring, in different shades, those parts which lie between different levels. Also called **ALTITUDE TINTS**, **COLOR GRADIENTS**, **ELEVATION TINTS**, **GRADIENT TINTS**, **LAYER TINTS**. See also **HYPSOMETRIC TINT SCALE**.

**hypsometric tint scale**. . A graphic scale in the margin of maps and charts which indicates heights or depths by graduated shades of color. See also **HYPSOMETRIC TINTING**.

**hysteresis**, *n.* The lagging of the effect caused by change of a force acting on anything.

**hysteresis error**. . That error in the reading of an instrument due to hysteresis.

## I

**IALA Maritime Buoyage System**. . A uniform system of maritime buoyage, organized by the International Association of Marine Aids to Navigation and Lighthouse Authorities, which is now implemented by most maritime nations. Within the system there are

two buoyage *regions*, designated as Region A and Region B, where lateral marks differ only in the colors of port and starboard hand marks. In Region A, red is to port on entering; in Region B, red is to starboard on entering. The system is a combined cardinal and lateral system, and applies to all fixed and floating marks, other than lighthouses, sector lights, leading lights and marks, lightships, and large navigational buoys.

**ice**, *n.* Frozen water, the solid form of H<sub>2</sub>O.

**ice anchor**. . An anchor designed for securing a vessel to ice.

**ice atlas**. . A publication containing a series of ice charts showing geographic distribution of ice, usually by seasons or months.

**iceberg**, *n.* A massive piece of ice greatly varying in shape, showing more than 5 meters above the sea surface, which has broken away from a glacier, and which may be afloat or aground. Icebergs may be described as blocky, dome shaped, dry dock, glacier, pinnacled, tabular, tilted, or weathered. For reports to the International Ice Patrol they are described with respect to size as small, medium, or large icebergs.

**iceberg tongue**. . A major accumulation of icebergs projecting from the coast, held in place by grounding, and joined together by fast ice.

**ice blink**. . A whitish glare on low clouds above an accumulation of distant ice.



ice blink

**icebound**, *adj.* Pertaining to a harbor, inlet, etc. when entry or exit is prevented by ice, except possibly with the assistance of an icebreaker.

**ice boundary**. . The demarcation at any given time between fast ice and pack ice or between areas of pack ice of different concentrations. See also ICE EDGE.

**ice breccia**. . Ice pieces of different age frozen together.

**ice bridge**, *n.* 1. Surface river ice of sufficient thickness to impede or prevent navigation. 2. An area of fast ice between the mainland and nearby inhabited islands used in winter as a means of travel.

**ice buoy**. . A sturdy buoy, usually a metal spar, used to replace a more easily damaged buoy during a period when heavy ice is anticipated.

**ice cake**. . Any relatively flat piece of sea ice less than 20 meters across. See also SMALL ICE CAKE.

**ice canopy**. . From the point of view of the submariner, PACK ICE.

**ice cap**. . A perennial cover of ice and snow over an extensive portion of the earth's surface. The largest ice caps are those in Antarctica and Greenland. Arctic Ocean ice is seasonal and in motion, and is not considered an ice cap.

**ice cover**. . The ratio, expressed in tenths, of the amount of ice to the total area of sea surface in a defined area; this locale may be global, hemispheric, or a specific geographic entity.

**ice crystal**. . Any one of a number of macroscopic crystalline forms in which ice appears.

**ice-crystal haze**. . A type of very light ice fog composed only of ice crystals (no droxtals). It is usually associated with precipitation of ice crystals.

**ice crystals**. . A type of precipitation composed of slowly falling, very small, unbranched crystals of ice which often seem to float in the air. It may fall from a cloud or from a cloudless sky. It is visible only in direct sunlight or in an artificial light beam, and does not appreciably reduce visibility. The latter quality helps to distinguish it from ice fog, which is composed largely of droxtals.

**ice edge**. . The demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting. See also COMPACTED ICE EDGE, DIFFUSE ICE EDGE, ICE BOUNDARY.

**ice field**. . An area of pack ice consisting of floes of any size, which is greater than 10 kilometers (5.4 nautical miles) across. Ice fields are subdivided according to areal extent. A large ice field is over 11 nautical miles across; a medium ice field is 8 to 11 nautical miles across; a small ice field is 5.4 to 8 nautical miles across.

**ice fog**. . Fog composed of suspended particles of ice, partly ice crystals 20 to 100 microns in diameter, but chiefly, especially when dense, droxtals 12 to 20 microns in diameter. It occurs at very low tem-

peratures, and usually in clear, calm weather in high latitudes. The sun is usually visible and may cause halo phenomena. Ice fog is rare at temperatures warmer than -30° C or -20°F. Also called RIME FOG. See also FREEZING FOG.

**ice foot**, *n.* A narrow fringe of ice attached to the coast, unmoved by tides and remaining after the fast ice has moved away.

**ice-free**, *adj.* Referring to a locale with no sea ice; there may be some ice of land origin present.

**ice front**. . The vertical cliff forming the seaward face of an ice shelf or other floating glacier varying in height from 2 to 50 meters above sea level. See also ICE WALL.

**ice island**. . A large piece of floating ice showing about 5 meters above the sea surface, which has broken away from an ice shelf, having a thickness of 30 to 50 meters and an area of from a few thousand square meters to 150 square nautical miles or more; usually characterized by a regularly undulating surface which gives it a ribbed appearance from the air.

**ice jam**. . An accumulation of broken river ice or sea ice caught in a narrow channel.

**ice keel**. . A downward projecting ridge on the underside of the ICE CANOPY, the counterpart of a RIDGE. An ice keel may extend as much as 50 meters below sea level.

**ice limit**. . The climatological term referring to the extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. The term should be preceded by minimum or maximum, as appropriate. See also MEAN ICE EDGE.

**ice massif**. . A concentration of sea ice covering an area of hundreds of kilometers, which is found in the same region every summer.

**ice needle**. . A long, thin ice crystal whose cross-section is typically hexagonal.

**ice of land origin**. . Ice formed on land or in an ice shelf, found floating in water, including ice that is stranded or grounded.

**ice patch**. . An area of pack ice less than 5.4 nautical miles (10 kilometers) across.

**ice pellets**. . A type of precipitation consisting of transparent or translucent pellets of ice, 5 millimeters or less in diameter. The pellets may be spherical, irregular, or (rarely) conical in shape. They usually bounce when hitting hard ground, and make a sound upon impact. The term includes two basically different types of precipitation, those which are known in the United States as SLEET and SMALL HAIL. Sleet is generally transparent, globular, solid grains of ice which have formed from the freezing of raindrops or the refreezing of largely melted snowflakes when falling through a below-freezing layer of air near the earth's surface. Small hail is generally translucent particles, consisting of snow pellets encased in a thin layer of ice. The ice layer may form either by the accretion of droplets upon the snow pellet, or by the melting and refreezing of the surface of the snow pellet.

**ice port**. . An embayment in an ice front, often of a temporary nature, where ships can moor alongside and unload directly onto the ice shelf.

**ice rind**. . A brittle, shiny crust of ice formed on a quiet surface by direct freezing or from grease ice, usually in water of low salinity. Of thickness to about 5 centimeters, ice rind is easily broken by wind or swell, commonly breaking into rectangular pieces.

**ice sheet**. . Continuous ice overlaying a large land area.

**ice shelf**. . A floating ice sheet attached to the coast and of considerable thickness, showing 20 to 50 meters or more above sea level. Usually of great horizontal extent and with a level or gently undulating surface, the ice shelf is augmented by annual snow accumulation and often also by the seaward extension of land glaciers. Limited areas of the ice shelf may be aground. The seaward edge is called ICE FRONT.

**ice storm**. . A storm characterized by a fall of freezing precipitation with significant buildup of ice on exposed surfaces.

**ice stream**. . The part of an inland ice sheet in which the ice flows more rapidly and not necessarily in the same direction as the surrounding ice. The margins are sometimes clearly marked by a change in direction of the surface slope, but may be indistinct.

**ice under pressure**. . Ice in which deformation processes are actively occurring; hence the ice is a potential impediment or danger to shipping.

**ice wall**. . An ice cliff forming the seaward margin of a glacier which is not afloat. An ice wall is aground with the underlying land at or below

- sea level. See also ICE FRONT.
- ice-worn**, *adj.* Abraded by ice.
- icicle**, *n.* A hanging mass of ice, usually conical, formed by the freezing of dripping water.
- IHO Transfer Standard for Digital Hydrographic Data**, *n.* In ECDIS a "THEORETICAL DATA MODEL", "DATA STRUCTURE", "OBJECT CATALOGUE", "ENC PRODUCT SPECIFICATION", "USE OF THE OBJECT CATALOGUE for ENC" and an "Object Catalogue DATA DICTIONARY Product Specification" for use in the exchange or transfer of digital hydrographic data.
- illuminance**, *n.* The luminous flux per unit of area. The derived unit of illuminance in the International System of Units is the LUX.
- IHO test data set**, *n.* See ENC test data set.
- image**, *n.* 1. The optical counterpart of an object. A real image is actually produced and is capable of being shown on a surface, as in a camera; while a virtual image cannot be shown on a surface, but is visible, as in a mirror. 2. A visual representation, as on a radarscope.
- improved channels**, *n.* Dredged channels under the jurisdiction of the U.S. Army Corps of Engineers, and maintained to provide an assigned CONTROLLING DEPTH. Symbolized on National Ocean Survey charts by black, broken lines to represent side limits, with the controlling depth and date of the survey given together with a tabulation of more detailed information.
- impulse train**, *n.* See PULSE TRAIN.
- in-band racon**, *n.* A racon which transmits in the marine radar frequency band. There are two types of in-band racons, swept-frequency racons and experimental fixed-frequency racons. The transmitter of the swept-frequency racon sweeps through a range of frequencies within the band to ensure that a radar receiver tuned to a particular frequency within the band will be able to detect the signal. The fixed-frequency racon transmits on a fixed frequency at the band edge. It is therefore necessary that the radar set be tuned to the racon's transmitting frequency or that auxiliary receiving equipment be used. When the radar is tuned to the fixed-frequency racon, normal radar echoes are not painted on the radarscope. See also CROSS-BAND RACON.
- incandescence**, *n.* Emission of light due to high temperature. Any other emission of light is called LUMINESCENCE.
- inch**, *n.* A unit of length equal to one-twelfth of a foot, or 2.54 centimeters.
- incidence**, *n.* 1. Partial coincidence, as a circle and a tangent line. 2. The impingement of a ray on a surface.
- incident ray**, *n.* A ray impinging on a surface.
- incineration area**, *n.* An officially designated offshore area for the burning of chemical waste by specially equipped vessels. The depiction of incineration areas on charts (in conjunction with radio warnings) is necessary to ensure that passing vessels do not mistake the burning of waste for a vessel on fire.
- inclination**, *n.* 1. The angle which a line or surface makes with the vertical, horizontal, or with another line or surface. 2. One of the orbital elements (parameters) that specifies the orientation of an orbit. It is the angle between the orbital plane and a reference plane, the plane of the celestial equator for geocentric orbits and the ecliptic for heliocentric orbits. See also ORBITAL ELEMENTS, ORBITAL PARAMETERS OF ARTIFICIAL EARTH SATELLITES.
- inclination of an orbit**, *n.* 1. See INCLINATION, definition 2. 2. As defined by the International Telecommunication Union (ITU), the angle determined by the plane containing an orbit and the plane of the earth's equator.
- increment**, *n.* A change in the value of a variable. A negative increment is also called DECREMENT.
- independent surveillance**, *n.* Position determination by means requiring no cooperation from the craft or vehicle.
- index**, *(pl. indices or indexes)*, *n.* 1. A mark on the scale of an instrument, diagram, etc., to indicate the origin of measurement. 2. A pointer or part of an instrument which points to a value, like the needle of a gauge. 3. A list or diagram serving as a guide to a book, set of charts, etc. 4. A ratio or value used as a basis for comparison of other values.
- index arm**, *n.* A slender bar carrying an index; particularly the bar which pivots at the center of curvature of the arc of a marine sextant and carries the index and the vernier or micrometer.
- index chart**, *n.* An outline chart showing the limits and identifying designations of navigational charts, volumes of sailing directions, etc.
- index correction**, *n.* The correction due to index error.
- index error**, *n.* The error in the reading of an instrument equal to the difference between the zero of the scale and the zero of the index. In a marine sextant it is due primarily to lack of parallelism of the index mirror and the horizon glass at zero reading.
- index glass**, *n.* See INDEX MIRROR.
- index mirror**, *n.* The mirror attached to the index arm of a marine sextant. The bubble or pendulum sextant counterpart is called INDEX PRISM. Also called INDEX GLASS.
- index prism**, *n.* A sextant prism which can be rotated to any angle corresponding to altitudes between established limits. It is the bubble or pendulum sextant counterpart of the INDEX MIRROR of a marine sextant.
- Indian Equatorial Countercurrent**, *n.* A complex Indian Ocean current which is influenced by the monsoons and the circulations of the Arabian Sea and the Bay of Bengal. At times it is easily distinguishable; at other times it is not evident. During December through March, the countercurrent has a marked tendency to migrate southward and to become narrower. In December the northern and southern boundaries are at 2°N and 4°S, respectively, moving southward to 3°S and 6°S by February. The northern boundary of Indian Equatorial Countercurrent is easily discernible at this time due to the generally westward current flow in the region immediately north. During May through July the cell, within which the Indian Equatorial Countercurrent and the Monsoon Drift flow clockwise, moves toward the west side of the region. In June and July the southeastward flowing currents prevail in the region between the Bay of Bengal and the Indian South Equatorial Current; only traces of the countercurrent remain. During August through November eastward flowing currents prevail north of the Indian Equatorial Countercurrent. As a result, the northern boundary of the countercurrent is difficult to distinguish from the eastward drift currents. See also MONSOON.
- Indian South Equatorial Current**, *n.* An Indian Ocean current that flows westward throughout the year, controlled by the southeast trade winds. Its northern and southern boundaries are at approximately 10°S and 25°S, respectively. The northern boundary of the current fluctuates seasonally between 9°S and 11°S, being at its northernmost limit during the southwest monsoon and at its southernmost limit during the northeast monsoon. The current flows westward toward the east coast of Madagascar to the vicinity of Tamatave and Ile Sainte-Marie, where it divides; one part turns northward, flows past the northern tip of the island with speeds up to 3.3 knots, and then flows westward and northwestward toward the African coast. The northern branch of the current divides upon reaching the coast of Africa near Cabo Delgado; one part turns and flows northward, the other turns and flows southward in the western part of the Mozambique Channel and forms the AGULHAS CURRENT. See also MONSOON.
- Indian spring low water**, *n.* A tidal datum originated by G.H. Darwin when investigating the tides of India. It is an elevation depressed below mean sea level by an amount equal to the sum of the amplitudes of certain harmonic constituents. Also called INDIAN TIDE PLANE, HARMONIC TIDE PLANE.
- Indian summer**, *n.* An indefinite and irregular period of mild, calm, hazy weather often occurring in autumn or early winter, especially in the United States and Canada.
- Indian tide plane**, *n.* See INDIAN SPRING LOW WATER.
- indicator**, *n.* See RADAR INDICATOR.
- indirect echo**, *n.* A radar echo which is caused by the electromagnetic energy being transmitted to the target by an indirect path and returned as an echo along the same path. An indirect echo may appear on the radar display when the main lobe of the radar beam is reflected off part of the structure of the ship (the stack for example) from which it is reflected to the target. Returning to own ship by the same indirect path, the echo appears on the PPI at the bearing of the reflecting surface. Assuming that the additional distance by the indirect path is negligible, the indirect echo appears on the PPI at the same range as the direct echo received. Also called FALSE ECHO.
- indirect wave**, *n.* A radio wave which reaches a given reception point by a path from the transmitting point other than the direct line path between the two. An example is the SKYWAVE received after reflection from one of the layers of the ionosphere.
- induced magnetism**, *n.* The magnetism acquired by soft iron while it is in a magnetic field. Soft iron will lose its induced magnetism when it

- is removed from a magnetic field. The strength and polarity of the induced magnetism will alter immediately as its magnetic latitude, or its orientation in a magnetic field, is changed. The induced magnetism has an immediate effect upon the magnetic compass as the magnetic latitude or heading of a craft changes. See also PERMANENT MAGNETISM, SUBPERMANENT MAGNETISM.
- induced precession.** . See REAL PRECESSION.
- inequality** . (*tidal*), *n.* A systematic departure from the mean value of a tidal quantity.
- inertia** . , *n.* The tendency of a body at rest to remain at rest and of a body in motion to remain in motion, unless acted upon by another force. See also GYROSCOPIC INERTIA.
- inertial alignment.** . The process of orienting the measuring axes of the inertial components of inertial navigation equipment with respect to the coordinate system in which the equipment is to be used.
- inertial coordinate system.** . A coordinate system in which the axes do not rotate with respect to the "fixed stars" and in which dynamic behavior can be described using Newton's laws of motion. See also EARTH-FIXED COORDINATE SYSTEM.
- inertial force.** . A force in a given coordinate system arising from the inertia of a mass moving with respect to another coordinate system.
- inertial navigation.** . The process of measuring a craft's velocity, attitude, and displacement from a known start point through sensing the accelerations acting on it in known directions using devices that mechanize Newton's laws of motion. Inertial navigation is described as self-contained because it is independent of external aids to navigation, and passive because no energy is emitted to obtain information. The basic principle of inertial navigation is the measurement of the accelerations acting on a craft, other than those not associated with its orientation or motion with respect to the earth, and the double integration of these accelerations along known directions to obtain the displacement from the start point. Due to increasing position errors with time, an inertial system must be reset from time to time using another navigation system.
- in extremis.** . Condition in which changes in course and/or speed are required on the part of both ships if the ships are to avoid collision.
- inferior conjunction.** . The conjunction of an inferior planet and the sun when the planet is between the earth and the sun.
- inferior planets.** . The planets with orbits smaller than that of the earth; Mercury and Venus. See also PLANET.
- inferior transit.** . See LOWER TRANSIT.
- infinite.** . , *adj.* Without limits. The opposite is FINITE.
- infinitesimal.** . , *adj.* 1. Immeasurably small. 2. Approaching zero as a limit.
- infinity.** . , *n.* Beyond finite limits. In navigation, a source of light is regarded as at infinity if it is at such a great distance that rays from it can be considered parallel. The sun, planets, and stars can be considered at infinity without serious error. See also PARALLAX.
- inflection, inflexion.** . , *n.* Reversal of direction of curvature. A point at which reversal takes place is called POINT OF INFLECTION.
- infrared.** . , *adj.* Having a frequency immediately beyond the red end of the visible spectrum; rays of longer wavelength than visible light, but shorter than radio waves.
- infrasonic.** . , *adj.* Having a frequency below the audible range. Frequencies above the audible range are called ULTRASONIC.
- initial great circle course.** . The direction, at the point of departure, of the great circle through that point and the destination, expressed as the angular distance from a reference direction, usually north, to that part of the great circle extending toward the designation. Also called INITIAL GREAT CIRCLE DIRECTION. See also FINAL GREAT CIRCLE COURSE.
- initial great circle direction.** . See INITIAL GREAT CIRCLE COURSE.
- injection messages.** . Messages periodically transmitted to artificial satellites for storage in satellite memory.
- Inland Rules of the Road.** . Officially the Inland Navigation Rules; Rules to be followed by all vessels while navigating upon certain defined inland waters of the United States. See also COLREGS DEMARCATION LINES, RULES OF THE ROAD.
- inland sea.** . A body of water nearly or completely surrounded by land, especially if very large or composed of salt water. If completely surrounded by land, it is usually called a LAKE. This should not be confused with CLOSED SEA, that part of the ocean enclosed by headlands, within narrow straits, etc., or within the territorial jurisdiction of a country.
- inlet.** . , *n.* A narrow body of water extending into the land from a larger body of water. A long, narrow inlet with gradually decreasing depth inward is called a RIA. Also called TONGUE.
- inner harbor.** . The part of a harbor most remote from the sea, as contrasted with the OUTER HARBOR. These expressions are usually used only in a harbor that is clearly divided into two parts by a narrow passageway or man-made structures.
- inner planets.** . The four planets nearest the sun; Mercury, Venus, Earth, and Mars.
- inoperative.** . , *adj.* Said of a sound signal or radionavigation aid out of service due to a malfunction.
- in phase.** . The condition of two or more cyclic motions which are at the same part of their cycles at the same instant. Two or more cyclic motions which are not at the same part of their cycles at the same instant are said to be OUT OF PHASE.
- input axis.** . The axis of applied torque of a gyroscope. See also OUTPUT AXIS, PRECESSION.
- inshore.** . , *adj., adv.* Near or toward the shore.
- inshore.** . , *n.* The zone of variable width between the shore face and the seaward limit of the breaker zone.
- inshore traffic zone.** . A routing measure comprising a designated area between the landward boundary of a traffic separation scheme and the adjacent coast, intended for local traffic.
- in situ.** . A Latin term meaning "in place"; in the natural or original position.
- insolation.** . , *n.* Solar radiation received, or the rate of delivery of such radiation.
- instability.** . , *n.* The state or property of submitting to change or of tending to increase the departure from original conditions after being disturbed. The opposite is STABILITY.
- instability line.** . Any non-frontal line or band of convective activity in the atmosphere. This is the general term and includes the developing, mature, and dissipating stages. However, when the mature stage consists of a line of active thunderstorms, it is properly called SQUALL LINE; therefore, in practice, *instability line* often refers only to the less active phases. Instability lines are usually hundreds of miles long (not necessarily continuous), 10 to 50 miles wide, and are most often formed in the warm sectors of wave cyclones. Unlike true fronts, they are transitory in character, ordinarily developing to maximum intensity in less than 12 hours and then dissipating in about the same time. Maximum intensity is usually attained in late afternoon.
- instrument correction.** . That correction due to instrument error.
- instrument error.** . The inaccuracy of an instrument due to imperfections within the instrument. See CALIBRATION ERROR, CENTERING ERROR, FRICTION ERROR, GRADUATION ERROR, HYSTERESIS ERROR, LAG ERROR, PRISMATIC ERROR, SECULAR ERROR, TEMPERATURE ERROR, VERNIER ERROR.
- instrument shelter.** . A cage or screen in which a thermometer and sometimes other instruments are placed to shield them from the direct rays of the sun and from other conditions that would interfere with registration of true conditions. It is usually a small wooden structure with louvered sides.
- insular.** . , *adj.* Of or pertaining to an island or islands.
- insular borderland.** . A region around an island normally occupied by or bordering a shelf, that is highly irregular with depths well in excess of those typical of a shelf. See also CONTINENTAL BORDERLAND.
- insular shelf.** . A zone around an island that extends from the low water line to a depth at which there is usually a marked increase of slope towards oceanic depths. See also CONTINENTAL SHELF.
- insulate.** . , *v., t.* To separate or isolate a conducting body from its surroundings, by means of a nonconductor, as to prevent transfer of electricity, heat, or sound.
- insulator.** . , *n.* A non-conducting substance or one offering high resistance to passage of energy.
- integer.** . , *n.* A whole number; a number that is not a fraction.
- integral.** . , *adj.* Of or pertaining to an integer.
- integral Doppler navigation.** . Navigation by means of integrating the Doppler frequency shift that occurs over a specific interval of time as the distance between a navigational satellite and navigator is changing to determine the time rate of change of range of the satellite from the navigator for the same interval. See also DOPPLER SATELLITE NAVIGATION.

- integrated navigation system.** . A navigation system which comprises two or more positioning systems combined in such manner as to achieve performance better than each constituent system.
- integrating accelerometer.** . An instrument which senses the component of specific acceleration along an axis known as the sensitive axis of the accelerometer, and produces an output equal to the time integral of that quantity. Also called VELOCITY METER.
- intended track.** . See TRACK, definition 2.
- intercalary day.** . A day inserted or introduced among others in a calendar, such as February 29 during leap years.
- intercardinal heading.** . A heading in the direction of any of the intercardinal points. See also CARDINAL HEADING.
- intercardinal point.** . Any of the four directions midway between the cardinal points; northeast, southeast, southwest, or northwest. Also called QUADRANTAL POINT.
- intercardinal rolling error.** . See under QUADRANTAL ERROR.
- intercept.** . *n.* See ALTITUDE INTERCEPT, ALTITUDE INTERCEPT METHOD.
- interference.** . *n.* 1. Unwanted and confusing signals or patterns produced by nearby electrical equipment or machinery, or by atmospheric phenomena. 2. The variation of wave amplitude with distance or time, caused by superposition of two or more waves. Sometimes called WAVE INTERFERENCE.
- interferometer.** . *n.* An apparatus used to produce and measure interference from two or more coherent wave trains from the same source. Used to measure wavelengths, to measure angular width of sources, to determine the angular position of sources (as in satellite tracking), and for other purposes. See also RADIO INTERFEROMETER.
- interlaced.** . Referring to a computer monitor which displays data by scanning alternate lines instead of each line sequentially.
- intermediate frequency.** . In super heterodyne reception, the frequency which is derived by mixing the signal-carrying frequency with the local oscillator frequency. If there is more than one such mixing process, the successive intermediate frequencies are known as the first, second, etc. intermediate frequency.
- intermediate light.** . The middle light of the three-light range.
- intermediate orbit.** . A central force orbit that is tangent to the real (or disturbed) orbit at some point. A fictitious satellite traveling in the intermediate orbit would have the same position, but not the same velocity, as the real satellite at the point of tangency.
- internal noise.** . In radio reception, the noise which is produced in the receiver circuits. Internal noise is in addition to external noise.
- internal tide.** . A tidal wave propagating along a sharp density discontinuity, such as at a thermocline, or in an area of gradual changing density (vertically).
- International Atomic Time.** . See under ATOMIC TIME.
- International Bureau of Weights and Measures.** . The International Bureau of Weights and Measures (BIPM) ensures worldwide unification of physical measurements. It is responsible for establishing the fundamental standards and scales for measurement of the principal physical quantities, maintaining the international prototypes, carrying out comparisons of national and international standards, ensuring coordination of corresponding measuring techniques, and carrying out and coordinating the determinations relating to the fundamental physical constants.
- international call sign.** . An alpha-numeric symbol assigned in accordance with the provisions of the International Telecommunications Union to identify a radio station. The nationality of the radio station is identified by the first three characters; also referred to as call letters or signal letters.
- international chart.** . One of a coordinated series of small-scale charts for planning and long range navigation. The charts are prepared and published by different Member States of the International Hydrographic Organization using the same specifications.
- International Code of Signals.** . See PUB. NO. 102.
- international date line.** . See DATE LINE.
- International ellipsoid of reference.** . The reference ellipsoid of which the semimajor axis is 6,378,388.0 meters, the semiminor axis is 6,356,911.946 meters, and the flattening or ellipticity is 1/297. Also called INTERNATIONAL SPHEROID OF REFERENCE.
- International Great Lakes Datum (1955).** . Mean water level at Pointeau-Pere, Quebec, on the Gulf of St. Lawrence over the period 1941-1956, from which dynamic elevations throughout the Great Lakes region are measured. The term is often used to mean the entire system of dynamic elevations rather than just the referenced water level.
- International Hydrographic Bulletin.** . A publication, published monthly by the International Hydrographic Bureau for the International Hydrographic Organization, which contains information of current hydrographic interest.
- International Hydrographic Bureau (IHB).** . The Directors and administrative staff of the International Hydrographic Organization, based in Monaco.
- International Hydrographic Organization (IHO).** . An institution formed in 1921, consisting of representatives of maritime nations organized for the purpose of coordinating the hydrographic work of the participating governments.
- International Maritime Organization (IMO).** . A Specialized Agency of the United Nations responsible for maritime safety and efficiency of navigation. The IMO enables cooperation among governments in matters affecting shipping and international trade. It encourages the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation, and the prevention and control of marine pollution.
- International Nautical Mile.** . A unit of length equal to 1,852 meters, exactly. See also NAUTICAL MILE.
- international number.** . An alpha-numeric designation given to navigational lights to facilitate the exchange of light information between maritime offices of different countries. The United Kingdom Hydrographic Office (UKHO) is responsible for the designation of an international number for a light. Both the national and the international light numbers are given in the light list, with the international number shown in italic type under the national number. See LIGHT LIST NUMBER.
- International spheroid of reference.** . See INTERNATIONAL ELLIPSOID OF REFERENCE.
- International System of Units (SI).** . A modern form of the metric system adopted in 1960 by the General Conference of Weights and Measures (CGPM). The units of the International System of Units (SI) are divided into three classes. The first class of SI units are the base units or the seven well defined units which by convention are regarded as dimensionally independent: the meter the kilogram, the second, the ampere, the kelvin, the mole, and the candela. The second class of SI units are the derived units, i.e., the units that can be formed by combining base units according to the algebraic relations linking the corresponding quantities. Several of these algebraic expressions in terms of base units can be replaced by special names and symbols which can themselves be used to form other derived units. The third class of SI units are the supplementary units, those units not yet classified by the CGPM as either base units or derived units. In 1969 the International Committee of Weights and Measures (CIPM) recognized that users of SI units will wish to employ with it certain units not part of SI, but which are important and widely used. These are the minute, the hour, the day, the degree of arc, the minute of arc, the second of arc, the liter, and the tonne. Outside the International System are some other units useful in specialized fields. Their value expressed in SI units must be obtained by experiment, and are therefore not known exactly. These are the electron-volt, the unified atomic mass unit, the astronomical unit, and the parsec. Other temporary units are the nautical mile, the knot, the angstrom, the arc, the hectare, the barn, the bar, the standard atmosphere, the gal, the curie, the röntgen, and the rod.
- interpolation.** . *n.* The process of determining intermediate values between given values in accordance with some known or assumed rate or system of change. Linear interpolation assumes that changes of tabulated values are proportional to changes in entering arguments. Interpolation is designated as single, double, or triple if there are one, two, or three arguments or variables respectively. The extension of the process of interpolation beyond the limits of known value is called EXTRAPOLATION.
- interpolation table.** . An auxiliary table used for interpolating. See also PROPORTIONAL PARTS.
- interrogating signal.** . The signal emitted by an interrogator to trigger a transponder.
- interrogation.** . *n.* The transmission of a radio frequency pulse, or combination of pulses, intended to trigger a transponder or group of transponders.
- interrogator.** . *n.* A radar transmitter which sends out a pulse that triggers a transponder. An interrogator may be combined in a single unit

- with a responder, which receives the reply from a transponder and produces an output suitable for feeding a display system; the combined unit is called INTERROGATOR-RESPONSOR. Also called CHALLENGER.
- interrogator-responder**, *n.* A radar transmitter and receiver combined to interrogate a transponder and display the resulting replies. Often shortened to INTERROGATOR and sometimes called CHALLENGER.
- interrupted quick flashing light**. A quick flashing light (50-80 flashes per minute) that is interrupted at regular intervals by eclipses of long duration. See also QUICK FLASHING LIGHT, VERY QUICK FLASHING LIGHT.
- interrupted quick light**. A quick light in which the sequence of flashes is interrupted by regularly repeated eclipses of constant and long duration. See also CONTINUOUS QUICK LIGHT, GROUP QUICK LIGHT.
- interrupted very quick light**. A very quick light (80-160 flashes per minute) in which the sequence of flashes is interrupted by regularly repeated eclipses of long duration. See also CONTINUOUS VERY QUICK LIGHT, GROUP VERY QUICK LIGHT.
- inter scan**, *n.* See INTER-TRACE DISPLAY.
- intersect**, *v., t. & i.* To cut or cross. For example, two non parallel lines in a plane intersect in a point, and a plane intersects a sphere in a circle.
- inter-trace display**. A technique for presenting additional information, in the form of alphanumerics, markers, cursors, etc., on a radar display, by using the intervals between the normal presentation scans. Also called INTER-SCAN.
- Intracoastal Waterway**. An inland waterway for small craft and small commercial vessels extending, in three non-contiguous segments, from Brownsville, Texas to Norfolk, Virginia, through New Jersey; Segments stretch from Brownsville, Texas to Carrabelle, Florida; Tarpon Springs, Florida to Fort Myers, Florida; and Key West, Florida to Norfolk, Virginia. Some portions of the waterway are in exposed waters, and some portions are very limited in depth.
- Invar**, *n.* The registered trade name for an alloy of nickel and iron, containing about 36% nickel. Its coefficient of expansion is extremely small over a wide range of temperature.
- inverse chart**. See TRANSVERSE CHART.
- inverse cylindrical orthomorphic chart**. See TRANSVERSE MERCATOR CHART.
- inverse cylindrical orthomorphic map projection**. See TRANSVERSE MERCATOR MAP PROJECTION.
- inverse equator**. See TRANSVERSE EQUATOR.
- inverse latitude**. See TRANSVERSE LATITUDE.
- inverse logarithm**. See ANTILOGARITHM.
- inverse longitude**. See TRANSVERSE LONGITUDE.
- inverse Mercator chart**. See TRANSVERSE MERCATOR CHART.
- inverse Mercator map projection**. See TRANSVERSE MERCATOR MAP PROJECTION.
- inverse meridian**. See TRANSVERSE MERIDIAN.
- inverse parallel**. See TRANSVERSE PARALLEL.
- inverse rhumb line**. See TRANSVERSE RHUMB LINE.
- inversion**, *n.* In meteorology, a departure from the usual decrease or increase with altitude of the value of an atmospheric property. This term is almost always used to refer to a temperature inversion, an atmospheric condition in which the temperature increases with increasing altitude.
- inverted compass**. A marine magnetic compass designed and installed for observation from below the compass card. Frequently used as a telltale compass. Also called HANGING COMPASS, OVERHEAD COMPASS.
- inverted image**. An image that appears upside down in relation to the object.
- inverter**, *n.* A device for changing direct current to alternating current. A device for changing alternating current to direct current is called a CONVERTER if a rotary device and a RECTIFIER if a static device.
- inverting telescope**. An instrument with the optics so arranged that the light rays entering the objective of the lens meet at the crosshairs and appear inverted when viewed through the eyepiece without altering the orientation of the image. See also ERECTING TELESCOPE.
- inward bound**. Heading toward the land or up a harbor away from the open sea. The opposite is OUTWARD BOUND.
- ion**, *n.* An atom or group of atoms which has become electrically charged, either positively or negatively, by the loss or gain of one or more electrons.
- ionization**, *n.* The process by which neutral atoms or groups of atoms become electrically charged either positively or negatively, by the loss or gain of electrons; or the state of a substance whose atoms or groups of atoms have become thus charged.
- ionized layers**. Layers of charged particles existing in the upper reaches of the atmosphere as a result of solar radiation.
- ionosphere**, *n.* 1. The region of the atmosphere extending from about 40 to 250 miles above the earth's surface, in which there is appreciable ionization. The presence of charged particles in this region profoundly affects the propagation of certain electromagnetic radiation. 2. A region composed of highly ionized layers at varying heights above the surface of the earth which may cause the return to the earth of radio waves originating below these layers. See also D-LAYER, E-LAYER, F-LAYER, F1-LAYER, F2-LAYER.
- ionospheric correction**. A correction for ionospheric refraction, a major potential source of error in all satellite radionavigation systems. Navigation errors can result from the effect of refraction on the measurement of the doppler shift and from the errors in the satellite's orbit if refraction is not accurately accounted for in the satellite tracking. The refraction contribution can be eliminated by the proper mixing of the received Doppler shift from two harmonically related frequencies to yield an accurate estimate of the vacuum doppler shift. Also called REFRACTION CORRECTION.
- ionospheric delay**. The delay experienced by a wave or signal as it passes through the ionosphere.
- ionospheric disturbance**. A sudden outburst of ultraviolet light on the sun, known as a SOLAR FLARE or CHROMOSPHERIC ERUPTION, which produces abnormally high ionization in the region of the D-layer. The result is a sudden increase in radio wave absorption, with particular severity in the upper medium frequencies and lower high frequencies. It has negligible effects on the heights of the reflecting/refracting layers and, consequently, upon critical frequencies, but enormous transmission losses may occur. See also SUDDEN IONOSPHERIC DISTURBANCE.
- ionospheric error**. The total systematic and random error resulting from the reception of a navigation signal after ionospheric reflections. It may be due to variations in transmission paths, non-uniform height of the ionosphere, or non-uniform propagation within the ionosphere. Also called IONOSPHERIC-PATH ERROR, SKYWAVE ERROR.
- ionospheric-path error**. See IONOSPHERIC ERROR.
- ionospheric storm**. An ionospheric disturbance characterized by wide variations from normal in the state of the ionosphere, such as turbulence in the F-region, absorption increase, height increase, and ionization density decreases. The effects are most marked in high magnetic latitudes and are associated with abnormal solar activity.
- ionospheric refraction**. Change in the propagation speed of a signal as it passes through the ionosphere.
- ionospheric wave**. See SKYWAVE.
- iridescence**, *n.* Changing-color appearance, such as of a soap bubble, caused by interference of colors in a thin film or by diffraction.
- iridescent clouds**. Ice-crystal clouds which exhibit brilliant spots or borders of colors, usually red and green, observed up to about 30° from the sun.



iridescent clouds

**irisation**, *n.* The coloration exhibited by iridescent clouds.

**Irminger Current**. A North Atlantic Ocean current, one of the terminal branches of the Gulf Stream System (part of the northern branch of the North Atlantic Current); it flows toward the west off the southwest coast of Iceland. A small portion of the water of the Irminger Current bends around the west coast of Iceland but the greater amount turns south and becomes more or less mixed with the water of the East Greenland Current.

**ironbound**, *adj.* Rugged, rocky, as an *ironbound coast*.

**irradiation**, *n.* The apparent enlargement of a bright surface against a darker background.

**irradiation correction**. A correction due to irradiation, particularly that sextant altitude correction caused by the apparent enlargement of the bright surface of a celestial body against the darker background of the sky.

**irregular error**. See RANDOM ERROR.

**irregular iceberg**. See PINNACLED ICEBERG.

**isallobar**, *n.* A line of equal change in atmospheric pressure during a specified time interval.

**isallotherm**, *n.* A line connecting points having the same anomalies of temperature, pressure, etc.

**isanomal**, *n.* A line connecting points of equal variations from a normal value.

**island**, *n.* An area of land not a continent, surrounded by water.

**islet**, *n.* A very small and minor island.

**iso-**. A prefix meaning equal.

**isobar**, *n.* A line connecting points having the same atmospheric pressure reduced to a common datum, usually sea level.

**isobaric**, *adj.* Having the same pressure.

**isobaric chart**. See CONSTANT-PRESSURE CHART.

**isobaric surface**. See CONSTANT-PRESSURE SURFACE.

**isobath**, *n.* See DEPTH CONTOUR.

**isobathic**, *adj.* Having equal depth.

**isobathytherm**, *n.* A line on the earth's surface connecting points at which the same temperature occurs at some specified depth.

**isobront**, *n.* A line connecting points at which some specified phase of a thunderstorm occurs at the same time.

**isoceraunic, isokeraunic**, *adj.* Indicating or having equal frequency or intensity of thunderstorms.

**isochasm**, *n.* A line connecting points having the same average frequency of auroras.

**isochronal**, *adj.* Of equal time; recurring at equal intervals of time. Also called ISOCHRONOUS.

**isochrone**, *n.* A line connecting points having the same time or time difference relationship, as a line representing all points having the same time difference in the reception of signals from two radio stations such as the master and secondary stations of a Loran rate.

**isochronize**, *v., t.* To render isochronal.

**isochronon**, *n.* A clock designed to keep very accurate time.

**isochronous**, *adj.* See ISOCHRONAL.

**isoclinal**, *adj.* Of or pertaining to equal magnetic dip.

**isoclinal**, *n.* See ISOCLINIC LINE.

**isoclinal chart**. See ISOCLINIC CHART.

**isoclinic chart**. A chart of which the chief feature is a system of isoclinic lines. Also called ISOCLINICAL CHART.

**isoclinic line**. A line drawn through all points on the earth's surface having the same magnetic dip. The particular isoclinic line drawn through points of zero dip is called ACLINIC LINE. Also called ISOCLINAL.

**isodynamic chart**. A chart showing isodynamic lines. See also MAGNETIC CHART.

**isodynamic line**. A line connecting points of equal magnetic intensity, either the total or any component.

**isogonal**, *adj.* Having equal angles; isogonic.

**isogonic**, *adj.* Having equal angles; isogonal.

**isogonic**, *n.* A line connecting points of equal magnetic variation. Also called ISOGONIC LINE, ISOGONAL.

**isogonic chart**. A chart showing magnetic variation with isogonic lines and the annual rate of change in variation with isoporic lines. See also MAGNETIC CHART.

**isogonic line**. See ISOGONIC, *n.*

**isogram**, *n.* That line, on a chart or diagram, connecting points of equal value of some phenomenon.

**isogriv**, *n.* A line drawn on a map or chart joining points of equal grivation.

**isogriv chart**. A chart showing isogrivs. See also MAGNETIC CHART.

**isohaline, isohalsine**, *n.* A line connecting points of equal salinity in the ocean.

**isolated danger mark (or buoy)**. An IALA navigation aid marking a danger with clear water all around; it has a double ball topmark and is black with at least one red band. If lighted its characteristic is F(2).

**isolated node**. In ECDIS an isolated zero-dimensional SPATIAL

OBJECT that represents the geometric location of a point FEATURE.

**isosceles**, *adj.* Having two equal sides.

**isosceles triangle**. A triangle having two of its sides equal.

**isomagnetic**, *adj.* Of or pertaining to lines connecting points of equality in some magnetic element *t*.

**isomagnetic**, *n.* A line connecting points of equality in some magnetic element. Also called ISOMAGNETIC LINE.

**isomagnetic chart**. A chart showing isomagnetics. See also MAGNETIC CHART.

**isomagnetic line**. See ISOMAGNETIC, *n.*

**isometric**, *n.* Of or pertaining to equal measure.

**isophase**, *adj.* Referring to a light having a characteristic of equal intervals of light and darkness.

**isopleth**, *n.* 1. An isogram indicating the variation of an element with respect to two variables, one of which is usually the time of year. The other may be time of day, altitude, or some other variable. 2. A line on a map depicting points of constant value of a variable. Examples are contours, isobars, and isogons.

**isopor**, *n.* See ISOPORIC LINE.

**isoporic chart**. A chart with lines connecting points of equal annual rate of change of any magnetic element. See also ISOPORIC LINE.

**isoporic line**. A line connecting points of equal annual rate of change of any magnetic element. Also called ISOPOR. See also ISOGONIC.

**isostasy**, *n.* A supposed equality existing in vertical sections of the earth, whereby the weight of any column from the surface of the earth to a constant depth is approximately the same as that of any other column of equal area, the equilibrium being maintained by plastic flow of material from one part of the earth to another.

**isotropic antenna**. A hypothetical antenna which radiates or receives equally well in all directions. Although such an antenna does not physically exist, it provides a convenient reference for expressing the directional properties of actual antennas. Also called UNIPOLE ANTENNA.

**isotropic gain**. The gain of an antenna in a given direction when the reference antenna is an isotropic antenna isolated in space. Also called ABSOLUTE GAIN (of an antenna).

**isthmus**, *n.* A narrow strip of land connecting two larger portions of land. A submarine elevation joining two land areas and separating two basins or depressions by a depth less than that of the basins is called a submarine isthmus.

**Issuing Authority**, *n.* In ECDIS the official agency which issues nautical chart and updates including ENC's and ENC UPDATES.

## J

**Jacob's staff**. See CROSS-STAFF.

**jamming**, *n.* Intentional transmission or re-radiation of radio signals in such a way as to interfere with reception of desired signals by the intended receiver.

**Janus configuration**. A term describing orientations of the beams of acoustic or electromagnetic energy employed with doppler navigation systems. The Janus configuration normally used with doppler sonar speed logs, navigators, and docking aids employs four beams of ultrasonic energy, displaced laterally 90° from each other, and each directed obliquely (30° from the vertical) from the ship's bottom, to obtain true ground speed in the fore and aft and athwartship directions. These speeds are measured as doppler frequency shifts in the reflected beams. Certain errors in data extracted from one beam tend to cancel the errors associated with the oppositely directed beam.

**Japan Current**. See KUROSHIO.

**jetsam**, *n.* Articles that sink when thrown overboard, particularly those jettisoned for the purpose of lightening a vessel in distress. See also FLOTSAM, JETTISON, LAGAN.

**jet stream**. Relatively strong winds (50 knots or greater) concentrated in a narrow stream in the atmosphere. It usually refers only to a quasi-horizontal stream of maximum winds imbedded in the middle latitude westerlies, and concentrated in the high troposphere.

**jettison**, *n.* To throw objects overboard, especially to lighten a craft in distress. Jettisoned objects that float are termed FLOTSAM; those that sink JETSAM; and heavy articles that are buoyed for future recovery, LAGAN. See also DERELICT.

**jetty**, *n.* A structure built out into the water to restrain or direct currents, usually to protect a river mouth or harbor entrance from silting, etc. See also GROIN; MOLE, definition 1.

**jitter**, *n.* A term used to describe the short-time instability of a signal. The instability may be in amplitude, phase, or both. The term is applied especially to signals reproduced on the screen of a cathode-ray tube.

**joule**, *n.* A derived unit of energy of work in the International System of Units; it is the work done when the point of application of 1 newton (that force which gives to a mass of 1 kilogram an acceleration of 1 meter per second, per second) moves a distance of 1 meter in the direction of the force.

**Julian calendar**. A revision of the ancient calendar of the city of Rome, instituted in the Roman Empire by Julius Caesar in 46 B.C., which reached its final form in about 8 A.D. It consisted of years of 365 days, with an intercalary day every fourth year. The current Gregorian calendar is the same as the Julian calendar except that October 5, 1582, of the Julian calendar became October 15, 1582 of the Gregorian calendar. Furthermore, in the Gregorian calendar, only those centurial years which are divisible by 400 are leap years.

**Julian day**. The number of each day, as reckoned consecutively since the beginning of the present Julian period on January 1, 4713 B.C. It is used primarily by astronomers to avoid confusion due to the use of different calendars at different times and places. The Julian day begins at noon, 12 hours later than the corresponding civil day. The day beginning at noon January 1, 2017, was Julian day 2,457,755.000000.

**junction buoy**. A buoy which, when viewed from a vessel approaching from the open sea or in the same direction as the main stream of flood current, or in the direction established by appropriate authority, indicates the place at which two channels meet. See also BIFURCATION BUOY.

**junction mark**. A navigation mark which, when viewed from a vessel approaching from the open sea or in the same direction as the main stream of flood current, or in the direction established by appropriate authority, indicates the place at which two channels meet. See also BIFURCATION MARK.

**June solstice**. Summer solstice in the Northern Hemisphere.

**Jupiter**, *n.* The navigational planet whose orbit lies between those of Mars and Saturn. Largest of the known planets.

**Jutland Current**. A narrow and localized nontidal current off the coast of Denmark between longitudes 8°30'E and 10°30'E. It originates partly from the resultant counterclockwise flow in the tidal North Sea. The main cause, however, appears to be the winds which prevail from south through west to northwest over 50 percent of the time throughout the year and the transverse flows from the English coast toward the Skaggeak. The current retains the characteristics of a major nontidal current and flows northeastward along the northwest coast of Denmark at speeds ranging between 1.5 to 2.0 knots 75 to 100 percent of the time.

## K

**Kaléma**, *n.* A very heavy surf breaking on the Guinea coast during the winter, even when there is no wind.

**Kalman filtering**. A statistical method for estimating the parameters of a dynamic system, using recursive techniques of estimation, measurement, weighting, and correction. Weighting is based on variances of the measurements and of the estimates. The filter acts to reduce the variance of the estimate with each measurement cycle. In navigation, the technique is used to refine the positions given by one or more electronic systems.

**katabatic wind**. Any wind blowing down an incline. If the wind is warm, it is called a foehn; if cold, a fall wind. An ANABATIC WIND blows up an incline. Also called GRAVITY WIND.

**kaver**, *n.* See CAVER.

**kay**, *n.* See CAY.

**K-band**. A radio-frequency band of 10,900 to 36,000 megahertz. See also FREQUENCY, FREQUENCY BAND.

**kedge**, *v, t.* To move a vessel by carrying out an anchor, letting it go, and winching the ship to the anchor. See also WARP.

**keeper**, *n.* A piece of magnetic material placed across the poles of a permanent magnet to assist in the maintenance of magnetic strength.

**kelp**, *n.* 1. A family of seaweed found in cool to cold waters along rocky coasts, characterized by its extreme length. 2. Any large seaweed. 3. The ashes of seaweed.

**kelvin**, *n.* The base unit of thermodynamic temperature in the International System of Units; it is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.

**Kelvin temperature**. Temperature based upon a thermodynamic scale with its zero point at absolute zero (-273.16°C) and using Celsius degrees. Rankine temperature is based upon the Rankine scale starting at absolute zero (-459.69° F) and using Fahrenheit degrees.

**Kennelly-Heaviside layer**. See under KENNELLY-HEAVISIDE REGION.

**Kennelly-Heaviside region**. The region of the ionosphere, extending from approximately 40 to 250 miles above the earth's surface within which ionized layers form which may affect radio wave propagation. The E-layer, which is the lowest useful layer from the standpoint of wave propagation, is sometimes called KENNELLY-HEAVISIDE LAYER or, in some instances, simply the HEAVISIDE LAYER.

**Kepler's laws**. The three empirical laws describing the motions of the planets in their orbits. These are: (1) The orbits of the planets are ellipses, with the sun at a common focus; (2) As a planet moves in its orbit, the line joining the planet and sun sweeps over equal areas in equal intervals of time; (3) The squares of the periods of revolution of any two planets are proportional to the cubes of their mean distances from the sun. Also called KEPLER'S PLANETARY LAWS.

**Kepler's planetary laws**. See KEPLER'S LAWS.

**key**, *n.* 1. See CAY. 2. In ECDIS, an identifier which establishes linkages, e.g. between different LAYERS, or FEATURES and ATTRIBUTES.

**Keyhole Markup Language (KML)**, *n.* A file format used to specify a set of geographical features for display in Google Earth, Google Maps, and Google Mobile, or any other 3D Earth browser. KML is one of a number of extended versions of XML (Extensible Markup Language).

**Keyhole Markup Language Zipped (KMZ)**. A zipped KML file with a ".kmz" extension. When a KMZ file is unzipped, a single "doc.kml" is found along with any overlay and icon images referenced in the KML.

**kick**, *n.* 1. The distance a ship moves sidewise from the original course away from the direction of turn after the rudder is first put over. 2. The swirl of water toward the inside of the turn when the rudder is put over to begin the turn.

**kilo-**. A prefix meaning one thousand (10<sup>3</sup>).

**kilobyte**. One thousand bytes of information in a computer.

**kilocycle**, *n.* One thousand cycles, the term is often used as the equivalent of one thousand cycles per second.

**kilogram**, *n.* 1. The base unit of mass in the International System of Units; it is equal to the mass of the international prototype of the kilogram, which is made of platinum-iridium and kept at the International Bureau of Weights and Measures. 2. One thousand grams exactly, or 2.204623 pounds, approximately.

**kilometer**, *n.* One thousand meters; about 0.54 nautical mile, 0.62 U.S. Survey mile, or 3,281 feet.

**kinetic energy**. Energy possessed by a body by virtue of its motion, in contrast with POTENTIAL ENERGY, that possessed by virtue of its position.

**klaxon**, *n.* A diaphragm horn similar to a nautophone, but smaller, and sometimes operated by hand.

**knik wind**. A strong southeast wind in the vicinity of Palmer, Alaska, most frequent in the winter.

**knoll**, *n.* 1. On the sea floor, an elevation rising generally more than 500 meters and less than 1,000 meters and of limited extent across the summit. 2. A small rounded hill.

**knot**, *n.* A unit of speed equal to 1 nautical mile per hour.

**Kona storm**. A storm over the Hawaiian Islands, characterized by strong southerly or southwesterly winds and heavy rains.

**Krassowski ellipsoid of 1938**. A reference ellipsoid of which the semi-major axis is 6,378,245 meters and the flattening of ellipticity equals 1/298.3.

**Kuroshio**, *n.* A North Pacific Ocean current flowing northeastward from Taiwan to the Ryukyu Islands and close to the coast of Japan. The Kuroshio is the northward flowing part of the Pacific North Equatorial Current (which divides east of the Philippines). The Kuroshio divides near Yaku Shima, the weaker branch flowing northward

through the Korea Strait and the stronger branch flowing through Tokara Kaikyo and then along the south coast of Shikoku. There are light seasonal variations in speed; the Kuroshio is usually strongest in summer, weakens in autumn, strengthens in winter, and weakens in spring. Strong winds can accelerate or retard the current but seldom change its direction. Beyond latitude 35°N on the east coast of Japan, the current turns east-northeastward to form the transitional KUROSHIO EXTENSION. The Kuroshio is part of the KUROSHIO SYSTEM. Also called JAPAN CURRENT.

**Kuroshio Extension.** . The transitional, eastward flowing ocean current that connects the Kuroshio and the North Pacific Current.

**Kuroshio System.** . A system of ocean currents which includes part of the Pacific North Equatorial Current, the Tsushima Current, the Kuroshio, and the Kuroshio Extension.

**kymatology.** , *n.* The science of waves and wave motion.

## L

**L-1 Signal.** . The primary L-band signal transmitted by each GPS satellite at 1572.42 MHz. It is modulated with the C/A and P codes and the navigation message.

**L-2 Signal.** . The second L-band signal of the GPS satellite, transmitted at 1227.60 MHz, modulated with the P-code and navigation message.

**label/code.** . In ECDIS, a group of related information displayed as a whole.

**labor.** , *v., i.* To pitch and roll heavily under conditions which subject the ship to unusually heavy stresses caused by confused or turbulent seas or unstable stowage of cargo.

**Labrador Current.** . Originating from cold arctic water flowing south-eastward through the Davis Strait at speeds of 0.2 to 0.5 knot and from a westward branching of the warmer West Greenland Current, the Labrador Current flows south eastward along the shelf of the Canadian coast. Part of the current flows into Hudson Strait along its north shore. The outflow of fresh water along the south shore of the strait augments the part of the current flowing along the Labrador coast. The current also appears to be influenced by surface outflow from inlets and fjords along the Labrador coast. The mean speed is about 0.5 knot, but current speed at times may reach 1.5 to 2.0 knots.

**Labrador Current Extension.** . A name sometimes given to the nontidal current flowing southwestward along the northeast coast of the United States. This coastal current originates from part of the Labrador Current flowing clockwise around the southeastern tip of Newfoundland. Its speeds are fairly constant throughout the year and average about 0.6 knot. The greatest seasonal fluctuation appears to be in the width of the current. The current is widest during winter between Newfoundland and Cape Cod. Southwest of Cape Cod to Cape Hatteras the current shows very little seasonal change. The current narrows considerably during summer and flows closest to shore in the vicinity of Cape Sable, Nova Scotia and between Cape Cod and Long Island in July and August. The current in some places encroaches on tidal regions.

**lagan.** , *n.* A heavy object thrown overboard and buoyed to mark its location for future recovery. See also JETTISON.

**lag error.** . Error in the reading of an instrument due to lag.

**lagging of tide.** . The periodic retardation in the time of occurrence of high and low water due to changes in the relative positions of the moon and the sun. See also PRIMING OF TIDE.

**lagoon.** , *n.* 1. A shallow sound, pond, or lake generally separated from the open sea. 2. A body of water enclosed by the reefs and islands of an atoll.

**Lagrangian current measurement.** . The direct observation of the current speed or direction, or both, by a recording device such as a parachute drogue which follows the movement of a water mass through the ocean. See also EULERIAN CURRENT MEASUREMENT.

**lake.** , *n.* 1. A standing body of inland water, generally of considerable size. There are exceptions such as the lakes in Louisiana which are open to or connect with the Gulf of Mexico. Occasionally a lake is called a SEA, especially if very large and composed of salt water. 2. An expanded part of a river.

**lake ice.** . Ice formed on a lake.

**Lambert conformal chart.** . A chart on the Lambert conformal projec-

tion. See also CONIC CHART WITH TWO STANDARD PARALLELS, MODIFIED LAMBERT CONFORMAL CHART.

**Lambert conformal map projection.** . A conformal map projection of the conic type, on which all geographic meridians are represented by straight lines which meet in a common point outside the limits of the map, and the geographic parallels are represented by a series of arcs of circles having this common point for a center. Meridians and parallels intersect at right angles, and angles on the earth are correctly represented on the projection. This projection may have one standard parallel along which the scale is held exact; or there may be two such standard parallels, both maintaining exact scale. At any point on the map, the scale is the same in every direction. The scale changes along the meridians and is constant along each parallel. Where there are two standard parallels, the scale between those parallels is too small; beyond them, too large. See also MODIFIED LAMBERT CONFORMAL MAP PROJECTION.

**laminar flow.** . See under STREAMLINE FLOW.

**land.** , *v., t. & i.* To bring a vessel to a landing.

**land breeze.** . A breeze blowing from the land to the sea. It usually blows by night, when the sea is warmer than the land, and alternates with a SEA BREEZE, which blows in the opposite direction by day. See also OFFSHORE WIND.

**landfall.** , *n.* The first sighting of land when approached from seaward. By extension, the term is sometimes used to refer to the first contact with land by any means, as by radar.

**landfall buoy.** . See SEA BUOY.

**landfall light.** . See PRIMARY SEACOAST LIGHT.

**landing.** , *n.* 1. A place where boats receive or discharge passengers, freight, etc. See also LANDING STAGE, WHARF. 2. Bringing of a vessel to a landing.

**landing compass.** . A compass taken ashore so as to be unaffected by deviation. If reciprocal bearings of the landing compass and the magnetic compass on board are observed, the deviation of the latter can be determined.

**landing stage.** . A platform attached to the shore for landing or embarking passengers or cargo. In some cases the outer end of the landing stage is floating. Ships can moor alongside larger landing stages.

**landmark.** , *n.* A conspicuous artificial feature on land, other than an established aid to navigation, which can be used as an aid to navigation. See also SEA MARK.

**land mile.** . See MILE.

**land sky.** . Dark streaks or patches or a grayness on the underside of extensive cloud areas, due to the absence of reflected light from bare ground. Land sky is not as dark as WATER SKY. The clouds above ice or snow covered surfaces have a white or yellowish white glare called ICE BLINK. See also SKY MAP.

**lane.** , *n.* In any continuous wave phase comparison system, the distance between two successive equiphase lines, taken as 0°–360°, in a system of hyperbolic or circular coordinates.

**lane count.** . An automatic method of counting and totaling the number of hyperbolic or circular lanes traversed by a moving vessel.

**language.** . A set of characters and rules which allow human interface with the computer, allowing PROGRAMS to be written.

**lapse rate.** . The rate of decrease of temperature in the atmosphere with height, or, sometimes, the rate of change of any meteorological element with height.

**large fracture.** . See under FRACTURE.

**large iceberg.** . For reports to the International Ice Patrol, an iceberg that extends more than 150 feet (45 meters) above the sea surface and which has a length of more than 400 feet (122 meters). See also SMALL ICEBERG, MEDIUM ICEBERG.

**large ice field.** . See under ICE FIELD.

**large navigational buoy (LNB).** . A large buoy designed to take the place of a lightship where construction of an offshore light station is not feasible. These buoys may show secondary lights from heights of about 30–40 feet above the water. In addition to the light, they may mount a radiobeacon and provide sound signals. A station buoy may be moored nearby.

**large scale.** . A scale involving a relatively small reduction in size. A large-scale chart is one covering a small area. The opposite is SMALL SCALE. See also REPRESENTATIVE FRACTION.

**last quarter.** . The phase of the moon when it is near west quadrature, when the eastern half of it is visible to an observer on the earth. See also PHASES OF THE MOON.

**latent heat of fusion.** . See under FUSION.

- latent heat of vaporization.** . See under EVAPORATION.
- lateral.** , *adj.* Of or pertaining to the side, such as lateral motion.
- lateral drifting.** . See SWAY.
- lateral mark.** . A navigation aid intended to mark the sides of a channel or waterway. See CARDINAL MARK.
- lateral sensitivity.** . The property of a range which determines the rapidity with which the two lights of the range open up as a vessel moves laterally from the range line, indicating to the mariner that he is off the center line.
- lateral system.** . A system of aids to navigation in which the shape, color, and number are assigned in accordance with their location relative to navigable waters. When used to mark a channel, they are assigned colors to indicate the side they mark and numbers to indicate their sequence along the channel. In the CARDINAL SYSTEM the aids are assigned shape, color, and number distinction in accordance with location relative to obstructions.
- latitude.** , *n.* Angular distance from a primary great circle or plane. Terrestrial latitude is angular distance from the equator, measured northward or southward through 90° and labeled N or S to indicate the direction of measurement; astronomical latitude at a station is angular distance between the plumb line and the plane of the celestial equator; geodetic or topographical latitude at a station is angular distance between the plane of the geodetic equator and a normal to the ellipsoid; geocentric latitude is the angle at the center of the reference ellipsoid between the celestial equator and a radius vector to a point on the ellipsoid. Geodetic and sometimes astronomical latitude are also called geographic latitude. Geodetic latitude is used for charts. Assumed (or chosen) latitude is the latitude at which an observer is assumed to be located for an observation or computation. Observed latitude is determined by one or more lines of position extending in a generally east-west direction. Fictitious latitude is angular distance from a fictitious equator. Grid latitude is angular distance from a grid equator. Transverse or inverse latitude is angular distance from a transverse equator. Oblique latitude is angular distance from an oblique equator. Middle or mid-latitude is the latitude at which the arc length of the parallel separating the meridians passing through two specific points is exactly equal to the departure in proceeding from one point to the other by middle-latitude sailing. Mean latitude is half the arithmetical sum of the latitude of two places on the same side of the equator. The mean latitude is usually used in middle-latitude sailing for want of a practical means of determining middle latitude. Difference of latitude is the shorter arc of any meridian between the parallels of two places, expressed in angular measure. Magnetic latitude, magnetic inclination, or magnetic dip is angular distance between the horizontal and the direction of a line of force of the earth's magnetic field at any point. Geomagnetic latitude is angular distance from the geomagnetic equator. A parallel of latitude is a circle (or approximation of a circle) of the earth, parallel to the equator, and connecting points of equal latitude - or a circle of the celestial sphere, parallel to the ecliptic. Celestial latitude is angular distance north or south of the ecliptic. See also VARIATION OF LATITUDE.
- latitude factor.** . The change in latitude along a celestial line of position per 1' change in longitude. The change in longitude for a 1' change in latitude is called LONGITUDE FACTOR.
- latitude line.** . A line of position extending in a generally east-west direction. Sometimes called OBSERVED LATITUDE. See also LONGITUDE LINE; COURSE LINE, definition 2; SPEED LINE.
- lattice.** , *n.* A pattern formed by two or more families of intersecting lines, such as that pattern formed by two or more families of hyperbolas representing, for example, curves of equal time difference associated with a hyperbolic radionavigation system. Sometimes the term *pattern* is used to indicate curves of equal time difference, with the term *lattice* being used to indicate its representation on the chart. See also PATTERN, definition 2.
- lattice beacon.** . A beacon or daymark in the form of a lattice. See also BEACON TOWER.
- laurence.** , *n.* A shimmering seen over a hot surface on a calm, cloudless day, caused by the unequal refraction of light by innumerable convective air columns of different temperatures and densities.
- lava.** , *n.* Rock in the fluid state, or such material after it has solidified. Lava is formed at very high temperature and issues from the earth through volcanoes. Part of the ocean bed is composed of lava.
- law of equal areas.** . Kepler's second law.
- layer tints.** . See HYPOMETRIC TINTING.
- L-band.** . A radio-frequency band of 390 to 1,550 megahertz. See also FREQUENCY, FREQUENCY BAND.
- lead.** , *n.* A fracture or passageway through ice which is navigable by surface vessels.
- lead.** , *n.* A weight attached to a line. A sounding lead is used for determining depth of water. A hand lead is a light sounding lead (7 to 14 pounds), usually having a line of not more than 25 fathoms. A deep sea lead is a heavy sounding lead (about 30 to 100 pounds), usually having a line 100 fathoms or more in length. A light deep sea lead (30 to 50 pounds), used for sounding depths of 20 to 60 fathoms is called a coasting lead. A type of sounding lead used without removal from the water between soundings is called a fish lead. A drift lead is one placed on the bottom to indicate movement of a vessel.
- leader cable.** . A cable carrying an electric current, signals from or the magnetic influence of which indicates the path to be followed by a craft equipped with suitable instruments.
- leading lights.** . See RANGE LIGHTS.
- leading line.** . On a nautical chart, a straight line drawn through leading marks. A ship moving along such line will clear certain dangers or remain in the best channel. See also RANGE, definition, *n.* 1.
- leading marks.** . See RANGE, *n.* definition 1.
- lead line.** . A line, graduated with attached marks and fastened to a sounding lead, used for determining the depth of water when making soundings by hand. The lead line is usually used in depths of less than 25 fathoms. Also called SOUNDING LINE.
- leadsman.** , *n.* A person using a sounding lead to determine depth of water.
- leap second.** . A step adjustment to Coordinated Universal Time (UTC) to maintain it within 0.95<sup>s</sup> of UT1. The 1 second adjustments, when necessary, are normally made at the end of June or December. Because of the variations in the rate of rotation of the earth, the occurrences of the leap second adjustments are not predictable in detail.
- leap year.** . A calendar year having 366 days as opposed to the COMMON YEAR having 365 days. Each year exactly divisible by 4 is a leap year, except century years (1800, 1900, etc.) which must be exactly divisible by 400 (2000, 2400, etc.) to be leap years.
- least squares adjustment.** . A statistical method of adjusting observations in which the sum of the squares of all the deviations or residuals derived in fitting the observations to a mathematical model is made a minimum.
- ledge.** , *n.* On the sea floor, a rocky projection or datum outcrop, commonly linear and near shore.
- lee.** , *adj.* Referring to the downwind, or sheltered side of an object.
- lee.** , *n.* The sheltered area on the downwind side of an object.
- lee shore.** . As observed from a ship, the shore towards which the wind is blowing. See also WEATHER SHORE.
- lee side.** . That side of a craft which is away from the wind and therefore sheltered.
- lee tide.** . See LEEWARD TIDAL CURRENT.
- leeward.** , *adj. & adv.* Toward the lee, or in the general direction toward which the wind is blowing. The opposite is WINDWARD.
- leeward.** , *n.* The lee side. The opposite is WINDWARD.
- leeward tidal current.** . A tidal current setting in the same direction as that in which the wind is blowing. Also called LEE TIDE, LEEWARD TIDE.
- leeward tide.** . See LEEWARD TIDAL CURRENT.
- leeway.** , *n.* The leeward motion of a vessel due to wind. See also LEEWAY ANGLE.
- leeway angle.** . The angular difference between a vessel's course and the track due to the effect of wind in moving a vessel bodily to leeward. See also DRIFT ANGLE, definition 2.
- left bank.** . The bank of a stream or river on the left of an observer facing downstream.
- leg.** , *n.* 1. A part of a ship's track line that can be represented by a single course line. 2. In ECDIS a line connecting two WAYPOINTS.
- legend.** , *n.* A title or explanation on a chart, diagram, illustration, etc.
- lens.** , *n.* A piece of glass or transparent material with plane, convex, or concave surfaces adapted for changing the direction of light rays to enlarge or reduce the apparent size of objects. See also EYEPIECE; FIELD LENS, MENISCUS, definition 2. OBJECTIVE.
- lenticular, lenticularis.** , *adj.* In the shape of a lens, used to refer to an apparently stationary cloud resembling a lens, being broad in its middle and tapering at the ends and having a smooth appearance. Actually, the cloud continually forms to windward and dissipates to

leeward.

**lesser ebb.** . See under EBB CURRENT.

**lesser flood.** . See under FLOOD CURRENT.

**leste.** , *n.* A hot, dry, easterly wind of the Madeira and Canary Islands.

**levanter.** , *n.* A strong easterly wind of the Mediterranean, especially in the Strait of Gibraltar, attended by cloudy, foggy, and sometimes rainy weather especially in winter.

**levantera.** , *n.* A persistent east wind of the Adriatic, usually accompanied by cloudy weather.

**levanto.** , *n.* A hot southeasterly wind which blows over the Canary Islands.

**leveche.** , *n.* A warm wind in Spain, either a foehn or a hot southerly wind in advance of a low pressure area moving from the Sahara Desert. Called a SIROCCO in other parts of the Mediterranean area.

**levee.** , *n.* 1. An artificial bank confining a stream channel or limiting adjacent areas subject to flooding. 2. On the sea floor, an embankment bordering a canyon, valley, or sea channel.



levee

**level ice.** . Sea ice which is unaffected by deformation.

**leveling.** , *n.* A survey operation in which heights of objects are determined relative to a specified datum.

**libration.** , *n.* A real or apparent oscillatory motion, particularly the apparent oscillation of the moon, which results in more than half of the moon's surface being revealed to an observer on the earth, even though the same side of the moon is always toward the earth.

**light.** , *adj.* 1. Of or pertaining to low speed, such as light air, force 1 (1-3 knots or 1-3 miles per hour) on the Beaufort scale or light breeze, force 2 (4-7 knots or 4-7 miles per hour) on the Beaufort scale. 2. Of or pertaining to low intensity, as light rain, light fog, etc.

**light.** , *n.* 1. Luminous energy. 2. An apparatus emitting light of distinctive character for use as an aid to navigation.

**light air.** . Wind of force 1 (1-3 knots or 1-3 miles per hour) on the Beaufort wind scale.

**light attendant station.** . A shore unit established for the purpose of servicing minor aids to navigation within an assigned area.

**light-beacon.** , *n.* See LIGHTED BEACON.

**light breeze.** . Wind of force 2 (4-6 knots or 4-7 miles per hour) on the Beaufort wind scale.

**lighted beacon.** . A beacon exhibiting a light. Also called LIGHT-BEACON.

**lighted buoy.** . A buoy exhibiting a light.

**lighted sound buoy.** . See SOUND BUOY.

**lighting area.** . An area designated for handling ship's cargo by barge or lighter.

**light-float.** , *n.* A buoy having a boat-shaped body. Light-floats are usually unmanned and are used instead of smaller lighted buoys in waters where strong currents are experienced.

**lighthouse.** , *n.* A distinctive structure exhibiting a major navigation light.

**light list.** . 1. A publication giving detailed information regarding lighted navigational aids and fog signals. In the United States, light lists are published by the U.S. Coast Guard and the National Geospatial-Intelligence Agency.

**light list number.** . The sequential number used to identify a navigational light in the light list. This may or may not be the same as the INTERNATIONAL NUMBER.

**light nilas.** . Nilas which is more than 5 centimeters in thickness and somewhat lighter in color than dark nilas.

**light sector.** . As defined by bearings from seaward, the sector in which a navigational light is visible or in which it has a distinctive color different from that of adjoining sectors, or in which it is obscured. See also SECTOR LIGHT.

**lightship.** , *n.* A distinctively marked vessel providing aids to navigation services similar to a light station, i.e., a light of high intensity and reliability, sound signal, and radiobeacon are moored at a station where erection of a fixed structure is not feasible. Most lightships

are anchored to a very long scope of chain and, as a result, the radius of their swinging circle is considerable. The chart symbol represents the approximate location of the anchor. Also called LIGHT VESSEL. See also LIGHT-FLOAT.

**lights in line.** . Two or more lights so situated that when observed in transit they define the alignment of a submarine cable, the limit of an area, an alignment for use in anchoring, etc. Not to be confused with RANGE LIGHTS which mark a direction to be followed. See also RANGE, definition 1.

**light station.** . A manned station providing a light usually of high intensity and reliability. It may also provide sound signal and radiobeacon services.

**light vessel.** . See LIGHTSHIP.

**light-year.** , *n.* A unit of length equal to the distance light travels in 1 year, equal to about  $5.88 \times 10^{12}$  miles. This unit is used as a measure of stellar distances.

**liman.** , *n.* A shallow coastal lagoon or embayment with a muddy bottom; also a region of mud or slime deposited near a stream mouth.

**Liman Current.** . Formed by part of the Tsushima Current and river discharge in the Tatar Strait, the coastal Liman Current flows southward in the western part of the Sea of Japan. During winter, it may reach as far south as 35°N. See also under TSUSHIMA CURRENT.

**limb.** , *n.* 1. The graduated, curved part of an instrument for measuring angles, such as the part of a marine sextant carrying the altitude scale, or ARC. 2. The circular outer edge of a celestial body, usually referred to with the designation upper or lower.

**limbo echo.** . See CLASSIFICATION OF RADAR ECHOES.

**line.** , *n.* 1. A series of related points, the path of a moving point. A line has only one dimension, which is length. 2. A row of letters, numbers, etc. 3. A mark of division or demarcation, as a *boundary line*. 4. In ECDIS, a one-dimensional GEOMETRIC PRIMITIVE of an OBJECT.

**linear.** , *adj.* 1. Of or pertaining to a line. 2. Having a relation such that a change in one quantity is accompanied by an exactly proportional change in a related quantity.

**linear interpolation.** . Interpolation in which changes of tabulated values are assumed to be proportional to changes in entering arguments.

**linear light.** . A luminous signal having perceptible length, as contrasted with a POINT LIGHT, which does not have perceptible length.

**linearly polarized wave.** . A transverse electromagnetic wave, the electric field vector of which lies along a fixed line at all times.

**linear scale.** . A scale graduated at uniform intervals.

**linear speed.** . Rate of motion in a straight line. See also ANGULAR SPEED.

**linear sweep.** . Short for LINEAR TIME BASE SWEEP.

**linear time base.** . A time base having a constant speed, particularly a linear time base sweep.

**linear time base sweep.** . A sweep having a constant sweep speed before retrace. Usually shortened to LINEAR SWEEP, and sometimes to LINEAR TIME BASE.

**line blow.** . A strong wind on the equator side of an anticyclone, probably so called because there is little shifting of wind direction during the blow, as contrasted with the marked shifting which occurs with a cyclonic windstorm.

**line of apsides.** . The line connecting the two points of an orbit that are nearest and farthest from the center of attraction, such as the perigee and apogee of the moon or the perihelion and aphelion of a planet. Also called APSE LINE.

**line of force.** . A line indicating the direction in which a force acts, as in a magnetic field.

**line of nodes.** . The straight line connecting the two points of intersection of the orbit of a planet, planetoid, or comet and the ecliptic; or the line of intersection of the planes of the orbits of a satellite and the equator of its primary.

**line of position.** . A plotted line on which a vessel is located, determined by observation or measurement. Also called POSITION LINE.

**line of sight.** . The straight line between two points, which does not follow the curvature of the earth.

**line of soundings.** . A series of soundings obtained by a vessel underway, usually at regular intervals. In piloting, this information may be used to determine an estimated position, by recording the soundings at appropriate intervals (to the scale of the chart) along a line drawn on transparent paper or plastic to represent the track, and then fitting the plot to the chart, by trial and error. A vessel obtaining soundings along a course line, for use in making or improving a chart, is said

- to run a *line of soundings*.
- line of total force.** . The direction of a freely suspended magnetic needle when acted upon by the earth's magnetic field alone.
- line squall.** . A squall that occurs along a squall line.
- lipper.** , *n.* 1. Slight ruffling or roughness on a water surface. 2. Light spray from small waves.
- liquid compass.** . A magnetic compass of which the bowl mounting the compass card is completely filled with liquid. Nearly all modern magnetic compasses are of this type. An older liquid compass using a solution of alcohol and water is sometimes called a SPIRIT COMPASS. Also called WET COMPASS. See also DRY COMPASS.
- list.** , *n.* Inclination to one side. LIST generally implies equilibrium in an inclined condition caused by uneven distribution of mass aboard the vessel itself, while HEEL implies either a continuing or momentary inclination caused by an outside force, such as the wind. The term ROLL refers to the oscillatory motion of a vessel rather than its inclined condition.
- list.** , *v.*, *t.* & *i.* To incline or be inclined to one side.
- lithometeor.** , *n.* The general term for dry atmospheric suspensoids, including dust, haze, smoke, and sand. See also HYDROMETEOR.
- little brother.** . A secondary tropical cyclone sometimes following a more severe disturbance.
- littoral.** , *adj.* & *n.* 1. A littoral region. 2. The marine environment influenced by a land mass. 3. Of or pertaining to a shore, especially a seashore. See also SEABOARD.
- load line marks.** . Markings stamped and painted amidships on the side of a vessel, to indicate the minimum permissible freeboard. Also called PLIMSOLL MARKS. See also DRAFT MARKS.
- lobe.** , *n.* 1. The portion of the overall radiation pattern of a directional antenna which is contained within a region bounded by adjacent minima. The main beam is the beam in the lobe containing the direction of maximum radiation (main lobe) lying within specified values of field strength relative to the maximum field strength. See also BACK LOBE, SIDE LOBE, BEAM WIDTH 2. The radiation within the region of definition 1.
- local apparent noon.** . Twelve o'clock local apparent time, or the instant the apparent sun is over the upper branch of the local meridian. Local apparent noon at the Greenwich meridian is called Greenwich apparent noon. Sometimes called HIGH NOON.
- local apparent time.** . . The arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the local celestial meridian and the hour circle of the apparent or true sun, measured westward from the lower branch of the local celestial meridian through 24 hours; local hour angle of the apparent or true sun, expressed in time units, plus 12 hours. Local apparent time at the Greenwich meridian is called Greenwich apparent time.
- local attraction.** . . See LOCAL MAGNETIC DISTURBANCE.
- local civil noon.** . . *United States terminology from 1925 through 1952.* See LOCAL MEAN NOON.
- local civil time.** . . *United States terminology from 1925 through 1952.* See LOCAL MEAN TIME.
- local hour angle (LHA).** . . Angular distance west of the local celestial meridian; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the local celestial meridian and the hour circle of a point on the celestial sphere, measured westward from the local celestial meridian through 360°. The local hour angle at longitude 0° is called Greenwich hour angle.
- local knowledge.** . . The term applied to specialized, detailed knowledge of a port, harbor, or other navigable water considered necessary for safe navigation. Local knowledge extends beyond that available in charts and publications, being more detailed, intimate, and current.
- local lunar time.** . . The arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the local celestial meridian and the hour circle of the moon, measured westward from the lower branch of the local celestial meridian through 24 hours; local hour angle of the moon, expressed in time units, plus 12 hours. Local lunar time at the Greenwich meridian is called Greenwich lunar time.
- local magnetic disturbance.** . An anomaly of the magnetic field of the earth, extending over a relatively small area, due to local magnetic influences. Also called LOCAL ATTRACTION, MAGNETIC ANOMALY.
- local mean noon.** . Twelve o'clock local mean time, or the instant the mean sun is over the upper branch of the local meridian. Local mean noon at the Greenwich meridian is called Greenwich mean noon.
- local mean time.** . The arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the local celestial meridian and the hour circle of the mean sun, measured westward from the lower branch of the local celestial meridian through 24 hours; local hour angle of the mean sun, expressed in time units, plus 12 hours. Local mean time at the Greenwich meridian is called Greenwich mean time, or Universal Time.
- local meridian.** . The meridian through any particular place of observer, serving as the reference for local time, in contrast with GREENWICH MERIDIAN.
- local noon.** . Noon at the local meridian.
- Local Notice to Mariners.** . A notice issued by each U.S. Coast Guard District to disseminate important information affecting navigational safety within the District. The *Local Notice* reports changes to and deficiencies in aids to navigation maintained by and under the authority of the U.S. Coast Guard. Other information includes channel depths, new charts, naval operations, regattas, etc. Since temporary information, known or expected to be of short duration, is not included in the weekly *Notice to Mariners* published by the National Geospatial-Intelligence Agency, the appropriate *Local Notice to Mariners* may be the only source of such information. Much of the information contained in the *Local Notice to Mariners* is included in the weekly *Notice to Mariners*. The *Local Notice to Mariners* is published as often as required; usually weekly and available on the USCG Navigation Center (NAVCEN) website.
- local oscillator.** . An oscillator used to drive an intermediate frequency by beating with the signal carrying frequency in superheterodyne reception.
- local sidereal noon.** . Zero hours local sidereal time, or the instant the vernal equinox is over the upper branch of the local meridian. Local sidereal noon at the Greenwich meridian is called Greenwich sidereal noon.
- local sidereal time.** . Local hour angle of the vernal equinox, expressed in time units; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the local celestial meridian and the hour circle of the vernal equinox, measured westward from the upper branch of the local celestial meridian through 24 hours. Local sidereal time at the Greenwich meridian is called Greenwich sidereal time.
- local time.** . 1. Time based upon the local meridian as reference, as contrasted with that based upon a standard meridian. Local time was in general use in the United States until 1883, when standard time was adopted. 2. Any time kept locally.
- local update.** . In ECDIS a generic term used to indicate all update information other than OFFICIAL UPDATES, regardless of source; for application as a MANUAL UPDATE only as opposed to automatic updates.
- local vertical.** . The direction of the acceleration of gravity as opposed to the normal to the reference ellipsoid. It is in the direction of the resultant of the gravitational and centrifugal accelerations of the earth at the location of the observer. Also called PLUMB-BOB VERTICAL. See also MASS ATTRACTION VERTICAL.
- lock.** , *n.* 1. A lake. 2. An arm of the sea, especially when nearly landlocked.
- lock.** , *n.* 1. A basin in a waterway with caissons or gates at each end by means of which vessels are passed from one water level to another.



lock

- lock.** , *v. t.* To pass through a lock, referred to as *locking through*.
- lock on.** . To identify and begin to continuously track a target in one or more coordinates (e.g., range, bearing, elevation).
- locus.** , *n.* All possible positions of a point or curve satisfying stated conditions.
- log.** , *n.* 1. An instrument for measuring the speed or distance or both traveled by a vessel. A chip log (ancient) consists essentially of a weighted wooden quadrant (quarter of a circle) attached to a bridle

in such a manner that it will float in a vertical position, and a line with equally spaced knots. A mechanical means of determining speed or distance is called a patent log. A harpoon log consists essentially of a combined rotator and distance registering device towed through the water. This has been largely replaced by the taffrail log, a somewhat similar device but with the registering unit secured at the taffrail. A Pitometer log consists essentially of a Pitot tube projecting into the water, and suitable registering devices. An electromagnetic log consists of suitable registering devices and an electromagnetic sensing element, extended below the hull of a vessel, which produces a voltage directly proportional to speed through the water. A Forbes log consists of a small rotator in a tube projecting below the bottom of the vessel, and suitable registering devices. A Dutchman's log is a buoyant object thrown overboard, the speed of a vessel being determined by noting the time required for a known length of the vessel to pass the object. 2. A written record of the movements of a craft, with regard to courses, speeds, positions, and other information of interest to navigators, and of important happenings aboard the craft. The book in which the log is kept is called a LOG BOOK. Also called DECK LOG. See also NIGHT ORDER BOOK 3. A written record of specific related information, as that concerning performance of an instrument. See GYRO LOG.

**logarithm.** , *n.* The power to which a fixed number, called the base, usually 10 or  $e$  (2.7182818), must be raised to produce the value to which the logarithm corresponds. A logarithm (base 10) consists of two parts: the characteristic is that part to the left of the decimal point and the mantissa is that part to the right of the decimal point. An ANTILOGARITHM or INVERSE LOGARITHM is the value corresponding to a given logarithm. Logarithms are used to multiply or divide numbers, the sum or difference of the logarithms of two numbers being the logarithm of the product or quotient, respectively, of the two numbers. A COLOGARITHM is the logarithm of the reciprocal of a number. Logarithms to the base 10 are called common or Briggsian and those to the base  $e$  are called natural or Napierian logarithms.

**logarithmic.** , *adj.* Having to do with a logarithm, used with the name of a trigonometric function to indicate that the value given is the logarithm of that function, rather than the function itself which is called the natural trigonometric function.

**logarithmic coordinate paper.** . Paper ruled with two sets of mutually-perpendicular, parallel lines spaced according to the logarithms of consecutive numbers, rather than the numbers themselves. On SEMILOGARITHMIC COORDINATE PAPER one set of lines is spaced logarithmically and the other set at uniform intervals.

**logarithmic scale.** . A scale graduated in the logarithms of uniformly-spaced consecutive numbers.

**logarithmic tangent.** . See under TANGENT, definition 1.

**logarithmic trigonometric function.** . See under TRIGONOMETRIC FUNCTIONS.

**log book.** . See LOG, definition 2.

**log chip.** . The wooden quadrant forming part of a chip log. Also called LOG SHIP.

**log file.** . In ECDIS a record of nautical information, including time of application and identification parameters.

**log glass.** . A small hour glass used to time a chip log. The period most frequently used is 28 seconds.

**log line.** . 1. A graduated line used to measure the speed of a vessel through the water or to measure the speed of a current, the line may be called a CURRENT LINE. 2. The line secured to a log.

**long flashing light.** . A navigation light with a duration of flash of not less than 2 seconds.

**longitude.** , *n.* Angular distance, along a primary great circle, from the adopted reference point. Terrestrial longitude is the arc of a parallel, or the angle at the pole, between the prime meridian and the meridian of a point on the earth measured eastward or westward from the prime meridian through 180°, and labeled E or W to indicate the direction of measurement. Astronomical longitude is the angle between the plane of the prime meridian and the plane of the celestial meridian; geodetic longitude is the angle between the plane of the geodetic meridian and a station and the plane of the geodetic meridian at Greenwich. Geodetic and sometimes astro-

nomical longitude are also called geographic longitude. Geodetic longitude is used in charting. Assumed longitude is the longitude at which an observer is assumed to be located for an observation or computation. Observed longitude is determined by one or more lines of position extending in a generally north-south direction. Difference of longitude is the smaller angle at the pole or the shorter arc of a parallel between the meridians of two places, expressed in angular measure. Fictitious longitude is the arc of the fictitious equator between the prime fictitious meridian and any given fictitious meridian. Grid longitude is angular distance between a prime grid meridian and any given grid meridian. Oblique longitude is angular distance between a prime oblique meridian and any given oblique meridian. Transverse or inverse longitude is angular distance between a prime transverse meridian and any given meridian. Celestial longitude is angular distance east of the vernal equinox, along the ecliptic.

**longitude factor.** . The change in longitude along a celestial line of position per 1' change in latitude. The change in latitude for a 1' change in longitude is called LATITUDE FACTOR.

**longitude line.** . A line of position extending in a generally north-south direction. Sometimes called OBSERVED LONGITUDE. See also LATITUDE LINE; COURSE LINE, definition 2; SPEED LINE.

**longitude method.** . The establishing of a line of position from the observation of the latitude of a celestial body by assuming a latitude (or longitude), and calculating the longitude (or latitude) through which the line of position passes, and the azimuth. The line of position is drawn through the point thus found, perpendicular to the azimuth. See also ST. HILAIRE METHOD, SUMNER METHOD, HIGH ALTITUDE METHOD.

**longitude of Greenwich at time of perigee.** . See RIGHT ASCENSION OF GREENWICH AT TIME OF PERIGEE.

**longitude of pericenter.** . An orbital element that specifies the orientation of an orbit; it is a broken angle consisting of the angular distance in the ecliptic from the vernal equinox to the ascending node of the orbit plus the angular distance in the orbital plane from the ascending node to the pericenter, i.e. the sum of the longitude of the ascending node and the argument of pericenter.

**longitude of the ascending node.** . 1. The angular distance in the ecliptic from the vernal equinox to the ascending node of the orbit. See also LONGITUDE OF PERICENTER, RIGHT ASCENSION OF THE ASCENDING NODE. 2. The angular distance, always measured eastward, in the plane of the celestial equator from Greenwich through 360°.

**longitude of the moon's nodes.** . The angular distance along the ecliptic of the moon's nodes from the vernal equinox; the nodes have a retrograde motion, and complete a cycle of 360° in approximately 19 years.

**longitudinal axis.** . The fore-and-aft line through the center of gravity of a craft, around which it rolls.

**longitudinal wave.** . A wave in which the vibration is in the direction of propagation, as in sound waves. This is in contrast with a TRANSVERSE WAVE, in which the vibration is perpendicular to the direction of propagation.

**long path interference.** . See under MULTIPATH ERROR.

**long period constituent.** . A tidal or tidal current constituent with a period that is independent of the rotation of the earth but which depends upon the orbital movement of the moon or of the earth. The principal lunar long period constituents have periods approximating the month and half-month, and the principal solar long period constituents have periods approximating the year and half-year.

**long period perturbations.** . Periodic eccentricities in the orbit of a planet or satellite which require more than one orbital period to execute one complete periodic variation.

**long range systems.** . Radionavigation systems providing positioning capability on the high seas. See also SHORT RANGE SYSTEMS.

**longshore current.** . A current paralleling the shore largely within the surf zone. It is caused by the excess water brought to the zone by the small net mass transport of wind waves. Longshore currents feed into rip currents.

**look angles.** . The elevation and azimuth at which a particular satellite is predicted to be found at a specified time.

**lookout station.** . A label on a nautical chart which indicates a tower sur-

mounted by a small house from which a watch is kept regularly.



lookout  
station

**look-up table.** . In ECDIS, a table giving symbology instructions to link SENC objects to point, line or area symbolization, and providing DISPLAY PRIORITY, radar priority, IMO category and optional viewing group.

**loom.** , *n.* The diffused glow observed from a light below the horizon, due to atmospheric scattering.

**looming.** , *n.* 1. An apparent elevation of distant terrestrial objects by abnormal atmospheric refraction. Because of looming, objects below the horizon are sometimes visible. The opposite is SINKING. 2. The appearance indistinctly of an object during a period of low visibility.

**loop antenna.** . A closed circuit antenna in the form of a loop, lying in the same plane, or of several loops lying in parallel planes.

**loop of stationary wave.** . See under STATIONARY WAVE.

**Loran.** , *n.* The general designation of a type of radionavigation system by which a hyperbolic line of position is determined through measuring the difference in the times of reception of synchronized signals from two fixed transmitters. The name Loran is derived from the words long range navigation.

**Loran A.** , *n.* A long range medium frequency (1850 to 1950 kHz) radionavigation system by which a hyperbolic line of position of medium accuracy was obtained. System operation in U.S. waters was terminated on 31 December 1980. See also LORAN, HYPERBOLIC NAVIGATION.

**Loran C.** , *n.* A long range, low frequency (90-110 kHz) radionavigation system by which a hyperbolic line of position of high accuracy was obtained by measuring the difference in the times of arrival of signals radiated by a pair of synchronized transmitters (master station and secondary station) which are separated by several hundred miles. The U.S. Coast Guard terminated the transmission of all U.S. LORAN-C signals on 08 Feb 2010. See also LORAN, HYPERBOLIC NAVIGATION.

**Lorhumb line.** . A line along which the rates of change of the values of two families of hyperbolae are constants.

**lost motion.** . Mechanical motion which is not transmitted to connected or related parts, due to loose fit. See also BACKLASH.

**low.** , *n.* Short for area of low pressure. Since a low is, on a synoptic chart, always associated with cyclonic circulation, the term is used interchangeably with CYCLONE. See also HIGH.

**low clouds.** . Types of clouds the mean level of which is between the surface and 6,500 feet. The principal clouds in this group are stratocumulus, stratus, and nimbostratus.

**lower branch.** . The half of a meridian or celestial meridian from pole to pole which passes through the antipode or nadir of a place. See also UPPER BRANCH.

**lower culmination.** . See LOWER TRANSIT.

**lower high water.** . The lower of the two high waters of any tidal day.

**lower high water interval.** . See under LUNITIDAL INTERVAL.

**lower limb.** . The lower edge (closest to the horizon) of a celestial body having measurable diameter; opposite is the UPPER LIMB, or the upper edge.

**lower low water.** . The lower of the two low waters of any tidal day.

**lower low water datum.** . An approximation of mean lower low water that has been adopted as a standard reference for a limited area, and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean lower low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes. Columbia River lower low water datum is an example.

**lower low water interval.** . See under LUNITIDAL INTERVAL.

**lower transit.** . Transit of the lower branch of the celestial meridian. Transit of the upper branch is called UPPER TRANSIT. Also called INFERIOR TRANSIT, LOWER CULMINATION.

**low frequency.** . Radio frequency of 30 to 300 kilohertz.

**low light.** . See FRONT LIGHT.

**low tide.** . See under LOW WATER.

**low water.** . The minimum height reached by a falling tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of meteorological conditions.

**low water datum.** . 1. The dynamic elevation for each of the Great Lakes, Lake St. Clair, and the corresponding sloping surfaces of the St. Marys, St. Clair, Detroit, Niagara, and St. Lawrence Rivers to which are referred the depths shown on the navigation charts and the authorized depths for navigation improvement projects. Elevations of these planes are referred to International Great Lakes Datum (1955) and are: Lake Superior - 600.0 feet, Lakes Michigan and Huron - 576.8 feet, Lake St. Clair - 571.7 feet, Lake Erie - 568.6 feet, and Lake Ontario - 242.8 feet. 2. An approximation of mean low water that has been adopted as a standard reference for a limited area and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes.

**low water equinoctial springs.** . Low water spring tides near the times of the equinoxes. Expressed in terms of the harmonic constituents, it is an elevation depressed below mean sea level by an amount equal to the sum of the amplitudes of constituents  $M_2$ ,  $S_2$  and  $K_2$ .

**low water inequality.** . See under DIURNAL INEQUALITY.

**low water interval.** . See under LUNITIDAL INTERVAL.

**low water line.** . The intersection of the land with the water surface at an elevation of low water.

**low water neaps.** . See under NEAP TIDES.

**low water springs.** . Short for MEAN LOW WATER SPRINGS.

**low water stand.** . The condition at low water when there is no sensible change in the height of the tide. A similar condition at high water is called HIGH WATER STAND. See also STAND.

**loxodrome.** , *n.* See RHUMB LINE. See also ORTHODROME.

**loxodromic curve.** . See RHUMB LINE.

**lubber's line.** . A reference line on a compass marking the reading which coincides with the heading.

**lubber's line error.** . The angular difference between the heading as indicated by a lubber's line, and the actual heading; the horizontal angle, at the center of an instrument, between a line through the lubber's line and one parallel to the keel.

**lull.** , *n.* A momentary decrease in the speed of the wind.

**lumen.** , *n.* The derived unit of luminous flux in the International System of Units; it is the luminous flux emitted within unit solid angle (1 steradian) by a point source having a uniform luminous intensity of 1 candela.

**luminance.** , *n.* In a given direction, at a point on the surface of a source or receptor, or at a point on the path of a beam, the quotient of the luminous flux leaving, arriving at, or passing through an element of surface at this point and propagated in directions defined by an elementary cone containing the given directions, by the product of the solid angle of the cone and the area of the orthogonal projection of the element of surface on a plane perpendicular to the given direction. The derived unit of luminance in the International System of Units is the CANDELA PER SQUARE METER.

**luminescence.** , *n.* Emission of light other than incandescence, as in bioluminescence; emission as a result of and only during absorption of radiation from some other source is called FLUORESCENCE; continued emission after absorption of radiation has ceased is called PHOSPHORESCENCE.

**luminous.** , *adj.* Emitting or reflecting light.

**luminous flux.** . The quantity characteristic of radiant flux which expresses its capacity to produce a luminous sensation, evaluated according to the values of spectral luminous efficiency. Unless otherwise indicated, the luminous flux relates to photopic vision, and is connected with the radiant flux in accordance with the formula adopted in 1948 by the International Commission on Illumination. The derived unit of luminous flux in the International System of Units is the LUMEN.

**luminous range.** . See under VISUAL RANGE (OF A LIGHT).

**Luminous Range Diagram.** . A diagram used to convert the nominal range of a light to its luminous range under existing conditions.

**lunar.** , *adj.* Of or pertaining to the moon.

**lunar cycle.** . An ambiguous expression which has been applied to various cycles associated with the moon's motion, including CALLIPPIC CYCLE, METONIC CYCLE, NODE CYCLE, SYNODICAL

MONTH or LUNATION.

**lunar day.** . 1. The duration of one rotation of the earth on its axis, with respect to the moon. Its average length is about 24<sup>h</sup> 50<sup>m</sup> of mean solar time. Also called TIDAL DAY. 2. The duration of one rotation of the moon on its axis, with respect to the sun.

**lunar distance.** . The angle, at an observer on the earth, between the moon and another celestial body. This was the basis of a method formerly used to determine longitude at sea.

**lunar eclipse.** . An eclipse of the moon. When the moon enters the shadow of the earth, it appears eclipsed to an observer on the earth. A lunar eclipse is penumbral when it enters only the penumbra of the earth's shadow, partial when part of its surface enters the umbra of the earth's shadow, and total if its entire surface is obscured by the umbra.

**lunar inequality.** . 1. Variation in the moon's motion in its orbit, due to attraction by other bodies of the solar system. See also EVECTION, PERTURBATIONS. 2. A minute fluctuation of a magnetic needle from its mean position, caused by the moon.

**lunar interval.** . The difference in time between the transit of the moon over the Greenwich meridian and a local meridian. The lunar interval equals the difference between the Greenwich and local intervals of a tide or current phase.

**lunar month.** . The period of revolution of the moon about the earth, especially a synodical month.

**lunar node.** . A node of the moon's orbit. See also LINE OF NODES.

**lunar noon.** . The instant at which the sun is over the upper branch of any meridian of the moon.

**lunar parallax.** . Parallax of the moon.

**lunar rainbow.** . See MOON BOW.

**lunar tide.** . That part of the tide due solely to the tide-producing force of the moon. That part due to the tide-producing force of the sun is called SOLAR TIDE.

**lunar time.** . Time based upon the rotation of the earth relative to the moon. Lunar time may be designated as local or Greenwich according to whether the local or Greenwich meridian is used as the reference.

**lunation.** , *n.* See SYNODICAL MONTH.

**lune.** , *n.* The part of the surface of a sphere bounded by halves of two great circles.

**lunirecurrent interval.** . The interval between the moon's transit (upper or lower) over the local or Greenwich meridian and a specified phase of the tidal current following the transit. Examples are strength of flood interval and strength of ebb interval, which may be abbreviated to flood interval and ebb interval, respectively. The interval is described as local or Greenwich according to whether the reference is to the moon's transit over the local or Greenwich meridian. When not otherwise specified, the reference is assumed to be local. See also LUNITIDAL INTERVAL.

**lunisolar effect.** . Gravitational effects caused by the attractions of the moon and of the sun.

**lunisolar perturbation.** . Perturbations of the orbits of artificial earth satellites due to the attractions of the sun and the moon. The most important effects are secular variations in the mean anomaly, in the right ascension of the ascending node, and in the argument of perigee.

**lunisolar precession.** . That component of general precession caused by the combined effect of the sun and moon on the equatorial protuberance of the earth, producing a westward motion of the equinoxes along the ecliptic. See also PRECESSION OF THE EQUINOXES.

**lunitidal interval.** . The interval between the moon's transit (upper or lower) over the local or Greenwich meridian and the following high or low water. The average of all high water intervals for all phases of the moon is known as mean high water lunitidal interval and is abbreviated to high water interval. Similarly the mean low water lunitidal interval is abbreviated to low water interval. The interval is described as local or Greenwich according to whether the reference is to the transit over the local or Greenwich meridian. When not otherwise specified, the reference is assumed to be local. When there is considerable diurnal inequality in the tide separate intervals may be obtained for the higher high waters, the lower high waters, the higher low waters and the lower low waters. These are designated respectively as higher high water interval, lower high water interval higher low water interval, and lower low water interval. In such cases, and also when the tide is diurnal, it is necessary to distinguish between the upper and lower transit of the moon with ref-

erence to its declination.

**lux.** , *n.* The derived unit of illuminance in the International System of Units; it is equal to 1 lumen per square meter.

## M

**mackerel sky.** . An area of sky with a formation of rounded and isolated cirrocumulus or altocumulus resembling the pattern of scales on the back of a mackerel.

**macroscopic.** , *adj.* Large enough to be seen by the unaided eye.

**madrepore.** , *n.* A branching or stag-horn coral, or any perforated stone coral.

**maelstrom.** , *n.* A powerful often violent whirlpool.

**maestro.** , *n.* A northwesterly wind with fine weather which blows, especially in summer, in the Adriatic. It is most frequent on the western shore. This wind is also found on the coasts of Corsica and Sardinia.

**magnet.** , *n.* A body which produces a magnetic field around itself. It has the property of attracting certain materials capable of being magnetized. A magnet occurring in nature is called a natural magnet in contrast with a man-made artificial magnet. See also HEELING MAGNET, KEEPER.

**magnetic.** , *adj.* Of or pertaining to a magnet or related to magnetic north.

**magnetic amplitude.** . Amplitude relative to magnetic east or west.

**magnetic annual change.** . The amount of secular change in the earth's magnetic field which occurs in 1 year. magnetic annual variation; the small systematic temporal variation in the earth's magnetic field which occurs after the trend for secular change has been removed from the average monthly values.

**magnetic anomaly.** . See LOCAL MAGNETIC DISTURBANCE.

**magnetic azimuth.** . Azimuth relative to magnetic north.

**magnetic bay.** . A small magnetic disturbance whose magnetograph resembles an indentation of a coastline. On earth, magnetic bays occur mainly in the polar regions and have duration of a few hours.

**magnetic bearing.** . Bearing relative to magnetic north; compass bearing corrected for deviation.

**magnetic chart.** . A chart showing magnetic information. If it shows lines of equality in one or more magnetic elements, it may be called an isomagnetic chart. It is an isoclinal or isoclinic chart if it shows lines of equal magnetic dip, an isodynamic chart if it shows lines of equal magnetic intensity, an isogonic chart if it shows lines of equal magnetic variation, an isogriv chart if it shows lines of equal grid variation, an isoporic chart if it shows lines of equal rate or change of a magnetic element.

**magnetic circle.** . A sphere of specified radius about the magnetic compass location to be kept free of any magnetic or electrical equipment which would interfere with the compass.

**magnetic compass.** . A compass depending for its directive force upon the attraction of the horizontal component of the earth's magnetic field for a magnetized needle or sensing element free to turn in a horizontal direction.

**magnetic course.** . Course relative to magnetic north; compass course corrected for deviation. magnetic daily variation. See MAGNETIC DIURNAL VARIATION.

**magnetic declination.** . See VARIATION, definition 1.

**magnetic deviation.** . See DEVIATION, definition 1.

**magnetic dip.** . Angular distance between the horizontal and the direction of a line of force of the earth's magnetic field at any point. Also called DIP, MAGNETIC INCLINATION.

**magnetic dip pole.** . See MAGNETIC POLE, definition 1.

**magnetic direction.** . Horizontal direction expressed as angular distance from magnetic north. magnetic diurnal variation. Oscillations of the earth's magnetic field which have a periodicity of about a day and which depend to a close approximation only on local time and geographic latitude. Also called MAGNETIC DAILY VARIATION.

**magnetic element.** . 1. Variation, dip, or magnetic intensity. 2. The part of an instrument producing or influenced by magnetism.

**magnetic equator.** . The line on the surface of the earth connecting all points at which the magnetic dip is zero. Also called ACLINIC LINE. See also GEOMAGNETIC EQUATOR.

**magnetic field.** . Any space or region in which magnetic forces are present, as in the earth's magnetic field, or in or about a magnet, or in or about an electric current. See also MAGNETIC VECTOR.

**magnetic force.** . The strength of a magnetic field. Also called

- MAGNETIC INTENSITY.
- magnetic heading.** . Heading relative to magnetic north; compass heading corrected for deviation.
- magnetic inclination.** . See MAGNETIC DIP.
- magnetic induction.** . The act or process by which material becomes magnetized when placed in a magnetic field.
- magnetic intensity.** . The strength of a magnetic field. Also called MAGNETIC FORCE.
- magnetic latitude.** . Angular distance north or south of the magnetic equator. The angle is equal to an angle, the tangent of which is equal to half the tangent of the magnetic dip at the point.
- magnetic lines of force.** . Closed lines indicating by their direction the direction of magnetic influence.
- magnetic meridian.** . A line of horizontal magnetic force of the earth. A compass needle without deviation lies in the magnetic meridian.
- magnetic moment.** . The quantity obtained by multiplying the distance between two magnetic poles by the average strength of the poles.
- magnetic needle.** . A small, slender, magnetized bar which tends to align itself with magnetic lines of force.
- magnetic north.** . The direction indicated by the north seeking pole of a freely suspended magnetic needle, influenced only by the earth's magnetic field.
- magnetic observation.** . Measurement of any of the magnetic elements.
- magnetic parallel.** . An isoclinic; a line connecting points of equal magnetic dip.
- magnetic pole.** . 1. Either of the two places on the surface of the earth where the magnetic dip is 90°, that in the Northern Hemisphere being designated north magnetic pole, and that in the Southern Hemisphere being designated south magnetic pole. Also called MAGNETIC DIP POLE. See also MAGNETIC LATITUDE, GEOMAGNETIC POLE, MAGNETIC LATITUDE. 2. Either of those two points of a magnet where the magnetic force is greatest.
- magnetic prime vertical.** . The vertical circle through the magnetic east and west points of the horizon.
- magnetic range.** . A range oriented in a given magnetic direction and used to assist in the determination of the deviation of a magnetic compass.
- magnetic retentivity.** . The ability to retain magnetism after removal of the magnetizing force.
- magnetic secular change.** . The gradual variation in the value of a magnetic element which occurs over a period of years.
- magnetic storm.** . A disturbance in the earth's magnetic field, associated with abnormal solar activity, and capable of seriously affecting both radio and wire transmission.
- magnetic temporal variation.** . Any change in the earth's magnetic field which is a function of time.
- magnetic track.** . The direction of the track relative to magnetic north.
- magnetic variation.** . See VARIATION, definition 1.
- magnetic vector.** . The component of the electromagnetic field associated with electromagnetic radiation which is of the nature of a magnetic field. The magnetic vector is considered to coexist with, but to act at right angles to, the electric vector.
- magnetism.** , *n.* The phenomena associated with magnetic fields and their effects upon magnetic materials, notably iron and steel. The magnetism of the north-seeking end of a freely suspended magnet is called red magnetism; the magnetism of the south-seeking end is called blue magnetism. Magnetism acquired by a piece of magnetic material while it is in a magnetic field is called induced magnetism. Permanent magnetism is retained for long periods without appreciable reduction, unless the magnet is subjected to a demagnetizing force. The magnetism in the intermediate iron of a ship which tends to change as the result of vibration, aging, or cruising in the same direction for a long period but does not alter immediately so as to be properly termed induced magnetism is called sub permanent magnetism. Magnetism which remains after removal of the magnetizing force may be called residual magnetism. The magnetism of the earth is called terrestrial magnetism or geomagnetism.
- magnetize.** , *v., t.* To produce magnetic properties. The opposite is DEMAGNETIZE.
- magnetometer.** , *n.* An instrument for measuring the intensity and direction of the earth's magnetic field. See also DECLINOMETER.
- magnetron.** , *n.* An electron tube characterized by the interaction of electrons with the electric field of circuit element in crossed steady electric and magnetic fields to produce an alternating current power output. It is used to generate high power output in the ultra-high and super-high frequency bands.
- magnification.** , *n.* The apparent enlargement of anything.
- magnifying power.** . The ratio of the apparent length of a linear dimension as seen through an optical instrument to that seen by the unaided eye. See POWER.
- magnitude.** , *n.* 1. Relative brightness of a celestial body. The smaller (algebraically) the number indicating magnitude, the brighter the body. The expression first magnitude is often used somewhat loosely to refer to all bodies of magnitude 1.5 or brighter, including negative magnitudes. 2. Amount; size; greatness.
- magnitude ratio.** . The ratio of relative brightness of two celestial bodies differing in magnitude by 1.0. This ratio is 2.512, the 5th root of 100. A body of magnitude 1.0 is 2.512 times as bright as a body of magnitude 2.0, etc.
- main beam.** . See under LOBE.
- mainland.** , *n.* The principal portion of a large land area. The term is used loosely to contrast a principal land mass from outlying islands and sometimes peninsulas.
- main light.** . The principal light of two or more lights situated on the same support or neighboring supports.
- main lobe.** . The lobe of the radiation pattern of a directional antenna which contains the direction of maximum radiation.
- major axis.** . The longest diameter of an ellipse or ellipsoid. Opposite is MINOR AXIS.
- major datum.** . See PREFERRED DATUM.
- major light.** . A light of high intensity and reliability exhibited from a fixed structure or on marine site (except range lights). Major lights include primary seacoast lights and secondary lights. See also MINOR LIGHT.
- major planets.** . See under PLANET.
- make the land.** . To sight and approach or reach land from seaward.
- make way.** . To progress through the water.
- making way.** . Progressing through the water. See also UNDERWAY.
- Malvin Current.** . See FALKLAND CURRENT.
- mamma.** , *n.* Hanging protuberances, like pouches on the under surface of a cloud. This supplementary cloud feature occurs mostly with cirrus, cirrocumulus, altocumulus, altostratus, stratocumulus, and cumulonimbus; in the case of cumulonimbus, mamma generally appear on the under side of the anvil.
- mammatus.** , *n.* See MAMMA.
- maneuvering board.** . A polar coordinate plotting sheet devised to facilitate solution of problems involving relative movement.
- Maneuvering Board Manual.** . See PUB. NO. 217.
- Manganese nodules.** , *n.* A small, lumpy rock concretions found on the ocean floor formed by layers of metal which have slowly crystallized around a core.
- man-made noise.** . In radio reception, noise due entirely to unwanted transmissions from electrical or electronic apparatus, which has been insufficiently suppressed.
- manned light.** . A light which is operated and maintained by full-time resident personnel.
- mantissa.** , *n.* The part of a logarithm (base 10) to the right of the decimal point. The part of a logarithm (base 10) to the left of the decimal point is called the CHARACTERISTIC.
- manual.** , *adj.* By hand, in contrast with AUTOMATIC.
- manual radio direction finder.** . A radio direction finder which requires manual operation of the antenna and determination of the aural null by speaker or headphones.
- manual update.** . In ECDIS, the manual application of corrections to ENC DATA in the SENC by human operator, usually based on unformatted UPDATE INFORMATION (such as NtMs, voice radio, verbal communications, etc.) The manual application of hand corrections to nautical charts.
- map.** , *n.* A digital or graphic representation of all or part of the surface of the earth, celestial sphere, or other area; showing relative size and position, according to a given projection, of the features represented. Such a representation intended primarily for navigational use is called a chart. A planimetric map indicates only the horizontal positions of features; a topographic map both horizontal and vertical positions. The pattern on the underside of extensive cloud areas, created by the varying amounts of light reflected from the earth's surface, is called a sky map. A chart which shows the distribution of meteorological conditions over an area at a given moment may be called a weather map.
- map accuracy standards.** . See UNITED STATES NATIONAL MAP

## ACCURACY STANDARDS.

**map chart.** . See COMBAT CHART.

**mapping, charting and geodesy.** . The collection, transformation, generation, dissemination, and storing of geodetic, geomagnetic, gravimetric, aeronautical, topographic, hydrographic, cultural, and toponymic data. These data may be used for military planning, training, and operations including aeronautical, nautical, and land navigation, as well as for weapon orientation and target positioning. Mapping, charting and geodesy (MC&G) also includes the evaluation of topographic, hydrographic, or aeronautical features for their effect on military operations or intelligence. The data may be presented in the form of topographic, planimetric, relief, or thematic maps and graphics; nautical and aeronautical charts and publications, and in simulated, photographic, digital, or computerized formats.

**map projection.** . A systematic drawing of lines on a plane surface to represent the parallels of latitude and the meridians of longitude of the earth or a section of the earth. A map projection may be established by analytical computation or may be constructed geometrically.

**map symbol.** . A character, letter, or similar graphic representation used on a map to indicate some object, characteristic, etc. May be called a CHART SYMBOL when applied to a chart.

**March equinox.** . See VERNAL EQUINOX.

**mare's tails.** . Long, slender, well-defined streaks of cirrus cloud which resemble horse's tails.

**marigram.** , *n.* A graphic record of the rise and fall of the tide. The record is in the form of a curve, in which time is generally represented on the abscissa and the height of the tide on the ordinate.

**marina.** , *n.* A harbor facility for small boats, yachts, etc., where supplies, repairs, and various services are available.

**marine.** , *adj.* Of or pertaining to the sea. See also NAUTICAL.

**marine chart.** . See NAUTICAL CHART.

**marine climate.** . The type of climate characteristic of coastal areas, islands, and the oceans, the distinctive features of which are small annual and daily temperature range and high relative humidity in contrast with CONTINENTAL CLIMATE, which is characteristic of the interior of a large landmass, and the distinctive features of which are large annual and daily temperature range and dry air with few clouds.

**Marine Information Object (MIO).** . In ECDIS an OBJECT which has one or more ATTRIBUTES, the value or values of which vary with time.

**marine light.** . A luminous or lighted aid to navigation intended primarily for marine navigation. One intended primarily for air navigation is called an AERONAUTICAL LIGHT.

**marine parade.** . See MARINE REGATTA.

**marine radiobeacon.** . A radiobeacon whose service is intended primarily for the benefit of ships.

**marine railway.** . A track, a wheeled cradle, and winching mechanism for hauling vessels out of the water so that the bottom can be exposed.



marine  
railway

**marine regatta.** . An organized race or other public water event, conducted according to a prearranged schedule, noted in the Local Notice to Mariners. Also called MARINE PARADE.

**marine sanctuary.** . An area established under provisions of the Marine Protection, Research, and Sanctuaries Act of 1972, Public Law 92-532 (86 Stat. 1052), for the preservation and restoration of its conservation, recreational, ecological, or esthetic values. Such an area may lie in ocean waters as far seaward as the outer edge of the continental shelf, in coastal waters where the tide ebbs and flows, or in the Great Lakes and connecting waters, and may be classified as a habitat, species, research, recreational and esthetic, or unique area.

**marine sextant.** . A sextant designed primarily for marine navigation. On a clamp screw sextant the position of the tangent screw is controlled by a clamp screw; on an endless tangent screw sextant the position of the index arm and the vernier or micrometer drum is controlled

by an endless tangent screw. A vernier sextant provides a precise reading by means of a vernier used directly with the arc, and may have either a clamp screw or an endless tangent screw for controlling the position of the tangent screw or the index arm. A micrometer drum sextant provides a precise reading by means of a micrometer drum attached to the index arm, and has an endless tangent screw for controlling the position of the index arm. See also SEXTANT.

**mariner's information.** . In ECDIS, the information is entered to the SENC, e.g. area of strong currents. Information originated by and added by the mariner.

**mariner's navigational objects.** . In ECDIS features other than chart objects, such as the ownship symbol and velocity vector, planned route, bearing line, etc.

**maritime.** , *adj.* Bordering on, concerned with, or related to the sea. See also NAUTICAL.

**maritime polar air.** . See under AIR-MASS CLASSIFICATION.

**maritime position.** . The location of a seaport or other point along a coast.

**Maritime Safety Information (MSI).** . Designation of the IHO/IMO referring to navigational information of immediate importance to mariners, affecting the safety of life and/or property at sea.

**maritime tropical air.** . See under AIR-MASS CLASSIFICATION.

**mark.** , *n.* 1. An artificial or natural object of easily recognizable shape or color, or both, situated in such a position that it may be identified on a chart. A fixed artificial navigation mark is often called a BEACON. This may be lighted or unlighted. Also called NAVIGATION MARK; SEAMARK. See also CLEARING MARKS. 2. A major design or redesign of an instrument, denoted by a number. Minor changes are designated MODIFICATIONS. 3. One of the bits of leather, cloth, etc., indicating a specified length of a lead line. 4. An indication intended as a datum or reference, such as a bench mark.

**mark.** , *v., i.* "Now" or "at this moment." A call used when simultaneous observations are being made, to indicate to the second person the moment a reading is to be made, as when the time of a celestial observation is to be noted; or the moment a reading is a prescribed value, as when the heading of a vessel is exactly a desired value.

**marker beacon.** . 1. See MARKER RADIOBEACON. 2. As defined by the International Telecommunication Union (ITU), a transmitter in the aeronautical radionavigation service which radiates vertically a distinctive pattern for providing position information to aircraft.

**marker buoy.** . A small, brightly painted moored float used to temporarily mark a location on the water while placing a buoy on station.

**marker radiobeacon.** . A low powered radiobeacon used primarily to mark a specific location such as the end of a jetty. Usually used primarily for homing bearings. Also called MARKER BEACON.

**marl.** , *n.* A crumbling, earthy deposit, particularly one of clay mixed with sand, lime, decomposed shells, etc. Sometimes a layer of marl becomes quite compact.

**Mars.** , *n.* The navigational planet whose orbit lies between the orbits of the Earth and Jupiter.

**marsh.** , *n.* An area of soft wet land. Flat land periodically flooded by salt water is called a salt marsh. Sometimes called SLOUGH.



marsh

**mascaret.** , *n.* See TIDAL BORE.

**mass.** , *n.* The measure of a body's inertia, or the amount of material it contains. This term should not be confused with WEIGHT.

**mass attraction vertical.** . The normal to any surface of constant geopotential. On the earth this vertical is a function only of the distribution of mass and is unaffected by forces resulting from the motions of the earth.

**master.** , *n.* Short for MASTER STATION.

**master compass.** . The main part of a remote-indicating compass system which determines direction for transmission to various repeaters.

**master gyrocompass.** . See under GYROCOMPASS.

**master station.** . In a radionavigation system, the station of a chain which

- provides a reference by which the emissions of other (secondary) stations are controlled.
- masthead light.** . A fixed running light placed on the centerline of a vessel showing an unbroken white light over an arc of the horizon from dead ahead to 22.5° abaft the beam on either side of the vessel.
- Matanuska wind.** . A strong, gusty, northeast wind which occasionally occurs during the winter in the vicinity of Palmer, Alaska.
- matrix.** . In ECDIS an array of regularly spaced locations.
- maximum ebb.** . See under EBB CURRENT.
- maximum flood.** . See under FLOOD CURRENT.
- maximum thermometer.** . A thermometer which automatically registers the highest temperature occurring since its last setting. One which registers the lowest temperature is called a MINIMUM THERMOMETER.
- mean.** , *adj.* Occupying a middle position.
- mean.** , *n.* The average of a number of quantities, obtained by adding the values and dividing the sum by the number of quantities involved. Also called AVERAGE, ARITHMETIC MEAN. See also MEDIAN.
- mean anomaly.** . See under ANOMALY, definition 2.
- mean diurnal high water inequality.** . See under DIURNAL INEQUALITY.
- mean diurnal low water inequality.** . See under DIURNAL INEQUALITY.
- mean elements.** . Elements of an adopted reference orbit that approximates the actual, perturbed orbit. Mean elements serve as the basis for calculating perturbations. See also ORBITAL ELEMENTS.
- mean higher high water.** . A tidal datum that is the average of the highest high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent of a 19-year datum. See also HIGH WATER.
- mean higher high water line.** . The intersection of the land with the water surface at the elevation of mean higher high water.
- mean high tide.** . See under MEAN HIGH WATER.
- mean high water.** . A tidal datum, the average of all the high water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent of a 19-year datum. See also HIGH WATER.
- mean high water line.** . The intersection of the land with the water surface at the elevation of mean high water. See also SHORELINE.
- mean high water lunitidal interval.** . See under LUNITIDAL INTERVAL. mean high water neaps. See as NEAP HIGH WATER or HIGH WATER NEAPS under NEAP TIDES.
- mean high water springs.** . See under SPRING TIDES.
- mean ice edge.** . The average position of the ice edge in any given month or period based on observations over a number of years. Other terms which may be used are mean maximum ice edge and mean minimum ice edge. See also ICE LIMIT.
- mean latitude.** . Half the arithmetical sum of the latitudes of two places on the same side of the equator. Mean latitude is labeled N or S to indicate whether it is north or south of the equator. The expression is occasionally used with reference to two places on opposite sides of the equator, but this usage is misleading as it lacks the significance usually associated with the expression. When the places are on opposite sides of the equator, two mean latitudes are generally used, the mean of each latitude north and south of the equator. The mean latitude is usually used in middle-latitude sailing for want of a practicable means of determining the middle latitude. See also MIDDLE LATITUDE, MIDDLE-LATITUDE SAILING.
- mean lower low water.** . A tidal datum that is the average of the lowest low water height of each tidal day observed over the National Tidal Datum Epoch. For station with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent of a 19-year datum. See also LOW WATER.
- mean lower low water line.** . The intersection of the land with the water surface at the elevation of mean lower low water.
- mean low water.** . A tidal datum that is the average of all the low water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent of a 19-year datum. See also LOW WATER.
- mean low water line.** . The intersection of the land with the water surface at the elevation of mean low water.
- mean low water lunitidal interval.** . See under LUNITIDAL INTERVAL.
- mean low water neaps.** . See as NEAP LOW WATER or LOW WATER NEAPS under NEAP TIDES.
- mean low water springs.** . 1. A tidal datum that is the arithmetic mean of the low waters occurring at the time of the spring tides observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). It is usually derived by taking an elevation depressed below the halftide level by an amount equal to one-half the spring range of tide, necessary corrections being applied to reduce the result to a mean value. This datum is used, to a considerable extent, for hydrographic work outside of the United States and is the level of reference for the Pacific approaches to the Panama Canal. Often shortened to SPRING LOW WATER. See also DATUM. 2. See under SPRING TIDES.
- mean motion.** . In undisturbed elliptic motion, the constant angular speed required for a body of a specified mass to complete one revolution in an orbit of a specified semimajor axis.
- mean noon.** . Twelve o'clock mean time, or the instant the mean sun is over the upper branch of the meridian. Mean noon may be either local or Greenwich depending upon the reference meridian. Zone, standard, daylight saving or summer noon are also forms of mean noon, the mean sun being over the upper branch of the zone, standard, daylight saving or summer reference meridian, respectively.
- mean power.** . See under POWER (OF A RADIO TRANSMITTER).
- mean range.** . The average difference in the extreme values of a variable quantity, as the mean range of tide.
- mean range of tide.** . The difference in height between mean high water and mean low water.
- mean rise interval.** . The average interval between the meridian transit of the moon and the middle of the period of the rise of the tide. It may be computed by adding the half of the duration of rise to the mean low water interval, rejecting the semidiurnal tidal period of 12.42 hours when greater than this amount. The mean rise interval may be either local or Greenwich according to whether it is referred to the local or Greenwich meridian.
- mean rise of tide.** . The height of mean high water above the reference or chart sounding datum.
- mean river level.** . A tidal datum that is the average height of the surface of a tidal river at any point for all stages of the tide observed over a 19-year Metonic cycle (the National Tidal Datum Epoch) usually determined from hourly height readings. In rivers subject to occasional freshets, the river level may undergo wide variations, and for practical purposes certain months of the year may be excluded in the determination of tidal datums. For charting purposes, tidal datums for rivers are usually based on observations during selected periods when the river is at or near low water state. See also DATUM.
- mean sea level.** . A tidal datum that is the arithmetic mean of hourly water elevations observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). Shorter series are specified in the name, e.g., monthly mean sea level and yearly mean sea level. See also DATUM; EPOCH, definition 2.
- mean sidereal time.** . See under SIDEREAL TIME.
- mean solar day.** . The duration of one rotation of the earth on its axis, with respect to the mean sun. The length of the mean solar day is 24 hours of mean solar time or 24<sup>h</sup> 03<sup>m</sup> 56.555<sup>s</sup> of mean sidereal time. See also CALENDAR DAY.
- mean solar time.** . See MEAN TIME, the term usually used.
- mean sun.** . A fictitious sun conceived to move eastward along the celestial equator at a rate that provides a uniform measure of time equal to the average apparent time. It is used as a reference for reckoning mean time, zone time, etc. Also called ASTRONOMICAL MEAN SUN. See also DYNAMICAL MEAN SUN.
- mean tide level.** . See HALF-TIDE LEVEL.
- mean time.** . Time based upon the rotation of the earth relative to the mean sun. Mean time may be designated as local or Greenwich as the local or Greenwich meridian is the reference. Greenwich mean time is also called UNIVERSAL TIME. Zone, standard, daylight saving or summer time are also variations of mean time, specified meridians being used as the reference. See also EQUATION OF TIME, MEAN SIDEREAL TIME.
- mean tropic range.** . The mean between the great tropic tidal range and

- the small tropic range. The small tropic range and the mean tropic range are applicable only when the type of tide is semidiurnal or mixed. See also GREAT TROPIC RANGE.
- mean water level.** . The mean surface elevation as determined by averaging the heights of the water at equal intervals of time, usually hourly.
- mean water level line.** . The line formed by the intersection of the land with the water surface at an elevation of mean water level.
- measured mile.** . A length of 1 nautical mile, the limits of which have been accurately measured and are indicated by ranges ashore. It is used by vessels to calibrate logs, engine revolution counters, etc., and to determine speed.
- measured-mile buoy.** . A buoy marking the end of a measured mile.
- mechanical scanning.** . Scanning effected by moving all or part of the antenna.
- median.** , *n.* A value in a group of quantities below and above which fall an equal number of quantities. Of the group 60, 75, 80, 95, and 100, the median is 80. If there is no middle quantity in the group, the median is the value interpolated between the two middle quantities. The median of the group 6, 10, 20, and 31 is 15. See also MEAN.
- median valley.** . The axial depression of the midoceanic ridge system.
- medium.** . A method of electronic data storage and physical transfer, commonly relying on the properties of electromagnetic coatings on tape, disks, or other surfaces, or on the effects of laser light on light-sensitive surfaces.
- medium first-year ice.** . First-year ice 70 to 120 centimeters thick.
- medium floe.** . See under FLOE.
- medium fracture.** . See under FRACTURE.
- medium frequency.** . Radio frequency of 300 to 3,000 kilohertz.
- medium iceberg.** . For reports to the International Ice Patrol, an iceberg that extends 51 to 150 feet (16 to 45 meters) above the sea surface and which has a length of 201 to 400 feet (61 to 122 meters). See also SMALL ICEBERG, LARGE ICEBERG.
- medium ice field.** . See under ICE FIELD.
- medium range systems.** . Those radionavigation systems providing positioning capability beyond the range of short range systems, but their use is generally limited to ranges permitting reliable positioning for about 1 day prior to making landfall; Decca is an example.
- mega.** -. A prefix meaning one million ( $10^6$ ).
- megabyte.** . One million bytes of information in a computer.
- megacycle.** , *n.* One million cycles; one thousand kilocycles. The term is often used as the equivalent of one million cycles per second.
- megahertz.** , *n.* One million hertz or one million cycles per second.
- megaripple.** , *n.* See SAND WAVE.
- meniscus.** , *n.* 1. The curved upper surface of a liquid in a tube. 2. A type of lens.
- mensuration.** , *n.* 1. The act, process, or art of measuring. 2. That branch of mathematics dealing with determination of length, area, or volume.
- Mentor Current.** . Originating mainly from the easternmost extension of the South Pacific Current at about 40°S 90°W, the Mentor Current flows first northward and then northward. It has the characteristic features of a WIND DRIFT in that it is a broad, slow-moving flow that extends about 900 miles westward from the Peru Current to about longitude 90°W at its widest section and tends to be easily influenced by winds. It joins the westward flowing Pacific South Equatorial Current and forms the eastern part of the general counterclockwise oceanic circulation of the South Pacific Ocean. The speed in the central part of the current at about 26°S 80°W, may at times reach about 0.9 knots. Also called PERU OCEANIC CURRENT.
- Mercator bearing.** . See RHUMB BEARING.
- Mercator chart.** . A chart on the Mercator projection. This is the chart commonly used for marine navigation. Also called EQUATORIAL CYLINDRICAL ORTHOMORPHIC CHART.
- Mercator course.** . See RHUMB-LINE COURSE.
- Mercator direction.** . Horizontal direction of a rhumb line, expressed as angular distance from a reference direction. Also called RHUMB DIRECTION.
- Mercator map projection.** . A conformal cylindrical map projection in which the surface of a sphere or spheroid, such as the earth, is developed on a cylinder tangent along the equator. Meridians appear as equally spaced vertical lines and parallels as horizontal lines drawn farther apart as the latitude increases, such that the correct relationship between latitude and longitude scales at any point is maintained. The expansion at any point is equal to the secant of the latitude of that point, with a small correction for the ellipticity of the earth. The Mercator is not a perspective projection. Since rhumb lines appear as straight lines and directions can be measured directly, this projection is widely used in navigation. If the cylinder is tangent along a meridian, a transverse Mercator map projection results; if the cylinder is tangent along an oblique great circle, an oblique Mercator map projection results. Also called EQUATORIAL CYLINDRICAL ORTHOMORPHIC MAP PROJECTION.
- Mercator sailing.** . A method of solving the various problems involving course, distance, difference of latitude, difference of longitude, and departure by considering them in the relation in which they are plotted on a Mercator chart. It is similar to plane sailing, but uses meridional difference and difference of longitude in place of difference of latitude and departure, respectively.
- mercurial barometer.** . An instrument which determines atmospheric pressure by measuring the height of a column of mercury which the atmosphere will support. See also ANEROID BAROMETER.
- mercury ballistic.** . A system of reservoirs and connecting tubes containing mercury used with a type of non-pendulous gyrocompass. The action of gravity on this system provides the torques and resultant precessions required to convert the gyroscope into a compass.
- meridian.** , *n.* A north-south reference line, particularly a great circle through the geographical poles of the earth. The term usually refers to the upper branch, the half, from pole to pole, which passes through a given place; the other half being called the lower branch. An astronomical (terrestrial) meridian is a line connecting points having the same astronomical longitude. A geodetic meridian is a line connecting points of equal geodetic longitude. Geodetic and sometime astronomical meridians are also called geographic meridians. Geodetic meridians are shown on charts. The prime meridian passes through longitude 0°. Sometimes designated TRUE MERIDIAN to distinguish it from magnetic meridian, compass meridian, or grid meridian, the north-south lines relative to magnetic, compass, or grid direction, respectively. A fictitious meridian is one of a series of great circles or lines used in place of a meridian for certain purposes. A transverse or inverse meridian is a great circle perpendicular to a transverse equator. An oblique meridian is a great circle perpendicular to an oblique equator. Any meridian used as a reference for reckoning time is called a time meridian. The meridian used for reckoning standard zone, daylight saving, or war time is called standard, zone, daylight saving, or war meridian respectively. The meridian through any particular place or observer, serving as the reference for local time, is called local meridian, in contrast with the Greenwich meridian, the reference for Greenwich time. A celestial meridian is a great circle of the celestial sphere, through the celestial poles and the zenith. Also called CIRCLE OF LATITUDE. See also ANTE MERIDIAN, POST MERIDIAN.
- meridian altitude.** . The altitude of a celestial body when it is on the celestial meridian of the observer, bearing 000° or 180° true.
- meridian angle.** . Angular distance east or west of the local celestial meridian; the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the local celestial meridian and the hour circle of a celestial body measured eastward or westward from the local celestial meridian through 180°, and labeled E or W to indicate the direction of measurement. See also HOUR ANGLE.
- meridian angle difference.** . The difference between two meridian angles, particularly between the meridian angle of a celestial body and the value used as an argument for entering a table. Also called HOUR ANGLE DIFFERENCE.
- meridian observation.** . Measurement of the altitude of a celestial body on the celestial meridian of the observer, or the altitude so measured.
- meridian passage.** . See MERIDIAN TRANSIT.
- meridian sailing.** . Following a true course of 000° or 180°, sailing along a meridian. Under these conditions the dead reckoning latitude is assumed to change 1 minute for each mile run and the dead reckoning longitude remains unchanged.
- meridian transit.** . The passage of a celestial body across a celestial meridian. Upper transit, the crossing of the upper branch of the celestial meridian, is understood unless lower transit, the crossing of the lower branch, is specified. Also called TRANSIT, MERIDIAN PASSAGE, CULMINATION.
- meridional difference.** . The difference between the meridional parts of any two given parallels. This difference is found by subtraction if

- the two parallels are on the same side of the equator and by addition if on opposite sides. Also called DIFFERENCE OF MERIDIONAL PARTS.
- meridional parts.** . The length of the arc of a meridian between the equator and a given parallel on a Mercator chart, expressed in units of 1 minute of longitude at the equator.
- mesoscale.** . Typically a spatial scale between 10 and 1000 kilometers.
- metacenter.** , *n.* For small angles of inclination of a ship, the instantaneous center of a very small increment of the curved path of the center of buoyancy locus. Or, for small angles of inclination, the point of intersection of the lines of action of the buoyant force and the original vertical through the center of buoyancy.
- meta object.** . In ECDIS a FEATURE OBJECT containing information about other OBJECTS.
- meteor.** , *n.* The phenomenon occurring when a solid particle from space enters the earth's atmosphere and is heated to incandescence by friction of the air. A meteor whose brightness does not exceed that of Venus (magnitude -4) is popularly called SHOOTING STAR or FALLING STAR. A shooting star results from the entrance into the atmosphere of a particle having a diameter between a few centimeters and just visible to the naked eye. Shooting stars are observed first as a light source, similar to a star, which suddenly appears in the sky and moves along a long or short path to a point where it just as suddenly disappears. The brighter shooting stars may leave a trail which remains luminous for a short time. Meteors brighter than magnitude -4 are called BOLIDES or FIREBALLS. Light bursts, spark showers, or splitting of the trail are sometimes seen along their luminous trails which persist for minutes and for an hour in exceptional cases. The intensity of any meteor is dependent upon the size of the particle which enters the atmosphere. A particle 10 centimeters in diameter can produce a bolide as bright as the full moon. See also METEORITE.
- meteorite.** , *n.* 1. The solid particle which causes the phenomenon known as a METEOR. 2. The remnant of the solid particle, causing the meteor, which reaches the earth.
- meteorological optical range.** . The length of path in the atmosphere required to reduce the luminous flux in a collimated beam from an incandescent lamp at a color temperature of 2,700°K to 0.05 of its original value, the luminous flux being evaluated by means of the curve of spectral luminous efficiencies for photopic vision given by the International Commission on Illumination. The quantity so defined corresponds approximately to the distance in the atmosphere required to reduce the contrast of an object against its background to 5 percent of the value it would have at zero distance, for daytime observation. See also METEOROLOGICAL VISIBILITY.
- Meteorological Optical Range Table.** . A table from the International Visibility Code which gives the code number of meteorological visibility and the meteorological visibility for several weather conditions.
- meteorological tide.** . A change in water level caused by local meteorological conditions, in contrast to an ASTRONOMICAL TIDE, caused by the attractions of the sun and moon. See also SEICHE, STORM SURGE.
- meteorological tides.** . Tidal constituents having origin in the daily or seasonal variations in weather conditions which may occur with some degree of periodicity. See also STORM SURGE.
- meteorological visibility.** . The greatest distance at which a black object of suitable dimensions can be seen and recognized by day against the horizon sky, or, in the case of night observations, could be seen and recognized if the general illumination were raised to the normal daylight level. It has been established that the object may be seen and recognized if the contrast threshold is 0.05 or higher. The term may express the visibility in a single direction or the prevailing visibility in all directions. See also VISIBILITY, METEOROLOGICAL OPTICAL RANGE, CONTRAST THRESHOLD.
- meteor swarm.** . The scattered remains of comets that have broken up.
- meter.** , *n.* 1. The base unit of length in the International System of Units, equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels  $2p_{10}$  and  $5p_5$  of the krypton-86 atom. It is equal to 39.37008 inches, approximately, or approximately one ten-millionth of the distance from the equator to the North or South Pole. The old international prototype of the meter is still kept at the International Bureau of Weights and Measures under the conditions specified in 1889. 2. A device for measuring, and usually indicating, some quantity.
- method of bisectors.** . As applied to celestial lines of position, the movement of each of three or four intersecting lines of position an equal amount, in the same direction toward or away from the celestial bodies, so as to bring them as nearly as possible to a common intersection. When there are more than four lines of position, the lines of position in the same general direction are combined to reduce the data to not more than four lines of position. See also OUTSIDE FIX.
- Metonic cycle.** . A period of 19 years or 235 lunations, devised by Meton, an Athenian astronomer who lived in the fifth century B.C., for the purpose of obtaining a period in which new and full moon would recur on the same day of the year. Taking the Julian year of 365.25 days and the synodic month as 29.53058 days, we have the 19-year period of 6939.75 days as compared with the 235 lunations of 6939.69 days, a difference of only 0.06 days. See also CALLIPPIC CYCLE.
- meter per second.** . The derived unit of speed in the International System of Units.
- meter per second squared.** . The derived unit of acceleration in the International System of Units.
- metric system.** . A decimal system of weights and measures based on the meter as the unit of length and the kilogram as a unit mass. See also INTERNATIONAL SYSTEM OF UNITS.
- Mexico Current.** . From late October through April an extension of the California Current, known as the Mexico Current, flows southeastward along the coast to the vicinity of longitude 95°W where it usually turns west, but at times extends southward as far as Honduras with speeds from 0.5 to 1 knot. During the remainder of the year, this current flows northwestward along the Mexican coast as far as Cabo Corrientes, where it turns westward and becomes a part of the Pacific North Equatorial Current.
- micro-.** . A prefix meaning one-millionth ( $10^{-6}$ ).
- micrometer.** , *n.* An auxiliary device to provide measurement of very small angles or dimensions by an instrument such as a telescope.
- micrometer drum.** . A cylinder carrying an auxiliary scale and sometimes a vernier, for precise measurement, as in certain type sextants.
- micrometer drum sextant.** . A marine sextant providing a precise reading by means of a micrometer drum attached to the index arm, and having an endless tangent screw for controlling the position of the index arm. The micrometer drum may include a vernier to enable a more precise reading. On a vernier sextant the vernier is directly on the arc.
- micron.** , *n.* A unit of length equal to one-millionth of a meter.
- microprocessor.** . An integrated circuit in a computer which executes machine-language instructions.
- microsecond.** , *n.* One-millionth of a second.
- microwave.** , *n.* A very short electromagnetic wave, usually considered to be about 30 centimeters to 1 millimeter in length. While the limits are not clearly defined, it is generally considered as the wavelength of radar operation.
- microwave frequency.** . Radio frequency of 1,000 to 300,000 megahertz, having wavelengths of 30 centimeters to 1 millimeter.
- mid-channel buoy.** . See FAIRWAY BUOY.
- mid-channel mark.** . A navigation mark serving to indicate the middle of a channel, which can be passed on either side safely.
- middle clouds.** . Types of clouds the mean level of which is between 6,500 and 20,000 feet. The principal clouds in this group are alto-cumulus and altostratus.
- middle ground.** . A shoal in a fairway having a channel on either side.
- middle ground buoy.** . One of the buoys placed at each end of a middle ground. See BIFURCATION BUOY, JUNCTION BUOY.
- middle latitude.** . The latitude at which the arc length of the parallel separating the meridians passing through two specific points is exactly equal to the departure in proceeding from one point to the other by middle-latitude sailing. Also called MID-LATITUDE. See also MEAN LATITUDE, MIDDLE-LATITUDE SAILING.
- middle-latitude sailing.** . A method that combines plane sailing and parallel sailing. Plane sailing is used to find difference of latitude and departure when course and distance are known, or vice versa. Parallel sailing is used to inter-convert departure and difference of longitude. The mean latitude is normally used for want of a practicable means of determining the middle latitude, the latitude at which the arc length of the parallel separating the meridians passing through two specific points is exactly equal to the departure in pro-

ceeding from one point to the other. See also MEAN LATITUDE.

**mid-extreme tide.** . An elevation midway between the extreme high water and the extreme low water occurring in any locality. See also HALFTIDE LEVEL.

**mid-latitude.** . See MIDDLE LATITUDE.

**midnight.** , *n.* Twelve hours from noon, or the instant the time reference crosses the lower branch of the reference celestial meridian.

**midnight sun.** . The sun when it is visible at midnight. This occurs during the summer in high latitudes, poleward of the circle at which the latitude is approximately equal to the polar distance of the sun.

**mill.** , *n.* 1. A unit of angular measurement equal to an angle having a tangent of 0.001. 2. A unit of angular measurement equal to an angle subtended by an arc equal to 1/6,400th part of the circumference of a circle.

**mile.** , *n.* A unit of distance. The nautical mile, or sea mile, is used primarily in navigation. Nearly all maritime nations have adopted the International Nautical Mile of 1,852 meters proposed in 1929 by the International Hydrographic Bureau. The U.S. Departments of Defense and Commerce adopted this value on July 1, 1954. Using the yard-meter conversion factor effective July 1, 1959, (1 yard = 0.9144 meter, exactly) the International Nautical Mile is equivalent to 6076.11549 feet, approximately. The geographical mile is the length of 1 minute of arc of the equator considered to be 6,087.08 feet. The U.S. Survey mile or land mile (5,280 feet in the United States) is commonly used for navigation on rivers and lakes, notably the Great Lakes of North America. See also CABLE, MEASURED MILE.

**mileage number.** . A number assigned to aids to navigation which gives the distance in sailing miles along the river from a reference point to the aid. The number is used principally in the Mississippi and other river systems.

**miles of relative movement.** . The distance, in miles, traveled relative to a reference point which is usually in motion.

**military grid.** . Two sets of parallel lines intersecting at right angles and forming squares; the grid is superimposed on maps, charts, and other similar representations of the earth's surface in an accurate and consistent manner to permit identification of ground locations with respect to other locations and the computation of direction and distance to other points. See also MILITARY GRID REFERENCE SYSTEM, UNIVERSAL POLAR STEREOGRAPHIC GRID, UNIVERSAL TRANSVERSE MERCATOR GRID, WORLD GEOGRAPHIC REFERENCE SYSTEM.

**military grid reference system.** . A system which uses a standard-scaled grid square, based on a point of origin on a map projection of the earth's surface in an accurate and consistent manner to permit either position referencing or the computation of direction and distance between grid positions. See also MILITARY GRID.

**Milky Way.** . The galaxy of which the sun and its family of planets are a part. It appears as an irregular band of misty light across the sky. Through a telescope, it is seen to be composed of numerous individual stars. See also COALSACK.

**milli-** . A prefix meaning one-thousandth.

**millibar.** , *n.* A unit of pressure equal to 1,000 dynes per square centimeter, or 1/1,000th of a bar. The millibar is used as a unit of measure of atmospheric pressure, a standard atmosphere being equal to 1,013.25 millibars or 29.92 inches of mercury.

**milligal.** , *n.* A unit of acceleration equal to 1/1,000th of a gal, or 1/1,000 centimeter per second per second. This unit is used in gravity measurements, being approximately one-millionth of the average gravity at the earth's surface.

**millimeter.** , *n.* One thousandth of a meter- one tenth of a centimeter.:03937008 inch.

**millisecond.** , *n.* One-thousandth of a second.

**minaret.** , *n.* A tall, slender tower attached to a mosque and surrounded by one or more projecting balconies; frequently charted as landmarks.



minaret

**minimal depiction of detail.** . A term used to indicate the extreme case of generalization of detail on a chart. In the extreme case most features are omitted even though there is space to show at least some of them. The practice is most frequently used for semi-enclosed areas such as estuaries and harbors on smaller-scale charts, where use of a larger scale chart is essential.

**minimum distance.** (of a navigational system). The minimum distance at which a navigational system will function within its prescribed tolerances.

**minimum ebb.** . See under EBB CURRENT.

**minimum flood.** . See under FLOOD CURRENT.

**minimum signal.** . The smallest signal capable of satisfactorily operating an equipment, e.g., the smallest signal capable of triggering a racon.

**minimum thermometer.** . A thermometer which automatically registers the lowest temperature occurring since its last setting. One which registers the highest temperature is called a MAXIMUM THERMOMETER.

**minor axis.** . The shortest diameter of an ellipse or ellipsoid.

**minor light.** . An automatic unmanned light on a fixed structure usually showing low to moderate intensity. Minor lights are established in harbors, along channels, along rivers, and in isolated locations. See also MAJOR LIGHT.

**minor planets.** . See under PLANET.

**minute.** , *n.* 1. The sixtieth part of a degree of arc. 2. The sixtieth part of an hour.

**mirage.** , *n.* An optical phenomenon in which objects appear distorted, displaced (raised or lowered), magnified, multiplied, or inverted due to varying atmospheric refraction when a layer of air near the earth's surface differs greatly in density from surrounding air. See also TOWERING, STOOPING, LOOMING, SINKING, FATA MORGANA.

**mirror reflection.** . See SPECULAR REFLECTION.

**missing.** , *adj.* Said of a floating aid to navigation which is not on station with its whereabouts unknown.

**mist.** , *n.* An aggregate of very small water droplets suspended in the atmosphere. It produces a thin, grayish veil over the landscape. It reduces visibility to a lesser extent than fog. The relative humidity with mist is often less than 95 percent. Mist is intermediate in all respects between haze (particularly damp haze) and fog. See also DRIZZLE.

**mistake.** , *n.* The result of carelessness or of a mistake. For the purpose of error analysis, a mistake is not classified as an error. Also called BLUNDER.

**mistral.** , *n.* A cold, dry wind blowing from the north over the northwest coast of the Mediterranean Sea, particularly over the Gulf of Lions. Also called CIERZO. See also FALL WIND.

**mixed current.** . Type of tidal current characterized by a conspicuous speed difference between the two floods and/or ebbs usually occurring each tidal day. See also TYPE OF TIDE.

**mixed tide.** . Type of tide with a large inequality in either the high and/or low water heights, with two high waters and two low waters usually occurring each tidal day. All tides are mixed, but the name is usually applied to the tides intermediate to those predominantly semidiurnal and those predominantly diurnal. See also TYPE OF TIDE.

**moat.** , *n.* An annular depression that may not be continuous, located at the base of many sea mounts, islands, and other isolated elevations of the sea floor, analogous to the moat around a castle.

**mobile service.** . As defined by the International Telecommunication Union (ITU), a service of radiocommunication between mobile and land stations, or between mobile stations.

**mobile offshore drilling unit (MODU).** . A movable drilling platform used in offshore oil exploration and production. It is kept stationary by vertically movable legs or by mooring with several anchors. After drilling for oil it may be replaced by a production platform or a submerged structure.

**mock fog.** . A rare simulation of true fog by anomalous atmospheric refraction.

**mock moon.** . See PARASALENE.

**mock sun.** . See PARHELION.

**mock-sun ring.** . See PARHELIC CIRCLE.

**modal interference.** . Omega signals propagate in the earth-ionosphere wave guide. This waveguide can support many different electromagnetic field configurations, each of which can be regarded as an identifiable signal component or mode having the same signal frequency, but with slightly different phase velocity. Modal interfer-

- ence is a special form of signal interference wherein two or more waveguide modes interfere with each other and irregularities appear in the phase pattern. This type of interference occurs predominantly under nighttime conditions when most of the propagation path is not illuminated and the boundary conditions of the waveguide are unstable. It is most severe for signals originating at stations located close to the geomagnetic equator. During all daylight path conditions, the only region of modal interference is a more-less circular area of radius 500-1000 kilometers immediately surrounding a transmitting station.
- model atmosphere.** . Any theoretical representation of the atmosphere, particularly of vertical temperature distribution. See also STANDARD ATMOSPHERE.
- modem.** . An electronic device which converts digital information to analog signals and vice-versa, used in computer file transfer over telephone lines; derived from MODulator-DEModulator.
- moderate breeze.** . Wind of force 4 (11 to 16 knots or 13 to 18 miles per hour) on the Beaufort wind scale.
- moderate gale.** . A term once used by seamen for what is now called NEAR GALE on the Beaufort wind scale.
- modification.** . *n.* An instrument design resulting from a minor change, and indicated by number. A design resulting from a major change is called a MARK.
- modified Julian day.** . An abbreviated form of the Julian day which requires fewer digits and translates the beginning of each day from Greenwich noon to Greenwich midnight; obtained by subtracting 2400000.5 from Julian days.
- modified Lambert conformal chart.** . A chart on the modified Lambert conformal map projection. Also called NEY'S CHART.
- modified Lambert conformal map projection.** . A modification of the Lambert conformal projection for use in polar regions, one of the standard parallels being at latitude 89°59'58" and the other at latitude 71° or 74°, and the parallels being expanded slightly to form complete concentric circles. Also called NEY'S MAP PROJECTION.
- modified refractive index.** . For a given height above sea level, the sum of the refractive index of the air at this height and the ratio of the height to the radius of the earth.
- modulated wave.** . A wave which varies in some characteristic in accordance with the variations of a modulating wave. See also CONTINUOUS WAVE.
- modulating wave.** . A wave which modulates a carrier wave.
- modulation.** . *n.* A variation of some characteristic of a radio wave, called the CARRIER WAVE in accordance with instantaneous values of another wave called the MODULATING WAVE. These variations can be amplitude, frequency, phase, or pulse.
- modulator.** . *n.* The component in pulse radar which generates a succession of short pulses of energy which in turn cause a transmitter tube to oscillate during each pulse.
- mole.** . *n.* 1. A structure, usually massive, on the seaward side of a harbor for its protection against current and wave action, drift ice, wind, etc. Sometimes it may be suitable for the berthing of ships. See also JETTY, definition 1; QUAY. 2. The base unit of amount of substance in the International System of Units; it is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon atom 12. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.
- moment.** . *n.* The tendency or degree of tendency to produce motion about an axis. Numerically it is the quantity obtained by multiplying the force, speed, or mass by the distance from the point of application or center of gravity to the axis. See also MAGNETIC MOMENT.
- moment of inertia.** . The quantity obtained by multiplying the mass of each small part of a body by the square of its distance from an axis, and adding all the results.
- momentum.** . *n.* The quantity of motion. Linear momentum is the quantity obtained by multiplying the mass of a body by its linear speed. Angular momentum is the quantity obtained by multiplying the moment of inertia of a body by its angular speed.
- monitor.** . *v. t.* In radionavigation, to receive the signals of a system in order to check its operation and performance.
- monitor.** . *n.* The video display portion of a computer system.
- monitoring.** . *n.* In radionavigation, the checking of the operation and performance of a system through reception of its signals.
- monsoon.** . *n.* A name for seasonal winds first applied to the winds over the Arabian Sea, which blow for 6 months from the northeast (northeast monsoon) and for 6 months from the southwest (southwest monsoon). The primary cause is the much greater annual variation of temperature over large land areas compared with the neighboring ocean surfaces, causing an excess of pressure over the continents in winter and a deficit in summer, but other factors such as the relief features of the land have a considerable effect. In India the term is popularly applied chiefly to the southwest monsoon and by extension, to the rain which it brings.
- monsoon current.** . A seasonal wind-driven current occurring in the northern part of the Indian Ocean and the northwest Pacific Ocean. See also MONSOON DRIFT.
- Monsoon Drift.** . A drift current of the northeast Indian Ocean located north of the Indian Equatorial Countercurrent and south of the Bay of Bengal. During February and March when the northeast monsoon decreases in intensity, the monsoon drift is formed from the outflow of the Strait of Malacca and a small amount of north-westward flow along the upper southwest coast of Sumatra. Off the southwest coast of Sumatra, a current generally sets southeast during all months. It is strongest during October through April. The monsoon drift broadens as it flows westward and divides off the east coast of Sri Lanka, part joining the circulation of the Bay of Bengal and part joining the flow from the Arabian Sea. During April, the transition period between monsoons, the monsoon drift is ill-defined. A counterclockwise circulation exists between Sumatra and Sri Lanka. During May through October, the monsoon drift flows east to southeast. During November and December part of the monsoon drift is deflected into the Bay of Bengal and the remainder turns clockwise and flows southeastward. See also MONSOON.
- monsoon fog.** . An advection fog occurring as a monsoon circulation transports warm moist air over a colder surface.
- month.** . *n.* 1. The period of the revolution of the moon around the earth. The month is designated as sidereal, tropical, anomalistic, nodical or synodical, according to whether the revolution is relative to the stars, the vernal equinox, the perigee, the ascending node, or the sun. 2. The calendar month, which is a rough approximation to the synodical month.
- month of the phases.** . See SYNODICAL MONTH.
- moon.** . *n.* The astronomical satellite of the earth.
- moonbow.** . *n.* A rainbow formed by light from the moon. Colors in a moonbow are usually very difficult to detect. Also called LUNAR RAINBOW.
- moon dog.** . See PARASELENE.
- moonrise.** . *n.* The crossing of the visible horizon by the upper limb of the ascending moon.
- moonset.** . *n.* The crossing of the visible horizon by the upper limb of the descending moon.
- moor.** . *v., t.* To secure a vessel to land by tying to a pier, wharf or other land-based structure, or to anchor with two or more anchors.



moor

- mooring.** . *n.* 1. The act of securing a craft to the ground, a wharf, pier, quay, etc., other than anchoring with a single anchor. 2. The place where a craft may be moored. 3. Chains, bridles, anchors, etc. used in securing a craft to the ground.
- mooring buoy.** . A buoy secured to the bottom by permanent moorings and provided with means for mooring a vessel by use of its anchor chain or mooring lines.
- morning glory.** . A spectacular propagating roll cloud, which frequents the sparsely populated southern margin of the Gulf of Carpentaria. Morning Glories are frequently observed during the spring months near dawn over the southern Gulf area between Sweers Island and the remote community of Burketown in northern Queensland. They often appear in the form of one or more, rapidly advancing, rather formidable roll cloud formations, which extend from horizon to horizon in an arc as far as the eye can see.

**morning star.** . The brightest planet appearing in the eastern sky during morning twilight.

**morning twilight.** . The period of time between darkness and sunrise.

**Morse code light.** . A navigation light which flashes one or more characters in Morse code.

**motion.** , *n.* The act, process, or instance of change of position. Absolute motion is motion relative to a fixed point. Actual motion is motion of an object relative to the earth. Apparent or relative motion is change of position as observed from a reference point which may itself be in motion. Diurnal motion is the apparent daily motion of a celestial body. Direct motion is the apparent motion of a planet eastward among the stars; retrograde motion, the apparent motion westward among the stars. Motion of a celestial body through space is called space motion, which is composed of two components: proper motion, that component perpendicular to the line of sight; and radial motion, that component in the direction of the line of sight. Also called MOVEMENT, especially when used in connection with problems involving the motion of one vessel relative to another.

**mound.** , *n.* On the sea floor, a low, isolated, rounded hill.

**mountain breeze.** . A breeze that blows down a mountain slope due to the gravitational flow of cooled air. See also KATABATIC WIND, VALLEY BREEZE.

**mountains.** , *n., pl.* On the sea floor, a well delineated subdivision of a large and complex positive feature, generally part of a cordillera.

**movement.** , *n.* See MOTION.

**moving havens.** . Moving restricted areas established to prevent mutual interference of Naval vessels in transit.

**moving target indication.** . A radar presentation in which stationary targets are wholly or partially suppressed.

**Mozambique Current.** . The part of the Indian South Equatorial Current that turns and flows along the African coast in the Mozambique Channel. It is considered part of the AGULHAS CURRENT.

**mud.** , *n.* A general term applied to mixtures of sediments in water. Where the grains are less than 0.002 millimeter in diameter, the mixture is called clay. Where the grains are between 0.002 and 0.0625 millimeter in diameter, the mixture is called silt. See also SAND; STONES; ROCK, definition 2.

**mud berth.** . A berth where a vessel rests on the bottom at low water.

**mud flat.** . A tidal flat composed of mud.

**mud pilot.** . A person who pilots a vessel by visually observing changes in the color of the water as the depth of the water increases or decreases.

**multihop transmission.** . See MULTIPLE-HOP TRANSMISSION.

**multipath error.** . Interference between radio waves which have traveled between the transmitter and the receiver by two paths of different lengths, which may cause fading or phase changes at the receiving point due to the vector addition of the signals, making it difficult to obtain accurate information.

**multipath propagation.** . Radio propagation from the transmitter to the receiver by two or more paths simultaneously. Also called MULTIPATH TRANSMISSION.

**multipath transmission.** . See MULTIPATH PROPAGATION.

**multiple echoes.** . Radar echoes which may occur when a strong echo is received from another ship at close range. A second or third or more echoes may be observed on the radarscope at double triple, or other multiples of the actual range of the radar target, resulting from the echo's being reflected by own ship back to the target and received once again as an echo at a multiple of the preceding range to the target. This term should not be confused with MULTIPLE-TRACE ECHO. See also SECOND-TRACE ECHO.

**multiple-hop transmission.** . Radio wave transmission in which the waves traveling between transmitter and receiver undergo multiple reflections and refractions between the earth and ionosphere. Also called MULTIHOP TRANSMISSION.

**multiple ranges.** . A group of two ranges, having one of the range marks (either front or rear) in common.

**multiple star.** . A group of three or more stars so close together that they appear as a single star, whether through physical closeness or as a result of lying in approximately the same direction. See also STAR CLUSTER.

**multiple tide staff.** . A succession of tide staffs on a sloping shore so placed that the vertical graduations on the several staffs will form a continuous scale referred to the same datum.

**multiple-trace echo.** . See SECOND-TRACE ECHO.

**multi-year ice.** . Old ice up to 3 meters or more thick which has survived at least two summer's melt. Hummocks are even smoother than in second-year ice. The ice is almost salt-free. The color, where bare, is usually blue. The melt pattern consists of large interconnecting irregular puddles and a well-developed drainage system.

**Mumetal.** , *n.* The registered trade name for an alloy of about 75% nickel and 25% iron, having high magnetic permeability and low hysteresis.

## N

**nadir.** , *n.* The point on the celestial sphere vertically below the observer, or 180° from the zenith.

**name.** , *n.* The label of a numerical value, used particularly to refer to the N (north) or S (south) label of latitude and declination. When latitude and declination are both N or both S, they are said to be of same name, but if one is N and the other S, they are said to be of contrary name.

**nano-** . A prefix meaning one-billionth (10<sup>-9</sup>).

**nanosecond.** , *n.* One-billionth of a second.

**Napier diagram.** . A diagram on which compass deviation is plotted for various headings, and the points connected by a smooth curve, permitting deviation problems to be solved quickly without interpolation. It consists of a vertical line, usually in two parts, each part being graduated for 180° of heading, and two additional sets of lines at an angle of 60° to each other and to the vertical lines. See also DEVIATION TABLE.

**Napierian logarithm.** . A logarithm to the base e (2.7182818). Also called NATURAL LOGARITHM. See also COMMON LOGARITHM.

**Napier's Rule of Circular Parts.** , *n.* A series of mathematical rules which aid in solving right spherical triangles.

**narrows.** , *n.* A navigable narrow part of a bay, strait, river, etc.

**nashi, n'aschi.** , *n.* A northeast wind which occurs in winter on the Iranian coast of the Persian Gulf, especially near the entrance to the gulf, and also on the Makran coast. It is probably associated with an outflow from the central Asiatic anticyclone which extends over the high land of Iran. It is similar in character but less severe than the BORA.

**National Geodetic Vertical Datum.** . A fixed reference once adopted as a standard geodetic datum for heights in the United States. The geodetic datum now in use in the United States is the North American Vertical Datum of 1988. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because there are many variables affecting sea level, and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level is not consistent from one location to another in either time or space. For this reason the National Geodetic Vertical Datum should not be confused with MEAN SEA LEVEL.

**National Tidal Datum Epoch.** . The specific 19-year cycle adopted by the National Ocean Survey as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums. It is necessary for standardization because of apparent periodic and apparent secular trends in sea level. The present National Tidal Datum Epoch is 1960 through 1978.

**National Water Level Observation Network. (National Tidal Datum Control Network).** . A network composed of the primary control tide stations of the National Ocean Service. This network of coastal observation stations provides the basic tidal datums for coastal boundaries and chart datums of the United States. Tidal datums obtained at secondary control tide stations and tertiary tide stations are referenced to the Network.

**natural.** , *adj.* 1. Occurring in nature; not artificial. 2. Not logarithmic-used with the name of a trigonometric function to distinguish it from its logarithm (called LOGARITHMIC TRIGONOMETRIC FUNCTION).

**natural frequency.** . The lowest resonant frequency of a body or system.

**natural harbor.** . A harbor where the configuration of the coast provides the necessary protection. See also ARTIFICIAL HARBOR.

**natural logarithm.** . See NAPIERIAN LOGARITHM.

**natural magnet.** . A magnet occurring in nature, as contrasted with an

- ARTIFICIAL MAGNET, produced by artificial means.
- natural period.** . The period of the natural frequency of a body or system.
- natural range.** . A range formed by natural objects such as rocks, peaks, etc. See also ARTIFICIAL RANGE.
- natural scale.** . See REPRESENTATIVE FRACTION.
- natural tangent.** . See under TANGENT, definition 1.
- natural trigonometric function.** . See under TRIGONOMETRIC FUNCTIONS.
- natural year.** . See TROPICAL YEAR.
- nature of the bottom.** . See BOTTOM CHARACTERISTICS.
- nautical.** , *adj.* Of or pertaining to ships, marine navigation, or seamen.
- nautical almanac.** . 1. A periodical publication of astronomical data designed primarily for marine navigation. Such a publication designed primarily for air navigation is called an AIR ALMANAC. 2. *Nautical Almanac*; a joint annual publication of the U.S. Naval Observatory and the Nautical Almanac Office, Royal Greenwich Observatory listing the Greenwich hour angle and declination of various celestial bodies to a precision of 0.1' at hourly intervals; time of sunrise, sunset, moon rise, moonset; and other astronomical information useful to navigators.
- nautical astronomy.** . See NAVIGATIONAL ASTRONOMY.
- nautical chart.** . A representation of a portion of the navigable waters of the earth and adjacent coastal areas on a specified map projection, designed specifically to meet requirements of marine navigation.
- nautical day.** . Until January 1, 1925, a day that began at noon, 12 hours earlier than the calendar day, or 24 hours earlier than the astronomical day of the same date.
- nautical mile.** . A unit of distance used principally in navigation. For practical consideration it is usually considered the length of 1 minute of any great circle of the earth, the meridian being the great circle most commonly used. Because of various lengths of the nautical mile in use throughout the world, due to differences in definition and the assumed size and shape of the earth, the International Hydrographic Bureau in 1929 proposed a standard length of 1,852 meters, which is known as the International Nautical Mile. This has been adopted by nearly all maritime nations. The U.S. Departments of Defense and Commerce adopted this value on July 1, 1954. With the yard-meter relationship then in use, the International Nautical Mile was equivalent to 6076.10333 feet, approximately. Using the yard-meter conversion factor effective July 1, 1959, (1 yard = 0.9144 meter, exactly) the International Nautical Mile is equivalent to 6076.11549 feet, approximately. See also SEA MILE.
- nautical twilight.** . The time of incomplete darkness which begins (morning) or ends (evening) when the center of the sun is 12° below the celestial horizon. The times of nautical twilight are tabulated in the *Nautical Almanac*; at the times given the horizon is generally not visible and it is too dark for marine sextant observations. See also FIRST LIGHT.
- nautophone.** , *n.* A sound signal emitter comprising an electrically oscillated diaphragm. It emits a signal similar in power and tone to that of a REED HORN.
- Naval Vessel Lights Act.** . Authorized departure from the rules of the road for character and position of navigation lights for certain naval ships. Such modifications are published in *Notice to Mariners*.
- NAVAREA.** . A geographical subdivision of the Long Range Radio Broadcast Service.
- NAVAREA Warnings.** . Broadcast messages containing information which may affect the safety of navigation on the high seas. In accordance with international obligations, the National Geospatial-Intelligence Agency (NGA) is responsible for disseminating navigation information for ocean areas designated as NAVAREAS IV and XII of the World Wide Navigational Warning Service. NAVAREA IV broadcasts cover the waters contiguous to North America from the Atlantic coast eastward to 35°W and between latitudes 7°N and 67°N. NAVAREA XII broadcasts cover the waters contiguous to North America extending westward to the International Date Line and from 67°N to the equator east of 120°W, south to 3°25'S, thence east to the coast. Other countries are responsible for disseminating navigational information for the remaining NAVAREAS.
- navigable.** , *adj.* Affording passage to a craft; capable of being navigated.
- navigable semicircle (less dangerous semicircle).** . The half of a cyclonic storm area in which the rotary and forward motions of the storm tend to counteract each other and the winds are in such a direction as to tend to blow a vessel away from the storm track. In the Northern Hemisphere this is to the left of the storm center and in the Southern Hemisphere it is to the right. The opposite is DANGEROUS SEMICIRCLE.
- navigable waters.** . Waters usable, with or without improvements, as routes for commerce in the customary means of travel on water.
- navigating sextant.** . A sextant designed and used for observing the altitudes of celestial bodies, as opposed to a hydrographic sextant.
- navigation.** , *n.* The process of planning, recording, and controlling the movement of a craft or vehicle from one place to another. The word navigate is from the Latin *navigatus*, the past participle of the verb *navigere*, which is derived from the words *navis*, meaning "ship," and *agere* meaning "to move" or "to direct." Navigation of water craft is called marine navigation to distinguish it from navigation of aircraft, called air navigation. Navigation of a vessel on the surface is sometimes called surface navigation to distinguish it from navigation of a submarine. Navigation of vehicles across land or ice is called land navigation. The expression polar navigation refers to navigation in the regions near the geographical poles of the earth, where special techniques are employed.
- navigational aid.** . An instrument, tool, system, device, chart, method, etc., intended to assist in navigation. This expression is not the same as AID TO NAVIGATION, which refers to devices external to a craft such as lights and buoys.
- navigational astronomy.** . Astronomy of direct use to a navigator, comprising principally celestial coordinates, time, and the apparent motions of celestial bodies. Also called NAUTICAL ASTRONOMY.
- navigational information.** . In ECDIS the information contained in MARINER'S NAVIGATIONAL OBJECTS.
- navigational planets.** . The four planets commonly used for celestial observations: Venus, Mars, Jupiter, and Saturn.
- navigational plot.** . A graphic plot of the movements of a craft. A dead reckoning plot is the graphic plot of the dead reckoning, suitably labeled with respect to time, direction, and speed; a geographical plot is one relative to the surface of the earth.
- navigational purpose.** . In ECDIS, the specific purpose for which an ENC has been compiled. There are six such purposes; berthing, harbor, approach, coastal, general, and overview.
- navigational symbol.** . See MARINERS' NAVIGATIONAL OBJECTS
- navigational triangle.** . The spherical triangle solved in computing altitude and azimuth and great circle sailing problems. The celestial triangle is formed on the celestial sphere by the great circles connecting the elevated pole, zenith of the assumed position of the observer, and a celestial body. The terrestrial triangle is formed on the earth by the great circles connecting the pole and two places on the earth; the assumed position of the observer and geographical position of the body for celestial observations, and the point of departure and destination for great circle sailing problems. The expression astronomical triangle applies to either the celestial or terrestrial triangle used for solving celestial observations.
- navigation, head of.** . A transshipment point at the end of a waterway where loads are transferred between water carriers and land carriers; also the point at which a river is no longer navigable due to rapids or falls.
- navigation lights.** . Statutory, required lights shown by vessels during the hours between sunset and sunrise, in accordance with international agreements.
- navigation mark.** . See MARK.
- navigation/positioning system.** . A system capable of being used primarily for navigation or position fixing. It includes the equipment, its operators, the rules and procedures governing their actions and, to some extent, the environment which affects the craft or vehicle being navigated.
- navigation satellite.** . An artificial satellite used in a system which determines positions based upon signals received from the satellite.
- Navigation Sensor System Interface (NAVSSI).** . The U.S. Naval version of the electronic chart display and information system (ECDIS). It is integrated with command and control, weapons, and other systems.
- Navigation Tables for Mariners and Aviators.** . See H.O. PUB. NO. 208.
- navigator.** , *n.* 1. A person who navigates or is directly responsible for the navigation of a craft. 2. A book of instructions on navigation, such as the *The American Practical Navigator (Bowditch)*.
- NAVSTAR Global Positioning System.** . See GLOBAL POSITIONING SYSTEM.

- NAVTEX**. . A medium frequency radiocommunications system intended for the broadcast of navigational information up to 200 miles at sea, which uses narrow band direct printing technology to print out MSI and safety messages aboard vessels, without operator monitoring.
- Navy Navigation Satellite System**. . A satellite navigation system of the United States conceived and developed by the Applied Physics Laboratory of the Johns Hopkins University. It is an all-weather, worldwide, and passive system which provides two-dimensional positioning from low-altitude satellites in near-polar orbits. The Transit launch program ended in 1988, and the system is scheduled for termination in 1996, replaced by GPS.
- neaped**, . *adj.* Left aground following a spring high tide. Also called BENEAPED.
- neap high water**. . See under NEAP TIDES.
- neap low water**. . See under NEAP TIDES.
- neap range**. . See under NEAP TIDES.
- neap rise**. . The height of neap high water above the elevation of reference or datum of chart.
- neap tidal currents**. . Tidal currents of decreased speed occurring semi-monthly as the result of the moon being in quadrature. See also NEAP TIDES.
- neap tides**. . Tides of decreased range occurring semimonthly as the result of the moon being in quadrature. The neap range of the tide is the average semidiurnal range occurring at the time of neap tides and is most conveniently computed from the harmonic constants. It is smaller than the mean range where the type of tide is either semidiurnal or mixed and is of no practical significance where the type of tide is diurnal. The average height of the high waters of the neap tides is called neap high water or high water neaps and the average height of the corresponding low waters is called neap low water or low water neaps.
- nearest approach**. . The least distance between two objects having relative motion with respect to each other.
- near gale**. . Wind of force 8 (28 to 33 knots or 32 to 38 miles per hour) on the Beaufort wind scale. See also GALE.
- nearshore current system**. . The current system caused by wave action in or near the surf zone. The nearshore current system consists of four parts: the shoreward mass transport of water; longshore currents; rip currents; the longshore movement of expanding heads of rip currents.
- near vane**. . That instrument sighting vane on the same side of the instrument as the observer's eye. The opposite is FAR VANE.
- neatline**, . *n.* That border line which indicates the limit of the body of a map or chart. Also called SHEET LINE.
- nebula**. (*pl. nebulae*), . *n.* 1. An aggregation of matter outside the solar system, large enough to occupy a perceptible area but which has not been resolved into individual stars. One within our galaxy is called a galactic nebula and one beyond is called an extragalactic nebula. If a nebula is resolved into numerous individual stars, it is called a STAR CLUSTER. 2. A galaxy.
- necessary bandwidth**. . As defined by the International Telecommunication Union (ITU) for a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specified conditions. Emissions useful for the good functioning of the receiving equipment as, for example, the emission corresponding to the carrier of reduced carrier systems, shall be included in the necessary bandwidth.
- neck**, . *n.* 1. A narrow isthmus, cape or promontory. 2. The land areas between streams flowing into a sound or bay. 3. A narrow strip of land which connects a peninsula with the mainland. 4. A narrow body of water between two larger bodies; a strait.
- negative altitude**. . Angular distance below the horizon. Also called DEPRESSION.
- Network Coordinating Station**. . An INMARSAT COAST EARTH STATION (CES) equipped to process messages in the EGC SafetyNET system.
- neutral occlusion**. . See under OCCLUDED FRONT.
- new ice**. . A general term for recently formed ice which includes frazil ice, grease ice, slush, and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have definite form only while they are afloat.
- new moon**. . The moon at conjunction, when little or none of it is visible to an observer on the earth because the illuminated side is away from him. Also called CHANGE OF THE MOON. See also PHASES OF THE MOON.
- new ridge**. . A newly formed ice ridge with sharp peaks, the slope of the sides usually being about 40°. Fragments are visible from the air at low altitude.
- newton**, . *n.* The special name for the derived unit of force in the International System of Units; it is that force which gives to a mass of 1 kilogram an acceleration of 1 meter per second, per second.
- Newtonian telescope**. . A reflecting telescope in which a small plane mirror reflects the convergent beam from the speculum to an eyepiece at one side of the telescope. After the second reflection the rays travel approximately perpendicular to the longitudinal axis of the telescope. See also CASSEGRAINIAN TELESCOPE.
- newton per square meter**. . The derived unit of pressure in the International System of Units. See also PASCAL.
- Newton's laws of motion**. . Universal laws governing all motion, formulated by Isaac Newton. These are: (1) Every body continues in a state of rest or of uniform motion in a straight line unless acted upon by a force; (2) When a body is acted upon by a force, its acceleration is directly proportional to the force and inversely proportional to the mass of the body, and the acceleration takes place in the direction in which the force acts; (3) To every action there is always an equal and opposite reaction; or, the mutual actions of two bodies are always equal and oppositely directed.
- Ney's chart**. . See MODIFIED LAMBERT CONFORMAL CHART.
- Ney's map projection**. . See MODIFIED LAMBERT CONFORMAL MAP PROJECTION.
- night**, . *n.* The part of the solar day when the sun is below the visible horizon, especially the period between dusk and dawn.
- night effect**. . See under POLARIZATION ERROR.
- night error**. . See under POLARIZATION ERROR.
- night order book**. . A notebook in which the commanding officer of a ship writes orders with respect to courses and speeds, any special precautions concerning the speed and navigation of the ship, and all other orders for the night for the officer of the deck.
- nilas**, . *n.* A thin elastic crust of ice, easily bending on waves and swell and under pressure, thrusting in a pattern of interlocking "fingers." Nilas has a matte surface and is up to 10 centimeters in thickness. It may be subdivided into DARK NILAS and LIGHT NILAS. See also FINGER RAFTING.
- nimbostratus**, . *n.* A dark, low shapeless cloud layer (mean upper level below 6,500 ft.) usually nearly uniform; the typical rain cloud. When precipitation falls from nimbostratus, it is in the form of continuous or intermittent rain or snow, as contrasted with the showery precipitation of cumulonimbus.
- nimbus**, . *n.* A characteristic rain cloud. The term is not used in the international cloud classification except as a combining term, as cumulonimbus.
- nipped**, . *adj.* Beset in the ice with the surrounding ice forcibly pressing against the hull.
- nipping**, . *n.* The forcible closing of ice around a vessel such that it is held fast by ice under pressure. See also BESET, ICE-BOUND.
- no-bottom sounding**. . A sounding in which the bottom is not reached.
- nocturnal**, . *n.* An old navigation instrument which consisted of two arms pivoted at the enter of a disk graduated for date, time and arc. The nocturnal was used for determining time during the night and for obtaining a correction to be applied to an altitude observation of Polaris for finding latitude.
- nodal**, . *adj.* Related to or located at or near a node or nodes.
- nodal line**. . A line in an oscillating body of water along which there is a minimum or no rise and fall of the tide.
- nodal point**. . 1. See NODE, definition 1. 2. The no-tide point in an amphidromic region.
- node**, . *n.* 1. One of the two points of intersection of the orbit of a planet, planetoid, or comet with the ecliptic, or of the orbit of a satellite with the plane of the orbit of its primary. That point at which the body crosses to the north side of the reference plane is called the ascending node; the other, the descending node. The line connecting the nodes is called LINE OF NODES. Also called NODAL POINT. See also REGRESSION OF THE NODES. 2. A zero point in any stationary wave system. 3. In ECDIS a zero-dimensional SPATIAL OBJECT, located by a pair of coordinates. A node is either ISOLATED or CONNECTED.
- node cycle**. . The period of approximately 18.61 Julian years required for the regression of the moon's nodes to complete a circuit of 360° of longitude. It is accompanied by a corresponding cycle of changing

- inclination of the moon's orbit relative to the plane of the earth's equator, with resulting inequalities in the rise and fall of the tide and speed of the tidal current.
- node factor.** . A factor depending upon the longitude of the moon's node which, when applied to the mean coefficient of a tidal constituent, will adapt the same to a particular year for which predictions are to be made.
- nodical.** , *adj.* Of or pertaining to astronomical nodes; measured from node to node.
- nodical month.** . The average period of revolution of the moon about the earth with respect to the moon's ascending node, a period of 27 days, 5 hours, 5 minutes, 35.8 seconds.
- nodical period.** . The interval between two successive passes of a satellite through the ascending node. See also ORBITAL PERIOD.
- nominal orbit.** . The true or ideal orbit in which an artificial satellite is expected to travel. See also NORMAL ORBIT.
- nominal range.** . See under VISUAL RANGE (OF A LIGHT).
- nomogram.** , *n.* A diagram showing, to scale, the relationship between several variables in such manner that the value of one which corresponds to known values of the others can be determined graphically. Also called NOMOGRAPH.
- nomograph.** , *n.* See NOMOGRAM.
- non-chart symbol.** . See MARINERS NAVIGATIONAL OBJECTS.
- non-dangerous wreck.** . A term used to describe a wreck having more than 20 meters of water over it. This term excludes a FOUL GROUND, which is frequently covered by the remains of a wreck and is a hazard only for anchoring, taking the ground, or bottom fishing.
- nongravitational perturbations.** . Perturbations caused by surface forces due to mechanical drag of the atmosphere (in case of low flying satellites), electromagnetism, and solar radiation pressure.
- nonharmonic constants.** . Tidal constants such as lunital intervals, ranges, and inequalities which may be derived directly from high and low water observations without regard to the harmonic constituents of the tide. Also applicable to tidal currents.
- non-HO information.** . In ECDIS, the information contained in the SENC provided by non-HO sources (MARINER'S INFORMATION or other sources outside HOs).
- non-standard buoys.** . The general classification of all lighted and unlighted buoys built to specifications other than modern standard designs.
- non-tidal basin.** . An enclosed basin separated from tidal waters by a caisson or flood gates. Ships are moved into the dock near high tide. The dock is closed when the tide begins to fall. If necessary, ships are kept afloat by pumping water into the dock to maintain the desired level. Also called WET DOCK. See also BASIN, definition 2.
- nontidal current.** . See under CURRENT.
- noon.** , *n.* The instant at which a time reference is over the upper branch of the reference meridian. Noon may be solar or sidereal as the sun or vernal equinox is over the upper branch of the reference meridian. Solar noon may be further classified as mean or apparent as the mean or apparent sun is the reference. Noon may also be classified according to the reference meridian, either the local or Greenwich meridian or additionally in the case of mean noon, a designated zone meridian. Standard, daylight saving or summer noon are variations of zone noon. The instant the sun is over the upper branch of any meridian of the moon is called lunar noon. Local apparent noon may also be called high noon.
- noon constant.** . A predetermined value added to a meridian or ex-meridian sextant altitude to determine the latitude.
- noon interval.** . The predicted time interval between a given instant, usually the time of a morning observation, and local apparent noon. This is used to predict the time for observing the sun on the celestial meridian.
- noon sight.** . Measurement of the altitude of the sun at local apparent noon, or the altitude so measured.
- normal.** , *adj.* Perpendicular. A line is normal to another line or a plane when it is perpendicular to it. A line is normal to a curve or curved surface when it is perpendicular to the tangent line or plane at the point of tangency.
- normal.** , *n.* 1. A straight line perpendicular to a surface or to another line. 2. In geodesy, the straight line perpendicular to the surface of the reference ellipsoid. 3. The average, regular, or expected value of a quantity.
- normal curve.** . Short for NORMAL DISTRIBUTION CURVE.
- normal distribution.** . A mathematical law which predicts the probability that the random error of any given observation of a series of observations of a certain quantity will lie within certain bounds. The law can be derived from the following properties of random errors: (1) positive and negative errors of the same magnitude are about equal in number, (2) small errors occur more frequently than large errors, and (3) extremely large errors rarely occur. One immediate consequence of these properties is that the average or mean value of a large number of observations of a given quantity is zero. Also called GAUSSIAN DISTRIBUTION. See also SINGLE-AXIS NORMAL DISTRIBUTION, CIRCULAR NORMAL DISTRIBUTION, STANDARD DEVIATION.
- normal distribution curve.** . The graph of the normal distribution. Often shortened to NORMAL CURVE.
- normal orbit.** . The orbit of a spherical satellite about a spherical primary during which there are no disturbing elements present due to other celestial bodies, or to some physical phenomena. Also called UNPERTURBED ORBIT, UNDISTURBED ORBIT.
- normal section line.** . A line on the surface of a reference ellipsoid, connecting two points on that surface, and traced by a plane containing the normal at one point and passing through the other point.
- normal tide.** . A non technical term synonymous with tide, i.e., the rise and fall of the ocean due to the gravitational interactions of the sun, moon, and earth alone.
- norte.** , *n.* A strong cold northeasterly wind which blows in Mexico and on the shores of the Gulf of Mexico. It results from an outbreak of cold air from the north. It is the Mexican extension of a norther.
- north.** , *n.* The primary reference direction relative to the earth; the direction indicated by 000° in any system other than relative. True north is the direction of the north geographical pole; magnetic north the direction north as determined by the earth's magnetic compass; grid north an arbitrary reference direction used with grid navigation. See also CARDINAL POINT.
- North Africa Coast Current.** . A nontidal current in the Mediterranean Sea that flows eastward along the African coast from the Strait of Gibraltar to the Strait of Sicily. It is the most permanent current in the Mediterranean Sea. The stability of the current is indicated by the proportion of no current observations, which averages less than 1 percent. The current is most constant just after it passes through the Strait of Gibraltar; in this region, west of longitude 3°W, 65 percent of all observations show an eastward set, with a mean speed of 1.1 knots and a mean maximum speed of 3.5 knots. Although the current is weaker between longitudes 3°W and 11°E, it remains constant, the speed averaging 0.7 knot through its length and its maximum speed being about 2.5 knots.
- North American Datum of 1927.** . The geodetic datum the origin of which is located at Meade's Ranch, Kansas. Based on the Clarke spheroid of 1866, the geodetic position of triangulation station Meades Ranch and azimuth from that station to station Waldo are as follows: Latitude of Meades Ranch: 39°13'25.686"N; Longitude of Meades Ranch: 98°32'30.506"W Azimuth to Waldo: 75°28'09.64" The geoidal height at Meades Ranch is assumed to be zero.
- North American Datum of 1983.** . The modern geodetic datum for North America; it is the functional equivalent of the World Geodetic System (WGS). It is based on the GRS 80 ellipsoid, which fits the size and shape of the earth more closely, and has its origin at the earth's center of mass.
- North Atlantic Current.** . An ocean current which results from extensions of the Gulf Stream and the Labrador Current near the edge of the Grand Banks of Newfoundland. As the current fans outward and widens in a northeastward through eastward flow, it decreases sharply in speed and persistence. Some influence of the Gulf Stream is noticeable near the extreme southwestern boundary of the current. The North Atlantic Current is a sluggish, slow-moving flow that can easily be influenced by opposing or augmenting winds. There is some evidence that the weaker North Atlantic Current may consist of separate eddies or branches which are frequently masked by a shallow, wind-driven surface now called the NORTH ATLANTIC DRIFT. A branch of the North Atlantic Current flows along the west coasts of the British Isles at speeds up to 0.6 knot and enters the Norwegian Sea as the NORWAY CURRENT mainly through the east side of the Faeroe-Shetland Channel. A small portion of this current to the west of the Faeroe Islands mixes with

part of the southeastward flow from the north coast of Iceland; these two water masses join and form a clockwise circulation around the Faeroe Islands. The very weak nontidal current in the Irish Sea, which averages only about 0.1 knot, depends on the wind. The part of the North Atlantic Current that flows eastward into the western approaches to the English Channel tends to increase or decrease the speed of the reversing tidal currents. The southern branch of the North Atlantic Current turns southward near the Azores to become the CANARY CURRENT.

**North Atlantic Drift.** . See under NORTH ATLANTIC CURRENT.

**northbound node.** . See ASCENDING NODE.

**North Brazil Current.** . See GUIANA CURRENT.

**North Cape Current.** . An Arctic Ocean current flowing northeastward and eastward around northern Norway, and curving northeastward into the Barents Sea. The North Cape Current is the continuation of the northeastern branch of the NORWAY CURRENT.

**northeaster, nor'easter.** , *n.* A northeast wind, particularly a strong wind or gale associated with cold rainy weather. In the U.S., nor'easters generally occur on the north side of late-season low pressure systems which pass off the Atlantic seaboard, bringing onshore gales to the region north of the low. Combined with high tides, they can be very destructive.

**northeast monsoon.** . See under MONSOON.

**north equatorial current.** . See ATLANTIC NORTH EQUATORIAL CURRENT, PACIFIC NORTH EQUATORIAL CURRENT.

**norther.** , *n.* A northerly wind. In the southern United States, especially in Texas (Texas norther) in the Gulf of Mexico, in the Gulf of Panama away from the coast, and in central America (the norte), the norther is a strong cold wind from the northeast to northwest. It occurs between November and April, freshening during the afternoon and decreasing at night. It is a cold air outbreak associated with the southward movement of a cold anticyclone. It is usually preceded by a warm and cloudy or rainy spell with southerly winds. The norther comes as a rushing blast and brings a sudden drop of temperature of as much as 25°F in 1 hour or 50°F in 3 hours in winter. The California norther is a strong, very dry, dusty, northerly wind which blows in late spring, summer and early fall in the valley of California or on the west coast when pressure is high over the mountains to the north. It lasts from 1 to 4 days. The dryness is due to adiabatic warming during descent. In summer it is very hot. The Portuguese norther is the beginning of the trade wind west of Portugal. The term is used for a strong north wind on the coast of Chile which blows occasionally in summer. In southeast Australia, a hot dry wind from the desert is called a norther.

**northern lights.** . See AURORA BOREALIS.

**north frigid zone.** . That part of the earth north of the Arctic Circle.

**north geographical pole.** . The geographical pole in the Northern Hemisphere, at lat. 90°N.

**north geomagnetic pole.** . The geomagnetic pole in the Northern Hemisphere. This term should not be confused with NORTH MAGNETIC POLE. See also GEOMAGNETIC POLE.

**northing.** , *n.* The distance a craft makes good to the north. The opposite is SOUTHING.

**north magnetic pole.** . The magnetic pole in the Northern Hemisphere. This term should not be confused with NORTH GEOMAGNETIC POLE. See also GEOMAGNETIC POLE.

**North Pacific Current.** . Flowing eastward from the eastern limit of the Kuroshio Extension (about longitude 170°E), the North Pacific Current forms the northern part of the general clockwise oceanic circulation of the North Pacific Ocean.

**north polar circle.** . See ARCTIC CIRCLE.

**North Pole.** . 1. The north geographical pole. See also MAGNETIC POLE GEOMAGNETIC POLE. 2. The north-seeking end of a magnet. See also RED MAGNETISM.

**north temperate zone.** . That part of the earth between the Tropic of Cancer and the Arctic Circle.

**north up, north upward.** . One of the three basic orientations of display of relative or true motion on a radarscope or electronic chart. In the NORTH UP orientation, the presentation is in true (gyrocompass) directions from own ship, north being maintained UP or at the top of the radarscope. See also HEAD UP, BASE COURSE UP.

**north-up display.** . In ECDIS information shown on the display (radar or ECDIS) with the north direction upward. The north-up display corresponds with the usual ORIENTATION of the nautical chart.

**northwester, nor'wester.** , *n.* A northwesterly wind.

**Norway Coastal Current.** . Originating mainly from Oslofjord outflow, counterclockwise return flow of the Jutland Current within the Skaggerak, and outflow from the Kattegat, the Norway Coastal Current begins at about 59°N 10°E and follows the coast of Norway, and is about 20 miles in width. Speeds are strongest off the southeast coast of Norway, where they frequently range between 1 and 2 knots. Along the remainder of the coast the current gradually weakens. It may widen to almost 30 miles at about latitude 63°N, where it joins the NORWAY CURRENT. South of latitude 62°N the current speed usually ranges between 0.4 and 0.9 knots. Speeds are generally stronger in spring and summer, when the flow is augmented by increased discharge from fjords.

**Norway Current.** . An Atlantic Ocean current flowing northeastward along the northwest coast of Norway, and gradually branching and continuing as the SPITZBERGEN ATLANTIC CURRENT and the NORTH CAPE CURRENT. The Norway Current is the continuation of part of the northern branch of the North Atlantic Current. Also called NORWEGIAN CURRENT.

**Norwegian Current.** . See NORWAY CURRENT.

**notch filter.** . An arrangement of electronic components designed to attenuate or reject a specific frequency band with a sharp cut-off at either end.

**notice board.** . A signboard used to indicate speed restrictions, cable landings, etc.

**notice to mariners.** . A periodic publication used by the navigator to correct charts and publications.

**Notice to Mariners.** . A weekly publication of the National Geospatial-Intelligence Agency (NGA) prepared jointly with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Coast Guard giving information on changes in aids to navigation, dangers to navigation, selected items from the *Local Notice to Mariners*, important new soundings, changes in channels, harbor construction, radionavigation information, new and revised charts and publications, special warnings and notices, pertinent HYDROLANT, HYDROPAC, NAVAREA IV and XII messages and corrections to charts, manuals, catalogs, sailing directions (pilots), etc. The *Notice to Mariners* should be used routinely for updating the latest editions of nautical charts and related publications.

**nova.** (*pl. novae*), *n.* A star which suddenly becomes many times brighter than previously, and then gradually fades. Novae are believed to be exploding stars.

**nucleus.** , *n.* The central, massive part of anything, such as an atom or comet.

**numerical scale.** . A statement of that distance on the earth shown in one unit (usually an inch) on the chart, or vice versa. See also REPRESENTATIVE FRACTION.

**nun buoy.** . An unlighted buoy of which the upper part of the body (above the waterline), or the larger part of the superstructure, has a cone shape with vertex upwards.

**nutatation.** , *n.* Irregularities in the precessional motion of the equinoxes due chiefly to regression of the nodes.

## O

**object.** . In ECDIS an identifiable set of information. An object may have ATTRIBUTES and may be related to other objects. See also SPATIAL OBJECT and FEATURE OBJECT.

**Object Catalogue.** . In ECDIS a feature schema which provides a description of real world entities. It contains a list of FEATURE OBJECT classes (each relating to a real world entity), ATTRIBUTES and allowable ATTRIBUTE VALUES.

**object class.** . In ECDIS a generic description of OBJECTS which have the same characteristics.

**object description.** . In ECDIS the definition of which OBJECT CLASS a specific OBJECT belongs to.

**object glass.** . See OBJECTIVE.

**objective.** , *n.* The lens or combination of lenses which receives light rays from an object, and refracts them to form an image in the focal plane of the eyepiece of an optical instrument, such as a telescope. Also called OBJECT GLASS.

**oblate spheroid.** . An ellipsoid of revolution, the shorter axis of which is the axis of revolution. An ellipsoid of revolution, the longer axis of which is the axis of revolution, is called a PROLATE SPHEROID.

- The earth is approximately an oblate spheroid.
- oblique**, *adj.* Neither perpendicular nor parallel; slanting.
- oblique angle**. . Any angle not a multiple of 90°.
- oblique ascension**. . The arc of the celestial equator, or the angle at the celestial pole, between the hour circle of the vernal equinox and the hour circle through the intersection of the celestial equator and the eastern horizon at the instant a point on the oblique sphere rises, measured eastward from the hour circle of the vernal equinox through 24h. The expression is not used in modern navigation.
- oblique chart**. . A chart on an oblique map projection.
- oblique coordinates**. . Magnitudes defining a point relative to two intersecting non-perpendicular lines, called AXES. The magnitudes indicate the distance from each axis, measured along a parallel to the other axis. The horizontal distance is called the abscissa and the other distance the ordinate. This is a form of CARTESIAN COORDINATES.
- oblique cylindrical orthomorphic chart**. . See OBLIQUE MERCATOR CHART.
- oblique cylindrical orthomorphic map projection**. . See OBLIQUE MERCATOR MAP PROJECTION oblique equator. A great circle the plane of which is perpendicular to the axis of an oblique projection. An oblique equator serves as the origin for measurement of oblique latitude. On an oblique Mercator map projection, the oblique equator is the tangent great circle. See also FICTITIOUS EQUATOR.
- oblique graticule**. . A fictitious graticule based upon an oblique map projection.
- oblique latitude**. . Angular distance from an oblique equator. See also FICTITIOUS LATITUDE.
- oblique longitude**. . Angular distance between a prime oblique meridian and any given oblique meridian. See also FICTITIOUS LONGITUDE.
- oblique map projection**. . A map projection with an axis inclined at an oblique angle to the plane of the equator.
- oblique Mercator chart**. . A chart on the oblique Mercator map projection. Also called OBLIQUE CYLINDRICAL ORTHOMORPHIC CHART. See also MERCATOR CHART.
- oblique Mercator map projection**. . A conformal cylindrical map projection in which points on the surface of a sphere or spheroid, such as the earth, are developed by Mercator principles on a cylinder tangent along an oblique great circle. Also called OBLIQUE CYLINDRICAL ORTHOMORPHIC MAP PROJECTION. See also MERCATOR MAP PROJECTION.
- oblique meridian**. . A great circle perpendicular to an oblique equator. The reference oblique meridian is called prime oblique meridian. See also FICTITIOUS MERIDIAN.
- oblique parallel**. . A circle or line parallel to an oblique equator, connecting all points of equal oblique latitude. See also FICTITIOUS PARALLEL.
- oblique pole**. . One of the two points 90° from an oblique equator.
- oblique rhumb line**. . 1. A line making the same oblique angle with all fictitious meridians of an oblique Mercator map projection. Oblique parallels and meridians may be considered special cases of the oblique rhumb line. 2. Any rhumb line, real or fictitious, making an oblique angle with its meridians. In this sense the expression is used to distinguish such rhumb lines from parallels and meridians, real or fictitious, which may be included in the expression rhumb line. See also FICTITIOUS RHUMB LINE.
- oblique sphere**. . The celestial sphere as it appears to an observer between the equator and the pole, where celestial bodies appear to rise obliquely to the horizon.
- oblique triangle**. . A triangle with no right angle.
- obliquity factor**. . A factor in an expression for a constituent tide or tidal current involving the angle of the inclination of the moon's orbit to the plane of the earth's equator.
- obliquity of the ecliptic**. . The acute angle between the plane of the ecliptic and the plane of the celestial equator, about 23°27'.
- obscuration**, *n.* The designation for the sky cover when the sky is completely hidden by obscuring phenomena in contact with, or extending to the surface.
- obscuring phenomenon**. . Any atmospheric phenomenon, not including clouds, which restricts the vertical or slant visibility.
- observed altitude**. . Corrected sextant altitude; angular distance of the center of a celestial body above the celestial horizon of an observer measured along a vertical circle, through 90°. Occasionally called
- TRUE ALTITUDE. See also ALTITUDE INTERCEPT, APPARENT ALTITUDE, SEXTANT ALTITUDE.
- observed gravity anomaly**. . See GRAVITY ANOMALY.
- observed latitude**. . See LATITUDE LINE.
- observed longitude**. . See LONGITUDE LINE.
- obstruction**, *n.* Anything that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel or aircraft. The term is usually used to refer to an isolated danger to navigation, such as a submerged rock or reef in the case of marine navigation, and a tower, tall building, mountain peak, etc., in the case of air navigation.
- obstruction buoy**. . A buoy used to indicate a dangerous obstruction. See ISOLATED DANGER BUOY.
- obstruction light**. . A light indicating a radio tower or other obstruction to aircraft.
- obstruction mark**. . A navigation mark used to indicate a dangerous obstruction. See ISOLATED DANGER MARK.
- obtuse angle**. . An angle greater than 90° and less than 180°.
- obtuse triangle**. . A triangle with an obtuse angle. A plane triangle can have only one obtuse angle.
- occasional light**. . A light put into service only on demand.
- occluded front**. . A composite of two fronts, formed when a cold front overtakes a warm front or stationary front. This is common in the late stages of wave-cyclone development, but is not limited to occurrence within a wave-cyclone. There are three basic types of occluded front, determined by the relative coldness of the air behind the original cold front to the air ahead of the warm (or stationary) front. A cold occlusion results when the coldest air is behind the cold front. The cold front undercuts the warm front and, at the earth's surface, cold air replaces less-cold air. When the coldest air lies ahead of the warm front, a warm occlusion is formed in which case the original cold front is forced aloft at the warm-front surface. At the earth's surface, cold air is replaced by less-cold air. A third and frequent type, a neutral occlusion, results when there is no appreciable temperature difference between the cold air masses of the cold and warm fronts. In this case frontal characteristics at the earth's surface consist mainly of a pressure trough, a wind-shift line, and a band of cloudiness and precipitation. Commonly called OCCLUSION. Also called FRONTAL OCCLUSION.
- occlusion**, *n.* 1. See OCCLUDED FRONT. 2. The process of formation of an occluded front. Also called FRONTAL OCCLUSION.
- occultation**, *n.* 1. The concealment of a celestial body by another which crosses the line of view. Thus, the moon occults a star when it passes between the observer and the star. 2. The interval of darkness in the period of the light. See also FLASH.
- occulting light**. . A light totally eclipsed at regular intervals, with the duration of light always longer than the intervals of darkness called OCCULTATIONS. The term is commonly used for a SINGLE OCCULTING LIGHT, an occulting light exhibiting only single occultations which are repeated at regular intervals.
- occupied bandwidth**. . As defined by the International Telecommunication Union (ITU) the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission. In some cases, for example multi-channel frequency-division systems, the percentage of 0.5 percent may lead to certain difficulties in the practical application of the definitions of occupied and necessary bandwidth; in such cases a different percentage may prove useful.
- ocean**, *n.* 1. The major area of salt water covering the greater part of the earth. 2. One of the major divisions of the expanse of salt water covering the earth.
- ocean current**. . A movement of ocean water characterized by regularity, either of a cyclic nature, or as a continuous stream flowing along a definable path. Three general classes may be distinguished, by cause: (a) currents associated with horizontal pressure gradients, comprising the various types of gradient current; (b) wind-driven currents, which are those directly produced by the stress exerted by the wind upon the ocean surface; (c) currents produced by long-wave motions. The latter are principally tidal currents, but may also include currents associated with internal waves, tsunamis and seiches. The major ocean currents are of continuous, stream-flow character, and are of first-order importance in the maintenance of the earth's thermodynamic balance.
- oceanic**, *adj.* Of or pertaining to the ocean.

- oceanographic.** , *adj.* Of or pertaining to oceanography, or knowledge of the oceans.
- oceanographic survey.** . The study or examination of conditions in the ocean or any part of it. with reference to zoology, chemistry, geology, or other scientific discipline. See also HYDROGRAPHIC SURVEY.
- oceanography.** , *n.* The study of the sea, embracing and integrating all knowledge pertaining to the sea's physical boundaries, the chemistry and physics of sea water, and marine biology. Strictly, oceanography is the description of the marine environment, whereas OCEANOLOGY is the study of the oceans.
- oceanology.** , *n.* The study of the ocean. See also OCEANOGRAPHY.
- Ocean Passages for the World.** . A British publication relating to the planning and conduct of ocean passages. Published by the Hydrographer of the Navy, *Ocean Passages for the World* addresses those areas which lie mainly outside the areas covered in detail by Admiralty Sailing Directions. It is kept up-to-date by periodical supplements. The publication should not be used without reference to the latest supplement and those *Notices to Mariners* published to correct Sailing Directions.
- ocean waters.** . For application to the provisions of the Marine Protection, Research, and Sanctuaries Act of 1972, those waters of the open sea lying seaward of the base line from which the territorial sea is measured.
- octagon.** , *n.* A closed plane figure having 8 sides.
- octahedral cluster.** . An arrangement of eight corner reflectors with common faces designed to give substantially uniform response in all directions. The octahedral cluster is formed by mounting three rectangular plates mutually at right angles with the geometric centers of the plates coincident. See also PENTAGONAL CLUSTER.
- octant.** , *n.* A double-reflecting instrument for measuring angles, used primarily for measuring altitude of celestial bodies. It has a range of 90°, with the graduated arc subtending 45°, or 1/8 of a circle, hence the term octant; a precursor of the sextant, whose arc subtends 60° or 1/6 of a circle.
- octant altitude.** . See SEXTANT ALTITUDE.
- Odessey protractor.** . A device used in conjunction with a plotting sheet having equally spaced concentric circles (range circles) drawn about two or more stations of a radio determination system being operated in the ranging mode.
- oe.** , *n.* A whirlwind off the Faeroe Islands.
- oersted.** , *n.* The centimeter-gram-second electromagnetic system unit of magnetic field strength. It corresponds to  $1000/4\pi$  ampere per meter.
- off-center PPI display.** . A plan position indicator display in which the center about which the sweep rotates is offset from the center of the radarscope.
- Office of Coast Survey.** . The Office of Coast Survey is the oldest U.S. scientific organization, dating from 1807 when President Thomas Jefferson signed "An act to provide for surveying the coasts of the United States." OCS is the charting, surveying, and bathymetric modeling arm of the National Ocean Service (NOS), a component of the National Oceanic and Atmospheric Administration (NOAA). OCS supports safe and efficient navigation by maintaining over 1,000 nautical charts and Coast Pilots for U.S. coasts and the Great lakes, covering 95,000 miles of shoreline and 3.4 million square miles of water. The charts are distributed in a variety of formats, which include electronic navigation charts (ENCs), raster navigational charts (RNCs), print on demand (POD) paper charts, and digital chart tile service.
- official HO data.** . See HO information.
- official updates.** . In ECDIS, updates provided in digital format by the ISSUING AUTHORITY of the ENC being corrected, for integration with the ENC DATA in the SENC. Updates provided by the ISSUING AUTHORITY for application to a chart.
- offing.** , *n.* The part of the visible sea a considerable distance from the shore, or that part just beyond the limits of the area in which a pilot is needed.
- offshore.** , *adj. & adv.* Away from the shore.
- offshore.** , *n.* The comparatively flat zone of variable width which extends from the outer margin of the rather steeply sloping shore face to the edge of the shelf.
- offshore light stations.** . Manned light stations built on exposed marine sites to replace lightships.
- offshore navigation.** . Navigation at a distance from a coast, in contrast with COASTWISE NAVIGATION in the vicinity of a coast.
- offshore water.** . Water adjacent to land in which the physical properties are slightly influenced by continental conditions.
- offshore wind.** . Wind blowing from the land toward the sea. An ONSHORE WIND blows in the opposite direction. See also LAND BREEZE.
- off soundings.** . Navigating beyond the 100-fathom curve. In earlier times, said of a vessel in water deeper than could be sounded with the sounding lead.
- off station.** . Not in charted position.
- ogival buoy.** . A buoy with a pointed-arch shaped vertical cross-section. Used in the cardinal system.
- ohm.** , *n.* A derived unit of electrical resistance in the International System of Units; it is the electrical resistance between two points of a conductor when a constant potential difference of 1 volt, applied to these points, produces in the conductor a current of 1 ampere, the conductor not being the seat of an electromotive force.
- old ice.** . Sea ice which has survived at least one summer's melt. Most topographic features are smoother than on first-year ice. Old ice may be subdivided into SECOND-YEAR ICE and MULTI YEAR ICE.
- Omega Navigation System.** . A worldwide, continuous, radionavigation system of medium accuracy which provides hyperbolic lines of position through phase comparisons of VLF (10-14kHz) continuous wave signals transmitted on a common frequency on a time-shared basis. The full system is comprised of eight transmitting stations.
- Omega plotting chart.** . See under PLOTTING CHART.
- Omega Table.** . See PUB. 224.
- omni-** . A prefix meaning all.
- omni-azimuthal antenna.** . See OMNIDIRECTIONAL ANTENNA.
- omnidirectional antenna.** . An antenna whose radiating or receiving properties at any instant are the same on all bearings. Also called OMNIAZIMUTHAL ANTENNA. See also DIRECTIONAL ANTENNA.
- omnidirectional light.** . A light which presents the same characteristic over the whole horizon of interest to marine navigation. Also called ALL-ROUND LIGHT.
- omnidirectional radiobeacon.** . A radiobeacon transmitting a signal in all directions. A circular radiobeacon is an omnidirectional beacon which transmits in all horizontal directions simultaneously. A rotating radiobeacon is an omnidirectional beacon with one or more beams that rotate. A DIRECTIONAL RADIOBEACON is a beacon which beams its signals in one or several prescribed directions.
- on-demand information.** . In ECDIS, the SENC information which is not part of the standard display. See also ALL OTHER INFORMATION.
- onshore wind.** . Wind blowing from the sea towards the land. An OFFSHORE WIND blows in the opposite direction. See also SEA BREEZE.
- on soundings.** . Navigating within the 100-fathom curve. In earlier times, said of a vessel in water sufficiently shallow for sounding by sounding lead.
- on the beam.** . Bearing approximately 90° relative (on the starboard beam) or 270° relative (on the port beam). The expression is often used loosely for BROAD ON THE BEAM, or bearing exactly 90° or 270° relative. Also called ABEAM.
- on the bow.** . Bearing approximately 45° relative (on the starboard bow) or 315° relative (on the port bow). The expression is often used loosely for BROAD ON THE BOW, or bearing exactly 45° or 315° relative.
- on the quarter.** . Bearing approximately 135° relative (on the starboard quarter) or 225° relative (on the port quarter). The expression is often used loosely for BROAD ON THE QUARTER, or bearing exactly 135° or 225° relative.
- ooze.** , *n.* A soft, slimy, organic sediment covering part of the ocean bottom, composed principally of shells or other hard parts of minute organisms.
- open.** , *v., i.* To move or appear to move apart, such as when range lights appear to separate as the vessel moves off the channel centerline. The opposite is CLOSE.
- open basin.** . See TIDAL BASIN.
- open berth.** . An anchorage berth in an open roadstead.

- open coast.** . A coast that is not sheltered from the sea.
- open harbor.** . An unsheltered harbor exposed to the sea.
- opening.** , *n.* A break in a coastline or a passage between shoals, etc. See also GAT.
- open pack ice.** . Pack ice in which the concentration is 4/10 to 6/10, with many leads and polynyas, and the floes generally not in contact with one another.
- open roadstead.** . A roadstead with relatively little protection from the sea.
- open sea.** . 1. The part of the ocean not enclosed by headlands, within narrow straits, etc. 2. The part of the ocean outside the territorial jurisdiction of any country. The opposite is CLOSED SEA. See also HIGH SEAS.
- open water.** . A large area of freely navigable water in which sea ice is present in concentration less than 1/10. When there is no sea ice present, the area should be described as ICE FREE, even though icebergs may be present.
- operating area chart.** . A base chart with overprints of various operating areas necessary to control fleet exercise activities. Submarine Transit Lanes, Surface and Sub-surface Operating Areas, Air Space Warning Areas, Controlled Air Spaces, and other restricted areas are portrayed.
- operating system.** . The portion of a computer's software devoted to running programs and providing for operator interface.
- opposition.** , *n.* The situation of two celestial bodies having either celestial longitudes or sidereal hour angles differing by 180°. The term is usually used only in relation to the position of a superior planet or the moon with reference to the sun. The situation of two celestial bodies having either the same celestial longitude or the same sidereal hour angle is called conjunction.
- optic.** , *adj.* Of or pertaining to vision.
- optical.** , *adj.* Of or pertaining to optics or to vision.
- optical double star.** . Two stars in nearly the same line of sight but differing greatly in distance from the observer, as distinguished from a PHYSICAL DOUBLE STAR (two stars in nearly the same line of sight and at approximately the same distance from the observer).
- optical glass.** . Glass of which the composition and molding are carefully controlled in order to insure uniform refractive index and high transmission factor.
- optical path.** . The path followed by a ray of light through an optical system.
- optical system.** . A series of lenses, apertures, prisms, mirrors, etc., so arranged as to perform a definite optical function.
- optics.** , *n.* The science dealing with light, lenses, etc.
- Optimum Track Ship Routing.** . See under SHIP WEATHER ROUTING.
- orbit.** , *n.* 1. The path of a body or particle under the influence of a gravitational or other force. See also CENTRAL FORCE ORBIT, INERTIAL ORBIT, INTERMEDIATE ORBIT, NOMINAL ORBIT, NORMAL ORBIT, OSCULATING ORBIT, PERTURBED ORBIT, POLAR ORBIT, STATIONARY ORBIT.
- orbital altitude.** . The mean altitude of the orbit of a satellite above the surface of the parent body.
- orbital elements.** . Parameters that specify the position and motion of a body in orbit. The elliptical orbit of a satellite attracted by an exactly central gravitational force is specified by a set of six parameters as follows: Two parameters, the semimajor axis and eccentricity of the ellipse, establish the size and shape of the elliptical orbit. A third parameter, time of perifocal passage, enables determination of the location of the satellite in its orbit at any instant. The three remaining parameters establish the orientation of the orbit in space. These are the inclination of the orbital plane to a reference plane, the right ascension of the ascending node of the satellite, and the argument of pericenter. See also ORBITAL PARAMETERS OF ARTIFICIAL SATELLITE, MEAN ELEMENTS, OSCULATING ELEMENTS.
- orbital inclination.** . See as INCLINATION, definition 2.
- orbital mode.** . A method for determining the position of an unknown station position when the unknown position cannot be viewed simultaneously with known positions. The arc of the satellite orbit is extrapolated from the ephemeris of the satellite determined by the known stations which permits the determination of the position of the unknown station dependent completely on the satellite's orbital parameters.
- orbital motion.** . Continuous motion in a closed path about and as a direct result of a source of gravitational attraction.
- orbital parameters of artificial earth satellite.** . The precessing elliptical orbit of an artificial earth satellite is unambiguously specified by the following set of parameters: semimajor axis, eccentricity, time of perigee, inclination of the orbital plane to the plane of the reference plane (celestial equator), the right ascension of the ascending node of the satellite at time of perigee, the argument of perigee at time of perigee, right ascension of Greenwich at time of perigee, mean motion (rate of change of mean anomaly), rate of change of argument of perigee, and rate of change of right ascension of the ascending node at time of perigee. With the inclination expressed as the sine and cosine of the orbital inclination, the parameters number 11. See also ORBITAL ELEMENTS.
- orbital path.** . One of the tracks on a primary body's surface traced by the subpoint of a satellite that orbits about it several times in a direction other than normal to the primary body's axis of rotation. Each track is displaced in a direction opposite and by an amount equal to the degrees of rotation between each satellite orbit and of the nodical precession of the plane of the orbit. Also called SUBTRACK. See also WESTWARD MOTION.
- orbital period.** . If the orbit is unchanging and ideal, the interval between successive passages of a satellite through the same point in its orbit. If the orbit is not ideal, the point must be specified. When the perigee is specified it is called radial or anomalistic period. When the ascending node is specified, it is called nodical period. When the same geocentric right ascension is specified, it is called sidereal period. Also called PERIOD OF SATELLITE.
- orbital plane.** . The plane of the ellipse defined by a central force orbit.
- orbital velocity.** . The velocity of an earth satellite or other orbiting body at any given point in its orbit.
- ordinary.** , *adj.* With respect to tides, the use of this non technical term has, for the most part, been determined to be synonymous with mean. The use of the term ordinary in tidal terms is discouraged.
- ordinate.** , *n.* The vertical coordinate of a set of rectangular coordinates. Also used in a similar sense in connection with oblique coordinates.
- orient.** , *v.* , *t.* 1. To line up or adjust with respect to a reference. 2. To obtain a mental grasp of the existing situation.
- orientability of a sound signal.** . The property of a sound signal by virtue of which a listener can estimate the direction of the location of the signal.
- orientation.** . In ECDIS, the mode in which information on the ECDIS is being presented. Typical modes include: north-up - as shown on a nautical CHART, north is at the top of the display; Ship's head-up - based on the actual HEADING of the ship, (e.g. Ship's gyrocompass); course-up display - based on the COURSE or ROUTE being taken.
- orographic rain.** . Rain resulting when moist air is forced upward by a mountain range.
- orthodrome.** , *n.* See GREAT CIRCLE.
- orthodromic curve.** . See GREAT CIRCLE.
- orthogonal.** , *adj.* Right angled, rectangular.
- orthogonal map projection.** . See ORTHOGRAPHIC MAP PROJECTION.
- orthographic.** , *adj.* Of or pertaining to right angles or perpendicular lines.
- orthographic chart.** . A chart on the orthographic map projection.
- orthographic map projection.** . A perspective azimuthal projection in which the projecting lines, emanating from a point at infinity, are perpendicular to a tangent plane. The projection is used chiefly in navigational astronomy for inter converting coordinates of the celestial equator and horizon systems. Also called ORTHOGONAL PROJECTION.
- orthomorphic.** , *adj.* Preserving the correct shape. See also CONFORMAL MAP PROJECTION.
- orthomorphic chart.** . A chart on which very small shapes are correctly represented. See also CONFORMAL MAP PROJECTION.
- orthomorphic map projection.** . A projection in which very small shapes are correctly represented. See also CONFORMAL MAP PROJECTION.
- oscar satellite.** . A general term for one of the operational satellites of the Navy Navigation Satellite System, except for satellite 30110 called TRANSAT, placed in orbit prior to 1981. The improved satellites placed in orbit beginning in 1981 are called NOVA.
- oscillation.** , *n.* 1. Fluctuation or vibration to each side of a mean value or position. 2. Half an oscillatory cycle, consisting of fluctuation or vibration in one direction; half a vibration.

- oscillator**, *n.* A sound signal emitter comprising a resonant diaphragm maintained in vibrating motion by electromagnetic action.
- oscillatory wave**. A wave in which only the form advances, the individual particles of the medium moving in closed orbits, as ocean waves in deep water; in contrast with a WAVE OF TRANSLATION, in which the individual particles are shifted in the direction of wave travel, as ocean waves in shoal water.
- oscilloscope**, *n.* An instrument for producing a visual representation of oscillations or changes in an electric current. The face of the cathode-ray tube used for this representation is called a SCOPE or SCREEN.



oscilloscope

- osculating elements**. A set of parameters that specifies the instantaneous position and velocity of a celestial body, or artificial satellite in a perturbed orbit. Osculating elements describe the unperturbed (two-body) orbit (osculating orbit) that the body would follow if perturbations were to cease instantaneously.
- osculating orbit**. The ellipse that a satellite would follow after a specific time "t" (the epoch of osculation) if all forces other than central force ceased to act from "t" on. An osculating orbit is tangent to the real, perturbed, orbit and has the same velocity at the point of tangency. See also OSCULATING ELEMENTS.
- other chart information**. See DISPLAY CATEGORY.
- other navigational information**. In ECDIS, NAVIGATIONAL INFORMATION not contained in the SENC, that may be displayed by an ECDIS, such as radar information.
- outage**, *n.* The failure of an aid to navigation to function exactly as described in the light list.
- outer harbor**. See under INNER HARBOR.
- outfall**, *n.* The discharge end of a narrow street sewer, drain, etc.
- outfall buoy**. A buoy marking the position where a sewer or other drain discharges.
- outline chart**. A chart with only a generally presentation of the landmass with little or no culture or relief. See also PLOT CHART.
- output axis**. The axis of precession of a gyroscope. See also INPUT AXIS, PRECESSION.
- outside fix**. A term describing the fix position determined by the method of bisectors when the lines of position result from observations of objects or celestial bodies lying within a 180° arc of the horizon. See also METHOD OF BISECTORS.
- outward bound**. Heading for the open sea. The opposite is INWARD BOUND. See also HOMEWARD BOUND.
- overcast**, *adj.* Pertaining to a sky cover of 95% or more.
- overcast**, *n.* A cloud cover.
- overfalls**, *n. pl.* Breaking waves caused by the meeting of currents or by waves moving against the current. See also RIPS.
- overhead cable effect**. A radar phenomenon which may occur in the vicinity of an overhead power cable. The echo from the cable appears on the plan position indicator as a single echo, the echo being returned from that part of cable where the radar beam is at right angles to the cable. If this phenomenon is not recognized, the echo can be wrongly identified as the echo from a ship on a steady bearing. Evasive action results in the echo remaining on a constant bearing and moving to the same side of the channel as the ship altering course. This phenomenon is particularly apparent for the power cable spanning the Straits of Messina.
- overhead compass**. See INVERTED COMPASS.
- overhead constraints**. The elevation angle limitations between which usable navigation data may be obtained from a satellite in the doppler mode.
- overlay**, *n.* A printing or drawing on a transparent or translucent medium at the same scale as a map, chart, etc., to show details not appearing on the original.
- overprint**, *n.* New material printed on a map or chart to show data of importance or special value in addition to that originally printed.
- overscale**. In ECDIS, to display the chart information at a DISPLAY

SCALE larger than the COMPILATION SCALE. Overscaling may arise from a deliberate overscaling by the mariner, or from automatic overscaling by ECDIS in compiling a DISPLAY when the data included is of various NAVIGATIONAL PURPOSES.

- overscale area**. In ECDIS, when the data displayed is from data of two different NAVIGATIONAL PURPOSES the chart display will, where drawn at the larger SCALE, include an overscale area of data from the smaller scale CELL in order to complete the DISPLAY. This area should be identified by the "overscale pattern" of the PRESENTATION LIBRARY.
- overtide**, *n.* A harmonic tidal or tidal current constituent with a speed that is an exact multiple of the speed of one of the fundamental constituents derived from the development of the tide-producing force. The presence of overtides is usually attributed to shallow water conditions.
- own ship's safety contour**. In ECDIS the contour related to the own ship selected by the mariner from the contours provided for in the SENC, to be used by ECDIS to distinguish on the DISPLAY between the safe and the unsafe water, and for generating anti-grounding ALARMS.
- own ship's symbol**. In ECDIS (and ARPA) a non-chart symbol used to show the ship's position on the CHART or ARPA display.
- own ship**. In ECDIS a term identifying the vessel upon which an ECDIS is operating.
- Oyashio**, *n.* A cold ocean current flowing from the Bering Sea south-westward along the coast of Kamchatka, past the Kuril Islands to meet the Kuroshio off the coast of Honshu. The Oyashio turns and continues eastward, eventually joining the Aleutian Current.

## P

- Pacific Equatorial Countercurrent**. A Pacific Ocean current that flows eastward, counter to and between the westward flowing Pacific North and South Equatorial Currents, between latitudes 3°N and 10°N. East of the Philippines it is joined by the southern part of the Pacific North Equatorial Current.
- Pacific North Equatorial Current**. A North Pacific Ocean current that flows westward between latitudes 10°N and 20°N. East of the Philippines, it divides, part turning south to join the Pacific Equatorial Counter current and part turning north to flow along the coast of Japan as the KUROSHIO.
- Pacific South Equatorial Current**. A Pacific Ocean current that flows westward between latitudes 3°N and 10°S. In mid ocean, much of it turns south to form a large whirl. The portion that continues across the ocean divides as it approaches Australia, part flowing north toward New Guinea and part turning south along the east coast of Australia as the EAST AUSTRALIA CURRENT.
- Pacific standard time**. See STANDARD TIME.
- pack ice**. The term used in a wide sense to include any area of sea ice, other than fast ice, no matter what form it takes or how it is disposed.
- pagoda**, *n.* As a landmark, a tower having a number of stories and a characteristic architecture, used as a place of worship or as a memorial, primarily in Japan, China, and India.
- paint**, *n.* The bright area on the phosphorescent plan position indicator screen resulting from the brightening of the sweep by the echoes.
- paint**, *v., t & i.* To brighten the phosphorescent plan position indicator screen through the effects of the echoes on the sweep.
- painted mark**. A navigation mark formed simply by painting a cliff, wall, rock, etc.
- pancake ice**. Predominantly circular pieces of ice from 30 centimeters to 3 meters in diameter, and up to about 10 centimeters in thickness with raised rims due to pieces striking against one another. It may be formed on a slight swell from grease ice, shuga, or slush or as a result of the breaking of ice rind, nilas, or under severe conditions of swell or waves, of gray ice. It also sometimes forms at some depth, at an interface between water bodies of different physical characteristics, from where it floats to the surface; its appearance may rapidly cover wide areas of water.
- pantograph**, *n.* An instrument for copying maps, drawings, or other graphics at a predetermined scale.
- papagayo**, *n.* A violet northeasterly fall wind on the Pacific coast of Nicaragua and Guatemala. It consists of the cold air mass of a *norte*

- which has overridden the mountains of Central America. See also TEHUANTEPECER.
- parabola**, *n.* An open curve all points of which are equidistant from a fixed point, called the FOCUS, and a straight line. The limiting case occurs when the point is on the line, in which case the parabola becomes a straight line.
- parabolic reflector**. . A reflecting surface having the cross section along the axis in the shape of a parabola. Parallel rays striking the reflector are brought to a focus at a point, or if the source of the rays is placed at the focus, the reflected rays are parallel. See also CORNER REFLECTION RADAR REFLECTOR, SCANNER.
- parabolic velocity**. . See ESCAPE VELOCITY.
- parallactic angle**. . That angle at the navigational triangle at the celestial body; the angle between a body's hour circle and its vertical circle. Also called POSITION ANGLE.
- parallax**, *n.* The difference in apparent direction or position of an object when viewed from different points. For bodies of the solar system, parallax is the difference in the direction of the body due to the displacement of the observer from the center of the earth, and is called geocentric parallax, varying with the body's altitude and distance from the earth. The geocentric parallel when a body is in the horizon is called horizontal parallax, as contrasted with the parallax at any altitude, called parallax in altitude. Parallax of the moon is called lunar parallax. In marine navigation it is customary to apply a parallax correction to sextant altitudes of the sun, moon, Venus, and Mars. For stars, parallax is the angle at the star subtended by the semimajor axis of the earth's orbit and is called heliocentric or stellar parallax, which is too small to be significant as a sextant error.
- parallax correction**. . A correction due to parallax, particularly that sextant altitude correction due to the difference between the apparent direction from a point on the surface of the earth to celestial body and the apparent direction from the center of the earth to the same body.
- parallax in altitude**. . Geocentric parallax of a body at any altitude. The expression is used to distinguish the parallax at the given altitude from the horizontal parallax when the body is in the horizon. See also PARALLAX.
- parallax inequality**. . The variation in the range of tide or in the speed of a tidal current due to changes in the distance of the moon from the earth. The range of tide and speed of the current tend alternately to increase and decrease as the moon approaches its perigee and apogee, respectively, the complete cycle being the anomalistic month. There is a similar but relatively unimportant inequality due to the sun; this cycle is the anomalistic year. The parallax has little direct effect upon the lunital intervals but tends to modify the phase effect. When the moon is in perigee, the priming and lagging of the tide due to the phase is diminished and when in apogee the priming and lagging is increased.
- parallax reduction**. . Processing of observed high and low waters to obtain quantities depending upon changes in the distance of the moon, such as perigeon and apogean ranges.
- parallel**, *adj.* Everywhere equidistant, as of lines or surfaces.
- parallel**, *n.* See PARALLEL OF LATITUDE, definition 1.
- parallel indexing**. . The use of rotating parallel lines overlaid on a radar display to aid in piloting.
- parallel motion protractor**. . An instrument consisting of a protractor and one or more arms attached to a parallel motion device, so that the movement of the arms is everywhere parallel. The protractor can be rotated and set at any position so that it can be oriented to a chart. Also called DRAFTING MACHINE.
- parallel of altitude**. . A circle of the celestial sphere parallel to the horizon, connecting all points of equal altitude. Also called ALTITUDE CIRCLE, ALMUCANTAR. See also CIRCLE OF EQUAL ALTITUDE.
- parallel of declination**. . A circle of the celestial sphere parallel to the celestial equator. Also called CELESTIAL PARALLEL, CIRCLE OF EQUAL DECLINATION. See also DIURNAL CIRCLE.
- parallel of latitude**. . 1. A circle (or approximation of a circle) on the surface of the earth, parallel to the equator, and connecting points of equal latitude. Also called a PARALLEL. 2. A circle of the celestial sphere, parallel to the ecliptic, and connecting points of equal celestial latitude. Also called CIRCLE OF LONGITUDE.
- parallelogram**, *n.* A four-sided figure with both pairs of opposite sides parallel. A right-angled parallelogram is a rectangle; a rectangle with sides of equal length is a square. A parallelogram with oblique angles is a rhomboid; a rhomboid with sides of equal length is a rhombus.
- parallel rulers**. . An instrument for transferring a line parallel to itself. In its most common form it consists of two parallel bars or rulers connected in such manner that when one is held in place, the other may be moved, remaining parallel to its original position.
- parallel sailing**. . A method of converting departure into difference of longitude, or vice versa, when the true course is 090° or 270°.
- parallel sphere**. . The celestial sphere as it appears to an observer at the pole, where celestial bodies appear to move parallel to the horizon.
- parameter**, *n.* 1. A quantity which remains constant within the limits of a given case or situation. 2. One of the components into which a craft's magnetic field is assumed to be resolved for the purpose of compass adjustment. The field caused by permanent magnetism is resolved into orthogonal components or parameters: Parameter P, Parameter Q, and Parameter R. The field caused by induced magnetism is resolved into that magnetism induced in 9 imaginary soft iron bars or rods. With respect to the axis of a craft, these parameters lie in a fore-and-aft direction, an athwart ships direction, and in a vertical direction. See also ROD, definition 2.
- paranthesis**, *n.* A phenomenon similar to a PARHELION but occurring generally at a distance of 120° (occasionally 90° or 140°) from the sun.
- paraselenae** (*pl. paraselenae*), *n.* A form of halo consisting of an image of the moon at the same altitude as the moon and some distance from it, usually about 22°, but occasionally about 46°. Similar phenomena may occur about 90°, 120°, 140°, or 180° from the moon. A similar phenomenon in relation to the sun is called a PARHELION, SUN DOG, or MOCK SUN. Also called MOCK MOON.
- paraselenic circle**. . A halo consisting of a faint white circle through the moon and parallel to the horizon. It is produced by reflection of moonlight from vertical faces of ice crystals. A similar circle through the sun is called a PARHELIC CIRCLE.
- parhelic circle**. . A halo consisting of a faint white circle through the sun and parallel to the horizon. It is produced by reflection of sunlight from vertical faces of ice crystals. A similar circle through the moon is called a PARASELENIC CIRCLE. Also called MOCK SUN RING.
- parhelion** (*pl. parhelia*), *n.* A form of halo, consisting of an image of the sun at the same altitude as the sun and some distance from usually about 22°, but occasionally about 40°. A similar phenomenon occurring at a distance of 90°, 120°, or 140° from the sun is called a PARANTHELION, and if occurring at a distance of 180° from the sun, an ANTHELION. A similar phenomenon in relation to the moon is called PARASELENE, MOON DOG, or MOCK MOON. The term PARHELION should not be confused with PERIHELION, the orbital point near the sun when the sun is the center of attraction. Also called SUN DOG, MOCK SUN.
- parsec**, *n.* The distance at which 1 astronomical unit subtends an angle of 1 second of arc. One parsec equals about 206,265 astronomical units or 30,857 10<sup>12</sup> meters or 3.26 light years. The name parsec is derived from *parallax second*.
- partial eclipse**. . An eclipse in which only part of the source of light is obscured. See ECLIPSE.
- pascal**, *n.* The special name for the derived unit of pressure and stress in the International System of Units; it is 1 newton per square meter.
- pass**, *n.* 1. A navigable channel leading to a harbor or river. Sometimes called PASSAGE. 2. A break in a mountain range, permitting easier passage from one side of the range to the other; also called COL. 3. A narrow opening through a barrier reef atoll, or sand bar. 4. A single circuit of the earth by a satellite. See also ORBIT. 5. The period of time a satellite is within telemetry range of a data acquisition station.
- passage**, *n.* 1. A navigable channel, especially one through reefs or islands. Also called PASS. 2. A transit from one place to another; one leg of a voyage.
- passing light**. . A low intensity light which may be mounted on the structure of another light to enable the mariner to keep the latter light in sight when he passes out of its beam. See also SUBSIDIARY LIGHT.
- passive satellite**. . 1. A satellite which contains power source to augment the output signal (i.e., reflected only) as contrasted with ACTIVE SATELLITE; a satellite which is a passive reflector. 2. As defined by the International Telecommunications Union (ITU), an earth satellite intended to transmit radiocommunication signals by reflection.

- tion.
- passive system.** . A term used to describe a navigation system whose operation does not require the user to transmit a signal.
- patent log.** . A mechanical log, particularly a TAFFRAIL LOG.
- patent slip.** . See MARINE RAILWAY.
- path.** , *n.* See as ORBITAL PATH.
- pattern.** , *n.* 1. See under LATTICE. 2. In a hyperbolic radionavigation system, the family of hyperbolas associated with a single pair of stations, usually the master station and a secondary station.
- P-band.** . A radio-frequency band of 225 to 390 megahertz. See also FREQUENCY, FREQUENCY BAND.
- P-code.** . The precise code of the GPS signal, used by military receivers.
- polar cap anomaly.** . See under POLAR CAP DISTURBANCE.
- peak.** , *n.* 1. On the sea floor, a prominent elevation, part of a larger feature, either pointed or of very limited extent across the summit. 2. A pointed mountain summit. 3. An individual or conspicuous mountain with a single conspicuous summit, as Pikes Peak. 4. The summit of a mountain. 5. A term sometimes used for a headland or promontory.
- peak envelope power.** . See under POWER (OF A RADIO TRANSMITTER).
- pebble.** , *n.* See under STONES.
- pelorus.** , *n.* A dumb compass, or a compass card (called a PELORUS CARD) without a directive element, suitably mounted and provided with vanes to permit observation of relative bearings unless used in conjunction with a compass to give true or magnetic bearings.
- pelorus card.** . The part of a pelorus on which the direction graduations are placed. It is usually in the form of a thin disk or annulus graduated in degrees, clockwise, from 0° at the reference direction to 360°.
- pendulous gyroscope.** . A gyroscope with its axis of rotation constrained by a suitable weight to remain horizontal. The pendulous gyroscope is the basis of one type of gyrocompass.
- peninsula.** , *n.* A section of land nearly surrounded by water. Frequently, but not necessarily, a peninsula is connected to a larger body of land by a neck or isthmus.
- pentagon.** , *n.* A closed plane figure having five sides.
- pentagonal cluster.** . An arrangement of five corner reflectors, mounted so as to give their maximum response in a horizontal direction, and equally spaced on the circumference of a circle. The response is substantially uniform in all horizontal directions. See also OCTAHEDRAL CLUSTER.
- penumbra.** , *n.* 1. That part of a shadow in which light is partly cut off by an intervening object. The penumbra surrounds the darker UMBRA in which light is completely cut off. 2. The lighter part of a sun spot, surrounding the darker UMBRA.
- penumbral lunar eclipse.** . The eclipse of the moon when the moon passes only through the penumbra of the earth's shadow.
- performance monitor.** . A device used to check the performance of the transmitter and receiver of a radar set. Such device does not provide any indication of performance as it might be affected by the propagation of the radar waves through the atmosphere. An echo box is used in one type of performance monitor called an echo box performance monitor.
- Performance Standards for ECDIS.** . Minimum performance requirements for ECDIS, adopted by IMO as Assembly resolution and published as an Annex to IMO resolution MSC.232(82).
- per gyrocompass (PGC).** . Relating to or from the gyrocompass.
- periapsis.** , *n.* See PERICENTER.
- periastron.** , *n.* That point of the orbit of one member of a double star system at which the stars are nearest together. That point at which they are farthest apart is called APASTRON.
- pericenter.** , *n.* In an elliptical orbit, the point in the orbit which is the nearest distance from the focus where the attracting mass is located. The pericenter is at one end of the major axis of the orbital ellipse. The opposite is APOAPSIS, APOCENTER. Also called PERIAPSIS, PERIFOCUS.
- perifocus.** , *n.* See PERICENTER.
- perigean range.** . See under PERIGEAN TIDES.
- perigean tidal currents.** . Tidal currents of increased speed occurring monthly as the result of the moon being in perigee or nearest the earth.
- perigean tides.** . Tides of increased range occurring monthly as the result of the moon being in perigee or nearest the earth. The perigean range of tide is the average semidiurnal range occurring at the time of perigean tides and is most conveniently computed from the harmonic constants. It is larger than the mean range where the type of tide is either semidiurnal or mixed and is of no practical significance where the type of tide is diurnal.
- perigee.** , *n.* The orbital point nearest the earth when the earth is the center of attraction. The orbital point farthest from the earth is called APOGEE. See also APOCENTER, PERICENTER.
- perigee-to-perigee period.** . See ANOMALISTIC PERIOD.
- perigon.** , *n.* An angle of 360°.
- perihelion.** , *n.* That orbital point nearest the sun when the sun is the center of attraction. That point farthest from the sun is called APHELION.
- perimeter.** , *n.* 1. The length of a closed plane curve or the sum of the sides of a polygon. 2. The boundary of a plane figure. Also called PERIPHERY.
- period.** , *n.* 1. The interval needed to complete a cycle. See also NATURAL PERIOD, SIDEREAL PERIOD, SYNODIC PERIOD, WAVE PERIOD. 2. The interval of time between the commencement of two identical successive cycles of the characteristic of the light.
- periodic.** , *adj.* Of or pertaining to a period.
- periodic error.** . An error whose amplitude and direction vary systematically with time.
- periodic perturbations.** . Perturbations to the orbit of a satellite which change direction in regular or periodic manner in time, such that the average effect over a long period of time is zero.
- periodic terms.** . In the mathematical expression of the orbit of a satellite, terms which vary with time in both magnitude and direction in a periodic manner. See also SECULAR TERMS.
- period of satellite.** . 1. See ORBITAL PERIOD. 2. As defined by the International Telecommunication Union (ITU), the time elapsing between two consecutive passages of a satellite or planet through a characteristic point on its orbit.
- periphery.** , *n.* See PERIMETER.
- periplus.** , *n.* The early Greek name for SAILING DIRECTIONS. The literal meaning of the term is "a sailing round."
- periscope.** , *n.* An optical instrument which displaces the line of sight parallel to itself, to permit a view which may otherwise be obstructed.
- periscope sextant.** . A sextant designed to be used in conjunction with the periscope of a submarine.
- permafrost.** , *n.* Permanently frozen subsoil. Any soil or other deposit, including rock, the temperature of which has been below freezing continuously for 2 years or more is considered permafrost.
- Permalloy.** , *n.* The trade name for an alloy of about 80% nickel and 20% iron, which is very easily magnetized and demagnetized.
- permanent current.** . A current that runs fairly continuously and is independent of tides and other temporary causes.
- permanent echo.** . An echo from an object whose position relative to the radar set is fixed.
- permanent light.** . A light used in regular service.
- permanent magnetism.** . The magnetism which is acquired by hard iron, which is not readily magnetized by induction, but which retains a high percentage of magnetism acquired unless subjected to a demagnetizing force. The strength and polarity of this magnetism in a craft depends upon the heading, magnetic latitude, and building stresses imposed during construction. See also INDUCED MAGNETISM, SUBPERMANENT MAGNETISM.
- permeability.** , *n.* 1. The ability to transmit magnetism; magnetic conductivity. 2. The ability to permit penetration or passage. In this sense the term is applied particularly to substances which permit penetration or passage of fluids.
- perpendicular.** , *adj.* At right angles; normal.
- perpendicular.** , *n.* A perpendicular line, plane, etc. A distinction is sometimes made between PERPENDICULAR and NORMAL, the former applying to a line at right angles to a straight line or plane, and the latter referring to a line at right angles to a curve or curved surface.
- persistence.** , *n.* A measure of the time of decay of the luminescence of the face of the cathode ray tube after excitation by the stream of electrons has ceased. Relatively slow decay is indicative of high persistence. Persistence is the length of time during which phosphorescence takes place. See also AFTERGLOW, definition 1.
- personal correction.** . A correction due to personal error. Also called PERSONAL EQUATION.
- personal equation.** . A term used for both PERSONAL ERROR and

## PERSONAL CORRECTION.

**personal error.** . A systematic error in the observation of a quantity due to the personal idiosyncrasies of the observer. Also called PERSONAL EQUATION.

**perspective chart.** . A chart on a perspective map projection.

**perspective map projection.** . A map projection produced by the direct projection of the points of the ellipsoid (used to represent the earth) by straight lines drawn through them from some given point. The projection is usually made upon a plane tangent to the ellipsoid at the end of the diameter joining the point of projection and the center of the ellipsoid. The plane of projection is usually tangent to the ellipsoid at the center of the area being mapped. The analytical expressions that determine the elements of the projection. If the point of projection is at the center of the ellipsoid, a gnomonic map projection results; if it is at the point opposite the plane's point of tangency a stereographic map projection; and if at infinity (the projecting lines being parallel to each other), an orthographic map projection. Most map projections are not perspective. Also called GEOMETRIC MAP PROJECTION.

**perspective map projection upon a tangent cylinder.** . A cylindrical map projection upon a cylinder tangent to the ellipsoid produced by perspective projection from the ellipsoid's center. The geographic meridians are represented by a family of equally spaced parallel straight lines, perpendicular to a second family of parallel straight lines which represent the geographic parallels of latitude. The spacing, with respect to the equator of the lines which represent the parallels of latitude, increases as the tangent function of the latitude; the line representing 90° latitude is at an infinite distance from the line which represents the equator. Not to be confused with MERCATOR MAP PROJECTION to which it bears a general resemblance.

**perspective projection.** . The representation of a figure on a surface, either plane or curved, by means of projecting lines emanating from a single point, which may be infinity. Also called GEOMETRIC PROJECTION. See also PERSPECTIVE MAP PROJECTION.

**per standard compass.** . Relating to the standard magnetic compass.

**per steering compass.** . Relating to the magnetic steering compass.

**perturbations.** , *n. (pl.)*. In celestial mechanics differences of the actual orbit from a central force orbit, arising from some external force such as a third body attracting the other two; a resisting medium (atmosphere); failure of the parent body to act as a point mass, and so forth. Also the forces that cause differences between the actual and reference (central force) orbits. See also GRAVITATIONAL PERTURBATIONS, LONG PERIOD PERTURBATIONS, LUNISOLAR PERTURBATIONS, NONGRAVITATIONAL PERTURBATIONS, PERIODIC PERTURBATIONS, SECULAR PERTURBATIONS, SHORT PERIOD PERTURBATIONS, TERRESTRIAL PERTURBATIONS.

**perturbed orbit.** . The orbit of a satellite differing from its normal orbit due to various disturbing effects, such as nonsymmetrical gravitational effects, atmospheric drag, radiation pressure, and so forth. See also PERTURBATIONS.

**perturbing factor.** . In celestial mechanics, any factor that acts on an orbiting body to change its orbit from a central force orbit. Also called PERTURBING FORCE.

**perturbing force.** . See PERTURBING FACTOR.

**Peru Coastal Current.** . See PERU CURRENT.

**Peru Current.** . A narrow, fairly stable ocean current that flows northward close to the South American coast. It originates off the coast of Chile at about latitude 40°S and flows past Peru and Ecuador to the southwest extremity of Colombia. The southern portion of the Peru Current is sometimes called the CHILE CURRENT. It has sometimes been called the HUMBOLDT CURRENT because an early record of its temperature was taken by the German scientist Alexander von Humboldt in 1802. The name Corriente del Peru was adopted by a resolution of the Ibero-American Oceanographic Conference at its Madrid-Malaga meeting in April 1935. Also called PERU COASTAL CURRENT.

**Peru Oceanic Current.** . See MENTOR CURRENT.

**phantom.** , *n.* That part of a gyrocompass carrying the compass card.

**phantom bottom.** . A false bottom indicated by an echo sounder, some distance above the actual bottom. Such an indication, quite common in the deeper parts of the ocean, is due to large quantities of small organisms.

**phantom echo.** . See PHANTOM TARGET.

**phantom target.** . 1. An indication of an object on a radar display that does not correspond to the presence of an actual object at the point indicated. Also called PHANTOM ECHO. 2. See ECHO BOX.

**phase.** , *n.* The amount by which a cycle has progressed from a specified origin. For most purposes it is stated in circular measure, a complete cycle being considered 360°. See also PHASES OF THE MOON.

**phase angle.** . The angle at a celestial body between the sun and earth.

**phase inequality.** . Variations in the tides or tidal currents due to changes in the phase of the moon. At the times of new and full moon the tide-producing forces of the moon and sun act in conjunction, causing the range of tide and speed of the tidal current to be greater than the average, the tides at these times being known as spring tides. At the time of quadrature of the moon these forces are opposed to each other, causing the neap tides with diminished range and current speed.

**phase lag.** . See EPOCH, definition 3.

**phase lock.** . The technique whereby the phase of an oscillator signal is made to follow exactly the phase of a reference signal by first comparing the phases of the two signals and then using the resulting phase difference signal to adjust the reference oscillator frequency to eliminate phase difference when the two signals are next compared.

**phase meter.** . An instrument for measuring the difference in phase of two waves of the same frequency.

**phase modulation.** . The process of changing the phase of a carrier wave in accordance with the variations of a modulating wave. See also MODULATION.

**phase reduction.** . Processing of observed high and low waters to obtain quantities depending upon the phase of the moon, such as the spring and neap ranges of tide. Formerly this process was known as SECOND REDUCTION. Also applicable to tidal currents.

**phases of the moon.** . The various appearances of the moon during different parts of the synodical month. The cycle begins with new moon or change of the moon at conjunction. The visible part of the waxing moon increases in size during the first half of the cycle until full moon appears at opposition, after which the visible part of the waning moon decreases for the remainder of the cycle. First quarter occurs when the waxing moon is at east quadrature; last quarter when the waning moon is at west quadrature. From last quarter to new and from new to first quarter the moon is crescent; from first quarter to full and from full to last quarter it is gibbous. The elapsed time, usually expressed in days, since the last new moon is called age of the moon. The full moon occurring nearest the autumnal equinox is called harvest moon; the next full moon, hunter's moon.

**phase synchronized.** . A term used to indicate that radio wave transmissions have the same phase at their sources at any instant of time.

**phenomenon.** , *(pl. phenomena), n.* 1. An occurrence or event capable of being explained scientifically, particularly one relating to the unusual. 2. A rare or unusual event.

**phonetic alphabet.** . A list of standard words used to identify letters in a message transmitted by radio or telephone.

**phosphor.** , *n.* A phosphorescent substance which emits light when excited by radiation, as on the scope of a cathode-ray tube.

**phosphorescence.** , *n.* Emission of light without sensible heat, particularly as a result of but continuing after absorption of radiation from some other source. PERSISTENCE is the length of time during which phosphorescence takes place. The emission of light or other radiant energy as a result of and only during absorption of radiation from some other source is called FLUORESCENCE.

**photogrammetry.** , *n.* 1. The science of obtaining reliable measurements from photographic images. 2. The science of preparing charts and maps from aerial photographs using stereoscopic equipment and methods.

**photosphere.** , *n.* The bright portion of the sun visible to the unaided eye.

**physical double star.** . Two stars in nearly the same line of sight and at approximately the same distance from the observer, as distinguished from an OPTICAL DOUBLE STAR (two stars in nearly the same line of sight but differing greatly in distance from the observer). If they revolve about their common center of mass, they are called a **binary star**.

**pico-** . A prefix meaning one-trillionth (10<sup>-12</sup>).

**pedmont.** , *n.* An area of hills situated at the base of a range of mountains.

**pier.** , *n.* 1. A structure extending into the water from a shore or a bank which provides berthing for ships, or use as a promenade or fishing pier. See also WHARF. 2. A support for the spans of a bridge.

**pierhead**, *n.* The outer end of a pier or jetty.

**pile**, *n.* A long, heavy timber or section of steel, concrete, etc., forced into the earth to serve as a support, as for a pier, or to resist lateral pressure.

**pile beacon**, *n.* A beacon formed of one or more piles.

**pile dolphin**, *n.* A minor light structure consisting of a number of piles driven into the bottom in a circular pattern and drawn together with or without a light mounted at the top. Referred to in the *Light List* as a DOLPHIN.



pile dolphin

**pillar buoy**, *n.* A buoy composed of a tall central structure mounted on a broad flat base.

**pilot**, *n.* 1. A person who directs the movement of a vessel through pilot waters, usually a person who has demonstrated extensive knowledge of channels, aids to navigation, dangers to navigation, etc., in a particular area and is licensed in that area. See also LOCAL KNOWLEDGE. 2. A book of sailing directions. For waters the United States and its possessions, they are prepared by the National Ocean Survey, and are called COAST PILOTS.

**pilotage**, *n.* 1. The services of especially qualified navigators having local knowledge who assist in the navigation of vessels in particular areas. Also called PILOTAGE SERVICE. 2. A term loosely used for piloting.

**pilotage service**, *n.* See PILOTAGE, definition 1.

**pilotage waters**, *n.* See PILOT WATERS.

**pilot boat**, *n.* A small vessel used by the pilot to go or from a vessel employing his services. Also called PILOT VESSEL.

**pilot chart**, *n.* A chart of a major ocean area which presents in graphic form averages obtained from weather, wave, ice, and other marine data gathered over many years in meteorology and oceanography to aid the navigator in selecting the quickest and safest routes; published by the Defense Mapping Agency Hydrographic/Topographic Center from data provided by the U.S. Naval Oceanographic Office and the Environmental Data and Information Service of the National Oceanic and Atmospheric Administration.

**piloting**, *n.* Navigation involving frequent or continuous determination of position relative to observed geographical points, to a high order of accuracy; directing the movements of a vessel near a coast by means of terrestrial reference points is called coast piloting. Sometimes called PILOTAGE. See also PILOTAGE, definition 1.

**pilot rules**, *n.* Regulations supplementing the Inland Rules of the Road, superseded by the adoption of the Inland Navigation Rules in 1980 (1983 on the Great Lakes).

**pilot station**, *n.* The office or headquarters of pilots; the place where the services of a pilot may be obtained.

**pilot vessel**, *n.* See PILOT BOAT.

**pilot waters**, *n.* 1. Areas in which the services of a marine pilot are essential. 2. Waters in which navigation is by piloting. Also called PILOTAGE WATERS.

**pinnacle**, *n.* A high tower or spire-shaped pillar of rock or coral on the sea floor, alone or cresting a summit. It may or may not be a hazard to surface navigation. Due to the steep rise from the sea floor no warning is given by sounding.

**pinnacled iceberg**, *n.* An iceberg weathered in such manner as to produce spires or pinnacles. Also called PYRAMIDAL ICEBERG, IRREGULAR ICEBERG.

**pip**, *n.* See BLIP.

**pitch**, *n.* 1. Oscillation of a vessel about the transverse axis due to the vessel's bow and stern being raised or lowered on passing through successive crests and troughs of waves. Also called PITCHING. See also SHIP MOTIONS. 2. The distance a propeller would advance longitudinally in one revolution if there were no slip.

**pitch**, *v., i.* To oscillate about the transverse axis. See also SHIP MOTIONS.

**pitching**, *n.* See PITCH, definition 1.

**pivot point**, *n.* The point on the centerline between the bow and the center

of gravity at which the resultant of the velocities of rotation and translation is directed along the centerline, after a ship has assumed its drift angle in a turn. To an observer on board, the ship appears to rotate about this point.

**pixel**, *n.* The smallest area of phosphors on a video terminal that can be excited to form a picture element.

**place name**, *n.* See TOPONYM.

**plain**, *n.* On the sea floor, a flat, gently sloping or nearly level region. Sometimes called ABYSSAL PLAIN in very deep water.

**plan**, *n.* 1. An orthographic drawing or view on a horizontal plane, as of an instrument, a horizontal section, or a layout. 2. A large-scale map or chart of a small area, generally showing at increased scale a portion of the chart on which it is placed.

**planar**, *adj.* Lying in a plane.

**planar graph**, *n.* In ECDIS a 2-dimensional data structure in which the geometry is described in terms of NODES and EDGES which are TOPOLOGICALLY linked. A special case of a CHAINNODE data structure in which edges must not cross. CONNECTED NODES are formed at all points where edges meet.

**plane**, *n.* A surface without curvature, such that a straight line joining any two of its points lies wholly on the surface.

**plane of polarization**, *n.* With respect to a plane polarized wave, the plane containing the electric field vector and the direction of propagation.

**plane polarized wave**, *n.* An electromagnetic wave the electric field vector of which lies at all times in a fixed plane which contains the direction of propagation.

**plane sailing**, *n.* A method of solving the various problems involving a single course and distance, difference of latitude, and departure, in which the earth, or that part traversed, is considered as a plane surface.

**planet**, *n.* A celestial body of a solar system, in orbit around the sun or a star and shining by reflected light. The larger of such bodies are sometimes called major planets to distinguish them from minor planets (asteroids) which are very much smaller. Larger planets may have satellites. In the solar system an inferior planet has an orbit smaller than that of the earth; a superior planet has an orbit larger than that of the earth. The four planets commonly used for celestial observations are called navigational planets. The word planet is of Greek origin, meaning, literally, wanderer, applied because the planets appear to move relative to the stars.

**planetary**, *adj.* Of a planet or the planets; terrestrial; worldwide.

**planetary aberration**, *n.* See under ABERRATION definition 1.

**planetary configurations**, *n.* Apparent positions of the planets relative to each other and to other bodies of the solar system, as seen from the earth.

**planetary precession**, *n.* The component of general precession caused by the effect of other planets on the equatorial protuberance of the earth producing an eastward motion of the equinoxes along the ecliptic. See also PRECESSION OF THE EQUINOXES.

**planetoid**, *n.* See ASTEROID.

**plane triangle**, *n.* A closed plane figure having three straight lines as sides.

**planimetric map**, *n.* A map indicating only the horizontal positions of features, without regard to elevation, in contrast with a TOPOGRAPHIC MAP, which indicates both horizontal and vertical positions.

**planisphere**, *n.* A representation on a plane of the celestial sphere, especially one on a polar projection, with means provided for making certain measurements such as altitude and azimuth. See also STAR FINDER.

**plankton**, *n.* Floating, drifting, or feebly swimming plant and animal organisms of the sea. These are usually microscopic or very small, although jellyfish are included.

**planning chart**, *n.* A chart designed for use in planning voyages or flight operations or investigating areas of marine or aviation activities.

**plan position indicator**, *n.* An intensity-modulated radar display in which the radial sweep rotates on the cathode-ray tube in synchronism with the rotating antenna. The display presents a maplike representation of the positions of echo-producing objects. It is generally one of two main types: RELATIVE MOTION DISPLAY or TRUE MOTION DISPLAY.

**plastic relief map**, *n.* A topographic map printed on plastic and molded into a three-dimensional form.

**plateau**, *n.* On the sea floor, a comparatively flat-topped feature of considerable extent, dropping off abruptly on one or more sides.

**plate glass**, *n.* A fine quality sheet glass obtained by rolling, grinding, and

polishing.

**platform erection.** . In the alignment of inertial navigation equipment, the alignment of the stable platform vertical axis with the local vertical.

**platform tide.** . See STAND.

**Platonic year.** . See GREAT YEAR.

**Plimsoll mark.** . A special marking (positioned amidships) that indicates the draft of the ship and the legal limit to which a ship may be loaded for specific water types and temperatures in order to safely maintain buoyancy, particularly with regard to the hazard of waves that may arise.



Plimsoll mark

**plot.** , *n.* A drawing consisting of lines and points representing certain conditions graphically, as the progress of a craft. See also NAVIGATIONAL PLOT.

**plot.** , *v., t.* To draw lines and points to represent certain conditions graphically, as the various lines and points on a chart or plotting sheet representing the progress of a vessel, a curve of magnetic azimuths vs. time or of altitude vs. time, or a graphical solution of a problem, such as a relative motion solution.

**plotter.** , *n.* An instrument used for plotting straight lines and measuring angles on a chart or plotting sheet. See also PROTRACTOR.

**plotting chart.** . An outline chart on a specific scale and projection, usually showing a graticule and compass rose, designed to be used ancillary to a standard nautical chart, and produced either as an independent chart or part of a coordinated series. See also POSITION PLOTTING SHEET.

**plotting head.** . See REFLECTION PLOTTER.

**plumb bob.** . A conical device, usually of brass and suspended by a chord, by means of which a point can be projected vertically into space over relatively short distances.

**plumb-bob vertical.** . See LOCAL VERTICAL.

**plumb line.** . 1. A line in the direction of gravity. 2. A cord with a weight at one end for determining the direction of gravity.

**pluvial.** , *adj.* Of or pertaining to rain. The expression pluvial period is often used to designate an extended period or age of heavy rainfall.

**P.M..** Abbreviation for **Post Meridian**; after noon in zone time.

**pocosin.** , *n.* See DISMAL.

**point.** , *n.* 1. A place having position, but no extent. 2. A tapering piece of land projecting into a body of water. It is generally less prominent than a CAPE. 3. One thirty-second of a circle, or 11.25°. Also called COMPASS POINT when used in reference to compass directions. See also FOUR-POINT BEARING.

**point designation grid.** . A system of lines, having no relation to the actual scale or orientation, drawn on a map, chart, or air photograph, dividing it into squares so that points can be more readily located.

**point light.** . A luminous signal without perceptible length, as contrasted with a LINEAR LIGHT which has perceptible length.

**point of arrival.** . The position at which a craft is assumed to have reached or will reach after following specified courses for specified distance from a point of departure. See also DESTINATION.

**point of departure.** . The point from which the initial course to reach the destination begins. It is usually established by bearings of prominent landmarks as the vessel clears a harbor and proceeds to sea. When a person establishes this point, he is said to take departure. Also called the DEPARTURE.

**point of destination.** . See DESTINATION.

**point of inflection.** . The point at which a reverse in direction of curvature takes place.

**polar.** , *adj.* Of or pertaining to a pole or the poles.

**polar air.** . A type of air whose characteristics are developed over high latitudes, especially Within the subpolar highs. Continental polar air has low surface temperature, low moisture content, and especially in its source regions, has great stability in the lower layers. It is shallow in comparison with arctic air. Maritime polar air initially possesses similar properties to those of continental polar air, but in passing over warmer water it becomes unstable with a higher

moisture content.

**polar axis.** . 1. The straight line connecting the poles of a body 2. A reference line for one of the spherical coordinates.

**polar cap absorption.** . See under POLAR DISTURBANCE.

**polar cap disturbance.** . An ionospheric disturbance (which does not refer to the ice cap in the polar regions). It is a result of the focusing effect that the earth's magnetic field has on particles released from the sun during a solar proton event. The effect concentrates high-energy particles in the region of the magnetic pole with the result that normal very low frequency Omega propagation is disrupted. The effect on radio waves is known as POLAR CAP ABSORPTION (PCA). Historically, polar cap disturbances (PCDs) produced large or total absorption of high frequency radio waves crossing the polar region, hence the term POLAR CAP ABSORPTION. A transmission path which is entirely outside the polar region is unaffected by a PCD. The PCDs, often called PCA EVENTS (PCAs), may persist for a week or more, but duration of only a few days is more common. The PCD can cause line of position errors about 6 to 8 nautical miles. The *Omega Propagation Correction Tables* make no allowance for this phenomenon since it is not predictable. However, the frequency of the phenomenon increases during those years of peak solar activity. See also SUDDEN IONOSPHERIC DISTURBANCE, MODAL INTERFERENCE.

**polar chart.** . 1. A chart of polar areas. 2. A chart on a polar projection. The projections most used for polar charts are the gnomonic, stereographic, azimuthal equidistant, transverse Mercator, and modified Lambert conformal.

**polar circles.** . The minimum latitudes, north and south, at which the sun becomes circumpolar.

**polar continental air.** . Air of an air mass that originates over land or frozen ocean areas in polar regions. Polar continental air is characterized by low temperature, stability, low specific humidity, and shallow vertical extent.

**polar coordinates.** . A system of coordinates defining a point by its distance and direction from a fixed point, called the POLE. Direction is given as the angle between a reference radius vector and a radius vector to the point. If three dimensions are involved, two angles are used to locate the radius vector. See also SPACE-POLAR COORDINATES.

**polar distance.** . Angular distance from a celestial pole; the arc of an hour circle between a celestial pole, usually the elevated pole, and a point on the celestial sphere, measured from the celestial pole through 180°. See also CODECLINATION.

**polar front.** . The semi-permanent, semi-continuous front separating air masses of tropical and polar origin. This is the major front in terms of air mass contrast and susceptibility to cyclonic disturbance.

**Polaris correction.** . A correction to be applied to the corrected sextant altitude of Polaris to obtain latitude. This correction for the offset of Polaris from the north celestial pole varies with the local hour angle of Aries, latitude, and date. See Q-CORRECTION.

**polarization.** , *n.* The attribute of an electromagnetic wave which describes the direction of the electric field vector.

**polarization error.** . An error in a radio direction finder bearing or the course indicated by a radiobeacon because of a change in the polarization of the radio waves between the transmitter and receiver on being reflected and refracted from the ionosphere. Because the medium frequency radio direction finder normally operates with vertically polarized waves, a change to horizontal polarization in the process of reflection and refraction of the waves from the ionosphere can have a serious effect on bearing measurements. If the horizontally polarized skywaves are of higher signal strength than the vertically polarized groundwaves, the null position for the loop antenna cannot be obtained. If the skywaves are of lower signal strength than the groundwaves, the null position is made less distinct. Before the cause of the error was understood, it was called NIGHT EFFECT or NIGHT ERROR because it occurs principally during the night, and especially during twilight when rapid changes are occurring in the ionosphere.

**polar map projection.** . A map projection centered on a pole.

**polar maritime air.** . An air mass that originates in the polar regions and is then modified by passing over a relatively warm ocean surface. It is characterized by moderately low temperature, moderately high surface specific humidity, and a considerable degree of vertical instability. When the air is colder than the sea surface, it is further characterized by gusts and squalls, showery precipitation, variable

sky, and good visibility between showers.

**polar motion.** . See EULERIAN MOTION.

**polar navigation.** . Navigation in polar regions, where unique considerations and techniques are applied. No definite limit for these regions is recognized but polar navigation techniques are usually used from about latitude 70°N.

**polar orbit.** . An earth satellite orbit that has an inclination of about 90° and, hence, passes over or near the earth's poles.

**polar orthographic map projection.** . An orthographic map projection having the plane of the projection perpendicular to the axis of rotation of the earth, in this projection, the geographic parallels are full circles, true to scale, and the geographic meridians are straight lines.

**polar regions.** . The regions near the geographic poles. No definite limit for these regions is recognized.

**polar satellite.** . A satellite that passes over or near the earth's poles, i.e., a satellite whose orbital plane has an inclination of about 90° to the plane of the earth's equator.

**polar stereographic map projection.** . A stereographic map projection having the center of the projection located at a pole of the sphere.

**pole.** , *n.* 1. Either of the two points of intersection of the surface of a sphere or spheroid and its axis, labeled N or S to indicate whether the north pole or south pole. The two points of intersection of the surface of the earth with its axis are called geographical poles. The two points of intersection of the celestial sphere and the extended axis of the earth are called celestial poles. The celestial pole above the horizon is called the elevated pole; that below the horizon the depressed pole. The ecliptic poles are 90° from the ecliptic. Also, one of a pair of similar points on the surface of a sphere or spheroid, as a magnetic pole, definition 1; a geomagnetic pole; or a fictitious pole. 2. A magnetic pole, definition 2. 3. The origin of measurement of distance in polar or spherical coordinates. 4. Any point around which something centers.

**pole beacon.** . A vertical spar fixed in the ground or in the sea bed or a river bed to show as a navigation mark. Sometimes called SPINDLE BEACON or SINGLE-PILE BEACON in the United States.

**polyconic.** , *adj.* Consisting of or related to many cones.

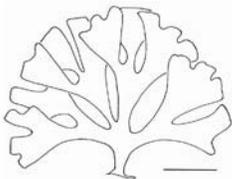
**polyconic chart.** . A chart on the polyconic map projection.

**polyconic map projection.** . A conic map projection in which the surface of a sphere or spheroid, such as the earth, is conceived as developed on a series of tangent cones, which are then spread out to form a plane. A separate cone is used for each small zone. This projection is widely used for maps but seldom used for charts, except for survey purposes. It is not conformal.

**polygon.** , *n.* A closed plane figure bounded by straight lines. See also HEXAGON, OCTAGON, PARALLELOGRAM, PENTAGON, QUADRILATERAL, RECTANGLE, SQUARE, TRAPEZOID, TRIANGLE.

**polynya.** , *n.* A non-linear shaped area of water enclosed by ice. Polynyas may contain brash ice and/or be covered with new ice, nilas, or young ice; submariners refer to these as SKYLIGHTS. Sometimes the POLYNIA is limited on one side by the coast and is called a SHORE POLYNIA or by fast ice and is called a FLAW POLYNIA. If it recurs in the same position every year, it is called a RECURRING POLYNIA.

**polyzoa.** , *n., pl.* Very small marine animals which reproduce by budding, many generations often being permanently connected by branchlike structures. These animals are often very numerous and in some areas they cover the bottom. Also called BRYOZOA.



polyzoa

**pond.** , *n.* A relatively small body of water, usually surrounded on all sides by land. A larger body of water is called a LAKE.

**pontoon.** , *n.* A float or low, flat-bottomed vessel to float machinery such as cranes, capstans, etc. or to support weights such as floating bridges boat landings, etc.

**pool.** , *n.* 1. A small body of water, usually smaller than a pond, especially one that is quite deep. One left by an ebb tide is called a **tide pool**. 2. A small and comparatively still, deep part of a larger body of water such as a river or harbor.

**poop.** , *n.* A short enclosed structure at the stern of a vessel, extending from side to side. It is covered by the poop deck, which is surrounded by the poop rail.

**pooped.** . To have shipped a sea or wave over the stern.

**pororoca.** , *n.* See TIDAL BORE.

**port.** , *n.* 1. A place provided with moorings and transfer facilities for loading and discharging cargo or passengers, usually located in a harbor. 2. The left side of a craft, facing forward. The opposite is STARBOARD.

**portable pilot unit.** , *n.* A portable, computer-based system that pilots bring aboard a vessel to use as a decision-support tool for navigating in confined waters.

**portfolio.** , *n.* A portable case for carrying papers. See also CHART PORTFOLIO.

**port hand buoy.** . A buoy which is to be left to the port side when approaching from the open sea or proceeding in the direction of the main stream of flood current, or in the direction established by appropriate authority.

**port of call.** . A port visited by a ship.

**Portugal Current.** . A slow-moving current that is the prevailing southward flow off the Atlantic coasts of Spain and Portugal. Its speed averages only about 0.5 knot during both winter and summer. The maximum speed seldom exceeds 2.0 knots north of latitude 40°N and 2.5 knots south of 40°N. It is easily influenced by winds.

**Portuguese norther.** . See under NORTHER.

**position.** , *n.* A point defined by stated or implied coordinates, particularly one on the surface of the earth. A fix is a relatively accurate position determined without reference to any former position. A running fix is a position determined by crossing lines of position obtained at different times and advanced or retired to a common time. An estimated position is determined from incomplete data or data of questionable accuracy. A dead reckoning position is determined by advancing a previous position for courses and distances. A most probable position is a position judged to be most accurate when an element of doubt exists as to the true position. It may be a fix, running fix, estimated position, or dead reckoning position depending upon the information upon which it is based. An assumed position is a point at which a craft is assumed to be located. A geographical position is that point on the earth at which a given celestial body is in the zenith at a specified time, or any position defined by means of its geographical coordinates. A geodetic position is a point on the earth the coordinates of which have been determined by triangulation from an accurately known initial station, or one defined in terms of geodetic latitude and longitude. An astronomical position is a point on the earth whose coordinates have been determined as a result of observation of celestial bodies, or one defined in terms of astronomical latitude and longitude. A maritime position is the location of a seaport or other point along a coast. A relative position is one defined with reference to another position, either fixed or moving. See also PINPOINT, LINE OF POSITION, BAND OF POSITION, SURFACE OF POSITION.

**position angle.** . See PARALLACTIC ANGLE.

**position approximate.** . Of inexact position. The expression is used principally on charts to indicate that the position of a wreck, shoal, etc., has not been accurately determined or does not remain fixed.

**position buoy.** . An object towed astern to assist a following vessel in maintaining the desired or prescribed distance, particularly in conditions of low visibility.

**position circle.** . 1. The chart symbol denoting the position of a buoy. 2. See CIRCLE OF POSITION.

**position doubtful.** . Of uncertain position. The expression is used principally on charts to indicate that a wreck, shoal, etc., has been reported in various positions and not definitely determined in any. See also VIGIA.

**positioning.** , *n.* The process of determining, at a particular point in time, the precise physical location of a craft, vehicle, person or site.

**position line.** . See LINE OF POSITION.

**position plotting sheet.** . A blank chart, usually on the Mercator projection, showing only the graticule and a compass rose. The meridians are usually unlabeled by the publisher so that they can be appropriately labeled when the chart is used in any longitude. It is designed

- and intended for use in conjunction with the standard nautical chart. See also SMALL AREA PLOTTING SHEET, UNIVERSAL PLOTTING SHEET, PLOTTING CHART.
- post meridian (PM).** . After noon, or the period of time between noon (1200) and midnight (2400). The period between midnight and noon is called ANTE MERIDIAN.
- potential.** , *n.* The difference in voltage at two points in a circuit.
- potential energy.** . Energy possessed by a body by virtue of its position, in contrast with KINETIC ENERGY, that possessed by virtue of its motion.
- pound.** , *n.* A unit of mass equal to 0.45359237 kilograms. Also called AVOIRDUPOIS POUND.
- pound.** , *v.* To strike oncoming waves repeatedly or heavily.
- pounding.** , *n.* A series of shocks received by a pitching vessel as it repeatedly or heavily strikes the water in a heavy sea. The shocks can be felt over the entire vessel and each one is followed by a short period of vibration.
- power.** , *n.* 1. Rate of doing work. 2. Luminous intensity. 3. The number of times an object is magnified by an optical system, such as a telescope. Usually called MAGNIFYING POWER. 4. The result of multiplying a number by itself a given number of times. See also EXPONENT.
- power gain (of an antenna).** . See DIRECTIVITY, definition 2.
- power gain (of a transmitter).** . The ratio of the output power delivered to a specified load by an amplifier to the power absorbed by its input circuit.
- power (of a radio transmitter).** , *n.* The power of a radio transmitter is expressed in one of the following forms: The peak envelope power is the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the highest crest of the modulation envelope, taken under conditions of normal operation. The mean power is the power supplied to the antenna transmission line by a transmitter during normal operation, averaged over a time sufficiently long compared with the period of the lowest frequency encountered in the modulation. The carrier power is the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle under conditions of no modulation. This definition does not apply to pulse modulated emissions.
- PPI display.** . See as PLAN POSITION INDICATOR.
- PPI repeater.** . See RADAR REPEATER.
- precautionary area.** . A routing measure comprising an area within defined limits where ships must navigate with particular caution and within which the direction of traffic flow may be recommended. See also ROUTING SYSTEM.
- precession.** , *n.* The change in the direction of the axis of rotation of a spinning body, as a gyroscope, when acted upon by a torque. The direction of motion of the axis is such that it causes the direction of spin of the gyroscope to tend to coincide with that of the impressed torque. The horizontal component of precession is called drift, and the vertical component is called topple. Also called INDUCED PRECESSION, REAL PRECESSION. See also APPARENT PRECESSION, PRECESSION OF THE EQUINOXES.
- precession in declination.** . The component of general precession along a celestial meridian, amounting to about 20.0" per year.
- precession in right ascension.** . The component of general precession along the celestial equator, amounting to about 46.1" per year.
- precession of the equinoxes.** . The conical motion of the earth's axis about the vertical to the plane of the ecliptic, caused by the attractive force of the sun, moon, and other planets on the equatorial protuberance of the earth. The effect of the sun and moon, called lunisolar precession, is to produce a westward motion of the equinoxes along the ecliptic. The effect of other planets, called planetary precession, tends to produce a much smaller motion eastward along the ecliptic. The resultant motion, called general precession, is westward along the ecliptic at the rate of about 50.3" per year. The component of general precession along the celestial equator, called precession in right ascension, is about 46.1" per year and the component along a celestial meridian, called precession in declination, is about 20.0" per year.
- precipice.** , *n.* A high and very steep cliff.
- precipitation.** , *n.* 1. Any or all forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground. It is distinguished from cloud, fog, rime, frost, etc., in that it must fall; and it is distinguished from cloud and virga in that it must reach the ground. Precipitation includes drizzle, rain, snow, snow pellets, snow grains, ice crystals, ice pellets, and hail. 2. The amount usually expressed in inches of liquid water depth, of the water substance that has fallen at a given point over a specified period of time.
- precipitation static.** . A type of interference experienced in a radio receiver, during snow storms, rain storms, and dust storms, caused by the impact of dust particles against the antenna. It may also be caused by the existence of induction fields created by nearby corona discharges.
- precipitation trails.** . See VIRGA.
- precision.** , *n.* A measure of how close the outcome of a series of observations or measurement cluster about some estimated value of a desired quantity. Precision implies repeatability of the observations within some specified limit and depends upon the random errors encountered due to the quality of the observing instrument, the skill of the observer and randomly fluctuating conditions such as temperature, pressure, refraction, etc. Precision should not be confused with ACCURACY. Observations may be of high precision but inaccurate due to the presence of systematic errors. For a quantity to be accurately measured, both systematic and random errors should be small. For a quantity to be known with high precision, only the random errors due to irregular effects need to be small. See ERROR.
- precision graphic recorder.** . A device used with the standard hydrographic echo sounder in ocean depths where soundings cannot be recorded on the expanded scale of the standard recorder. It provides a sounding record with a scale expansion and high accuracy. Commonly called a PGR.
- precision index.** . A measure of the magnitude of the random errors of a series of observations of some given quantity. If the precision index is large, most of the random errors of the observations are small. The precision index appears as a parameter in the normal (Gaussian) distribution law. While making a series of observations, the standard deviation can be calculated. The precision index is then calculated using a formula and a measure of the precision of the observing instrument is obtained. See also RANDOM ERROR, NORMAL DISTRIBUTION, PRECISION, STANDARD DEVIATION.
- Precise Positioning Service.** . The most accurate military positioning service of the Global Positioning System.
- precomputation.** , *n.* The process of making navigational solutions in advance; applied particularly to the determination of computed altitude and azimuth before making a celestial observation for a line of position. When this is done, the observation must be made at the time used for the computation, or a correction applied.
- precomputed altitude.** . The altitude of a celestial body computed before observation, and with the sextant altitude corrections applied with reversed sign. When a precomputed altitude has been calculated, the altitude difference can be determined by comparison with the sextant altitude.
- precomputed curve.** . A graphical representation of the azimuth or altitude of a celestial body plotted against time for a given assumed position, computed for use with celestial observations.
- predictability.** , *n.* In a navigation system, the measure of the accuracy with which the system can define the position in terms of geographical coordinates. See also REPEATABILITY, definition 2.
- predictable accuracy.** . The accuracy of predicting position with respect to precise space and surface coordinates. See also REPEATABLE ACCURACY.
- predicted tides.** . The times and heights of the tide as given in the Tide Tables in advance of their occurrence.
- predicting machine.** . See TIDE PREDICTING MACHINE.
- preferred datum.** . A geodetic datum selected as a base for consolidation of local independent datums within a geographical area. Also called MAJOR DATUM.
- Presentation Library.** . In ECDIS a set of mostly digital specifications, composed of SYMBOL libraries, color schemes, LOOK-UP TABLES and rules, linking every OBJECT CLASS and ATTRIBUTE of the SENC to the appropriate presentation of the ECDIS DISPLAY.
- preferred datum.** . A geodetic datum selected as a base for consolidation of local independent datums within a geographical area. Also called MAJOR DATUM.
- pressure.** , *n.* Force per unit area. The pressure exerted by the weight of the earth's atmosphere is called atmospheric or, if indicated by a

- barometer, barometric pressure. Pressure exerted by the vapor of a liquid is called vapor pressure. The pressure exerted by a fluid as a result of its own weight or position is called static pressure. Pressure exerted by radiant energy is called radiation pressure.
- pressure gage.** . A tide gage that is operated by the change in pressure at the bottom of a body of water due to rise and fall of the tide.
- pressure tendency.** . The character and amount of atmospheric pressure change for a 3-hour or other specified period ending at the time of observation. Also called BAROMETRIC TENDENCY.
- prevailing westerlies.** . The prevailing westerly winds on the poleward sides of the sub-tropical high-pressure belts.
- prevailing wind.** . The average or characteristic wind at any place.
- primary.** , *n.* See PRIMARY BODY.
- primary body.** . The celestial body or central force field about which a satellite orbits, or from which it is escaping, or towards which it is falling. The primary body of the earth is the sun, the primary body of the moon is the earth. Usually shortened to PRIMARY.
- primary circle.** . See PRIMARY GREAT CIRCLE.
- primary control tide station.** . A tide station at which continuous observations have been made over a minimum of a 19-year Metonic cycle. Its purpose is to provide data for computing accepted values of the harmonic and non harmonic constants essential to tide predictions and to the determination of tidal datums for charting and coastal boundaries. The data series from this station serves as a primary control for the reduction of relatively short series from subordinate tide stations through the method of comparisons of simultaneous observations, and for monitoring long-period sea-level trends and variations. See also TIDE STATION; SUBORDINATE TIDE STATION, definition 1; SECONDARY CONTROL TIDE STATION; TEMPORARY TIDE STATION.
- primary great circle.** . A great circle used as the origin of measurement of a coordinate; particularly such a circle  $90^\circ$  from the poles of a SYSTEM of spherical coordinates, as the equator. Also called PRIMARY CIRCLE, FUNDAMENTAL CIRCLE.
- primary radar.** . 1. Radar which transmits a SIGNAL and receives the incident energy reflected from an object to detect the object. 2. As defined by the International Telecommunications Union (ITU), a radio-determination system based on the comparison of reference signals with radio signals reflected from a position to be determined.
- primary seacoast light.** . A light established for purpose of making landfall or coastwise past from headland to headland. Also called LAND FALL LIGHT.
- primary tidal bench mark.** . See under BENCH MARK.
- primary tide station.** . See PRIMARY CONTROL TIDE STATION.
- prime fictitious meridian.** . The reference meridian (real or fictitious) used as the origin for measurement of fictitious longitude. Prime grid meridian is the reference meridian of a grid; prime transverse or prime inverse meridian is the reference meridian of a transverse graticule; prime oblique meridian is the reference fictitious meridian of an oblique graticule.
- prime grid meridian.** . The reference meridian of a grid. In polar regions it is usually the  $180^\circ$ - $0^\circ$  geographic meridian, used as the origin for measuring grid longitude.
- prime inverse meridian.** . See PRIME TRANSVERSE MERIDIAN.
- prime meridian.** . The  $0^\circ$  meridian of longitude, used as the origin for measurement of longitude. The meridian of Greenwich, England, is almost universally used for this purpose. See also PRIME FICTITIOUS MERIDIAN.
- prime oblique meridian.** . The reference fictitious meridian of an oblique graticule.
- prime transverse meridian.** . The reference meridian of a transverse graticule. Also called PRIME INVERSE MERIDIAN.
- prime vertical.** . See PRIME VERTICAL CIRCLE.
- prime vertical circle.** . The vertical circle perpendicular to the principal vertical circle. The intersections of the prime vertical circle with the horizon define the east and west points of the horizon. Often shortened to PRIME VERTICAL; Sometimes called TRUE PRIME VERTICAL to distinguish from magnetic, compass, or grid prime vertical, defined as the vertical circle passing through the magnetic, compass, or grid east and west points of the horizon, respectively.
- priming of tide.** . The periodic acceleration in the time of occurrence of high and low waters due changes in the relative positions of the moon and the sun. Priming occurs when the moon between new and first quarter and between full and third quarter. High tide occurs before transit of the moon. Lagging occurs when the moon is between first quarter and full and between third quarter and new. High tide occurs after transit of the moon. See also LAGGING OF TIDE.
- principal vertical circle.** . The vertical circle passing through the north and south celestial poles. The intersection of the principal vertical circle with the horizon defines the north and south points of the horizon.
- priority blanking.** . See DUAL-RATE BLANKING.
- prism.** , *n.* A solid having parallel, similar, equal, plane geometric figures as bases, and parallelograms as sides. By extension, the term is also applied to a similar solid having nonparallel bases, and trapezoids or a combination of trapezoids and parallelograms as sides. Prisms are used for changing the direction of motion of a ray of light and for forming spectra.
- prismatic error.** . That error due to lack of parallelism of the two faces of an optical element, such as a mirror or a shade glass. See also SHADE ERROR.
- private aids to navigation.** . In United States waters, those aids to navigation not established and maintained by the U.S. Coast Guard. Private aids include those established by other federal agencies with prior U.S. Coast Guard approval, aids to navigation on marine structures or other works which the owners are legally obligated to establish, maintain, and operate as prescribed by the U.S. Coast Guard, and those aids which are merely desired, for one reason or another, by the individual corporation, state or local government or other body that has established the aid with U.S. Coast Guard approval.
- probable error.** . A measure of the dispersion or spread of a series of observations about some value, usually the mean or average value of all the observations. See also CIRCULAR ERROR PROBABLE.
- processor.** . The brain of a computer, which executes programs to do work. Also known more correctly as the CENTRAL PROCESSING UNIT (CPU).
- production platform.** . A term used to indicate a permanent offshore structure equipped to control the flow of oil or gas. For charting purposes, the use of the term is extended to include all permanent platforms associated with oil or gas production, e.g. field terminal, drilling and accommodation platforms, and "booster" platforms sited at intervals along some pipelines. It does not include entirely submarine structures.
- prognostic chart.** . A chart showing, principally, the expected pressure pattern of a given synoptic chart at a specified future time. Usually, positions of fronts are also included, and the forecast values of other meteorological elements may be superimposed.
- program.** . A set of instructions which a computer executes to perform work. Programs are written in one of many LANGUAGES, which translate the instructions into MACHINE LANGUAGE used by the PROCESSOR.
- progressive wave.** . In the ocean, a wave that advances in distance along the sea surfaces or at some intermediate depth. Although the wave form itself travels significant distances, the water particles that make up the wave merely describe circular (in relatively deep water) or elliptical (in relatively shallow water) orbits. With high, steep, wind waves, a small overlap in the orbit motion becomes significant. This overlapping gives rise to a small net transport.
- prohibited area.** . 1. An area shown on nautical charts within which navigation and/or anchoring is prohibited except as authorized by appropriate authority. 2. A specified area within the land areas of a state or territorial waters adjacent thereto over which the flight of aircraft is prohibited. See also DANGER AREA, RESTRICTED AREA.
- projection.** , *n.* The extension of lines or planes to intersect a given surface; the transfer of a point from one surface to a corresponding position on another surface by graphical or analytical means. See also MAP PROJECTION.
- projector compass.** . A magnetic compass in which the lubber's line and compass card, or a portion thereof, are viewed as an image projected through a system of lenses upon a screen adjacent to the helmsman's position. See also REFLECTOR COMPASS.
- prolate cycloid.** . See TROCHOID.
- prolate spheroid.** . An ellipsoid of revolution, the longer axis of which is the axis of revolution. An ellipsoid of revolution, the shorter axis of which is the axis of REVOLUTION, is called an OBLATE SPHER-

OID.

**promontory**, *n.* High land extending into a large body of water beyond the line of the coast. Called HEADLAND when the promontory is comparatively high and has a steep face. Also called FORELAND.

**propagation**, *n.* The travel of waves of energy through or along a medium other than a specially constructed path such as an electrical circuit.

**proper motion**. The component of the space motion of a celestial body perpendicular to line of sight, resulting in the change of a star's apparent position relative to other stars. Proper motion is expressed in angular units.

**proportional dividers**. An instrument consisting in its simple form of two legs pointed at both ends and provided with an adjustable pivot, so that for any given pivot setting, the distance between one set of pointed ends always bears the same ratio to the distance between the other set. A change in the pivot changes the ratio. The dividers are used in transferring measurements between charts or other graphics which are not the same scale.



**proportional parts**. Numbers in the same proportion as a set of given numbers. Such numbers are used in an auxiliary interpolation table based on the assumption that the tabulated quantity and entering arguments differ in the same proportion. For each intermediate argument a "proportional part" or number is given to be applied the preceding tabulated value in the main table.

**protractor**, *n.* An instrument for measuring angles on a surface; an angular scale. In its most usual form it consists of a circle or part of one (usually a semicircle) graduated in degrees. See also COMPASS ROSE, THREE-ARM PROTRACTOR.

**province**, *n.* On the sea floor, a region identifiable by a group of similar physiographic features whose characteristics are markedly in contrast with surrounding areas.

**pseudo-independent surveillance**. Position determination that relies on craft or vehicle cooperation but is not subject to craft or vehicle navigational errors (e.g., secondary radar).

**pseudo-random noise**. An apparently random but reproducible sequence of binary code used in the GPS signal.

**pseudo-range**. Measure of distance from GPS satellite to receiver, uncorrected for synchronization errors between satellite and receiver clocks.

**psychrometer**, *n.* A type of hygrometer (an instrument for determining atmospheric humidity) consisting of dry-bulb and wet-bulb thermometers. The dry-bulb thermometer indicates the temperature of the air, and the wet bulb thermometer the lowest temperature to which air can be cooled by evaporating water into it at constant pressure. With the information obtained from a psychrometer, the humidity, dew point, and vapor pressure for any atmospheric pressure can be obtained by means of appropriate tables.

**psychrometric chart**. A nomogram for graphically determining relative humidity, absolute humidity, and dew point from wet- and dry-bulb thermometer readings.

**pteropod**, (*pl. pteropoda*), *n.* A small marine animal with or without a shell and having two thin, winglike feet. These animals are often so numerous they may cover the surface of the sea for miles. In some areas, their shells cover the bottom.

**Pub. No. 9. The American Practical Navigator**. A publication of the National Geospatial-Intelligence Agency, originally by Nathaniel Bowditch (1773-1838) and first published in 1802, comprising a complete manual of navigation with tables for solution of navigational problems. Popularly called BOWDITCH.

**Pub. No. 102. International Code of Signals**. A publication of the National Geospatial-Intelligence Agency intended primarily for communication at sea in situations involving safety of life at sea and navigational safety, especially when language difficulties arise between ships or stations of different nationalities. The Code is suitable for transmission by all means of communication, including radiotelephony, radiotelegraphy, sound, flashing light, and flags.

**Pub. 117. Radio Navigational Aids**. A publication of the National Geospatial-Intelligence Agency which contains data on radio aids to navigation services provided to mariners. Information on radio direction finder and radar stations, radio time signals, radio navigational warnings, distress signals, stations transmitting medical advice, long range radionavigation systems, emergency procedures and communications instructions, listed in text and tabular format.

**Pub. 150. World Port Index**. A publication of the National Geospatial-Intelligence Agency listing the location, characteristics, known facilities, and available services of ports, shipping facilities and oil terminals throughout the world. The applicable chart and Sailing Direction volume is given for each place listed. A code indicates certain types of information.

**Pub. 151. Distances Between Ports**. A publication of the National Geospatial-Intelligence Agency providing calculated distances in nautical miles over water areas between most of the seaports of the world. A similar publication published by the National Ocean Service of United States waters is entitled *Distances between United States Ports*.

**Pub. 217. Maneuvering Board Manual**. A publication of the National Geospatial-Intelligence Agency providing explanations and examples of various problems involved in maneuvering and in relative movement.

**Pub. No. 226. Handbook of Magnetic Compass Adjustment**. A publication of the National Geospatial-Intelligence Agency, providing information for adjustment of marine magnetic compasses.

**Pub. No. 229. Sight Reduction Tables for Marine Navigation**. A publication of the National Geospatial-Intelligence Agency, in six volumes each of which includes two 8° zones of latitude. An overlap of 1° of latitude occurs between volumes. The six volumes cover latitude bands 0°-15°, 15°-30°, 30°-45°, 45°-60°, 60°-75°, and 75°-90°. For entering arguments of integral degrees of latitude, declination, and local hour angle, altitudes and their differences are tabulated to the nearest tenth of a minute, azimuth angles to the nearest tenth of a degree. The tables are designed for precise interpolation of altitude for declination only by means of interpolation tables which facilitate linear interpolation and provide additionally for the effect of second differences. The data are applicable to the solutions of sights of all celestial bodies; there are no limiting values of altitude, latitude, hour angle, or declination.

**Pub. No. 249. Sight Reduction Tables for Air Navigation**. A publication of the National Geospatial-Intelligence Agency, in three volumes, with volume 1 containing tabulated altitudes and azimuths of selected stars, the entering arguments being latitude, local hour angle of the vernal equinox, and the name of the star; and volumes 2 and 3 containing tabulated altitudes and azimuth angles of any body within the limits of the entering arguments, which are latitude, local hour angle, and declination (0°-29°) of the body.

**Pub. 1310. Radar Navigation Manual**. A publication of the National Geospatial-Intelligence Agency which explains the fundamentals of shipboard radar, radar operation collision avoidance, radar navigation, and radar-assisted vessel traffic systems in the U.S.

**puddles**, *n.* An accumulation of melt-water on ice, mainly due to melting snow, but in the more advanced stages also due to the melting of ice.

**pulse**, *n.* A short burst of electromagnetic energy, such as emitted by a radar.

**pulse decay time**. The interval of time required for the trailing edge of a pulse to decay from 90 percent to 10 percent of the pulse amplitude.

**pulse duration**. The time interval during which the amplitude of a pulse is at or greater than a specified value, usually stated in terms of a fraction or percentage of the maximum value.

**pulse duration error**. A range distortion of a radar return caused by the duration of the pulse. See also SPOT-SIZE ERROR.

**pulse group**. See PULSE TRAIN.

**pulse interval**. See PULSE SPACING.

**pulse length**. See PULSE DURATION.

**pulse-modulated radar**. The type of radar generally used for shipboard navigational applications. The radio-frequency energy transmitted by a pulse-modulated radar consists of a series of equally spaced short pulses having a pulse duration of about 1 microsecond or less. The distance to the target is determined by measuring the transmit time of a pulse and its return to the source as a reflected echo. Also called PULSE RADAR.

**pulse modulation**. 1. The modulation of a carrier wave by a pulse train. In this sense, the term describes the process of generating carrier-

frequency pulses. 2. The modulation of one or more characteristics of a pulse carrier. In this sense, the term describes methods of transmitting information on a pulse carrier.

**pulse radar.** . See PULSE-MODULATED RADAR.

**pulse repetition frequency.** . The pulse repetition rate of a periodic pulse train.

**pulse repetition rate.** . The average number pulses per unit of time. See also PULSE REPETITION FREQUENCY.

**pulse rise time.** . The interval of time required for the leading edge of a pulse to rise from 10 to 90 percent of the pulse amplitude.

**pulse spacing.** . The interval between corresponding points on consecutive pulses. Also called PULSE INTERVAL.

**pulse train.** . A series of pulses of similar characteristics. Also called PULSE GROUP, IMPULSE TRAIN.

**pulse width.** . See PULSE DURATION.

**pumice.** , *n.* Cooled volcanic glass with a great number of minute cavities caused by the expulsion of water vapor at high temperature, resulting in a very light rocky material.



pumice

**pumping.** , *n.* Unsteadiness of the mercury in a barometer, caused by fluctuations of the air pressure produced by a gusty wind or due to the motion of a vessel.

**pure sound.** . See PURE TONE.

**pure tone.** . A sound produced by a sinusoidal acoustic oscillation. Also called PURE SOUND.

**purple light.** . The faint purple glow observed on clear days over a large region of the western sky after sunset and over the eastern sky before sunrise.

**put to sea.** . To leave a sheltered area and head out to sea.

**pyramidal iceberg.** . See PINNACLED ICEBERG.

## Q

**Q-band.** . A radio-frequency band 36 to 46 gigahertz. See also FREQUENCY, FREQUENCY BAND.

**Q-correction.** . The Polaris correction as tabulated in the *Air Almanac*.

**Q signals.** . Conventional code signals used in radiotelegraphy, each signal of three letters beginning with Q and representing a complete sentence.

**quadrant.** , *n.* 1. A quarter of a circle; either an arc of 90° or the area bounded by such an arc and two radii. 2. A double-reflecting instrument for measuring angles used primarily for measuring altitudes of celestial bodies.

**quadrantal correctors.** . Masses of soft iron placed near a magnetic compass to correct for quadrantal deviation. Spherical quadrantal correctors are called quadrantal spheres.

**quadrantal deviation.** . Deviation which changes its sign (E or W) approximately each 90° change of heading. It is caused by induced magnetism in horizontal soft iron.

**quadrantal error.** . An error which changes sign (plus or minus) each 90°. Also called INTERCARDINAL ROLLING ERROR when related to a gyrocompass.

**quadrantal point.** . See INTERCARDINAL POINT.

**quadrantal spheres.** . Two hollow spheres of soft iron placed near a magnetic compass to correct for quadrantal deviation. See also QUADRANTAL CORRECTORS.

**quadrant with two arcs.** . See BACKSTAFF.

**quadrature.** , *n.* An elongation of 90° usually specified as east or west in accordance with the direction of the body from the sun. The moon is at quadrature at first and last quarters.

**quadrilateral.** , *adj.* Having four sides.

**quadrilateral.** , *n.* A closed plane figure having four sides. See also PARALLELOGRAM, TRAPEZOID.

**quarantine anchorage.** . An area where a vessel anchors while satisfying

quarantine regulations.

**quarantine buoy.** . A buoy marking the location of a quarantine anchorage. In U.S. waters a quarantine buoy is yellow.

**quarantine mark.** . A navigation mark indicating a quarantine anchorage area for shipping, or defining its limits.

**quarterming sea.** . Waves striking the vessel on the quarter, or relative bearings approximately 045°, 135°, 225°, and 315°.

**quarter-power points.** . See under HALF-POWER POINTS.

**quartz.** , *n.* Crystalline form of silica. In its most common form it is colorless and transparent, but it takes a large variety of forms of varying degrees of opaqueness and color. It is the most common solid mineral.

**quartz clock.** . See QUARTZ CRYSTAL CLOCK.

**quartz crystal clock.** . A precision timepiece, consisting of a current generator of constant frequency controlled by a resonator made of quartz crystal with suitable methods for producing continuous rotation to operate time-indicating and related mechanisms. See also QUARTZ CRYSTAL MARINE CHRONOMETER.

**quartz crystal marine chronometer.** . A quartz crystal clock intended for marine use. The degree of accuracy is such that it requires no chronometer rate, but can be reset electrically if necessary.

**quasi-stationary front.** . See STATIONARY FRONT.

**quay.** , *n.* A structure of solid construction along a shore or bank which provides berthing for ships and which usually provides cargo handling facilities. A similar facility of open construction is called WHARF. See also MOLE, definition 1.

**quick flashing light.** . A light flashing 50-80 flashes per minute. See also CONTINUOUS QUICK LIGHT, GROUP QUICK LIGHT, INTERRUPTED QUICK LIGHT.

**quick light.** . See QUICK FLASHING LIGHT.

**quicksand.** , *n.* A loose mixture of sand and water that yields to the pressure of heavy objects. Such objects are difficult to extract once they begin sinking.

**quiet sun.** . The sun when it is free from unusual radio wave or thermal radiation such as that associated with sun spots.

**quintant.** , *n.* A double-reflecting instrument for measuring angles, used primarily for measuring altitudes of celestial bodies, having an arc of 72°.

## R

**race.** , *n.* A rapid current or a constricted channel in which such a current flows. The term is usually used only in connection with a tidal current, when it may be called a TIDE RACE.

**rakon.** , *n.* As defined by the International Telecommunication Union (ITU), in the maritime radionavigation service, a receiver-transmitter device which, when triggered by a surface search radar, automatically returns a distinctive signal which can appear on the display of the triggering radar, providing range, bearing and identification information. See also IN-BAND RACON, CROSS BAND RACON, SWEEP-FREQUENCY RACON, RAMARK. Also called RADAR TRANSPONDER BEACON.

**radar.** , *n.* 1. (from radio detection and ranging) A radio system which measures distance and usually direction by a comparison of reference signals with the radio signals reflected or retransmitted from the target whose position is to be determined. Pulse-modulated radar is used for shipboard navigational applications. In this type of radar the distance to the target is determined by measuring the time required for an extremely short burst or pulse of radio-frequency energy to travel to the target and return to its source as a reflected echo. Directional antennas allow determination of the direction of the target echo from the source. 2. As defined by the International Telecommunication Union (ITU) a radiodetermination system based on the comparison of reference signals with radio signals reflected, or re-transmitted, from the position to be determined.

**radar beacon.** . A radar transmitter whose emissions enable a ship to determine its direction and frequently position relative to the transmitter using the ship's radar equipment. There are two general types of radar beacons: one type, the RACON, must be triggered by the ship's radar emissions; the other type, the RAMARK transmits continuously and provides bearings only. See also TRANSPONDER.

**radar bearing.** . A bearing obtained by radar.

**radar buoy.** . A buoy having corner reflectors designed into the super-

- structure, the characteristic shape of the buoy being maintained. This is to differentiate from a buoy on which a corner reflector is mounted.
- radar conspicuous object.** . An object which return a strong radar echo which can be identified with a high degree of certainty.
- radar cross section.** . The area of a plane element situated at the position of an object and normal to the direction of the radar transmitter, which would be traversed by a power such that, if the power were re-radiated equally in all directions with suitable polarization, it would give an echo of the same power as that given by the object itself. Also called EQUIVALENT ECHOING AREA.
- radar echo.** . See ECHO, definition 3.
- radar fix.** . A fix established by means of radar.
- radar horizon.** . The sensible horizon of a radar antenna.
- radar indicator.** . A unit of a radar set which provides a visual indication of radar echoes received using a cathode-ray tube or video monitor. Besides the cathode-ray tube, the radar indicator is comprised of sweep and calibration circuit; and associated power supplies. Often shortened to INDICATOR.
- radar link.** . A means by which the information from a radar set is reproduced at a distance by use of a radio link or cable. Also called RADAR RELAY SYSTEM.
- radar nautical mile.** . The time interval required for the electromagnetic energy of a radar pulse to travel 1 nautical mile and the echo to return; approximately 12.4 microseconds.
- radar picture.** . See DISPLAY, definition 1.
- radar range.** . 1. The distance of a target as measured by radar. 2. The maximum distance at which a radar is effective in detecting targets. Radar range depends upon variables such as the weather, transmitted power, antenna height, pulse duration, receiver sensitivity, target size, target shape, etc.
- radar receiver.** . A unit of a radar set which demodulates received radar echoes, amplifies the echoes and delivers them to the radar indicator. A radar receiver differs from the usual superheterodyne communications receiver in that its sensitivity is much greater; it has a better signal noise ratio, and it is designed to pass a pulse-type signal.
- radar reference line.** . A mid-channel line on a chart which corresponds to a line incorporated in harbor radar display for the purpose of providing a reference for informing a vessel of its position. In some cases the line may be coincident with the recommended track. The line may be broken into sections of specified length having assigned names or numbers.
- radar reflector.** . A device arranged so that incident electromagnetic energy reflects back to its source. See also CORNER REFLECTOR, PENTAGONAL CLUSTER, OCTAHEDRAL CLUSTER, DIHEDRAL REFLECTOR, DIELECTRIC REFLECTOR, REFLECTOR.
- radar relay system.** . See RADAR LINK.
- radar repeater.** . A unit which duplicates the radar display at a location remote from the main radar indicator installation. Also called PPI REPEATER, REMOTE PPI.
- radar return.** . See ECHO, definition 2.
- radar scan.** . The motion of a radar beam through space in searching for an echo.
- radar scanning.** . The process or action of directing a radar beam through a search pattern.
- radarscope.** , *n.* The cathode-ray tube or video monitor in the indicator of a radar set which displays the received echo to indicate range and bearing. Often shortened to SCOPE. See also PLAN POSITION INDICATOR.
- radar set.** . An electronic apparatus consisting of a transmitter, antenna, receiver, and indicator for sending out radio-frequency energy and receiving and displaying reflected energy so as to indicate the range and bearing of the reflecting object. See also RADAR.
- radar shadow.** . The area shielded from radar signals because of an intervening obstruction or absorbing medium. The shadow region appears as an area void of targets.
- radar target.** . See as TARGET.
- radar transponder beacon.** . See RACON.
- radial.** , *adj.* Of or pertaining to a ray or radius; extending in a straight line outward from a center.
- radial.** , *n.* A straight line extending outward from a center.
- radial error.** . In a two-dimensional or elliptical error distribution, the measure of error as the radius of a circle of equivalent probability derived from the error ellipse. The error, expressed as  $1 d_{\text{rms}}$ , is the square root of the sum of the error components along the major and minor axes of the probability ellipse. The use of radial error or  $d_{\text{rms}}$  error as a measure of error is somewhat confusing because the term does not correspond to a fixed value of probability for a given value of the error measure.
- radial motion.** . Motion along a radius, or a component in such a direction, particularly the component of space motion of a celestial body in the direction of the line of sight.
- radial period.** . See ANOMALISTIC PERIOD.
- radian.** , *n.* The supplementary unit of plane angle in the International System of Units; it is the plane angle subtended at the center of a circle by an arc equal in length to the radius of the circle. It is equal to  $360 \text{ } \ddot{\text{O}} \text{ } 2\pi$ , or approximately  $57^{\circ}17'48.8''$ .
- radian per second.** . The derived unit of angular velocity in the International System of Units.
- radian per second squared.** . The derived unit of angular acceleration in the International System of Units.
- radiant.** , *adj.* Of, pertaining to, or transmitted by radiation.
- radiant energy.** . Energy consisting of electromagnetic waves.
- radiate.** , *v., t. & i.* To send out in rays or straight lines from a center.
- radiation.** , *n.* 1. The process of emitting energy in the form of electromagnetic waves. 2. The energy radiated in definition 1 above.
- radiational cooling.** . The cooling of the earth's surface and adjacent air, occurring mainly at night whenever the earth's surface suffers a net loss of heat due to terrestrial radiation.
- radiational tides.** . Periodic variations in sea level primarily related to meteorological changes such as the semi-daily (solar) cycle in barometric pressure, daily (solar) land and sea breezes, and seasonal (annual) changes in temperature. Only changes in sea level due to meteorological changes that are random in phase are not considered radiational tides.
- radiation fog.** . A major type of fog, produced over land when radiational cooling reduces the temperature to or below its dew point. Radiation fog is a nighttime occurrence although it may begin to form by evening twilight and often does not dissipate until aft sunrise.
- radiation pattern.** . A curve representing, in polar or Cartesian coordinates, the relative amounts of energy radiated in various directions. Also called DIRECTIVITY DIAGRAM.
- radialus.** , *adj.* Radial. A term used to refer to clouds in parallel bands which, owing to perspective, appear to converge toward a point on the horizon, or two opposite points if the bands cross the sky.
- radio.** , *n.* A general term applied to the use of radio waves.
- radio acoustic ranging.** . Determining distance by a combination of radio and sound, the radio being used to determine the instant of transmission or reception of the sound, and distance being determined by the time of transit of sound usually in water. See also ECHO RANGING.
- radio aid to navigation.** . An aid to navigation transmitting information by radio waves. See also ELECTRONIC AID TO NAVIGATION.
- radio altimeter.** . As defined by the International Telecommunications Union (ITU), a radionavigation device for aircraft, which uses reflected radio waves from the ground to determine the height of the aircraft above the ground.
- radiobeacon.** , *n.* A radio transmitting station which emits a distinctive or characteristic signal so a navigator can determine the direction of the source using a radio direction finder, providing a line of position. The most common type of marine radiobeacon transmits radio waves of approximately uniform strength in all directions. These omnidirectional beacons are called circular radiobeacons. A radiobeacon some or all of the emissions of which are directional so that the signal characteristic changes according to the vessel's bearing from the beacon is called a directional radiobeacon. A radiobeacon all or part of the emissions of which is concentrated in a beam which rotates is called a rotating radiobeacon. See also CONTINUOUS CARRIER RADIOBEACON, DUAL-CARRIER RADIOBEACON, SEQUENCED RADIOBEACON, ROTATING PATTERN RADIOBEACON, COURSE BEACON.
- radiobeacon characteristic.** . The description of the complete cycle of transmission of a radiobeacon in a given period of time, inclusive of any silent period.
- radiobeacon station.** . As defined by the International Telecommunications Union (ITU), a station in the radionavigation service the emissions of which are intended to enable a mobile station to determine

its bearing or direction from the radiobeacon station.

**radio bearing.** . The bearing of a radio transmitter from a receiver, as determined by a radio direction finder.

**radio compass.** . The name by which the radio direction finder was formerly known.

**radiodetermination.** , *n.* As defined by the International Telecommunication Union (ITU), the determination of position using propagation properties of radio waves.

**radiodetermination-satellite service.** . As defined by the International Telecommunication Union (ITU), a radiocommunication service involving the use of radiodetermination and the use of one or more space stations.

**radio direction finder.** . A radio receiver system used for radio direction finding. Also called DIRECTION FINDER. Formerly called RADIO COMPASS. See also AUTOMATIC DIRECTION FINDER.

**radio direction finder station.** . A radio station equipped with special apparatus for determining the direction of radio signals transmitted by ships and other stations. The bearing taken by a radio direction finder station, and reported to a ship, is corrected for all determinable errors except conversion angle. Also called DIRECTION FINDER STATION.

**radio direction finding.** . As defined by the International Telecommunication Union (ITU), radiodetermination using the reception of radio waves to determine the direction of a station or object.

**radio direction-finding station.** . As defined by the International Telecommunication Union (ITU), a radiodetermination station using radio direction finding.

**radio fix.** . A navigational position determined by radio direction finder.

**radio frequency.** . Any electromagnetic wave occurring within that segment of the spectrum normally associated with some form of radio propagation.

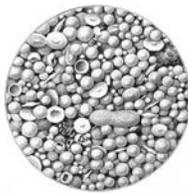
**radio guard.** . A ship, aircraft, or radio station designated to listen for and record transmissions, and to handle traffic on a designated frequency for a certain unit or units.

**radio horizon.** . The locus of points at which direct rays from a transmitting antenna become tangent to the earth's surface, taking into account the curvature due to refraction. Its distance from the transmitting antenna is greater than that of the visible horizon, and increases with decreasing frequency.

**radio interference.** . Interference due to unwanted signals from other radio transmitting stations operating on the same or adjacent frequencies.

**radio interferometer.** . An interferometer operating at radio frequencies; used in radio astronomy and in satellite tracking.

**radiolarian.** (*pl. radiolaria*), *n.* A minute sea animal with a siliceous outer shell. The skeletons of such animals are very numerous, covering the ocean bottom in certain areas, principally in the tropics.



radiolarian

**radiolocation.** , *n.* As defined by the International Telecommunication Union (ITU), radiodetermination used for purposes other than navigation.

**radio mast.** . A label on a nautical chart which indicates a pole or structure for elevating radio antennas, usually found in groups.

**radionavigation.** , *n.* 1. The determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves. 2. As defined by the International Telecommunication Union (ITU), radiodetermination used for the purposes of navigation, including obstruction warning. See also RADIODETERMINATION, RADIOLOCATION.

**Radio Navigational Aids.** . See PUB. 117.

**radio navigational warning.** . A radio-transmitted message affecting the

safe navigation of vessels or aircraft. See also HYDROLANT, HYDROPAC, NAVAREA WARNINGS, WORLD WIDE NAVIGATIONAL WARNING SERVICE.

**radionavigation-satellite service.** . As defined by the International Telecommunication Union (ITU) a radiodetermination-satellite service used for the same purposes as the radionavigation service; in certain cases this service includes transmission or retransmission of supplementary information necessary for the operation of radionavigation systems.

**radio receiver.** . An electronic device connected to an antenna or other receptor of radio signals which receives and processes the signals for use.

**radio silence.** . A period during which all or certain radio equipment capable of radiation is kept inoperative.

**radio spectrum.** . The range of electromagnetic radiation useful for communication by radio (approximately 10 kilohertz to 300,000 megahertz).

**radio station.** . A place equipped with one or more transmitters or receivers and accessory equipment for carrying on a radiocommunication service.

**radio tower.** . A label on a nautical chart which indicates a tall pole or structure for elevating radio antennas.

**radio transmitter.** . Equipment for generation and modulation of radio-frequency energy for the purpose of radiocommunication.

**radio wave propagation.** . The transfer of energy by electromagnetic radiation at radio frequencies.

**radio waves.** . Electromagnetic waves of frequencies lower than 3,000 GHz propagated in space without artificial guide. The practicable limits of radio frequency are approximately 10 kHz to 100 GHz. Also called HERTZIAN WAVES.

**radius.** , *n.* A straight line from the center of a circle, arc, or sphere to its circumference, or the length of such a line. Also called SEMIDIAMETER for a circle or sphere. See also DIAMETER.

**radius of action.** . The maximum distance a ship, aircraft, or vehicle can travel away from its base along a given course with normal combat load and return without refueling, allowing for all safety and operating factors.

**radius vector.** . A straight line connecting a fixed reference point or center with a second point, which may be moving. In astronomy the expression is usually used to refer to the straight line connecting a celestial body with another which revolves around it. See also POLAR COORDINATES, SPHERICAL COORDINATES.

**radome.** , *n.* A dome-shaped structure used to enclose radar apparatus.

**rafted ice.** . A type of deformed ice formed by one piece of ice overriding another. See also FINGER RAFTING.

**rain.** , *n.* Liquid precipitation consisting of drops of water larger than those which comprise DRIZZLE. Orographic rain results when moist air is forced upward by a mountain range. See also FREEZING RAIN.

**rainbow.** , *n.* A circular arc of concentric spectrally colored bands formed by the refraction of light in drops of water. One seen in ocean spray is called a marine or sea rainbow. See also FOGBOW, MOONBOW.

**rain clutter.** . Clutter on the radarscope which is the result of the radar signal being reflected by rain or other forms of precipitation.

**rain gush.** . See CLOUDBURST.

**rain gust.** . See CLOUDBURST.

**rain shadow.** . The condition of diminished rainfall on the lee side of a mountain or mountain range, where the rainfall is noticeably less than on the windward side.

**rain storm.** . See under STORM, definition 2.

**raise.** . To cause to appear over the horizon or higher above the horizon by approaching closer.

**ram.** , *n.* An underwater ice projection from an ice wall, ice front, iceberg, or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part.

**remark.** , (*from radar marker*) *n.* A radar beacon which continuously transmits a signal appearing as a radial line on the radar display, indicating the direction of the beacon from the ship. For identification purposes, the radial line may be formed by a series of dots or dashes. The radial line appears even if the beacon is outside the range for which the radar is set, as long as the radar receiver is within the power range of the beacon. Unlike the RACON, the remark does not provide the range to the beacon.

**ramming.** , *n.* In ice navigation, the act of an icebreaker at full power

striking ice to break a track through it.



ramming

**ramp**, *n.* On the sea floor, a gentle slope connecting areas of different elevations.

**random access memory (RAM)**. . Type of computer memory used for temporary storage and processing of data, as opposed to permanent storage of data. RAM is volatile, meaning it is unable to store data without a constant source of power. See READ ONLY MEMORY (ROM).

**random error**. . One of the two categories of errors of observation and measurement, the other category being systematic error. Random errors are the errors which occur when irregular, randomly occurring conditions affect the observing instrument, the observer and the environment, and the quantity being observed so that observations of the same quantity made with the same equipment and observer under the same observing conditions result in different values of the observed quantity. Random errors depend upon (1) the quality of the observing instrument. (2) the skill of the observer, particularly, the ability to estimate the fraction of the smallest division or graduation on the observing instrument, and (3) randomly fluctuating conditions such as temperature, pressure, refraction, etc. For many types of observations, random errors are characterized by the following properties: (1) positive and negative errors of the same magnitude are about equal in number, (2) small errors occur more frequently than large errors, and (3) extremely large errors rarely occur. These properties of random errors permit the use of a mathematical law called the Gaussian or normal distribution of errors to calculate the probability that the random error of any given observation of a series of observations will lie within certain limits. Random error might more properly be called deviation since mathematically, the random error of an individual observation is calculated as the difference or deviation between the actual observation and an improved or adjusted value of the observation obtained by some mathematical technique such as averaging all the observations. Also called ACCIDENTAL ERROR, CHANCE ERROR, IRREGULAR ERROR, STATISTICAL ERROR. See also ERROR, PRECISION, PRECISION INDEX, STANDARD DEVIATION.

**range**, *n.* 1. Two or more objects in line. Such objects are said to be in range. An observer having them in range is said to be on the range. Two beacons are frequently located for the specific purpose of forming a range to indicate a safe route or the centerline of a channel. See also BACK RANGE, LEADING LINE, MAGNETIC RANGE, MULTIPLE RANGES. 2. Distance in a single direction or along a great circle. 3. The extreme distance at which an object or light can be seen is called VISUAL RANGE. When the extreme distance is limited by the curvature of the earth and the heights of the object and the observer, this is called geographic range; when the range of a light is limited only by its intensity, clearness of the atmosphere, and sensitiveness of the observer's eyes, it is called luminous range. 4. The extreme distance at which a signal can be detected or used. The maximum distance at which reliable service is provided is called operating range. The spread of ranges in which there is an element of uncertainty of interpretation is called critical range. 5. The distance a vessel can travel at cruising speed without refueling is called CRUISING RADIUS. 6. The difference in extreme values of a variable quantity. See also RANGE OF TIDE. 7. A series of mountains or mountain ridges is called MOUNTAIN RANGE. 8. A predetermined line along which a craft moves while certain data are recorded by instruments usually placed below the line, or the entire station at which such information is determined. See also DEGAUSSING RANGE. 9. An area where practice firing of ordnance equipment is authorized is a firing range. See also BOMBING RANGE. 10. On the sea floor, a series of ridges or sea-

**range**, *v., t.* 1. To place in line. 2 To determine the distance to an object.

3 To move along or approximately parallel to something, as to range along coast.

**range daymark**. . 1. One of a pair of unlighted structures used to mark a definite line of bearing. See also RANGE, definition 1. 2. A daymark on a range light.

**range finder**. . An optical instrument for measuring the distance to an object. See also STADIMETER.

**range lights**. . Two or more lights at different elevations so situated to form a range (leading line) when brought into transit. The one nearest the observer is the front light and the one farthest from the observer is the rear light. The front light is at a lower elevation than the rear light.

**range marker**. . A visual presentation on a radar display for measuring the range or for calibrating the time base. See also VARIABLE RANGE MARKER, RANGE RING.

**range (of a light)**. . See VISUAL RANGE (OF A LIGHT).

**range of tide**. . The difference in height between consecutive high and low waters. The mean range is the difference in height between mean high water and mean low water. The great diurnal range or diurnal range is the difference in height between mean higher high water and mean lower low water. Where the type of tide is diurnal the mean range is the same as the diurnal range. For other ranges see APOGEAN TIDES, NEAP TIDES, PERIGEAN TIDES, SPRING TIDES, TROPIC TIDES.

**range-range mode**. . See RANGING MODE.

**range rate**. . Rate of change in range between satellite and receiver, measured by determining the Doppler shift of the satellite carrier signal.

**range resolution**. . See as RESOLUTION IN RANGE under RESOLUTION, definition 2. Also called DISTANCE RESOLUTION.

**range ring**. . One of a set of equally spaced concentric rings, centered on own ship's position, providing a visual presentation of range on a radar display. See also VARIABLE RANGE MARKER.

**ranging mode**. . A mode of operation of a radio navigation system in which the times for the radio signals to travel from each transmitting station to the receiver are measured rather than their *differences* as in the HYPERBOLIC MODE. Also called RHO-RHO MODE, RANGE-RANGE MODE.

**Rankine temperature**. . Temperature based upon a scale starting at absolute zero (-459.69°F) and using Fahrenheit degrees.

**rapids**, *n.* A portion of a stream in swift, disturbed motion, but without cascade or waterfall.

**raster**. . 1. A type of computerized display which consists of a single undifferentiated data file, analogous to a picture. See BIT-MAP, VECTOR. 2. In ECDIS a regular array with information pertaining to each element (PIXEL) or group of elements. See also RASTER DATA PRESENTATION.

**Raster Chart Display System (RCDS)**. . In ECDIS, a navigation information system displaying RNCs with positional information from navigation sensors to assist the mariner in route planning and route monitoring, and if required, display additional navigation-related information.

**Raster Navigational Chart (RNC)**. . A facsimile of a paper chart originated by, or distributed on the authority of, a government-authorized hydrographic office. It is either a single chart or a collection of charts.

**ratat**, *n.* An experimental short-range aid to navigation, not operational, in which radar harbor surveillance information is transmitted to the user by television.

**rate**, *n.* 1. Quantity or amount per unit of something else, usually time. See also ANGULAR RATE, CHRONOMETER RATE, PULSE REPETITION RATE, REPETITION RATE, WATCH RATE.

**rate gyro**. . A single-degree-of-freedom gyro having primarily elastic restraint of its spin axis about the output axis. In this gyro, an output signal is produced by gimbal angular displacement, relative to the base, which is proportional to the angular rate of the base about the input axis. See also RATE INTEGRATING GYRO.

**rate integrating gyro**. . A single-degree-of-freedom gyro having restraint of its spin axis about the output axis. In this gyro an output signal is produced by gimbal angular displacement, relative to the base, which is proportional to the integral of the angular rate of the base about the input axis. See also RATE GYRO.

**ratio**, *n.* The relation of one magnitude to another of the same kind, the quotient obtained by dividing one magnitude by another of the same kind. See also MAGNITUDE RATIO.

**rational horizon.** . See CELESTIAL HORIZON.

**ratio of ranges.** . The ratio of the ranges of tide at two places. It is used in the tide tables where the times and heights of all high and low tides are given for a relatively few places, called REFERENCE STATIONS. The tides at other places called SUBORDINATE TIDE STATIONS, are found by applying corrections to the values given for the reference stations. One of these corrections is the ratio of ranges, or the ratio between the height of the tide at the subordinate station and its reference station.

**ratio of rise.** . The ratio of the height of tide at two places.

**ravine.** , *n.* 1. A gulch; a small canyon or gorge, the sides of which have comparatively uniform slopes. 2. On the sea floor, a small canyon.

**RCDS.** . See RASTER CHART DISPLAY SYSTEM.

**read only memory (ROM).** . Computer memory used for permanent storage of data. It retains the data without a source of power. See RANDOM ACCESS MEMORY (RAM).

**reach.** , *n.* A comparatively straight segment of a river or channel between two bends.

**reach.** , *v.* To travel approximately perpendicular to the wind.

**reach ahead.** . The distance traveled from the time a new speed is ordered to the time the new speed is being made.

**real image.** . An image actually produced and capable of being shown on a surface, as in a camera.

**real precession.** . Precession of a gyroscope resulting from an applied torque such as that resulting from friction and dynamic unbalance as opposed to APPARENT PRECESSION. Also called INDUCED PRECESSION, PRECESSION.

**rear-light.** . The range light which is farthest from the observer. It is the highest of the lights of an established range. Also called HIGH LIGHT.

**receiver.** , *n.* A person who or a device which receives anything, particularly a radio receiver.

**receiver gain control.** . An operating control on a radar indicator used to increase or decrease the sensitivity of the receiver. The control regulates the intensity of the echoes displayed on the radarscope.

**receiver monitor.** . See under PERFORMANCE MONITOR.

**reciprocal.** , *adj.* In a direction 180° from a given direction. Also called BACK.

**reciprocal.** , *n.* 1. A direction 180° from a given direction 2. The quotient of 1 divided by a given number.

**reciprocal bearing.** . A bearing differing by 180° or one measured in the opposite direction, from a given bearing.

**recommended direction of traffic flow.** . A traffic flow pattern indicating a recommended directional movement of traffic in a routing system within which it is impractical or unnecessary to adopt an established direction of traffic flow.

**recommended track.** . A route which has been examined to ensure that it is free of dangers and along which vessels are advised to navigate. See also ROUTING SYSTEM.

**record.** . In ECDIS, a TRANSFER STANDARD construct which is comprised of one or more tagged FIELDS and identified by a KEY.

**rectangle.** , *n.* A four-sided figure with its opposite sides parallel and its angles 90°, a -right-angle parallelogram.

**rectangular chart.** . A chart on the rectangular projection.

**rectangular coordinates.** . Magnitudes defining a point relative to two perpendicular lines, called AXES. The magnitudes indicate the perpendicular distance from each axis. The vertical distance is called the ordinate and the horizontal distance the abscissa. This is a form of CARTESIAN COORDINATES.

**rectangular error.** . An error which results from rounding off values prior to their inclusion in table or which results from the fact that an instrument cannot be read closer than a certain value. The error is so called because of the shape of its plot. For example: if the altitudes tabulated in a sight reduction table are stated to the nearest 01', the error in the altitude as extracted from the table might have any value from (+) 0.05' to (-) 0.05', and any value within these limits is as likely to occur as another value having similar decimals. See also SIMILAR DECIMALS.

**rectangular projection.** . A cylindrical map projection with uniform spacing of the parallels. This projection is used for the star chart in the *Air Almanac*.

**rectified altitude.** . See APPARENT ALTITUDE.

**rectilinear.** , *adj.* Moving in or characterized by straight line.

**rectilinear current.** . See REVERSING CURRENT.

**recurring decimal.** . See REPEATING DECIMAL.

**recurring polynya.** . See under POLYNYA.

**recurved spit.** . A hook developed when the end or spit is turned toward the shore by current deflection or by opposing action of two or more currents. Also called HOOK, HOOKED SPIT.

**red magnetism.** . The magnetism of the north-seeking end of a freely suspended magnet. This is the magnetism of the earth's south magnetic pole.

**red sector.** . A sector of the circle of visibility of a navigational light in which a red light is exhibited. Such sectors are designated by their limiting bearings, as observed from a vessel. Red sectors are often located to warn of dangers.

**red shift.** . In astronomy, the displacement of observed spectral lines toward the longer wavelengths of the red end of the spectrum. The red shift in the spectrum of distant galaxies has been interpreted as evidence that the universe is expanding.

**red snow.** . Snow colored red by the presence in it either of minute algae or of red dust particles.

**reduction.** , *n.* The process of substituting for an observed value one derived from it; often referring specifically to the adjustment of soundings to the selected chart datum. Usually the term reduction of soundings does not pertain to corrections other than those for height of tide. See also CORRECTION OF SOUNDINGS.

**reduction of tidal current.** . The processing of observed tidal current data to obtain mean values of tidal current constants. See also REDUCTION OF TIDES.

**reduction of tides.** . The processing of observed tidal data to obtain mean values of tidal constants. See also REDUCTION OF TIDAL CURRENTS.

**reduction tables.** . See SIGHT REDUCTION TABLES.

**reduction to the meridian.** . The process of applying a correction to an altitude observed when a body is near the celestial meridian of the observer, to find the altitude at meridian transit. The altitude at the time of such an observation is called an EX-MERIDIAN ALTITUDE.

**reed.** , *n.* A steel tongue which is designed to vibrate when air is passed across its unsupported end.

**reed horn.** . A sound signal emitter comprising a resonant horn excited by a jet of air which is modulated by a vibrating reed. The signal is a high-pitched note. See also REED, HORN.

**reef.** , *n.* 1. An offshore consolidated rock hazard to navigation with a depth of 16 fathoms (or 30 meters) or less over it. See also SHOAL. 2. Sometimes used as a term for a low rocky or coral area some of which is above water. See BARRIER REEF, CORAL REEF, FRINGING REEF.

**reef flat.** . A flat expanse of dead reef rock which is partly or entirely dry at low tide. Shallow pools, potholes, gullies, and patches of coral debris and sand are features of the reef flat.

**reference datum.** . A general term applied to any datum, plane, or surface used as a reference or base from which other quantities can be measured.

**reference ellipsoid.** . A theoretical figure whose dimensions closely approach the dimensions of the geoid; the exact dimensions of the ellipsoid are determined by various considerations of the section of the earth's surface of concern. Also called REFERENCE SPHEROID, SPHEROID OF REFERENCE, ELLIPSOID OF REFERENCE.

**reference frequency.** . A frequency having a fixed and specified position with respect to the assigned frequency. The displacement of this frequency, with respect to the assigned frequency, has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the center of the frequency band occupied by the emission.

**reference grid.** . See GRID, definition 2.

**reference orbit.** . An orbit, usually but not exclusively, the best two-body orbit available, on the basis of which the perturbations are computed.

**reference ship.** . The ship to which the movement of other ships is referred.

**reference spheroid.** . See REFERENCE ELLIPSOID.

**reference station.** . A tide or current station for which independent daily predictions are given in the Tide Tables and Tidal Current Tables, and from which corresponding predictions obtained for subordinate stations by means differences and ratios. Also called STANDARD STATION. See also SUBORDINATE CURRENT STATION, SUBORDINATE TIDE STATION.

- reflecting prism.** . A prism that deviates a light beam by internal reflection.
- reflecting telescope.** . A telescope which collects light by means of a concave mirror. All telescopes more than 40 inches in diameter are of this type. See also CASSEGRAINIAN TELESCOPE, NEWTONIAN TELESCOPE.
- reflection.** , *n.* The return or the change in direction of travel of radiation by a surface without change of frequency of the monochromal components of which the radiation is composed. The radiation does not enter the substance providing the reflecting surface. If reflecting surface is smooth, specular reflection occurs; if the reflecting surface is rough with small irregularities, diffuse reflection occurs.
- reflection plotter.** . An attachment fitted to a radar display which provides a plotting surface permitting plotting without parallax errors. Marks made on the plotting surface are reflected on the radarscope directly below. Also called PLOTTING HEAD.
- reflectivity.** , *n.* The ratio of the radiant energy reflected by a surface to that incident upon it.
- reflector.** , *n.* A reflecting surface situated behind the primary radiator, an array of primary radiators or a feed for the purpose of increasing forward and reducing backward radiation from antenna. See also RADAR REFLECTOR.
- reflector compass.** . A magnetic compass in which the image of the compass card is viewed by direct reflection in a mirror adjacent to helmsman's position. See also PROJECTOR COMPASS.
- reflex angle.** . An angle greater than 180° and less than 360°.
- reflex reflection.** . See RETRO-REFLECTION.
- reflex-reflector.** , *n.* See RETRO-REFLECTOR.
- refracted ray.** . A ray extending onward from point of refraction.
- refracting prism.** . A prism that deviates a beam light by refraction. The angular deviation is function of the wavelength of light; therefore if the beam is composed of white light, the prism will spread the beam into a spectrum.
- refracting telescope.** . A telescope which collects light by means of a lens or system of lenses.
- refraction.** , *n.* The change in direction of motion of a ray of radiant energy as it passes obliquely from one medium into another in which the speed of propagation is different. Atmospheric refraction is caused by the atmosphere and may be further designated astronomical refraction if the ray enters from outside the atmosphere or terrestrial refraction if it emanates from a point on or near the surface of the earth. Super-refraction is greater than normal and sub-refraction is less than normal. See also DIFFRACTION, REFLECTION.
- refraction correction.** . 1. A correction due to refraction, particularly such a correction to a sextant altitude, due to atmospheric refraction. 2. See IONOSPHERIC CORRECTION.
- refractive index.** . The ratio of the velocity of light in vacuum to the velocity of light in a medium. This index is equal to the ratio of the sines of the angles of incidence and refraction when a ray crosses the surface separating vacuum and medium.
- refractive modulus.** . One million times the amount by which the modified refractive index exceeds unity.
- refrangible.** , *adj.* Capable of being refracted.
- regelation.** , *n.* The melting of ice under pressure and the subsequent refreezing when the pressure is reduced or removed.
- region.** . One of the major subdivisions of the earth based on the NGA chart numbering system.
- Regional ENC Coordinating Center (RENC).** . An organizational entity where IHO Member States have established cooperation amongst each other to guarantee a world-wide consistent level of high quality data, for bringing about coordinated services with official ENCs and updates to ENCs.
- regression of the nodes.** . Precessional motion of a set of nodes. The expression is used principally with respect to the moon, the nodes of which make a complete westerly revolution in approximately 18.6 years.
- regular error.** . See SYSTEMATIC ERROR.
- regular reflection.** . See SPECULAR REFLECTION.
- relationship.** . In ECDIS, a logical link between two elements from the DATA MODEL which may be spatial (e.g. TOPOLOGICAL relationship) and/or non-spatial. In general a relationship is implemented in the data structure as a POINTER.
- relative.** , *adj.* Having relationship. In navigation the term has several specific applications: a. related to a moving point; apparent, as relative wind, relative movement; b. related to or measured from the heading, as relative bearing; c. related or proportional to a variable, as relative humidity. See also TRUE.
- relative accuracy.** . The accuracy with which a user can measure current position relative to that of another user of the same navigation system at the same time. Hence, a system with high relative accuracy provides good rendezvous capability for the users of the system. The correlation between the geographical coordinates and the system coordinates is not relevant. See also PREDICTABLE ACCURACY, REPEATABLE ACCURACY.
- relative azimuth.** . Azimuth relative to heading.
- relative bearing.** . Bearing relative to heading of a vessel, expressed as the angular difference between the heading and the direction. It is usually measured from 0° at the heading clockwise through 360°, but is sometimes measured from 0° at the heading either clockwise or counterclockwise through 180°, when it is designated right or left.
- relative course.** . Misnomer for DIRECTION OF RELATIVE MOVEMENT.
- relative direction.** . Horizontal direction expressed as angular distance from heading.
- relative distance.** . Distance relative to a specified reference point, usually one in motion.
- relative gain of an antenna.** . The gain of an antenna in a given direction when the reference antenna is a half-wave loss-free dipole isolated in space, the equatorial plane of which contains the given direction.
- relative humidity.** . See under HUMIDITY.
- relative motion.** . See RELATIVE MOVEMENT.
- relative motion display.** . 1. A type of radarscope display in which the position of own ship is fixed, usually at the center of the display, and all detected targets move relative own ship. 2. In ECDIS, a DISPLAY in which OWN SHIP remains stationary, while all other charted information and targets move relative to own ship's position. See also TRUE MOTION DISPLAY.
- relative movement.** . Motion of one object relative to another. The expression is usually used in connection with problems involving motion of one vessel to another, the direction such motion being called DIRECTION RELATIVE MOVEMENT and the speed of the motion being called SPEED OF RELATIVE MOVEMENT or RELATIVE SPEED. Distance relative to a specified reference point, usually one in motion, is called RELATIVE DISTANCE. Usually called APPARENT MOTION applied to the change of position of a celestial body as observed from the earth. Also called RELATIVE MOTION.
- relative plot.** . A plot of the successive positions of a craft relative to a reference point, which is usually in motion. A line connecting successive relative positions of a maneuvering ship relative to a reference ship is called a RELATIVE MOVEMENT LINE. A relative plot includes relative movement lines and the position of the reference ship.
- relative position.** . A point defined with reference to another position, either fixed or moving coordinates of such a point are usually between true or relative, and distance from an identified reference point.
- relative speed.** . See SPEED OF RELATIVE MOVEMENT.
- relative wind.** . The wind with reference to a moving point. Sometimes called APPARENT WIND. See also APPARENT WIND, TRUE WIND.
- release.** , *n.* A device for holding or releasing a mechanism, particularly the device by which the tangent screw of a sextant is engaged or disengaged from the limb.
- relief.** , *n.* 1. The elevations of a land surface; represented graphics by contours, hypsometric tints, spot elevations, hachures, etc. Similar representation of the ocean floor is called SUBMARINE RELIEF. 2. The removal of a buoy (formerly also referred to lightships) from station and provision of another buoy having the operating characteristics authorized for that station.
- relief map.** . See HYPISOGRAPHIC MAP.
- relief model.** . Any three-dimensional representation of an object or geographic area, modeled in any size or medium. See also PLASTIC RELIEF MAP.
- relieved.** , *adj.* Said of a buoy that has been removed from a station and replaced by another having the proper operating characteristics.
- relighted.** , *adj.* Said of an extinguished aid to navigation returned to its advertised light characteristic.

**relocated.** , *adj.* Said of aid to navigation that has been permanently moved from one position to another.

**reluctance.** , *n.* Magnetic resistance.

**remanence.** , *n.* Ability to retain magnetism after removal of the magnetizing force. Also See RETENTIVITY.

**remote-indicating compass.** . A compass equipped with one or more indicators to repeat at a distance the readings of the master compass. The directive element and controls are called a master compass to distinguish this part of the system from the repeaters, or remote indicators. Most marine gyrocompass installations are of this type. Also called REMOTE-READING COMPASS.

**remotely controlled light.** . A light which is operated by personnel at a considerable distance from the light, through electrical or radio links.

**remote PPI.** . See RADAR REPEATER.

**remote-reading compass.** . See REMOTE-INDICATING COMPASS.

**repaired.** , *adj.* Said of a sound signal or radionavigation aid previously INOPERATIVE, placed back in operation, or of a structure previously DAMAGED, that has been restored as an effective aid to navigation.

**repeatability.** , *n.* 1. A measure of the variation in the accuracy of an instrument when identical tests are made under fixed conditions. 2. In a navigation system, the measure of the accuracy with which the system permits the user to return to a specified point as defined only in terms of the coordinates peculiar to that system. See also PREDICTABILITY.

**repeatable accuracy.** . In a navigation system, the measure of the accuracy with which the system permits the user to return to a position as defined only in terms of the coordinates peculiar to that system. The correlation between the geographical coordinates and the system coordinates may or may not be known. See also PREDICTABLE ACCURACY, RELATIVE ACCURACY.

**repeater.** , *n.* A device for repeating at a distance the indications of an instrument or device. See also COMPASS REPEATER, GYRO REPEATER, RADAR REPEATER, STEERING REPEATER.

**repeating decimal.** . A decimal in which all the digits after a certain digit consist of a set of one or more digits repeated and infinitum. Also called RECURRING DECIMAL.

**replaced.** , *adj.* Said of an aid to navigation previously OFF STATION, ADRIFT or MISSING that has been restored by another aid of the same type and characteristic.

**representative fraction.** . The scale of a map or chart expressed as a fraction or ratio that relates unit distance on the map to distance measured in the same unit on the ground. Also called NATURAL SCALE, FRACTIONAL SCALE. See also NUMERICAL SCALE.

**reradiation.** , *n.* 1. The scattering of incident radiation. Reradiation from metallic objects in proximity to either the transmitting or receiving antennas can introduce unwanted effects. This is particularly true on a vessel having a number of metallic structures or wires in the vicinity of an antenna. Where such structures are permanent, the effects can sometimes be allowed for by calibration. Also called SECONDARY RADIATION. 2. Radiation from a radio receiver due to poor isolation between the antenna circuit and the local oscillator within the receiver, causing unwanted interference in other receivers.

**research sanctuary.** . A marine sanctuary established for scientific research in support of management programs, and to establish ecological baselines. See also MARINE SANCTUARY.

**reset.** , *adj.* Said of a floating aid to navigation previously OFF STATION, ADRIFT, or MISSING that has been returned to its station.

**residual deviation.** . Deviation of a magnetic compass after adjustment or compensation. The values on various headings are called RESIDUALS.

**residual magnetism.** . Magnetism which remains after removal of the magnetizing force.

**residuals.** , *n., pl.* The remaining deviation of a magnetic compass on various headings after adjustment or compensation. See also DEVIATION TABLE.

**resistance.** , *n.* Opposition, particularly to the flow of electric current.

**resistivity.** , *n.* The amount of resistance in a system. Resistivity is the reciprocal of CONDUCTIVITY.

**resolution.** , *n.* 1. The ability of an optical system to distinguish between individual objects; the degree of ability to make such a separation, called RESOLVING POWER, is expressed as the minimum distance between two objects that can be separated. 2. The degree

of ability of a radar set to indicate separately the echoes of two targets in range, bearing, and elevation. Resolution in range is the minimum range difference between separate targets at the same bearing which will allow both to appear separately; Resolution in bearing is the minimum horizontal angular separation between two targets at the same range which will allow both to appear separately. Resolution in elevation is the minimum separation in the vertical plane between two contacts at the same range and bearing which will allow both to appear as distinct echoes. 3. In ECDIS, it is the capability of depicting detail, represented by the smallest distance apart at which two objects can be seen to be separate. The separation is called the RESOLVING POWER. In ECDIS, it is dependent on PIXEL size.

**resolution of vectors.** . The resolving of a vector into two or more components. The opposite is called VECTOR ADDITION.

**resolving power.** . The degree of ability of an optical system to distinguish between objects close together. See also RESOLUTION.

**resolving time.** . 1. The minimum time interval between two events which permits one event to be distinguishable from the other. 2. In computers, the shortest permissible period between trigger pulses for reliable operation of a binary cell.

**resonance.** , *n.* Re-enforcement or prolongation any wave motion, such as sound, radio waves etc., resulting when the natural frequency of a body or system in vibration is equal to that of an impressed vibration.

**resonant frequency.** . Any frequency at which a body or system vibrates most readily. The lowest resonant frequency is the natural frequency of the body or system.

**responder.** , *n.* A unit which receives the response emitted by a transponder.

**restricted area.** . 1. An area (land, sea, or air) in which there are special restrictive measures employed to prevent or minimize interference between friendly forces. 2. An area under military jurisdiction in which special security measures are employed to prevent unauthorized entry. See also DANGER AREA, PROHIBITED AREA.

**restricted waters.** . Areas which for navigational reasons such as the presence of shoals or other dangers confine the movements of shipping within narrow limits.

**resultant.** , *n.* The sum of two or more vectors.

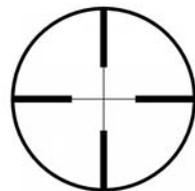
**retard.** , *v., t & i.* To delay. This term is sometimes used as the equivalent of RETIRE (meaning "to move back"), but this usage is not appropriate.

**retarded line of position.** . See RETIRED LINE OF POSITION.

**retentive error.** . Deviation of a magnetic compass due to the tendency of a vessel's structure to retain some of the induced magnetic effects for short periods of time. For example, a vessel on a northerly course for several days, especially if pounding in heavy seas, will tend to retain some fore-and-aft magnetism gained through induction. Although this effect is not large and generally decays within a few hours, it may cause incorrect observations or adjustments, if neglected. This error should not be confused with GAUSSIN ERROR.

**retentivity.** , *n.* See REMANENCE.

**reticle.** , *n.* A system of lines, wires, etc., placed in the focal plane of an optical instrument to serve as a reference. A cross hair is a hair, thread, or wire constituting part of a reticle. See also GRATICULE, definition 2.



reticle

**retire.** , *v., t. & i.* To move back, as to move a line of position back, parallel to itself, along a course line to obtain a line of position at an earlier time. The term RETARD (meaning "to delay") is sometimes used as an equivalent, but the term RETIRE (meaning "to move back") is more appropriate. The opposite is ADVANCE.

**retired line of position.** . A line of position which has been moved backward along the course line to correspond with a time previous

- to that at which the line was established. The opposite is **ADVANCED LINE OF POSITION**.
- retrace**, *n.* The path of the visible dot from the end of one sweep to the start of the next sweep across the face of a cathode-ray tube.
- retract**, *v., t. & i.* The opposite of **BEACH**, *v., t & i.*
- retrograde motion**. The apparent motion of a planet westward among the stars. Apparent motion eastward, called **DIRECT MOTION**, is more common. Also called **RETROGRESSION**.
- retrogression**, *n.* See **RETROGRADE MOTION**.
- retro-reflecting material**. A material which produces retro-reflection over a wide range of angles of incidence of a light beam, by use of a large number of very small reflecting and refracting elements, usually very small beads.
- retro-reflection**, *n.* Reflection in which light is returned in directions close to the direction from which it came over wide variations of the direction of the incident light. Also called **REFLEX REFLECTION**.
- retro-reflector**, *n.* A device intended to produce retro-reflection. It may comprise one or more retro-reflecting optical units, for example, corner reflectors or special lens units of glass or plastic. Such devices may be installed generally on unlighted buoys or other aids to navigation to increase the range at which they may be seen at night. Also called **REFLEX REFLECTOR**.
- return**, *n.* See **BLIP**; **ECHO**, definition 2.
- reverberation**, *n.* Continuation of radiant energy, particularly sound, by multiple reflection.
- reversing current**. A tidal current which flows alternately in approximately opposite directions with a slack water at each reversal of direction. Currents of this type usually occur in rivers and straits where the direction of flow is somewhat restricted to certain channels. When the movement is towards the shore or up a stream the current is said to be flooding, and when in the opposite direction it is said to be ebbing. The combined flood and ebb movement including the slack water covers, on an average, 12.4 hours for the semidiurnal current. If unaffected by a nontidal flow, the flood and ebb movements will each last about 6 hours, but when combined with such a flow, the durations of flood and ebb may be quite unequal. During the low in each direction the speed of the current will vary from zero at the time of slack water to a maximum about midway between the slacks. Also called **RECTILINEAR CURRENT**.
- reversing falls**. Falls which flow alternately in opposite directions in a narrow channel in the St. John River, New Brunswick, Canada, due to the large range of tide and a constriction in the river. The direction of flow is upstream or downstream according to whether it is high or low water on the outside, the falls disappearing at the half-tide level.
- revolution**, *n.* Circular motion about an axis usually external to the body. The terms **REVOLUTION** and **ROTATION** are often used interchangeably but, with reference to the motions of a celestial body, **REVOLUTION** refers to the motion in an orbit or about an axis external to the body while **ROTATION** refers to motion about axis within the body. Thus, the earth revolves about the sun annually and rotates about its axis daily.
- revolution counter, revolution indicator**. An instrument for registering the number of revolutions of a shaft, particularly a propeller shaft of a vessel (when it may be called **ENGINE REVOLUTION COUNTER**). This information is useful in estimating a vessel's speed through the water.
- revolution table**. A table listing the number of shaft revolutions corresponding to various speeds of a vessel.
- revolver**, *n.* The pair of horizontal angles between three points, as observed at any place on the circle defined by the three points. This is the only situation in which such angles do not establish a fix. Also called **SWINGER**.
- revolving light**. See **ROTATING LIGHT**.
- revolving storm**. A cyclonic storm, or one in which the wind revolves about a central low pressure area.
- rheostat**, *n.* A variable resistor for changing the amount of current in an electrical circuit.
- rhomboid**, *n.* A parallelogram with oblique angles. A rhomboid with sides of equal length is rhombus.
- rhombus**, *n.* A rhomboid with sides of equal length.
- Rho-Rho mode**. See **RANGING MODE**.
- rho-theta navigation**. Navigation by means measuring ranges and bearings of a known position.
- rhumb**, *n.* Short for **RHUMB LINE**.
- rhumb bearing**. The direction of a rhumb line through two terrestrial points, expressed angular distance from a reference direction. It is usually measured from 0° at the reference direction clockwise through 360°. Also called **MERCATOR BEARING**.
- rhumb direction**. See **MERCATOR DIRECTION**.
- rhumb line**. A line on the surface of the earth making the same oblique angle with all meridians; a loxodrome or loxodromic curve spirals toward the poles in a constant true direction. Parallels and meridians, which also maintain constant true directions, may be considered special cases of the rhumb line. A rhumb line is a straight line on a Mercator projection. Sometimes shortened to **RHUMB**. See also **FICTITIOUS RHUMB LINE**.
- rhumb-line course**. The direction of the rhumb line from the point of departure to the destination, expressed as the angular distance from a reference direction, usually north. Also called **MERCATOR COURSE**.
- rhumb-line distance**. Distance point to point along a rhumb line, usually expressed in nautical miles.
- rhumb-line sailing**. Any method of solving the various problems involving course, distance, difference of latitude, difference of longitude, and departure as they are related to a rhumb line.
- rhythmic light**. A light showing intermittently with a regular periodicity.
- ria**, *n.* A long, narrow inlet with gradually decreasing depth inward.
- ridge**, *n.* 1. On the sea floor, a long, narrow elevation with steep sides. 2. A line or wall of broken ice forced up by pressure. The ridge may be fresh or weathered. See also **AGED RIDGE**. 3. In meteorology, an elongated area of relatively high atmospheric pressure, almost always associated with and most clearly identified as an area of maximum anticyclonic curvature of wind flow. The opposite of a ridge is called **TROUGH**. Sometimes called **WEDGE**.
- ridged ice**. Ice piled haphazardly one piece over another in the form of ridges or walls; usually found in first-year ice.



ridged ice

- ridged-ice zone**. An area in which much ridged ice with similar characteristics has formed.
- ridging**, *n.* The pressure process by which sea ice is forced into ridges.
- riding light**. See **ANCHOR LIGHT**.
- rift**, *n.* An opening made by splitting; a crevasse; usually in the earth.
- right angle**. An angle of 90°.
- right angle reflector**. See **DIHEDRAL REFLECTOR**.
- right ascension**. Angular distance east of the vernal equinox; the arc of the celestial equator, or the angle at the celestial pole, between the hour circle of the vernal equinox and the hour circle of a point on the celestial sphere, measured eastward from the hour circle of the vernal equinox through 24 hours. Angular distance west of the vernal equinox, through 360°, is **SIDEREAL HOUR ANGLE**.
- right astern**. See **DEAD ASTERN**.
- right bank**. The bank of a stream or river on the right of the observer when he is facing in the direction of flow, or downstream. See also **LEFT BANK**.
- right circular cone**. A cone having a circular base perpendicular to the axis of the cone. Often shortened to **RIGHT CONE**.
- right cone**. Short for **RIGHT CIRCULAR CONE**.
- right sphere**. The celestial sphere as it appears to an observer at the equator, where celestial bodies appear to rise vertically above the horizon.
- right spherical triangle**. A spherical triangle with a right angle.
- right triangle**. A triangle one angle of which is 90°.
- rigidity in space**. See **GYROSCOPIC INERTIA**.
- rime**, *n.* A white or milky and opaque granular deposit of ice formed by the rapid freezing of supercooled water drops as they impinge on an exposed object. It is denser and harder than frost, but lighter, softer, and less transparent than glaze.
- rime fog**. See **ICE FOG**.
- ring time**. The time, reckoned from the end of pulse transmitted by a

- radar set, during which the output of an echo box produces a visible signal on the display.
- rip current.** . A narrow intense current setting seaward through the surf zone. It removes excess water brought to the zone by the small net mass transport of waves, and is fed by longshore currents. Rip currents usually occur at points groins, jetties, etc., of irregular beaches, and at regular intervals along straight, uninterrupted beaches. See also RIPS.
- riprap.** , *n.* Stones or broken rock thrown together without order to provide a revetment.
- riprap mounds.** . Mounds of riprap maintained at certain light structures to protect the structures against ice damage and scouring action. Submerged portions present a hazard to vessels attempting to pass very close aboard.
- rips.** , *n. pl.* Agitation of water caused by the meeting of currents or by a rapid current setting over an irregular bottom. Called TIDE RIPS when the tidal current is involved. See also OVERFALLS, RIP CURRENT.
- rise.** , *n.* A broad elevation that rises gently and generally smoothly from the sea floor. See also CONTINENTAL RISE.
- rise.** , *v., i.* To ascend past the visible horizon. The opposite is SET.
- rise of tide.** . Vertical distance from the chart sounding datum to a higher water datum. Mean rise of tide is the height of mean high water above the chart sounding datum. Spring rise and neap rise are the heights of spring high water and neap high water, respectively, above the chart sounding datum; while mean spring rise and mean neap rise are the heights of mean high water springs and mean high water neaps, respectively above the chart sounding datum. Also called TIDAL RISE. See also HEIGHT OF TIDE.
- rising tide.** . A tide in which the depth of water is increasing. Sometimes the term FLOOD is used as an equivalent, but since flood refers primarily to horizontal rather than vertical movement RISING TIDE is more appropriate. The opposite is FALLING TIDE.
- river.** , *n.* A natural stream of water, of greater volume than a creek or rivulet, flowing in a more or less permanent bed or channel, between defined banks or walls, with a current which may either be continuous in one direction or affected by the ebb and flow of the tidal current.
- river buoy.** . A lightweight nun or can buoy especially designed to withstand strong currents.
- river estuary.** . See ESTUARY, definition 2.
- river ice.** . Ice formed on a river, regardless of observed location.
- river radar.** . A marine radar set especially designated for river pilotage, generally characterized by high degree of resolution and a wide selection of range scales.
- rivulet.** , *n.* A small stream; a brook.
- RNC.** . See RASTER NAVIGATIONAL CHART.
- road.** , *n.* An open anchorage affording less protection than a harbor. Some protection may be afforded by reefs, shoals, etc. Often used in the plural. Also called ROADSTEAD.
- roadstead.** , *n.* See ROAD.
- roaring forties.** . The area of the oceans between 40° and 50° south latitude, where strong westerly winds prevail. See also BRAVE WEST WIND.
- roche moutonnée.** . A rock worn into a rounded shape by a glacier.
- rock.** , *n.* 1. An isolated rocky formation or single large stone, usually one constituting a danger navigation. It may be always submerged, always uncovered, or alternately covered and uncovered by the tide. A pinnacle is a sharp-pointed rock rising from the bottom. 2. The naturally occurring material that forms the firm, hard, and solid masses of the ocean floor. Also, rock is a collective term for hard material generally not smaller than 256 millimeters.
- rock awash.** . A rock that becomes exposed, or nearly so, between chart sounding datum and mean high water. In the Great Lakes, the rock awash symbol is used on charts for rocks that are awash, or nearly so, at low water datum. See also BARE ROCK, SUBMERGED ROCK.
- rocking the sextant.** . See SWINGING THE ARC.
- rod.** , *n.* 1. A unit of length equal to 5.5 yards or 16.5 feet. Also called POLE, PERCH. 2. One of the imaginary slender soft iron bars which are assumed to be components or parameters of a craft's magnetic field caused by magnetism induced in soft iron.
- roll.** , *n.* Oscillation of a craft about its longitudinal axis. Also called ROLLING. See also LIST, *n.*; SHIP MOTIONS.
- roll.** , *v., t. & i.* To oscillate or be oscillated about the longitudinal axis.
- roll angle.** . See ANGLE OF ROLL.
- rollers.** , *n.* Amongst the islands of the West Indies, the South Atlantic and the South Indian Ocean, swell waves which after moving into shallow water have grown to such height as to be destructive. See also COMBER.
- rolling.** , *n.* See ROLL, *n.*
- root mean square.** . The square root of the arithmetical mean of the squares of a group of numbers.
- root mean square error.** . For the one-dimensional error distribution, this term has the same meaning as STANDARD DEVIATION or STANDARD ERROR. For the two-dimensional error distribution, this term has the same meaning as RADIAL ( $d_{rms}$ ) ERROR. However, such use of the term is deprecated. Root mean square error is commonly called RMS ERROR.
- rotary current.** . A tidal current that flows continually, with the direction of flow changing through 360° during the tidal period. Rotary currents are usually found offshore where the direction of flow is not restricted by any barriers. The tendency for rotation is due to the Coriolis force and, unless modified by local conditions, is clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. The speed of the current usually varies throughout the tidal cycle, passing through the two maxima in approximately opposite directions and the two minima with the direction of the current at approximately 90° from the direction at time of maximum speed.
- rotating light.** . A light with one or more beams that rotate. Sometimes called REVOLVING LIGHT.
- rotation.** , *n.* Turning of a body about an axis within the body, such as the daily rotation of the earth. See also REVOLUTION.
- rotten ice.** . Sea ice which has become honeycombed and is in an advanced state of disintegration.
- round.** , *v., t.* To pass and alter direction of travel, as a vessel ROUNDS A CAPE. If the course is nearly reversed, the term DOUBLE may be used.
- roundabout.** , *n.* A routing measure comprising a separation point or circular separation zone and a circular traffic lane within defined limits. Traffic within the roundabout moves in a counterclockwise direction around the separation point or zone. See also ROUTING SYSTEM, TRAFFIC SEPARATION SCHEME.
- round of bearings.** . A group of bearings observed together for plotting as a fix.
- round of sights.** . A group of celestial observations made together for plotting a fix.
- round wind.** . A wind that gradually changes direction through approximately 180° during the daylight hours. See also LAND BREEZE.
- route.** . In ECDIS, a sequence of WAYPOINTS and LEGS.
- route chart.** . A chart showing routes between various places, usually with distances indicated.
- route monitoring.** . In ECDIS, the operational navigational function in which the chart information is displayed, under control of the positioning sensor input, according to the vessel's present position (either in TRUE MOTION or RELATIVE MOTION DISPLAY mode).
- route planning.** . In ECDIS, the pre-determination of COURSE, speed, and WAYPOINTS in relation to the waters to be navigated. Designed to plan a route between two geographical locations using computational software specialized for the purpose of ocean navigation. In addition, it provides, ETA, fuel burn rate information and numerous other data once the vessel's operating parameters are set in the system.
- routing system.** . Any system of one or more defined tracks and/or traffic control measures for reducing the risk of casualties; it includes traffic separation schemes, two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, roundabouts, precautionary areas, and deep water routes.
- rubble.** , *n.* 1. Fragments of hard sea ice, roughly spherical and up to 5 feet in diameter, resulting from the disintegration of larger ice formations. When afloat, commonly called BRASH ICE. 2. Loose angular rock fragments.
- Rude Star Finder.** . A star finder named for Captain Gilbert T. Rude, U.S. Coast and Geodetic Survey.
- rugged.** , *adj.* Rock-bound; craggy.
- rules of navigation.** . Rules of the road.
- rules of the road.** . The *International Regulations for Prevention of Collisions at Sea*, commonly called *International Rules of the Road*, and the *Inland Navigation Rules*, to be followed by all vessels while navigating upon certain inland waters of the United States. Also

called RULES OF NAVIGATION.

- run**, *n.* 1. A brook, or small creek. 2. A small, swift watercourse. 3. The distance traveled by a craft during any given time interval, or since leaving a designated place. See also DAY'S RUN.
- run a line of soundings**. . To obtain soundings along a course line, for use in making or improving a chart.
- run before the wind**. . To steer a course downwind, especially under sail.
- run down a coast**. . To sail approximately parallel with the coast.
- runnel**, *n.* The smallest of natural streams; a brook or run.
- running fix**. . A position determined by crossing lines of position obtained at different times and advanced or retired to a common time. However in celestial navigation or when using long-range electronic aids, a position determined by crossing lines of position obtained within a few minutes is considered a FIX; the expression RUNNING FIX is applied to a position determined by advancing or retiring a line over a considerable period of time. There is no sharp dividing line between a fix and a running fix in this case.
- running light**. . See NAVIGATION LIGHTS.
- run-off**, *n.* That portion of precipitation which is discharged from the area of fall as surface water in streams.
- run of the coast**. . The directional trend of a coast.
- run-up**. . The rush of water up a structure on the breaking of a wave. The amount of run-up is the vertical height above the still water level that the rush of water reaches. Also called UPRUSH.

## S

- saddle**, *n.* A low part of the sea floor resembling in shape a saddle, in a ridge or between contiguous seamounts.
- safety contour**. . See OWN SHIP'S SAFETY CONTOUR.
- safety depth**. . In ECDIS, the depth defined by the mariner, e.g. the ship's draft plus under keel clearance, to be used by ECDIS to emphasize soundings on the DISPLAY equal to or less than this value.
- safety lanes**. . Specified sea lanes designated for use by submarines and surface ships in transit to prevent attack by friendly forces. They may be called SUBMARINE SAFETY LANES when designated for use by submarines in transit.
- safe water mark**. . See under IALA MARITIME BUOYAGE SYSTEM.
- SafetyNET**. . The INMARSAT broadcast service for MARITIME SAFETY INFORMATION (MSI).
- sailing**, *n.* A method of solving the various problems involving course, distance, difference of latitude, difference of longitude, and departure. The various methods are collectively spoken of as the sailings. Plane sailing considers the earth as a plane. Traverse sailing applies the principles of plane sailing to determine the equivalent course and distance made good by a craft following a track consisting of a series of rhumb lines. Any of the sailings which considers the spherical or spheroidal shape of the earth is called spherical sailing. Middle-latitude sailing is a method of converting departure into difference of longitude, or vice versa, by assuming that such a course is steered at the middle or mean latitude; if the course is 090° or 270° true, it is called parallel sailing. Mercator sailing applies when the various elements are considered in their relation on a Mercator chart. Meridian sailing is used when the course is 000° or 180° true. Rhumb-line sailing is used when a rhumb line is involved; great-circle sailing when a great circle track is involved. Composite sailing is a modification of great circle sailing used when it is desired to limit the highest latitude. The expression current sailing is occasionally used to refer to the process of allowing for current in determining the predicted course made good, or of determining the effect of a current on the direction of motion of a vessel.
- sailing chart**. . See under CHART CLASSIFICATION BY SCALE.
- sailing directions**. . 1. A descriptive book for the use of mariners, containing detailed information of coastal waters, harbor facilities, etc. of an area. For waters of the United States and its possessions, they are published by the National Ocean Survey and are called UNITED STATES COAST PILOTS. Sailing directions, as well as light lists, provide the information that cannot be shown graphically on the nautical chart and that is not readily available elsewhere. See also UNITED STATES COAST PILOT.
- St. Elmo's fire**. . A luminous discharge of electricity from pointed objects such as the masts and arms of ships, lightning rods, steeples, etc. occurring when there is a considerable atmospheric difference in potential. Also called CORPOSANT, CORONA DISCHARGE.
- St. Hilaire method**. . Establishing a line position from observation of the altitude of a celestial body by using an assumed position, the difference between the observed and computed altitudes, and the azimuth. The method was devised by Marcq St. Hilaire, a French naval officer, in 1874. See also SUMNER METHOD, LONGITUDE METHOD, HIGH ALTITUDE METHOD. Also see ALTITUDE INTERCEPT METHOD.
- salinity marsh**. . A measure of the amount of dissolved solid material in water.
- sallying ship**. . Producing rolling motion of a ship by having the crew run in unison from to side. This is usually done to help float a ship which is aground or to assist it to make way when it is beset by ice.
- salt marsh**. . A flat coastal area flooded by most high tides, characterized by various species of marsh grasses and animal life.
- salt-water wedge**. . The intrusion of a tidal estuary by sea water in the form of a wedge underneath the less dense fresh water.
- same name**. . A name the same as that possessed by something else, as declination has the same name as latitude if both are north or both south. They are of CONTRARY NAME if one is north and the other south.
- sand**, *n.* Sediment consisting of small but distinguishable separate grains between 0.0625 and 2.0 millimeters in diameter. It is called very fine sand if the grains are between 0.0625 and 0.125 millimeter in diameter, fine sand between 0.125 and 0.25 millimeter, medium sand if between 0.25 and 0.50 millimeters, coarse sand if between 0.50 and 1.0 millimeters, and very coarse sand if between 1.0 and 2.0 millimeters. See also MUD, STONES, ROCK definition 2.
- sand bar**. . *n.* A ridge of sand built up by currents such that the top is near or just above the surface of the water.
- sand dune**. . See DUNE.
- sandstorm**, *n.* A strong wind carrying sand through the air, the diameter of most of the particles ranging from 0.08 to 1.0 millimeter. In contrast to a DUST STORM, the sand particles are mostly confined to the lowest 10 feet, and rarely rise more than 50 feet above the ground.
- sandwave**, *n.* A large wavelike sea-floor sediment feature in very shallow water and composed of sand. The wavelength may reach 100 meters, the amplitude is about 0.5 meter. Also called MEGARIPPLE.
- Santa Ana**. . A strong, dust-laden foehn occurring in Southern California near the mouth of the Santa Ana pass and river.
- Sargasso Sea**. . The west central region of the subtropical gyre of the North Atlantic Ocean. It is bounded by the North Atlantic, Canary, Atlantic North Equatorial, and Antilles Currents, and the Gulf Stream. It is characterized by the absence of well-marked currents and by large quantities of drifting Sargassum, or gulfweed.
- sargasso weed**. . See SARGASSUM.
- sargassum**, *n.* A genus of brown algae characterized by a bushy form, a substantial holdfast when attached, and a yellowish brown, greenish yellow, or orange color. Species of the group have a large variety of forms and are widely distributed in warm seas as attached and free floating plants. Two species (*S. fluitans* and *S. matans*) make up 99 percent of the macroscopic vegetation in the Sargasso Sea. Also called SARGASSO WEED, GULFWEED.



sargassum

- Saros**, *n.* A period of 223 synodic months corresponding approximately to 19 eclipse years or 18.03 Julian years, and is a cycle in which solar and lunar eclipses repeat themselves under approximately the same conditions.
- sastrugi**, (*sing. sastruga*), *n., pl.* Sharp, irregular ridges formed on a snow surface by wind erosion and deposition. On mobile floating ice, the ridges are parallel to the direction of the prevailing wind at the time they were formed.
- satellite**, *n.* 1. A body, natural or man-made, that orbits about another body, the primary body. The moon is a satellite of the earth, the

- primary body. 2. As defined by the International Telecommunication Union (ITU), a body which revolves around another body of preponderant mass and which has a motion primarily and permanently determined by the force of attraction of that other body. See also ACTIVE SATELLITE, EARTH SATELLITE, EQUATORIAL SATELLITE, GEODETIC SATELLITE, NAVIGATION SATELLITE, PASSIVE SATELLITE, POLAR SATELLITE, SYNCHRONOUS SATELLITE, TWENTY-FOUR HOUR SATELLITE.
- satellite geodesy.** . The discipline which employs observations of an earth satellite to extract geodetic information.
- satellite triangulation.** . The determination of the angular relationships between two or more stations by the simultaneous observation of an earth satellite from these stations.
- satellite triangulation stations.** . Triangulation stations whose angular positions relative to one another are determined by the simultaneous observations of an earth satellite from two or more of them.
- saturable system.** . A term used to describe a navigation system whose use is limited to a single user or a limited number of users on a time-shared basis.
- saturation.** , *n.* Complete impregnation under given conditions, such as the condition that exists in the atmosphere when no additional water vapor can added at the prevailing temperature without condensation or supersaturation occurring.
- Saturn.** , *n.* The navigational planet whose orbit lies outside that of Jupiter.
- santanna.** , *n.* A plain with low vegetation, especially in the sub-tropical latitudes.
- S-band.** . A radio-frequency band of 1,550 to 5,200 megahertz. See also FREQUENCY, FREQUENCY BAND.
- scalar.** , *adj.* Having magnitude only.
- scalar.** , *n.* Any physical quantity whose field can be described by a single numerical value at each point in space. A scalar quantity is distinguished from a VECTOR quantity by the fact that scalar quantity possesses only magnitude, where as, a vector quantity possesses both magnitude and direction.
- scale.** , *n.* 1. A series of marks or graduations at definite intervals. A linear scale is a scale graduated at uniform intervals; a logarithmic scale is graduated in the logarithms of uniformly-spaced consecutive numbers. 2. The ratio between the linear dimensions of chart, map drawing, etc. and the actual dimensions. See also CONVERSION SCALE, BAR SCALE, REPRESENTATIVE FRACTION, SMALL SCALE, LARGE SCALE.
- scale bar.** . A graduated line on a MAP, PLAN, PHOTOGRAPH, or MOSAIC, by means of which actual ground distances may be determined. Also called GRAPHIC SCALE or LINEAR SCALE. In ECDIS, a vertical bar scale of 1 nautical mile divided into 1/10ths, intended to convey an immediate sense of distance.
- scale error.** . See CALIBRATION ERROR.
- scalesh triangle.** . A triangle that has three unequal sides. In such a triangle, no two angles are equal.
- scan.** , *v., t.* In the use of radar, to search or investigate an area or space by varying the direction of the radar antenna and thus the beam. Normally scanning is done by continuous rotation of the antenna.
- scanner.** , *n.* 1. A unit of a radar set consisting of the antenna and drive assembly for rotating the antenna. 2. A computerized electronic device which digitizes printed images.
- scarf cloud.** . A thin cirrus-like cloud sometimes observed above a developing cumulus. See also CAP CLOUD.
- scarp.** , *n.* See ESCARPMENT.
- scatter reflections.** . Reflections from portions of the ionosphere having different virtual height which mutually interfere and cause rapid fading.
- Schuler frequency.** . The natural frequency of simple pendulum with a length equal to the earth's radius. The corresponding period is 84 minutes.
- Schuler loop.** . The portion of the inertial navigator in which the instrumental local vertical is established.
- Schuler tuned.** . The condition wherein gyroscopic devices should be insensitive to applied accelerations. M. Schuler determined that if gyroscopic devices were not to be affected by the motions of the craft in which installed, the devices should have a natural period of oscillation of about 84.4 minutes. This period is equal to the product of  $2\pi$  and the square root of the quotient: radius of the earth divided by the acceleration of gravity.
- scintillation.** , *n.* Twinkling; emission of sparks or quick flashes; shimmer.
- scope.** , *n.* Short for RADARSCOPE.
- scoria.** (*pl. scoriae*), *n.* Volcanic rock fragments usually of basic composition, characterized by marked vesicularity, dark color, high density and a partly crystalline structure. Scoria is a constituent of certain marine sediments.
- scouring basin.** . A basin containing impounded water which is released at about low water in order to maintain the desired depth in the entrance channel by scouring the bottom. Also called SLUICING POND.
- screen.** , *n.* The chemically coated inside surface of the large end of a cathode-ray tube which becomes luminous when struck by an electron beam.
- scud.** , *n.* Shreds or small detached masses of cloud moving rapidly before the wind, often below a layer of lighter clouds. See also FRACTO.
- scud.** , *v., i.* To run before a storm.
- sea.** , *n.* 1. A body of salt water more or less confined by continuous land or chains of islands and forming a distinct region. 2. A body of water nearly or completely surrounded by land, especially if very large or composed of salt water. Sometimes called INLAND SEA. See also LAKE. 3. Ocean areas in general, including major indentations in the coast line, such as gulfs. See also CLOSED SEA, OPEN SEA, HIGH SEA. 4. Waves generated or sustained by winds within their fetch as opposed to SWELL. 5. The character of a water surface, particularly the height, length (period), and direction of travel of waves generated locally. A smooth sea has waves no higher than ripples or small wavelets. A short sea has short, irregular, and broken waves. A confused sea has a highly disturbed surface without a single, well-defined direction of travel, as when waves from different directions meet following a sudden shift in the direction of the wind. A cross sea is a series of waves imposed across the prevailing waves. A sea may be designated as head, beam, quartering, or following. See also SWELL definition 1.
- Sea Area.** . A defined area under the Global Maritime Distress and Safety System (GMDSS) which regulates certain safety and communication equipment necessary according to the area of the ship's operations. Sea Area A-1 is within coverage of VHF coast radio stations (25-30 miles) providing digital selective calling. Sea Area A-2 is within range of the medium frequency coast radio stations (to approximately 300 miles). Sea Area A-3 is within the footprint of the geostationary INMARSAT communications satellites, covering the rest of the open seas except the poles. Sea Area A-4 covers the rest of the earth, chiefly the polar areas. The areas do not overlap.
- sea-air temperature difference correction.** . A correction due to a difference in the temperature of the sea and air, particularly the sextant altitude correction caused by abnormal terrestrial refraction occurring when there is a nonstandard density lapse rate in the atmosphere due to a difference in the temperature of the water and air at the surface.
- sea anchor.** . An object towed by a vessel, usually a small one, to keep the vessel end-on to a heavy sea or surf or to reduce the drift. Also called DRAG, DROGUE.
- seabeach.** , *n.* See under BEACH.
- seaboard.** , *n.* The region of land bordering the sea. The terms SEABOARD, COAST, and LITTORAL have nearly the same meanings. SEABOARD is a general term used somewhat loosely to indicate a rather extensive region bordering the sea. COAST is the region of indefinite width that extends from the sea inland to the first major change in terrain features. LITTORAL applies more specifically to the various parts of a region bordering the sea, including the coast, foreshore, backshore, beach, etc.
- sea breeze.** . A breeze blowing from the sea to adjacent land. It usually blows by day, when the land is warmer than the sea, and alternates with a LAND BREEZE, which blows in the opposite direction by night. See also ONSHORE WIND.
- sea buoy.** . The outermost buoy marking the entrance to a channel or harbor.
- seachannel.** , *n.* On the sea floor, a continuously sloping, elongated depression commonly found in fans or plains and usually bordered by levees on one or two sides.
- sea clutter.** . See SEA RETURN.
- seacoast.** , *n.* See COAST.
- sea fog.** . A type of advection fog formed when air that has been lying over

- a warm water surface is transported over colder water, resulting in cooling of the lower layer of air below its dew point. See also HAAR.
- sea gate.** . 1. A gate which serves to protect a harbor tidal basin from the sea, such as one of a pair of supplementary gates at the entrance to a tidal basin exposed to the sea. 2. A movable gate which protects the main deck of a ferry from waves and sea spray.
- seagirt.** , *adj.* Surrounded by sea. Also called SEA BOUND.
- sea ice.** . Any form of ice found at sea which has originated from the freezing of sea water.
- sea-ice nomenclature.** . See WMO SEA-ICE NOMENCLATURE.
- sea kindliness.** . A measure of the ease of motion of a vessel in heavy seas, particularly in regard to rolling, pitching, and shipping water. It is not to be confused with seaworthiness which implies that the vessel is able to sustain heavy rolling, pitching, etc., without structural damage or impaired stability.
- sea level.** . Height of the surface of the sea at any time.
- sea manners.** . Understood by seamen to mean consideration for the other vessel and the exercise of good judgment under certain condition when vessels meet.
- seaman's eye.** . To estimate your position without navigational instruments by utilizing distances and angles obtained from instinctive knowledge and experience of the local maritime environment.
- seamark.** , *n.* See MARK, *n.*, definition 1.
- sea mile.** . An approximate mean value of the nautical mile equal to 6,080 feet; the length of a minute of arc along the meridian at latitude 48°.
- sea mist.** . See STEAM FOG.
- seamount.** , *n.* On the sea floor, an elevation rising generally more than 1,000 meters and of limited extent across the summit.
- sea quadrant.** . See BACKSTAFF.
- search and rescue chart.** . A chart designed primarily for directing and conducting search and rescue operations.
- search and rescue radar transponder (SART).** . An electronic device which transmits a homing signal on the radar frequency used by rescue ships and aircraft.
- sea reach.** . The reach of a channel entering a harbor from seaward.
- sea return.** . Clutter on the radarscope which is the result of the radar signal being reflected from the sea, especially near the ship. Also called SEA CLUTTER. See also CLUTTER.
- sea room.** . Space in which to maneuver without danger of grounding or colliding.
- seashore.** , *n.* A loose term referring to the general area in close proximity to the sea.
- season.** , *n.* 1. One of the four principal divisions of the year: spring, summer, autumn, and winter. 2. An indefinite part of the year, such as the rainy season.
- seasonal current.** . An ocean current which changes in speed or direction due to seasonal winds.
- sea-temperature difference correction.** . A correction due to a difference in the temperature of the sea and air, particularly the sextant altitude correction caused by abnormal terrestrial refraction occurring when there is a nonstandard density lapse rate in the atmosphere due to a difference in the temperature of the water and air at the surface.
- seaward.** , *adj.* In a direction away from the land; toward the sea.
- seaward.** , *adv.* Away from the land; toward the sea.
- seaward boundary.** . Limits of any area or zone offshore from the mean low, or mean lower low water line and established by an act of the U.S. Congress.
- seaway.** , *n.* 1. A moderately rough sea. Used chiefly in the expression in a seaway. 2. The sea as a route of travel from one place to another; a shipping lane.
- secant.** , *n.* 1. The ratio of the hypotenuse of a plane right triangle to the side adjacent to one of the acute angles of the triangle, equal to  $1/\cos$ . The expression NATURAL SECANT is sometimes used to distinguish the secant from its logarithm (called LOGARITHMIC SECANT). 2. A line that intersects another, especially a straight line intersecting a curve at two or more points.
- secant conic chart.** . See CONIC CHART WITH TWO STANDARD PARALLELS.
- secant conic map projection.** . See CONIC MAP PROJECTION WITH TWO STANDARD PARALLELS.
- Secchi disk.** , *n.* A metal disk used for measuring water clarity. Users lower the disk into the water and record the depth at which it is no longer visible.
- second.** , *n.* 1. The base unit of time in the International System of Units. In 1967 the second was defined by the Thirteenth General Conference on Weights and Measures as the duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium-133 atom. This value was established to agree as closely as possible with the ephemeris second. Also called ATOMIC SECOND. See also ATOMIC TIME. 2. A sixtieth part of a minute in either time or arc.
- secondary.** , *n.* A small low pressure area accompanying a large or primary one. The secondary often grows at the expense of the primary, eventually replacing it.
- secondary circle.** . See SECONDARY GREAT CIRCLE.
- secondary control tide station.** . A tide station at which continuous observations have been made over a minimum period of 1 year but less than a 19-year Metonic cycle. The series is reduced by comparison with simultaneous observations from a primary control tide station. This station provides for a 365-day harmonic analysis including the seasonal fluctuation of sea level. See also PRIMARY CONTROL TIDE STATION; SUBORDINATE TIDE STATION, definition 1; TERTIARY TIDE STATION; TIDE STATION.
- secondary great circle.** . A great circle perpendicular to a primary great circle, as a meridian. Also called SECONDARY CIRCLE.
- secondary light.** . A major light, other than a primary seacoast light, established at harbor entrances and other locations where high intensity and reliability are required. See also MINOR LIGHT.
- secondary phase factor correction.** . A correction for additional time (or phase delay) for transmission of a low frequency signal over an all seawater path when the signal transit time is based on the free-space velocity. See also ADDITIONAL SECONDARY PHASE FACTOR CORRECTION.
- secondary radar.** . 1. Radar in which the target is fitted with a transponder and in which the target retransmits automatically on the interrogating frequency, or a different frequency. The response may be coded. See also PRIMARY RADAR, RACON, RAMARK. 2. As defined by the International Telecommunication Union (ITU), a radiodetermination system based on the comparison of reference signals with radio signals re-transmitted from the position to be determined.
- secondary radiation.** . See RERADIATION, definition 2.
- secondary station.** . In a radionavigation system, the station of a chain whose emissions are made with reference to the emissions of a master station without being triggered by the emissions of such station.
- secondary tide station.** . See as SECONDARY CONTROL TIDE STATION.
- second reduction.** . See PHASE REDUCTION.
- second-trace echo.** . A radar echo received from a target after the following pulse has been transmitted. Second-trace echoes are unusual except under abnormal atmospheric conditions, or conditions under which super-refraction is present, and are received from targets at actual ranges greater than the radar range scale setting. They may be recognized through changes in their position on the radarscope on changing the pulse repetition rate; their hazy, streaky or distorted shape; and their erratic movements on plotting. Also called MULTIPLE-TRACE ECHO.
- second-year ice.** . Old ice which has survived only one summer's melt. Because it is thicker and less dense than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.
- sector.** , *n.* 1. Part of a circle bounded by two radii and an arc. See also RED SECTOR. 2. Something resembling the sector of a circle, as a warm sector between the warm and cold fronts of a cyclone.
- sector display.** . A radar display in which a high persistence screen is excited only when the radar beam is within a narrow sector which can be selected at will.
- sector light.** . A light having sectors of different colors or the same color in specific sectors separated by dark sectors.
- sector scanning.** . In the use of radar, the process of scanning within a sector as opposed to scanning around the horizon.
- secular.** , *adj.* Of or pertaining to a long period of time.
- secular aberration.** . See under ABERRATION, definition 1.
- secular error.** . That error in the reading of an instrument due to secular change within the materials of the instrument.
- secular perturbations.** . Perturbations of the orbit of a planet or satellite that continue to act in one direction without limit, in contrast to

periodic perturbations which change direction in a regular manner.  
**secular terms.** . In the mathematical expression of the orbit of a satellite, terms which are proportional to time, resulting in secular perturbations. See also PERIODIC TERMS.

**secular trend.** . See APPARENT SECULAR TREND.

**seiche.** , *n.* A stationary wave usually caused by strong winds and/or changes in barometric pressure. It is usually found in lakes and semi-enclosed bodies of water. It may also be found in areas of the open ocean. See also STANDING WAVE.

**Seismic sea wave.** . See as TSUNAMI.

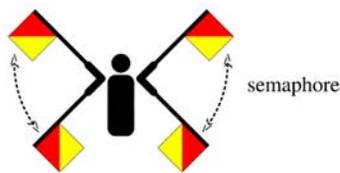
**selective availability.** . A Department of Defense program which degrades the accuracy of the pseudorange measurement of the GPS signal by dithering the clock time and ephemerides data, providing a less accurate fix for civilian users. It can be turned on or off at will by DoD.

**selective fading.** . 1. Fading of the skywave in which the carrier and various sideband frequencies fade at different rates, causing audio-frequency distortion. 2. Fading that affects the different frequencies within a specified band unequally. 3. Fading in which the variation in the received signal strength is not the same for all frequencies in the frequency band of the received signal. See also FADING.

**selectivity.** , *n.* 1. The characteristic of a radio receiver which enables it to differentiate between the desired signal and those of other frequencies. 2. The ability of a receiver to reject transmissions other than the one to which tuned. 3. The degree to which a radio receiver can accept the signals of one station while rejecting those of stations on adjacent channels. See also SENSITIVITY.

**selenographic.** , *adj.* Of or pertaining to the physical geography of the moon.

**semaphore.** , *n.* A device using visual signals, usually bodies of defined shapes or positions or both, by which information can be transmitted.



**semi-** . A prefix meaning half.

**semi-automatic updating.** . In ECDIS, the application of CORRECTIONS to ENC DATA in the SENC updating in a fully integrated state, by hard media or telecommunications transfer in a manner which requires human intervention at the ECDIS interface.

**semicircle.** , *n.* Half of a circle. See also DANGEROUS SEMICIRCLE, LESS DANGEROUS SEMICIRCLE, NAVIGABLE SEMICIRCLE.

**semicircular deviation.** . Deviation which changes sign (E or W) approximately each 180° change of heading.

**semidiameter.** , *n.* 1. Half the angle at the observer subtended by the visible disk of a celestial body. Sextant altitudes of the sun and moon should be corrected for semidiameter unless the center is observed. 2. The radius of a circle or sphere.

**semidiameter correction.** . A correction due to semidiameter, particularly that sextant altitude correction, when applied to the observation of the upper or lower limb of a celestial body, determines the altitude of the center of that body.

**semidiurnal.** , *adj.* Having a period or cycle of approximately one-half of a day. The predominating type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day. The tidal current is said to be semidiurnal when there are two flood and two ebb periods each tidal day. A semidiurnal constituent has two maxima and minima each constituent day. See also TYPE OF TIDE.

**semidiurnal current.** . Tidal current in which tidal day current cycle consists of two flood currents and two ebb currents, separated by slack water; or two changes in direction, 360° of a rotary current. This is the most common type of tidal current throughout the world.

**semidiurnal tide.** . See under TYPE OF TIDE, SEMIDIURNAL, *adj.*

**semilogarithmic coordinate paper.** . Paper ruled with two sets of mutually-perpendicular parallel lines, one set being spaced accord-

ing to the logarithms of consecutive numbers, and the other set uniformly spaced.

**semimajor axis.** . One-half of the longest diameter of an ellipse.

**semiminor axis.** . One-half of the shortest diameter of an ellipse.

**semi-reflecting mirror.** . See DICHROIC MIRROR.

**SENC.** . See SYSTEM ELECTRONIC NAVIGATIONAL CHART.

**sense.** , *n.* The solution of the 180° ambiguity present in some radio direction finding systems.

**sense antenna.** . An antenna used to resolve a 180° ambiguity in a directional antenna.

**sense finding.** . The process of eliminating 180° ambiguity from the bearing indication some types of radio direction finder.

**sensibility.** , *n.* The ability of a magnetic compass card to align itself with the magnetic meridian after deflection.

**sensible horizon.** . The circle of the celestial sphere formed by the intersection of the celestial sphere and a plane through any point, such as the eye of an observer, and perpendicular to the zenith-nadir line. See also HORIZON.

**sensitive axis.** . 1. The axis of an accelerometer along which specific acceleration is measured. 2. See also INPUT AXIS.

**sensitivity.** , *n.* The minimum input signal required to produce a specified output signal from a radio or similar device, having a specific signal-to-noise ratio. See also SELECTIVITY.

**sensitivity time control.** . An electronic circuit designed to reduce automatically the sensitivity of the radar receiver to nearby targets. Also called SWEPT GAIN, ANTI-CLUTTER GAIN CONTROL, ANTI-CLUTTER SEA.

**separation line.** . A line separating the traffic lanes in which ships are proceeding in opposite or nearly opposite directions, or separating a traffic lane from the adjacent inshore traffic zone. See also ROUTING SYSTEM, SEPARATION ZONE.

**separation zone.** . A defined zone which separates traffic lanes in which ships are proceeding in opposite directions, or which separates traffic lanes from the adjacent inshore traffic zone. See also ROUTING SYSTEM, SEPARATION LINE.

**September equinox.** . See AUTUMNAL EQUINOX.

**sequenced radiobeacon.** . One of a group of marine radiobeacons in the same geographical area, except those operating continuously, that transmit on a single frequency. Each radiobeacon transmits for 1 minute of each period in sequence with other beacons of the group. If less than six radiobeacons are assigned to a group, one or more of the beacons may transmit during two 1-minute periods.

**sequence of current.** . The order of occurrence of the four tidal current strengths of a day, with special reference as to whether the greater flood immediately precedes or follows the greater ebb.

**sequence of tide.** . The order in which the four tides of a day occur, with special reference as to whether the higher high water immediately precedes or follows the lower low water.

**service area.** . The area within which a navigational aid is of use. This may be divided into primary and secondary service areas having different degrees of accuracy.

**service area diagram.** . See RELIABILITY DIAGRAM.

**service period.** . The number of days that an automatic light or buoy is expected to operate without requiring recharging.

**set.** , *n.* The direction towards which a current flows.

**set.** , *v., i.* Of a celestial body, to cross the visible horizon while descending. The opposite is RISE.

**set.** , *v., t.* To establish, as to set a course.

**set screw.** . A screw for locking a movable part of an instrument or device.

**setting a buoy.** . The act of placing a buoy on station in the water.

**settled.** , *adj.* Pertaining to weather, devoid of storms for a considerable period. See also UNSETTLED.

**seven-eighths rule.** . A rule of thumb which states that the approximate distance to an object broad on the beam equals 7/8 of the distance traveled by a craft while the relative bearing (right or left) changes from 30° or 60° or from 120° to 150°, neglecting current and wind.

**seven seas.** . Figuratively, all the waters or oceans of the world. Applied generally to the seven oceans - Arctic, Antarctic, North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian.

**seven-tenths rule.** . A rule of thumb which states that the approximate distance to an object broad on the beam equals 7/10 of the distance traveled by a craft while the relative bearing (right or left) changes from 22.5° to 45° or from 135° to 157.5°, neglecting current and wind.

**seven-thirds rule.** . A rule of thumb which states that the approximate

- distance to an object broad on the beam equals 7/3 of the distance traveled by a craft while the relative bearing (right or left) changes from 22.5° to 26.5°, 67.5° to 90°, 90° to 112.5°, or 153.5° to 157.5°, neglecting current and wind.
- sexagesimal system.** . A system of notation by increments of 60°, such as the division of the circle into 360°, each degree into 60 minutes, and each minute into 60 seconds.
- sextant.** , *n.* A double-reflecting instrument for measuring angles, primarily altitudes of celestial bodies. As originally used, the term applied only to instruments having an arc of 60°, a sixth of a circle, from which the instrument derived its name. Such an instrument had a range of 120°. In modern practice the term applies to a similar instrument, regardless of its range, very few modern instruments being sextants in the original sense. Thus, an octant, having a range of 90°; a quintant, having a range of 144°; and a quadrant, having a range of 180°, may be called sextants. A marine sextant is designed primarily for marine navigation. See also MARINE SEXTANT.
- sextant adjustment.** . The process of checking the accuracy of a sextant and removing or reducing its error.
- sextant altitude.** . Altitude as indicated by a sextant or similar instrument, before corrections are applied. See also OBSERVED ALTITUDE, APPARENT ALTITUDE.
- sextant altitude correction.** . Any of several corrections applied to a sextant altitude in the process of converting it to observed altitude. See also ACCELERATION CORRECTION, AIR TEMPERATURE CORRECTION, AUGMENTATION CORRECTION, BAROMETRIC PRESSURE CORRECTION, CORIOLIS CORRECTION, DEFLECTION OF THE VERTICAL CORRECTION, DIP CORRECTION, HEIGHT OF EYE CORRECTION, INDEX CORRECTION, INSTRUMENT CORRECTION, IRRADIATION CORRECTION, PARALLAX CORRECTION, PERSONAL CORRECTION, REFRACTION CORRECTION, SEA-AIR TEMPERATURE DIFFERENCE CORRECTION, SEMI-DIAMETER CORRECTION, TIDE CORRECTION, TILT CORRECTION, WAVE HEIGHT CORRECTION.
- sextant chart.** . See CIRCLE SHEET.
- sextant error.** . The error in reading a sextant, due either to lack of proper adjustment or imperfection of manufacture. See CALIBRATION ERROR, CENTERING ERROR, COLLIMATION ERROR, ERROR OF PERPENDICULARITY, GRADUATION ERROR, INDEX ERROR, INSTRUMENT ERROR, PRISMATIC ERROR, SHADE ERROR, SIDE ERROR, VERNIER ERROR.
- shade.** , *n.* See SHADE GLASS.
- shaded relief.** . A cartographic technique that provides an apparent three-dimensional configuration of the terrain on maps and charts by the use of graded shadows that would be cast if light were shining from the northwest. Shaded relief is usually used in combination with contours.
- shade error.** . The error of an optical instrument due to refraction in the shade glasses. If this effect is due to lack of parallelism of the faces it is usually called PRISMATIC ERROR.
- shade glass.** . A darkened transparent glass that can be moved into the line of sight of an optical instrument, such as a sextant, to reduce the intensity of light reaching the eye. Also called SHADE.
- shadow.** , *n.* 1. Darkness in a region, caused by an obstruction between the source of light and the region. By extension, the term is applied to similar condition when any form of radiant energy is cut off by an obstruction, as in a radar shadow. The darkest part of a shadow in which light is completely cut off is called the UMBRA; the lighter part surrounding the umbra in which the light is only partly cut off is called the PENUMBRA. 2. A region of diminished rainfall on the lee side of a mountain or mountain range, where the rainfall is noticeably less than on the windward side. Usually called RAIN SHADOW.
- shadow bands.** . See CREPUSCULAR RAYS.
- shadow bar.** . A rod or bar used to cast a shadow, such as on the sighting assembly of an astro compass.
- shadow pin.** . A small rod or pin used to cast a shadow on an instrument, such as a magnetic compass or sun compass, to determine the direction of the luminary; a GNOMON.
- shadow region.** . A region shielded from radar signals because of an intervening obstruction or absorbing medium. This region appears as an area void of targets on a radar display such as a plan position indicator. The phenomenon is called RADAR SHADOW. See also SHADOW SECTOR, BLIND SECTOR.
- shadow sector.** . A sector on the radarscope in which the appearance of radar echoes is improbable because of an obstruction near the antenna. While both blind and shadow sectors have the same basic cause, blind sectors generally occur within the larger angles subtended by the obstruction. See also SHADOW REGION.
- shallow.** , *adj.* Having little depth; shoal.
- shallow.** , *n.* An area where the depth of water is relatively slight.
- shallow water constituent.** . A short-period harmonic term introduced into the formula of tidal (or tidal current) constituents to take account of the change in the form of a tide wave resulting from shallow water conditions. Shallow water constituents include the overtides and compound tides.
- shallow water wave.** . A wave is classified as a shallow water wave whenever the ratio of the depth (the vertical distance of the still water level from the bottom) to the wave length (the horizontal distance between crests) is less than 0.04. Tidal waves are shallow water waves.
- shamal.** , *n.* A northwesterly wind blowing over Iraq and the Persian Gulf, in summer, often strong during the day, but decreasing during the night.
- sharki.** , *n.* A southeasterly wind which sometimes blows in the Persian Gulf.
- shearing.** , *n.* An area of pack ice is subject to shear when the ice motion varies significantly in the direction normal to the motion, subjecting the ice to rotational forces. These forces may result in phenomena similar to a FLAW.
- sheet line.** . See NEATLINE.
- shelf.** , *n.* A zone adjacent to a continent, or around an island, that extends from the low water line to a depth at which there is usually a marked increase of slope towards oceanic depths.
- shelf valley.** . A valley on the shelf, generally the shoreward extension of a canyon.
- shield.** , *n.* A metal housing around an electrical or magnetic element to eliminate or reduce the effect of its electric or magnetic field, or to reduce the effect of an exterior field on the element.
- shielding factor.** . The ratio of the strength of the magnetic field at a compass to the strength if there were no disturbing material nearby; usually expressed as a decimal. Because of the metal of a vessel, the strength of the earth's magnetic field is reduced somewhat at a compass location aboard ship. The shielding factor is one minus the percentage of reduction.
- shimmer.** , *v., i.* To appear tremulous or wavering due to varying atmospheric refraction in the line of sight.
- shingle.** , *n.* See under STONES.
- ship.** , *n.* Originally a sailing vessel with three or more masts, square-rigged on all. The term is now generally applied to any large, ocean-going vessel, except submarines which are called boats regardless of size.
- ship earth station (SES).** . An INMARSAT satellite system installed aboard a vessel.
- ship error.** . The error in radio direction finder bearings due to reradiation of radio waves by the metal of the ship.
- ship motions.** . Surge is the bodily motion of a ship forward and backward along the longitudinal axis, caused by the force of the sea acting alternately on the bow and stern; heave is the oscillatory rise and fall due to the entire hull being lifted by the force of the sea; sway is the side-to-side bodily motion, independent of rolling caused by uniform pressure being exerted all along one side of the hull; yaw is the oscillation about a vertical axis approximately through the center of gravity of the vessel; roll is the oscillation about the longitudinal axis; and pitch is oscillation about the transverse axis, due to the bow and stern being raised or lowered on passing through successive crests and troughs of waves.
- shipping lane.** . An established route traversed by ocean shipping.
- ship's emergency transmitter.** . As defined by the International Telecommunication Union (ITU) a ship's transmitter to be used exclusively on a distress frequency for distress, urgency or safety purposes.
- ship's head.** . Heading of a vessel.
- ship simulator.** . A computerized system which uses video projection techniques to simulate navigational and shiphandling situations. A full capability system includes a completely equipped ship's bridge and can duplicate almost any aspect of ship operation; partial systems focus on a particular function, such as radar collision avoidance or nighttime navigation.

- Ships' Routing.** . A publication of the International Maritime Organization (IMO) which describes the general provisions of ships' routing, traffic separation schemes, deep water routes and areas to be avoided, which have been adopted by IMO. All details of routing systems are promulgated through *Notices to Mariners* and *Sailing Directions* and are depicted on charts.
- ship weather routing.** . A procedure whereby an optimum route is developed based on the forecasts of weather and seas and the ship's characteristics for a particular transit. Within specified limits of weather and sea conditions, ship weather routing seeks maximum safety and crew comfort, minimum fuel consumption, minimum time underway, or any desired combination of these factors.
- shoal.** , *adj.* Shallow.
- shoal.** , *n.* An offshore hazard to navigation on which there is a depth of 16 fathoms or 30 meters or less, composed of unconsolidated material. See also REEF.
- shoal.** , *v., i.* To become less deep.
- shoal.** , *v., t.* To cause to become less deep.
- shoaling.** . A process wherein waves encounter shallow water resulting in reduced wave speed. As the wave speed slows, the period remains the same, so the wavelength becomes shorter. Since the energy in the waves remains the same, the shortening of wavelengths results in increased heights.
- shoal patches.** . Individual and scattered elevations of the bottom, with depths of 16 fathoms (or 30 meters) or less, but composed of any material except rock or coral.
- shoal water.** . Shallow water; water over a shoal.
- shoot.** , *v., t.* To observe the altitude of (a celestial body).
- shooting star.** . See METEOR.
- shore.** , *n.* That part of the land in immediate contact with a body of water including the area between high and low water lines. The term SHORE is usually used with reference to the body of water and COAST with reference to the land, as the east coast of the United States is part of the western shore of Atlantic Ocean. The term SHORE usually refers to a narrow strip of land in immediate contact with any body of water, while COAST refers to a general region in proximity to the sea. A shore bordering the sea may be called a SEASHORE. See also FORESHORE, BACKSHORE.
- shoreface.** , *n.* The narrow zone seaward from the low tide shoreline, permanently covered by water, over which the beach sands and gravels actively oscillate with changing wave conditions.
- shore lead.** . A lead between pack ice and the shore or between pack ice and an ice front.
- shoreline.** , *n.* The intersection of the land with the water surface. The shoreline shown on charts represents the line of contact between the land and a selected water elevation.
- shore polynya.** . See under POLYNYA.
- short period perturbations.** . Periodic perturbations in the orbit of a planet or satellite which execute one complete periodic variation in the time of one orbital period or less.
- short range systems.** . Radionavigation systems limited in their positioning capability to coastal regions, or those systems limited to making landfall. See also MEDIUM RANGE SYSTEMS, LONG RANGE SYSTEMS.
- short sea.** . A sea in which the waves are short, irregular, and broken.
- short wave.** . A radio wave shorter than those of the standard broadcast band. See also WAVE, definition 2.
- shower.** , *n.* Precipitation from a convective cloud. Showers are characterized by the suddenness with which they start and stop, by the rapid changes of intensity, and usually by rapid changes in the appearance of the sky. In weather observing practice, showers are always reported in terms of the basic type of precipitation that is falling, i.e., rain showers, snow showers, sleet showers.
- shuga.** , *n.* An accumulation of spongy white ice lumps, a few centimeters across, the lumps are formed from grease ice or slush and sometimes from anchor ice rising to the surface.
- side echo.** . The effect on a radar display by a side lobe of a radar antenna. See also ECHO.
- side error.** . The error in the reading of a sextant due to nonperpendicularity of horizon glass to the frame.
- side lights.** . Running lights placed on the sides of a vessel, green to starboard and red to port, showing an unbroken light over an arc of the horizon from dead ahead to 22.5° abaft the beam.
- side lobe.** . Any lobe of the radiation pattern of a directional antenna other than the main or lobe.
- sidereal.** , *adj.* Of or pertaining to the stars, though SIDEREAL generally refers to the stars and TROPICAL to the vernal equinox, sidereal time and the sidereal day are based upon position of the vernal equinox relative the meridian. The SIDEREAL YEAR is based on the stars.
- sidereal day.** . See under SIDEREAL TIME.
- sidereal hour angle.** . Angular distance west of the vernal equinox; the arc of the celestial equator or the angle at the celestial pole between the hour circle of the vernal equinox and the hour circle of a point on the celestial sphere, measured westward from the hour circle of the equinox through 360°. Angular distance east of the vernal equinox, through 24 hours, is RIGHT ASCENSION.
- sidereal month.** . The average period of revolution of the moon with respect to the stars, a period of 27 days, 7 hours, 43 minutes, 11.5 seconds.
- sidereal noon.** . See under SIDEREAL TIME.
- sidereal period.** . 1. The length of time required for one revolution of a celestial body about a primary, with respect to the stars. 2. The interval between two successive returns of an artificial earth satellite in orbit to the same geocentric right ascension.
- sidereal time.** . Time defined by the daily rotation of the earth with respect to the vernal equinox of the first point of Aries. Sidereal time is numerically measured by the hour angle of the equinox, which represents the position of the equinox in the daily rotation. The period of one rotation of the equinox in hour angle, between two successive upper meridian transits, is a sidereal day. It is divided into 24 sidereal hours, reckoned at upper transit which is known as sidereal noon. The true equinox is at the intersection of the true celestial equator of date with the ecliptic of date; the time measured by its daily rotation is apparent sidereal time. The position of the equinox is affected by the nutation of the axis of rotation of the earth, and the nutation consequently introduces irregular periodic inequities into the apparent sidereal time and the length of the sidereal day. The time measured by the motion of the mean equinox of date, affected only by the secular inequalities due to the precession of the axis, is mean sidereal time. The maximum difference between apparent mean sidereal times is only a little over a second and its greatest daily change is a little more than a hundredth of a second. Because of its variable rate, apparent sidereal time is used by astronomers only as a measure of epoch; it is not used for time interval. Mean sidereal time is deduced from apparent sidereal time by applying the equation of equinoxes.
- sidereal year.** . The period of one apparent rotation of the earth around the sun, with relation to a fixed point, or a distant star devoid of proper motion, being 365 days, 6 hours, 9 minutes and 9.5 seconds in 1900, and increasing at a rate of rate of 0.0001 second annually. Because of the precession of the equinoxes this is about 20 minutes longer than a tropical year.
- sight.** , *n.* Observation of the altitude, and sometimes also the azimuth, of a celestial body for a line of position; or the data obtained by such observation. An observation of a celestial body made by facing 180° from the azimuth of the body is called a back sight. See also NOON SIGHT, TIME SIGHT.
- sighting vane.** . See VANE, definition 2.
- sight reduction.** . The process of deriving from a sight the information needed for establishing a line of position.
- sight reduction tables.** . Tables for performing sight reduction, particularly those for comparison with the observed altitude of a celestial body to determine the altitude difference for establishing a line of position.
- Sight Reduction Tables for Air Navigation.** . See PUB. NO. 249.
- Sight Reduction Tables for Marine Navigation.** . See PUB. NO. 229.
- signal.** , *n.* 1. As applied to electronics, any transmitted electrical impulse. 2. That which conveys intelligence in any form of communication, such as a time signal or a distress signal.
- signal-to-noise ratio.** . The ratio of the magnitude of the signal to that of the noise, often expressed in decibels.
- signature.** , *n.* The graphic record of the magnetic or acoustic properties of a vessel.
- sign conventions.** . See as GEOGRAPHIC SIGN CONVENTIONS.
- significant digits.** . Those digits of a number which have a significance, zeros at the left and sometimes those at the right being excluded.
- sikussak.** , *n.* Very old ice trapped in fjords. Sikussak resembles glacier ice, since it is formed partly from snow.
- sill.** , *n.* On the sea floor, the low part of a gap or saddle separating basins.

- See also DOCK SILL.
- sill depth.** . The depth over a sill.
- silt.** , *n.* See under MUD.
- similar decimals.** . Decimals having the same number of decimal places, as 3.141 and 0.789. Decimals can be made similar by adding the appropriate number of zeros. For example, 0.789 can be made similar to 3.1416 by stating it as 0.7890. See also REPEATING DECIMAL, SIGNIFICANT DIGITS.
- simple conic chart.** . A chart on a simple conic projection.
- simple conic map projection.** . A conic map projection in which the surface of a sphere or spheroid, such as the earth, is conceived as developed on a tangent cone, which is then spread out to form a plane.
- simple harmonic motion.** . The projection of uniform circular motion on a diameter of the circle of such motion. The combination of two or more simple harmonic motions results in COMPOUND HARMONIC MOTION.
- simplified symbols.** . In ECDIS, SYMBOLS designed specifically for fast draw and to give the maximum clarity under all conditions of viewing the CRT. They are less complex than the equivalent paper CHART SYMBOLS.
- simultaneous altitudes.** . Altitudes of two or more celestial bodies observed at the same time.
- simultaneous observations (of a satellite).** . Observations of a satellite that are made from two or more distinct points or tracking stations at exactly the same time.
- sine.** , *n.* The ratio of the side opposite an angle of a plane right triangle to the hypotenuse. The expression NATURAL SINE is used to distinguish the sine from its logarithm (called LOGARITHMIC SINE).
- sine curve.** . Characteristic simple wave pattern; a curve which represents the plotted values of sines of angles, with the sine as the ordinate and the angle as the abscissa. The curve starts at 0 amplitude at the origin, increases to a maximum at 90°, decreases to 0 at 180°, increases negatively to a maximum negative amplitude at 270°, and returns to 0 at 360°, to repeat the cycle. Also called SINUSOID.
- sine wave.** . A simple wave in the form of curve.
- single astronomic station datum orientation.** . Orientation of a geodetic datum by accepting the astronomically determined coordinates of the origin and the azimuth to one other station without any correction.
- single-axis normal distribution.** . A one-time normal distribution along an axis perpendicular to a line of position. Two single-axis normal distributions may be used to establish the error ellipse and the corresponding circle of equivalent probability when the error distribution is two-dimensional or bivariate.
- single-degree-of-freedom gyro.** . A gyroscope, the spin axis of which is free to rotate about one of the orthogonal axes, the spin axis not being counted. See also DEGREE-FREEDOM, RATE GYRO.
- single-flashing light.** . See under FLASHING LIGHT.
- single interpolation.** . Interpolation with only one argument or variable.
- single-occulting light.** . See under OCCULTING LIGHT.
- single-sideband transmission.** . A method of transmission in which the frequencies produced by the process of modulation on one side of the carrier are transmitted and those on the other side are suppressed. The carrier frequency may either be transmitted or suppressed. With this method, less power is required for the effective signal at the receiver, a narrower frequency band can be used, and the signal is less subject to man-made interference or selective fading.
- single station range light.** . A directional light bound by other sectors of different characteristic which define its margins with small angular uncertainty. Most commonly the bounding sectors are of different colors (red and green).
- sinking.** , *n.* An apparent lowering of distant terrestrial objects by abnormal atmospheric refraction. Because of sinking, objects normally visible near the horizon sometimes disappear below the horizon. The opposite is LOOMING.
- sinusoid.** , *n.* See SINE CURVE.
- sinusoidal.** , *adj.* Of or pertaining to a sine wave or sinusoid.
- siren.** , *n.* A sound signal emitter using the periodic escape of compressed air through a rotary shutter.
- sirocco.** , *n.* A warm wind of the Mediterranean area, either a foehn or a hot southerly wind in advance of a low pressure area moving from the Sahara or Arabian deserts. Called LEVECHE in Spain.
- skeleton tower.** . A tower, usually of steel and often used for navigation aids, constructed of open legs with various horizontal and diagonal bracing members.
- skip distance.** . The least distance from a transmitting antenna at which a skywave can normally be received at a given frequency.
- skip zone.** . The area between the outer limit of reception of groundwaves and the inner limit of reception of skywaves, where no signal is received.
- sky diagram.** . A diagram of the heavens, indicating the apparent position of various celestial bodies with reference to the horizon system of coordinates.
- skylight.** , *n.* Thin plates in the ice canopy, usually less than 1 meter thick and appearing from below as relatively light, translucent patches in dark surroundings. The under-surface of a skylight is normally flat, but may have ice keels below. Skylights are called large if big enough for a submarine to attempt to surface through them, or small if not.
- sky map.** . The pattern on the underside of extensive cloud areas, created by the varying amounts of light reflected from the earth's surface. Snow surfaces produce a white glare (SNOW BLINK) and ice surfaces produce a yellowish-white glare (ICE BLINK). Bare land reflects relatively little light (LAND SKY) and open water even less (WATER SKY).
- skywave.** , *n.* A radio wave that is propagated by way of the ionosphere. Also called IONOSPHERIC WAVE.
- skywave correction.** . The correction to be applied to the time difference reading of signals received via the ionosphere to convert it to the equivalent groundwave reading. The correction for a particular place is established on the basis of an average height of the ionosphere.
- skywave error.** . See IONOSPHERIC ERROR.
- skywave transmission delay.** . The amount by which the time of transit from transmitter to receiver of a pulse carried by skywaves reflected once from the E-layer exceeds the time of transit of the same pulse carried by groundwaves.
- slack water.** . The state of a tidal current when its speed is near zero, especially the moment when a reversing current changes direction and its speed is zero. The term is also applied to the entire period of low speed near the time of turning of the current when it is too weak to be of any practical importance in navigation. The relation of the time of slack water to the tidal phases varies in different localities. For standing tidal waves, slack water occurs near the times of high and low water, while for progressive tidal waves, slack water occurs midway between high and low water.
- slant range.** . The line-of-sight distance between two points not at the same elevation.
- slave station.** . (*antiquated, possibly offensive*) In a radionavigation system, the station of a chain whose emissions are made with reference to the emissions of a master station, its emissions being triggered by the emissions of the master station. See also SECONDARY STATION.
- sleet.** , *n.* See under ICE PELLETS; colloquially some parts of the United States, precipitation the form of a mixture of rain and snow.
- slewing.** , *n.* In ice navigation, the act of forcing a ship through ice by pushing apart adjoining ice floes.
- slick.** , *n.* A smooth area of water, such as one caused by the sweep of a vessel's stern during a turn, or by a film of oil on the water.
- slime.** , *n.* Soft, fine, oozy mud or other substance of similar consistency.
- slip.** , *n.* 1. A berthing space between two piers. Also called DOCK. 2. The difference between the distance a propeller would travel longitudinally in one revolution if operating in a solid and the distance it travels through a fluid.
- slope.** , *n.* On the sea floor, the slope seaward from the shelf edge to the beginning of a continental or insular rise or the point where there is a general reduction in slope.
- slot radiator.** . A slot in the wall of a slotted wave guide antenna which acts as a radiating element.
- slotted guide antenna.** . See SLOTTED WAVE GUIDE ANTENNA.
- slotted wave guide antenna.** . An antenna consisting of a metallic waveguide in the walls of which are cut one or more slot radiators.
- slough.** (sloo), *n.* A minor marshland or tidal waterway which usually connects other tidal areas; often more or less equivalent to a bayou occasionally applied to the sea level portion of a creek on the U.S. West Coast.
- slow-sweep racon.** . See under SWEPT-FREQUENCY RACON.
- slue.** , *n.* A slough or swamp.

**sluice**, *n.* A floodgate. sluicing pond. See SCOURING BASIN.

**slush**, *n.* Snow which is saturated and mixed with water on land or ice surfaces, or which is viscous floating mass in water after a heavy snow fall.

**small area plotting sheet**. For a relatively small area, a good approximation of a Mercator position plotting sheet, constructed by the navigator by either of two methods based upon graphical solution of the secant of the latitude which approximates the expansion. A partially completed small area plotting sheet printed in advance for later rapid completion according to requirements is called UNIVERSAL PLOTTING SHEET.

**small circle**. The intersection of a sphere and plane which does not pass through its center.

**small diurnal range**. The difference in height between mean lower high water and mean higher low water. Applicable only when the type of tide is either semidiurnal or mixed. See also TROPIC RANGES.

**small floe**. See under FLOE.

**small fracture**. See under FRACTURE.

**small hail**. See under ICE PELLETS.

**small iceberg**. For reports to the International Ice Patrol, an iceberg that extends 4 to 50 feet (1 to 15 meters) above the sea surface and which has a length of 20 to 200 feet (6 to 60 meters). See also MEDIUM ICEBERG, LARGE ICEBERG.

**small ice cake**. A flat piece of ice less than 2 meters across.

**small ice field**. See under ICE FIELD.

**small scale**. A scale involving a relatively large reduction in size. A small-scale chart usually covers a large area. The opposite is LARGE SCALE, which covers a small area. See also REPRESENTATIVE FRACTION.

**small-scale chart**. See under CHART. See also SMALL SCALE.

**small tropic range**. The difference in height between tropic lower high water and tropic higher low water. Applicable only when the type of tide is either semidiurnal or mixed. See also MEAN TROPIC RANGE, GREAT TROPIC RANGE.

**smell the bottom**. See FEEL THE BOTTOM.

**smog**, *n.* Originally a natural fog contaminated by industrial pollutants, or a mixture of smoke and fog. Today, smog is a common term applied to visible air pollution with or without fog.

**smoke**, *n.* Small particles of carbon and other solid matter, resulting from incomplete combustion, suspended in the air. When it settles, it is called SOOT.

**smokes**, *n., pl.* Dense white haze and dust clouds common in the dry season on the Guinea coast of Africa, particularly at the approach of the harmattan.

**smooth sea**. Sea with waves no higher than ripples or small wavelets.

**snow**, *n.* 1. Frozen precipitation consisting of translucent or white ice crystals which fall either separately or in loose clusters called snowflakes. Very fine, simple crystals, or minute branched, star-like snowflakes are called snow grains. Snow pellets are white, opaque, roundish grains which are crisp and easily compressible, and may rebound or burst when striking a hard surface. Snow is called brown, red, or yellow when it is colored by the presence of brown dust, red dust or algae, or pine or cypress pollen, respectively. See also BLOWING SNOW, DRIFTING SNOW. 2. The speckled background on the plan position indicator or video display due to electrical noise.

**snow barchan**. See under SNOWDRIFT.

**snow blink**. A white glare on the underside of extensive cloud areas, created by light reflected from snow-covered surfaces. Snow blink is brighter than the yellowish-white glare of ICE BLINK. Clouds above bare land or open water have no glare. See also LAND SKY, WATER SKY, SKY MAP.

**snowdrift**, *n.* An accumulation of wind-blown snow deposited in the lee of obstructions or heaped by wind eddies. A crescent-shaped snowdrift, with ends pointing downwind, is called a SNOW BARCHAN.

**snowflake**, *n.* A loose cluster of ice crystals, or rarely, a single crystal.

**snow flurry**. A popular term for SNOW SHOWER, particularly of a very light and brief nature.

**snow grains**. Frozen precipitation consisting of very fine, single crystals, or of minute, branched star-like snowflakes. Snow grains are the solid equivalent of drizzle. Also called GRANULAR SNOW.

**snow pellets**. Frozen precipitation consisting of small, white, opaque, roundish grains of snowlike structure which are crisp and easily compressible, and may rebound or burst when striking a hard surface. Also called SOFT HAIL, GRAUPEL. See also SMALL

HAIL.

**snow storm**. See under STORM, definition 2.

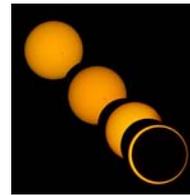
**soft hail**. See SNOW PELLETS.

**soft iron**. Iron or steel which is easily magnetized by induction, but loses its magnetism when the magnetic field is removed. The opposite is HARD IRON.

**solar**, *adj.* Of or pertaining to the sun.

**solar day**. 1. The duration of one rotation of the earth on its axis, with respect to the sun. This may be either a mean solar day, or an apparent solar day, as the reference is the mean or apparent sun, respectively. 2. The duration of one apparent rotation of the sun.

**solar eclipse**. An eclipse of the sun. When the moon passes between the sun and the earth, the sun appears eclipsed to an observer in the moon's shadow. A solar eclipse is partial if the sun is partly obscured; total if the entire surface is obscured, or annular if a thin ring of the sun's surface appears around the obscuring body.



solar eclipse

**solar flare**. A bright eruption from the sun's chromosphere. Solar flares may appear within minutes and fade within an hour.

**solar noon**. Twelve o'clock solar time, or the instant the sun is over the upper branch of the reference meridian. Solar noon may be classified as mean if the mean sun is the reference, or as apparent if the apparent sun is the reference. It may be further classified according to the reference meridian, either the local or Greenwich meridian or additionally in the case of mean noon, a designated zone meridian. Standard, daylight saving or summer noon are variations of zone noon. Local apparent noon may also be called high noon.

**solar-radiation pressure**. A cause of perturbations of high flying artificial satellites of large diameter. The greater part is directly from the sun, a minor part is from the earth, which is usually divided into direct (reflected) and indirect terrestrial (radiated) radiation pressures.

**solar system**. The sun and other celestial bodies within its gravitational influence, including planets, planetoids, satellites, comets, and meteors.

**solar tide**. 1. The part of the tide that is due to the tide-producing force of the sun. See also LUNAR TIDE. 2. The observed tide in areas where the solar tide is dominant. This condition provides for phase repetition at about the same time each solar day.

**solar time**. Time based upon the rotation of the earth relative to the sun. Solar time may be classified as mean if the mean sun is the reference; or as apparent if the apparent sun is the reference. The difference between mean and apparent time is called EQUATION OF TIME. Solar time may be further classified according to the reference meridian, either the local or Greenwich meridian or additionally in the case of mean time, a designated zone meridian. Standard and daylight saving or summer time are variations of zone time. Time may also be designated according to the timepiece, as chronometer time or watch time, the time indicated by these instruments.

**solar year**. See TROPICAL YEAR.

**solid color buoy**. A buoy which is painted only one color above the water line.

**solitary wave**. A wave of translation consisting of a single crest rising above the undisturbed water level, without any accompanying trough, in contrast with a WAVE TRAIN. The rate of advance of a solitary wave depends upon the depth of water.

**solstice**, *n.* 1. One of the two points of the ecliptic farthest from the celestial equator; one of the two points on the celestial sphere occupied by the sun at maximum declination. That in the Northern Hemisphere is called the summer solstice and that in the Southern Hemisphere the winter solstice. Also called SOLSTITIAL POINT. 2. That instant at which the sun reaches one of the solstices about June 21 (summer solstice) or December 22 (winter solstice).

**solstitial colure**. The great circle of the celestial sphere through the celestial poles and the solstices.

- solstitial point.** . One of the two points on the ecliptic at the greatest distance from the celestial equator. Also called SOLSTICE.
- solstitial tides.** . Tides occurring near the times of the solstices. The tropic range may be expected to be especially large at these times.
- Somali Current.** . See EAST AFRICA COASTAL CURRENT.
- sonar.** , *n.* A system which determines distance and/or direction of an underwater object by measuring the interval of time between transmission of an underwater sonic or ultrasonic signal and the return of its echo. The name sonar is derived from the words *sound navigation and ranging*. See also ECHO RANGING.
- sonic.** , *adj.* Of, or pertaining to, the speed of sound.
- sonic depth finder.** . A direct-reading instrument which determines the depth of water by measuring the time interval between the emission of a sound and the return of its echo from the bottom. A similar instrument utilizing signals above audible range is called an ULTRASONIC DEPTH FINDER. Both instruments are also called ECHO SOUNDERS.
- sonic frequency.** . See AUDIO FREQUENCY.
- sonic navigation.** . Navigation by means of sound waves whether or not they are within the audible range. Also called ACOUSTIC NAVIGATION.
- sonne.** , *n.* A German forerunner of the CONSOL navigation system.
- sonobuoy.** , *n.* A buoy with equipment for automatically transmitting a radio signal when triggered by an underwater sound signal.
- sound.** , *n.* 1. A relatively long arm of the sea or ocean forming a channel between an island and a mainland or connecting two larger bodies of water, as a sea and the ocean, or two parts of the same body but usually wider and more extensive than a strait. The term has been applied to many features which do not fit the accepted definition. Many are very large bodies of water such as Mississippi Sound and Prince William Sound, others are mere salt water ponds or small passages between islands. 2. A vibratory disturbance in air or some other elastic medium, capable of being heard by the human ear, and generally of a frequency between about 20 and 20,000 cycles per second.
- sound.** , *v., i.* To measure the depth of the water.
- sound.** , *v., t.* For a whale or other large sea mammal to dive for an extended period of time.
- sound buoy.** . A buoy equipped with a gong, bell, whistle, or horn.
- sounding.** , *n.* Measured or charted depth of water, or the measurement of such depth. A minimum sounding chosen for a vessel of specific draft in a given area to indicate the limit of safe navigation is called a danger sounding. See also ECHO SOUNDING, LINE OF SOUNDINGS.
- sounding datum.** . Short for CHART SOUNDING DATUM.
- sounding lead.** . See under LEAD.
- sounding machine.** . An instrument for measuring depth of water, consisting essentially of a reel of wire to one end of which is attached a weight which carries a device for recording the depth. A crank or motor is provided for reeling in the wire.
- sounding sextant.** . See HYDROGRAPHIC SEXTANT.
- sound signal.** . A sound transmitted in order to convey information.
- sound signal station.** . An attended station whose function is to operate a sound signal.
- sound wave.** . An audio-frequency wave in any material medium, in which vibration is in the direction of travel, resulting in alternate compression and rarefaction of the medium, or, by extension, a similar wave outside the audible range.
- south.** , *n.* The direction 180° from north. See also CARDINAL POINT.
- South Atlantic Current.** . An eastward flowing current of the South Atlantic Ocean that is continuous with the northern edge of the WEST WIND DRIFT. It appears to originate mainly from the Brazil Current and partly from the northernmost flow of the West Wind Drift west of longitude 40°W. The current is under the influence of the prevailing westerly trade winds; the constancy and speed increase from the northern boundary to about latitude 40°S, where the current converges with the West Wind Drift. The mean speed varies from about 0.5 to 0.7 knots.
- southbound node.** . See DESCENDING NODE.
- Southeast Drift Current.** . See AZORES CURRENT.
- southeaster, sou'easter.** , *n.* A southeasterly wind, particularly a strong wind or gale.
- south equatorial current.** . See ATLANTIC SOUTH EQUATORIAL CURRENT, PACIFIC SOUTH EQUATORIAL CURRENT, INDIAN SOUTH EQUATORIAL CURRENT.
- south frigid zone.** . That part of the earth south of the Antarctic Circle.
- south geographical pole.** . The geographical pole in the Southern Hemisphere, at lat. 90°S.
- south geomagnetic pole.** . The geomagnetic pole in the Southern Hemisphere. This term should not be confused with SOUTH MAGNETIC POLE. See also GEOMAGNETIC POLE.
- South Indian Current.** . An eastward flowing current of the Indian Ocean that is continuous with the northern edge of the WEST WIND DRIFT.
- southing.** , *n.* The distance a craft makes good to the south. The opposite is NORTHING.
- south magnetic pole.** . The magnetic pole in the Southern Hemisphere. This term should not be confused with SOUTH GEOMAGNETIC POLE. See also GEOMAGNETIC POLE.
- South Pacific Current.** . An eastward flowing current of the South Pacific Ocean that is continuous with the northern edge of the WEST WIND DRIFT.
- south polar circle.** . See ANTARCTIC CIRCLE.
- South Pole.** . 1. The south geographical pole. See also MAGNETIC POLE, GEOMAGNETIC POLE. 2. The south-seeking end of a magnet. See also BLUE MAGNETISM.
- south temperate zone.** . The part of the earth between the Tropic of Capricorn and the Antarctic Circle.
- southwester, sou'wester.** , *n.* A southwest wind, particularly a strong wind or gale.
- southwest monsoon.** . See under MONSOON.
- space coordinates.** . A three-dimensional system of Cartesian coordinates by which a point is located by three magnitudes indicating distance from three planes which intersect at a point.
- spacecraft.** , *n.* Devices, manned and unmanned which are designed to be placed into an orbit about the earth or into a trajectory to another celestial body.
- space motion.** . Motion of a celestial body through space. The component perpendicular to the line of sight is called proper motion and that component in the direction of the line of sight is called radial motion.
- space-polar coordinates.** . A system of coordinates by which a point on the surface of a sphere is located in space by (1) its distance from a fixed point at the center, called the POLE; (2) the COLATITUDE or angle between the POLAR AXIS (a reference line through the pole) and the RADIUS VECTOR (a straight line connecting the pole and the point); and (3) the LONGITUDE or angle between a reference plane through the polar axis and a plane through the radius vector and polar axis. See also POLAR COORDINATES, SPHERICAL COORDINATES.
- space wave.** . See DIRECT WAVE, definition 2.
- spaghetti data.** . In ECDIS, a DATA STRUCTURE in which all lines and points are unrelated to each other (i.e. no topological RELATIONSHIPS exist in the data structure).
- spar buoy.** . A buoy in the shape of a spar, or tapered pole, floating nearly vertically. See also SPINDLE BUOY.
- spatial object.** . In ECDIS, an OBJECT which contains locational information about real world ENTITIES.
- spatial record.** . In ECDIS, the implemented term used in the IHO transfer standard data structure for a spatial object (i.e. a SPATIAL OBJECT as defined in the data model is encoded as a spatial record in the data structure). There are three types of spatial records: VECTOR, RASTER and MATRIX.
- special mark.** . See under IALA MARITIME BUOYAGE SYSTEM.
- Special Notice To Mariners.** . These notices contain important information of interest to all mariners such as cautions on the use of foreign charts; warning on use of floating aids; use of the Automated Mutual-Assistance Vessel Rescue (AMVER) system; rules, regulations, and proclamations issued by foreign governments; oil pollution regulations, etc. *Special Notice to Mariners* is published annually in *Notice to Mariners No. 1* by the National Geospatial-Intelligence Agency.
- special purpose buoy.** . A buoy used to indicate a special meaning to the mariner and having no lateral significance, such as one used to mark a quarantine or anchorage area.
- Special Warnings.** . Messages originated by the U.S. government which promulgate official warning of dangers to navigation, generally involving political situations. They remain active until canceled, and are published in *Notice to Mariners No. 1* issued by NGA.
- species of constituent.** . A classification depending upon the period of a

- constituent. The principal species are semidiurnal, diurnal, and long period.
- species sanctuary.** . A sanctuary established for the conservation of marine life. See also MARINE SANCTUARY.
- specific humidity.** . See HUMIDITY.
- spectral.** , *adj.* Of or pertaining to a spectrum.
- spectroscope.** , *n.* An optical instrument for forming spectra, very useful in studying the characteristics of celestial bodies.
- spectrum.** (*pl. spectra*), *n.* 1. A series of images formed when a beam of radiant energy is separated into its various wavelength components. 2. The entire range of electromagnetic radiation, or any part of it used for a specific purpose, such as the radio spectrum (10 kilohertz to 300 gigahertz).
- specular reflection.** . Reflection without diffusion in accordance with the laws of optical reflection, such as in a mirror. Also called REGULAR REFLECTION, MIRROR REFLECTION.
- speculum.** , *n.* An optical instrument reflector of polished metal or of glass with a film of metal.
- speed.** , *n.* Rate of motion. The terms SPEED and VELOCITY are often used interchangeably but SPEED is a scalar, having magnitude only while VELOCITY is a vector quantity, having both magnitude and direction. Rate of motion in a straight line is called linear speed, while change of direction per unit time is called angular velocity. Subsonic, sonic, and supersonic refer to speeds respectively less than, equal to, greater than the speed of sound in standard air at sea level. Transonic speeds are those in the range in which flow patterns change from subsonic to supersonic, or vice versa.
- speed circle.** . A circle having a radius equal to a given speed and drawn about a specified center. The expression is used chiefly in connection with relative movement problems.
- speed-course-latitude error.** . See SPEED ERROR.
- speed error.** . An error in both pendulous and nonpendulous type gyrocompasses resulting from movement of the gyrocompass in other than an east-west direction. The error is westerly if any component of the ship's course is north, and easterly if south. Its magnitude is proportional to the course, speed, and latitude of the ship. Sometimes called SPEED-COURSE-LATITUDE ERROR.
- speed line.** . A line of position approximately perpendicular to the course line, thus providing a check on the speed of advance. See also COURSE LINE.
- speed made good.** . The speed estimated by dividing the distance between the last fix and an EP by the time between the fix and the EP.
- speed of advance.** . 1. The speed intended to be made good along the track. 2. The average speed in knots which must be maintained during a passage to arrive at a destination at an appointed time.
- speed of relative movement.** . Speed relative to a reference point, usually itself in motion.
- speed over ground.** . The vessel's actual speed, determined by dividing the distance between successive fixes by the time between the fixes.
- speed triangle.** . See under VECTOR DIAGRAM.
- spending beach.** . In a wave basin, the beach on which the entering waves spend themselves, except for the small remainder entering the inner harbor.
- sphere.** , *n.* 1. A curved surface all points of which are equidistant from a fixed point within, called the center. The celestial sphere is an imaginary sphere of infinite radius concentric with the earth, on which all celestial bodies except the earth are imagined to be projected. The celestial sphere as it appears to an observer at the equator, where celestial bodies appear to rise vertically above the horizon, is called a right sphere; at the pole, where bodies appear to move parallel to the horizon, it is called a parallel sphere; between the equator and pole, where bodies appear to rise obliquely to the horizon, it is called an oblique sphere. Half a sphere is called a HEMISPHERE. 2. A body or the space bounded by a spherical surface. For most practical problems of navigation, the earth is considered a sphere, called the terrestrial sphere.
- spherical.** , *adj.* Of or pertaining to a sphere.
- spherical aberration.** . See under ABERRATION, definition 2.
- spherical angle.** . The angle between two intersecting great circles.
- spherical buoy.** . A buoy of which the upper part of the body (above the waterline), or the larger part of the superstructure, is spherical.
- spherical coordinates.** . A system of coordinates defining a point on a sphere or spheroid by its angular distances from a primary great circle and from a reference secondary great circle, as latitude and longitude. See also CELESTIAL COORDINATES, POLAR COORDINATES.
- spherical excess.** . The amount by which the sum of the three angles of a spherical triangle exceeds 180°.
- spherical harmonics.** . Trigonometric terms of an infinite series used to approximate a two- or three-dimensional function of locations on or above the earth.
- spherical sailing.** . Any of the sailings which solve the problems of course, distance, difference of latitude, difference of longitude, and departure by considering the spherical or spheroidal shape of the earth.
- spherical triangle.** . A closed figure having arcs of three great circles as sides.
- spherical wave.** . A wave with a spherical wave front.
- spheroid.** , *n.* An ellipsoid; a figure resembling a sphere. Also called ELLIPSOID or ELLIPSOID OF REVOLUTION, from the fact that it can be formed by revolving an ellipse about one of its axes. If the shorter axis is used as the axis of revolution, an oblate spheroid results, and if the longer axis is used, a prolate spheroid results. The earth is approximately an oblate spheroid.
- spheroidal excess.** . The amount by which the sum of the three angles on the surface of a spheroid exceeds 180°.
- spheroid of reference.** . See REFERENCE ELLIPSOID.
- spin axis.** . The axis of rotation of a gyroscope.
- spindle buoy.** . A buoy having a spindle-like shape floating nearly vertically. See also SPAR BUOY.
- spire.** , *n.* A pointed structure extending above a building, often charted with the symbol of a position circle. The spire is seldom less than two-thirds of the entire height of the structure, and its tines are rarely broken by stages or other features.
- spirit compass.** . A magnetic compass of which the bowl mounting the compass card is filled with a solution of alcohol and water.
- spit.** , *n.* A small tongue of land or a long narrow shoal (usually sand) extending from the shore into a body of water. Generally the tongue of land continues in a long narrow shoal for some distance from the shore.
- Spitzbergen Atlantic Current.** . An ocean current flowing northward and westward from a point south of Spitzbergen, and gradually merging with the EAST GREENLAND CURRENT in the Greenland Sea. The Spitzbergen Atlantic Current is the continuation of the northwestern branch of the NORWAY CURRENT. Also called SPITZBERGEN CURRENT.
- Spitzbergen Current.** . See SPITZBERGEN ATLANTIC CURRENT.
- split fix.** . A fix by horizontal sextant angles obtained by measuring two angles between four charted features, with no common center object observed.
- split-second timer.** . A watch with two sweep second hands which can be started and stopped together with one push button.
- spoil area.** . Area for the purpose of disposing dredged material, usually near dredged channels. Spoil areas are usually a hazard to navigation and navigators should avoid crossing these areas. Spoil areas are shown on nautical charts. See also DISPOSAL AREA, DUMPING GROUND DUMP SITE. Also called SPOIL GROUND.
- spoil ground.** . See SPOIL AREA.
- spoil ground buoy.** . A buoy which marks a spoil ground.
- spoil ground mark.** . A navigation mark indicating an area used for deposition of dredge spoil.
- sporadic E-ionization.** . Ionization that appears at E-layer heights, is more noticeable toward the polar regions, and is caused by particle radiation from the sun. It may occur at any time of day. A sporadic E-layer sometimes breaks away from the normal E-layer and exhibits especially erratic characteristics.
- spot elevation.** . A point on a map or chart where height above a specified datum is noted, usually by a dot and the height value.

- spot-size error.** . The distortion of the radar return on the radarscope caused by the diameter of the electron beam which displays the returns on the scope and the lateral radiation across the scope of part of the glow produced when the electron beam strikes the phosphorescent coating of the cathode-ray tube. See also PULSE-DURATION ERROR.
- spring.** , *n.* The season in the Northern Hemisphere which begins astronomically at the vernal equinox and ends at the summer solstice. In the Southern Hemisphere the limits are the autumnal equinox and the winter solstice.
- spring high water.** . See under SPRING TIDES.
- spring low water.** . See under SPRING TIDES.
- spring range.** . See under SPRING TIDES.
- spring tidal currents.** . Tidal currents of increased speed occurring semi-monthly as the result of the moon being new or full. See also SPRING TIDES.
- spring tides.** . Tides of increased range occurring semimonthly as the result of the moon being new or full. The spring range of tide is the average semidiurnal range occurring at the time of spring tides and is most conveniently computed from the harmonic constants. It is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal. The average height of the high waters of the spring tides is called spring high water or mean high water springs and the average height of the corresponding low waters is called spring low water or mean low water springs. See also SPRING TIDAL CURRENTS.
- spur.** , *n.* A terrestrial or bathymetric feature consisting of a subordinate elevation, ridge, or rise projecting outward from a larger feature.
- spurious disk.** . The round image of perceptible diameter of a star as seen through a telescope, due to diffraction of light in the telescope.
- spurious emission.** . Emission on a frequency or frequencies which are outside the necessary band, the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions and intermodulation products, but exclude emissions in the immediate vicinity of the necessary band, which are a result of the modulation process for the transmission of information.
- squall.** , *n.* A wind of considerable intensity caused by atmospheric instability. It forms and dissipates relatively quickly, and is often accompanied by thunder, lightning, and precipitation, when it may be called a thundersquall. An arched squall is one relatively high in the center, tapering off on both sides. A bull's eye squall is one formed in fair weather, characteristic of the ocean off the coast of South Africa. See also GUST, LINE SQUALL, SQUALL LINE, WHITE SQUALL.
- squall cloud.** . A small eddy cloud sometimes formed below the leading edge of a thunderstorm cloud, between the upward and downward currents.
- squall line.** . A non-frontal line or narrow band of active thunderstorms (with or without squalls); a mature instability line.
- squally.** , *adj.* Having or threatening numerous squalls.
- squamish.** , *n.* A strong and often violent wind occurring in many of the fjords of British Columbia. Squamishes occur in those fjords oriented in a northeast-southwest or east-west direction where cold polar air can be funneled westward. They are notable in Jervis, Toba, and Bute inlets and in Dean Channel and Portland Canal. Squamishes lose their strength when free of the confining fjords and are not noticeable 15 to 20 miles offshore.
- square.** , *n.* 1. A four-sided geometrical figure with all sides equal and all angles 90°; a rectangle or right-angled parallelogram with sides of equal length. 2. The second power of a quantity.
- square meter.** . The derived unit of area in the International System of Units.
- squat.** , *n.* For a vessel underway, the bodily sinkage and change of trim which are caused by the pressure distribution on the hull due to the relative motion of water and hull. The effect begins to increase significantly at depth-to-draft ratios less than 2.5. It increases rapidly with speed and is augmented in narrow channels.
- SRNC.** . See SYSTEM RASTER NAVIGATIONAL CHART DATA-BASE.
- stability.** , *n.* The state or property of resisting change or of tending to return to original conditions after being disturbed. The opposite is INSTABILITY.
- stabilization of radarscope display.** . Orientation of the radar display to some reference direction. A radarscope display is said to be STABILIZED IN AZIMUTH when the orientation of the display is fixed to an unchanging reference (usually north). The NORTH UP orientation is an example. A radarscope display is said to be UNSTABILIZED IN AZIMUTH when the orientation of the display changes with changes in own ship's heading. The HEAD UP orientation is an example. A radarscope display is said to be DOUBLY STABILIZED or to have DOUBLE STABILIZATION when the basic orientation of the display is fixed to an unchanging reference (usually north) but the radarscope is rotated to keep own ship's heading or heading flasher up on the radarscope.
- stabilized in azimuth.** . See under STABILIZATION OF RADARSCOPE DISPLAY.
- stabilized platform.** . A gimbal-mounted platform, usually containing gyros and accelerometers, the purpose of which is to maintain a desired orientation in inertial space independent of craft motion. Also called STABLE PLATFORM.
- stable platform.** . See STABILIZED PLATFORM.
- stack.** , *n.* A label on a nautical chart which indicates a tall smokestack or chimney. The term is used when the stack is more prominent as a landmark than the accompanying buildings.
- stadimeter.** , *n.* An instrument for determining the distance to an object of known height by measuring the vertical angle subtended by the object. The instrument is graduated directly in distance. See also RANGE FINDER.
- stand.** , *n.* The state of the tide at high or low water when there is no sensible change in the height of the tide. The water level is stationary at high and low water for only an instant, but the change in level near these times is so slow that it is not usually perceptible. In general, the duration of the apparent stand will depend upon the range of tide, being longer for a small range than for a large range, but where there is a tendency for a double tide the stand may last for several hours, even with a large range of tide. It may be called high water stand if it occurs at the time of high water, and low water stand if it occurs at low water. Sometimes called PLATFORM TIDE.
- standard.** , *n.* 1. Something established by custom, agreement, or authority as a basis for comparison. 2. A physical embodiment of a unit. In general it is not independent of physical conditions, and it is a true embodiment of the unit only under specified conditions.
- standard acceleration of gravity.** . The value adopted in the International Service of Weights and Measures for the standard acceleration due to gravity is 980.665 centimeters per second, per second. See also WEIGHT.
- standard atmosphere.** . 1. A unit accepted temporarily for use with the International System of Units; 1 standard atmosphere is equal to 101,325 pascals. 2. A hypothetical vertical distribution of atmospheric temperature, pressure, and density which is taken to be representative of the atmosphere for various purposes.
- standard chronometer.** . See CHRONOMETER.
- standard circle sheet.** . See CIRCLE SHEET.
- standard compass.** . A magnetic compass designated as the standard for a vessel. It is normally located in a favorable position with respect to magnetic influences.
- standard deviation.** . A measure of the dispersion of random errors about the mean value. If a large number of measurements or observations of the same quantity are made, the standard deviation is the square root of the sum of the squares of deviations from the mean value divided by the number of observations less one. The square of the standard deviation is called the VARIANCE. Also called RMS ERROR. See also ROOT MEAN SQUARE ERROR.
- standard display.** . See DISPLAY CATEGORY.
- standard error.** . See under STANDARD DEVIATION.
- standard meridian.** . 1. The meridian used for reckoning standard time. Throughout most of the world the standard meridians are those whose longitudes are exactly divisible by 15°. The DAYLIGHT SAVING MERIDIAN is usually 15° east of the standard meridian. 2. A meridian of a map projection, along which the scale is as stated.
- standard noon.** . Twelve o'clock standard time, or the instant the mean sun is over the upper branch of the standard meridian. DAYLIGHT SAVING or SUMMER NOON usually occurs 1 hour later than standard noon.
- standard parallel.** . 1. A parallel of latitude which is used as a control line in the computation of a map projection. 2. A parallel of latitude on a map or chart along which the scale is as stated for that map or

chart.

**standard propagation.** . The propagation of radio waves over a smooth spherical earth of uniform electrical characteristics, under conditions of standard refraction in the atmosphere.

**standard positioning service (SPS).** . GPS service provided to non-military users using the single-frequency C/A code. Accuracy is 100 meters 95% (2 drms) of the time with SA turned on.

**standard radio atmosphere.** . An atmosphere having the standard refractive modulus gradient.

**standard radio horizon.** . The radio horizon corresponding to propagation through the standard radio atmosphere.

**standard refraction.** . The refraction which would occur in a standard atmosphere.

**standard refractive modulus gradient.** . The uniform variation of refractive modulus with height above the earth's surface which is regarded as a standard for comparison. The gradient considered as normal has a value of 0.12M unit per meter. The M unit is the unit in terms of which the refractive modulus is expressed.

**standard station.** . Use of this term is discouraged. See REFERENCE STATION.

**standard tactical diameter.** . A prescribed tactical diameter used by different types of vessels, or by vessels of the same formation in maneuvers.

**standard time.** . The legally established time for a given zone. The United States and its possessions are, by law, divided into eight time zones. The limits of each time zone are defined by the Secretary of Transportation in Part 71, Title 49 of the *Code of Federal Regulations*. The standard time within each zone is the local mean time at the standard meridian that passes approximately through the center of the zone. Since the standard meridians are the same as those used with ZONE TIME, standard time conforms generally with the zone time for a given area. The standard time zone boundary may vary considerably from the zone time limits ( $7.5^\circ$  in longitude on each side of the standard meridian) to conform to political or geographic boundaries or both. The standard times used in various countries and places are tabulated in the *Air Almanac* and the *Nautical Almanac* and are displayed on Chart 76, *Standard Time Zone Chart of the World*.

**standard type buoy.** . The general classification of lighted and unlighted buoys in U.S. waters built to modern (1962) specifications.

**standby lamp.** . A lamp brought into service in the event of failure of the lamp in regular service.

**standby light.** . A permanently installed navigation light used in the event of failure of the main light; it is usually of lesser intensity.

**standing floe.** . A separate floe standing vertically or inclined and enclosed by rather smooth ice.

**standing wave.** . See STATIONARY WAVE.

**stand on.** . To proceed on the same course.

**standpipe.** . *n.* A label on a nautical chart which indicates a tall cylindrical structure in a waterworks system.

**star.** . *n.* A large self-luminous celestial body. Stars are generally at such great distances from the earth that they appear to the eye to be fixed in space relative to each other. Comets, meteors, and nebulae may also be self-luminous, but are much smaller. Two stars appearing close together are called a double star, an optical double star if they appear close because they are in nearly the same line of sight but differ greatly in distance from the observer, a physical double star if in nearly the same line of sight and at approximately the same distance from the observer. A system of two stars that revolve about their common center of mass is called a binary star. A group of three or more stars so close together that they appear as a single star is called a multiple star. A group of stars physically close together is called a star cluster. A variable star changes in magnitude. A star which suddenly becomes many times brighter than previously, and then gradually fades, is called a nova. The brightest planet appearing in the western sky during evening twilight is called evening star, and the brightest one appearing in the eastern sky during morning twilight is called morning star. A shooting star or meteor is a solid particle too small to be seen until it enters the earth's atmosphere, when it is heated to incandescence by friction of the air. See also GALAXY, MILKY WAY.

**starboard.** . *n.* The right side of a craft, facing forward. The opposite is PORT.

**starboard hand buoy.** . A buoy which is to be left to the starboard side

when approaching from seaward or in the general direction of buoyage, or in the direction established by the appropriate authority.

**star chain.** . A radionavigation transmitting system comprised of a master station about which three (or more) secondary stations are more or less symmetrically located.

**star chart.** . A representation, on a flat surface, of the celestial sphere or a part of it, showing the positions of the stars and sometimes other features of the celestial sphere.

**star cloud.** . A large number of stars close together, forming a congested part of a galaxy.

**star cluster.** . A group of stars physically close together. See also MULTIPLE STAR.



star cluster

**star finder.** . A device to facilitate the identification of stars. Sometimes called a STAR IDENTIFIER. See also PLANISPHERE.

**Star Finder and Identifier (No. 2102-D).** . A circular star finder and identifier, which consists of a white opaque base with an azimuthal equidistant projection of most of the celestial sphere on each side, one side having the north celestial pole at the center and the other side having the south celestial pole at the center, and a series of transparent templates, at  $10^\circ$  intervals of latitude, each template having a family of altitude and azimuth curves.

**star globe.** . A small globe representing the celestial sphere, on which the apparent positions of the stars are indicated. It is usually provided with graduated arcs and a suitable mount for determining the approximate altitude and azimuth of the stars, to serve as a star finder. Star globes are more commonly used by the British than by Americans. Also called CELESTIAL GLOBE.

**star identifier.** . See STAR FINDER.

**star telescope.** . An accessory of the marine navigational sextant designed primarily for star observations. It has a large object glass to give a greater field of view and increased illumination. It is an erect telescope, i.e., the object viewed is seen erect as opposed to the inverting telescope in which the object viewed is inverted. The latter type telescope requires one less lens than the erect telescope, consequently for the same size object glass, it has greater illumination. The telescope may be used for all observations.

**static.** . *adj.* Having a fixed, nonvarying condition.

**static.** . *n.* 1. Radio wave interference caused by natural electrical disturbances in the atmosphere, or the electromagnetic phenomena capable of causing such interference 2. Noise heard in a radio receiver caused by electrical disturbances in the atmosphere, such as lightning, northern lights, etc.

**station.** . *n.* 1. The authorized location of an aid to navigation. 2. One or more transmitters or receivers, or a combination of transmitters and receivers, including the accessory equipment necessary at one location, for carrying on a radiocommunication service.

**stationary front.** . A front which is stationary or nearly so. A front which is moving at a speed less than about 5 knots is generally considered to be stationary. In synoptic chart analysis, a stationary front is one that has not moved appreciably from its position on the last previous synoptic chart (3 or 6 hours before). Also called QUASI-STATIONARY FRONT.

**stationary orbit.** . An equatorial orbit in which the satellite revolves about the primary at the angular rate at which the primary rotates on its axis. From the primary, the satellite appears to be stationary over a point on the primary's equator. See also GEOSTATIONARY SATELLITE.

**stationary wave.** . A wave that oscillates without progressing. One-half of such a wave may be illustrated by the oscillation of the water in a pan that has been tilted. Near the axis, which is called the node or nodal line, there is no vertical rise and fall of the water. The ends of the wave are called loops and at these places the vertical

- rise and fall is at a maximum. The current is maximum near the node and minimum at the loops. The period of a stationary wave depends upon the length and depth of the body of water. A stationary wave may be resolved into two progressive waves of equal amplitude and equal speeds moving in opposite directions. Also called **STANDING WAVE**.
- stationary wave theory**. . An assumption that the basic tidal movement in the open ocean consists of a system of stationary wave oscillations, any progressive wave movement being of secondary importance except as the tide advances into tributary waters. The continental masses divide the sea into irregular basins, which, although not completely enclosed, are capable of sustaining oscillations which are more or less independent. The tide-producing force consists principally of two parts, a semidiurnal force with a period approximating the half-day and a diurnal force with a period of a whole day. Insofar as the free period of oscillation of any part of the ocean, as determined by its dimensions and depth, is in accord with the semidiurnal or diurnal tide producing forces, there will be built up corresponding oscillations of considerable amplitude which will be manifested in the rise and fall of the tide. The diurnal oscillations, superimposed upon the semidiurnal oscillations, cause the inequalities in the heights of the two high and the two low waters of each day. Although the tidal movement as a whole is somewhat complicated by the overlapping of oscillating areas, the theory is consistent with observational data.
- station buoy**. . An unlighted buoy established in the vicinity of a lightship or an important lighted buoy as a reference point in case the lightship or buoy should be dragged off station. Also called **WATCH BUOY**.
- station error**. . See **DEFLECTION OF THE VERTICAL**.
- statistical error**. . See **RANDOM ERROR**.
- steady bearing**. . A bearing line to another vessel or object, which does not change over time. An approaching or closing craft is said to be on a steady bearing if the compass bearing does not change and risk of collision therefore exists. Also called **CONSTANT BEARING**, **DECREASING RANGE (CBDR)**.
- steam fog**. . Fog formed when water vapor is added to air which is much colder than the source of the vapor. It may be formed when very cold air drifts across relatively warm water. At temperatures below about-20°F, ice particles or droplets may be formed in the air producing a type of ice fog known as frost smoke. See also **ARCTIC SEA SMOKE**, **FROST SMOKE**. Also called **ARCTIC SMOKE**, **SEA MIST**, **STEAM MIST**, **WATER SMOKE**, **ARCTIC SEA SMOKE**, **FROST SMOKE**.
- steam mist**. . See **STEAM FOG**.
- steep-to**. , *adj.* Precipitous. The term is applied particularly to a shore, bank, or shoal that descends steeply to the sea.
- steerage way**. , *n.* The condition wherein a ship has sufficient way on to respond to rudder movements to maintain a desired course.
- steering compass**. . A compass by which a craft is steered, generally meaning the magnetic compass at the helm. See **STEERING REPEATER**.
- steering repeater**. . A compass repeater by which a craft is steered. Sometimes loosely called a **STEERING COMPASS**.
- stellar**. , *adj.* Of or pertaining to stars.
- stellar observation**. . See **CELESTIAL OBSERVATION**.
- stellar parallax**. . See **HELIOCENTRIC PARALLAX**.
- stem**. , *v., t.* To make headway against a current.
- steradian**. , *n.* The supplementary unit of solid angle in the International System of Units, which, having its vertex in the center of a sphere, cuts off an area on the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.
- stereographic**. , *adj.* Of or pertaining to stereography, the art of representing the forms of solid bodies on a plane.
- stereographic chart**. . A chart on the stereographic map projection.
- stereographic map projection**. . A perspective, conformal, azimuthal map projection in which points on the surface of a sphere or spheroid, such as the earth, are conceived as projected by radial lines from any point on the surface to a plane tangent to the antipode of the point of projection. Circles project as circles except for great circles through the point of tangency, which project as straight lines. The principal navigational use of the projection is for charts of the polar regions. Also called **AZIMUTHAL ORTHOMORPHIC MAP PROJECTION**.
- sternboard**. , *n.* Making way through the water in a direction opposite to the heading. Also called **STERNWAY**, though the term **STERNBOARD** is sometimes used to refer to the beginning of motion astern and **STERNWAY** is used as the vessel picks up speed. Motion in the forward direction is called **HEADWAY**.
- stern light**. . A running light placed on the centerline of a vessel showing a continuous white light from dead astern to 67.5° to either side.
- sternway**. , *n.* Making way through the water in a direction opposite to the heading. Motion in the forward direction is called **HEADWAY**. See also **STERNBOARD**.
- stilling well**. . See **FLOAT WELL**.
- still water level**. . The level that the sea surface would assume in the absence of wind waves not to be confused with **MEAN SEA LEVEL** or **HALF TIDE LEVEL**.
- stippling**. , *n.* Graduation of shading by numerous separate dots or marks. Shallow areas on charts, for instance, are sometimes indicated by numerous dots decreasing in density as the depth increases.
- stones**. , *n., pl.* A general term for rock fragments ranging in size from 2 to 256 millimeters. An individual water-rounded stone is called a cobble if between 64 to 256 millimeters (size of clenched fist to size of man's head), a pebble if between 4 and 64 millimeters (size of small pea to size of clenched fist), and gravel if between 2 and 4 millimeters (thickness of standard pencil lead to size of small pea). An aggregate of stones ranging from 16 to 256 millimeters is called shingle. See also **MUD**; **SAND**; **ROCK**, definition 2.
- strooping**. , *n.* Apparent decrease in the vertical dimension of an object near the horizon, due to large inequality of atmospheric refraction in the line of sight to the top and bottom of the object. The opposite is **TOWERING**.
- stop watch**. . A watch that can be started, stopped, and reset at will, to indicate elapsed time.
- storm**. , *n.* 1. Wind of force 10 (48 to 55 knots or 55 to 63 miles per hour) on the Beaufort wind scale. See also **VIOLENT STORM**. 2. Any disturbed state of the atmosphere implying severe weather. In synoptic meteorology, a storm is a complete individual disturbance identified on synoptic charts as a complex of pressure, wind, clouds, precipitation, etc., or identified by such means as radar. Thus, storms range in scale from tornadoes and thunderstorms, through tropical cyclones, to widespread extra tropical cyclones. From a local and special interest viewpoint, a storm is a transient occurrence identified by its most destructive or spectacular aspect. Examples are rain storms, wind storms, hail storms, snow storms, etc. Notable special cases are blizzards, ice storms, sandstorms, and dust storms. 3. A term once used by seamen for what is now called **VIOLENT STORM** on the Beaufort wind scale.
- storm center**. . The area of lowest atmospheric pressure of a cyclone. This is a more general expression than **EYE OF THE STORM**, which refers only to the center of a well-developed tropical cyclone, in which there is a tendency of the skies to clear.
- storm surge**. . Increase or decrease in sea level by strong winds such as those accompanying a hurricane or other intense storm. Reduced atmospheric pressure often contributes to the decrease in height during hurricanes. It is potentially catastrophic, especially in deltaic regions with onshore winds at the time of high water and extreme wind wave heights. Also called **STORM TIDE**, **STORM WAVE**, **TIDAL WAVE**.
- storm tide**. . See **STORM SURGE**.
- storm track**. . The horizontal component of the path followed or expected to be followed by a storm **CENTER**.



**storm wave**. . See **STORM SURGE**.

**straight angle**. . An angle of 180°.

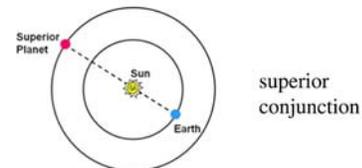
**strait**. , *n.* A relatively narrow waterway connecting two larger bodies of water.

**strand**. , *n.* See **BEACH**.

**strand**. , *v., t. & i.* To run hard aground. The term **STRAND** usually refers

- to a serious grounding, while the term **GROUND** refers to any grounding, however slight.
- stranded ice**. . Ice which has been floating and has been deposited on the shore by retreating high water.
- stranding**, , *n*. The grounding of a vessel so that it is not easily refloated; a serious grounding.
- strapped-down inertial navigation equipment**. . Inertial navigation equipment in which a stable platform and gimbal system are not utilized. The inertial devices are attached or strapped directly to the carrier. A computer utilizing gyro information resolves accelerations sensed along the carrier axes and refers these accelerations to an inertial frame of reference. Also called **GIMBALLESS INERTIAL NAVIGATION EQUIPMENT**. See also **INERTIAL NAVIGATION**.
- stratiform**, , *adj*. Descriptive of clouds of extensive horizontal development, as contrasted to the vertically developed **CUMULIFORM** types. See also **CIRRIFORM**.
- stratocumulus**, , *n*. A principal cloud type (cloud genus), predominantly stratiform, in the form of a gray and/or whitish layer or patch, which nearly always has dark parts and is non-fibrous (except for virga). Its elements are tessellated, rounded, roll-shaped, etc.; they may or may not be merged, and usually are arranged in orderly groups, lines or undulations, giving the appearance of a simple (or occasionally a cross-pattern) wave system. These elements are generally flat-topped, smooth and large; observed at an angle of more than 30° above the horizon, the individual stratocumulus element subtends an angle of greater than 5°. Stratocumulus is composed of small water droplets, sometimes accompanied by larger droplets, soft hail, and (rarely) by snowflakes. When the cloud is not very thick, the diffraction phenomena corona and irisation appear. Precipitation rarely occurs with stratocumulus. Stratocumulus frequently forms in clear air. It may also form from the rising of stratus, and by the convective or undulatory transformation of stratus, or nimbostratus, with or without change of height. Since stratocumulus may be transformed directly from or into altocumulus, stratus, and nimbostratus, all transitional stages may be observed. When the base of stratocumulus is rendered diffuse by precipitation, the cloud becomes nimbostratus. See also **STRATIFORM**, **CLOUD CLASSIFICATION**.
- stratosphere**, , *n*. The atmospheric shell extending upward from the tropopause to the height where the temperature begins to increase in the 20- to 25-kilometer region.
- stratus**, , *n*. A low cloud (mean upper level below 6,500 ft.) in a uniform layer, resembling fog but not resting on the surface.
- stray line**. . Ungraduated portion of line connected with a current pole used in taking current observations. The stray line is usually about 100 feet long and permits the pole to acquire the velocity of the current at some distance from the disturbed waters in the immediate vicinity of the observing vessel before the current velocity is read from the graduated portion of the current line.
- stream**, , *v., t*. To place overboard and tow, as to stream a log or stream a sea anchor.
- stream current**. . A relatively narrow, deep, fast-moving ocean current. The opposite is **DRIFT CURRENT**.
- streamline**, , *n*. The path followed by a particle of fluid flowing past an obstruction. The term generally excludes the path of a particle in an eddy current.
- streamline flow**. . Fluid motion in which the fluid moves uniformly without eddies or turbulence. If it moves in thin layers, it is called laminar flow. The opposite is **TURBULENT FLOW**.
- stream the log**. . To throw the log overboard and secure it in place for taking readings.
- strength of current**. . Phase of tidal current in which the speed is a maximum; also the speed at this time.
- strength of ebb**. . See **EBB STRENGTH**.
- strength of ebb interval**. . See **EBB INTERVAL**. See also **LUNICURRENT INTERVAL**.
- strength of flood**. . See **FLOOD STRENGTH**.
- strength of flood interval**. . See **FLOOD INTERVAL**. See also **LUNICURRENT INTERVAL**.
- strip**, , *n*. A long narrow area of pack ice, about 1 kilometer or less in width, usually composed of small fragments detached from the main mass of ice, and run together under the influence of wind, swell, or current.
- stripes**, , *n*. In navigation terminology, stripes are vertically arranged areas of color, such as the red and white stripes on a safe-water buoy. Horizontal areas are called bands.
- strong breeze**. . Wind of force 6 (22 to 27 knots or 25 to 31 miles per hour) on the Beaufort wind scale.
- strong fix**. . A fix determined from horizontal sextant angles between objects so situated as to give very accurate results.
- strong gale**. . Wind of force 9 (41 to 47 knots or 47 to 54 miles per hour) on the Beaufort wind scale. See also **GALE**.
- sub-**. . A prefix meaning under, less, or marginal. The opposite is **SUPER-**.
- Subarctic Current**. . See **ALEUTIAN CURRENT**.
- subastral point**. . See **SUBSTELLAR POINT**.
- sublimation**, , *n*. The transition of a substance directly from the solid state to the vapor state, or vice versa, without passing through the intermediate liquid state. See also **CONDENSATION**, **EVAPORATION**, **FUSION**.
- sublunar point**. . The geographical position of the moon; the point on the earth at which the moon is in the zenith.
- submarine bell**. . See under **BELL**.
- submarine cable**. . A submarine conductor or fiber-optic conduit for electric current or communications.
- submarine havens**. . Specified sea areas for submarine operations established by the submarine commander in which no friendly ASW attack may be launched. Compare with **MOVING HAVENS**, which are designed to prevent collisions.
- submarine relief**. . Variations in elevation of the sea bed, or their representation by depth contours, hypsometric tints, or soundings.
- submarine safety lanes**. . See **SAFETY LANES**.
- submarine site**. . The site of a structure when located below the surface of the water.
- submerge**, , *v., i*. To descend below the surface. The opposite is **SURFACE**. See also **DIVE**.
- submerged**, , *adj. & adv.* 1. Under water. The opposite is **UNCOVERED**. See also **AWASH**. 2. Having descended below the surface. The opposite is **SURFACED**.
- submerged breakwater**. . A breakwater with its top below the still water level. When this structure is struck by a wave, part of the wave energy is reflected seaward. The remaining energy is largely dissipated in a breaker, transmitted shoreward as a multiple crest system, or as a simple wave system.
- submerged lands**. . Lands covered by water at any stage of the tide, as distinguished from tidelands which are attached to the mainland or an island and cover and uncover with the tide. Tidelands presuppose a highwater line as the upper boundary; submerged lands do not.
- submerged production well**. . An oil or gas well that is a seabed installation only, i.e., the installation does not include a permanent production platform. See also **WELLHEAD**.
- submerged rock**. . A rock covered at the chart sounding datum and considered to be potentially dangerous to navigation. See also **BARE ROCK**, **ROCK AWASH**.
- submerged screw log**. . A type of electric log which is actuated by the flow of water past a propeller.
- subordinate current station**. . 1. A current station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a control current station. 2. A station listed in the *Tidal Current Tables* for which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station. See also **CURRENT STATION**, **CONTROL CURRENT STATION**, **REFERENCE STATION**.
- subordinate tide station**. . 1. A tide station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a tide station with a relatively long series of observations. 2. A station listed in the *Tide Tables* for which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station. See also **PRIMARY CONTROL TIDE STATION**, **REFERENCE STATION**, **SECONDARY CONTROL TIDE STATION**, **TERTIARY TIDE STATION**.

- subpermanent magnetism.** . The magnetism in the intermediate iron of a ship which tends to change as a result of vibration, aging, or cruising in the same direction for a long period, but does not alter immediately so as to be properly termed induced magnetism. This magnetism is the principal cause of deviation changes of a magnetic compass. At any instant this magnetism is recognized as part of the ship's permanent magnetism, and consequently must be corrected as such by means of permanent magnet correctors. See also MAGNETISM.
- sub-refraction.** , *n.* Less-than-normal refraction, particularly as related to the atmosphere. Greater than normal refraction is called SUPER-REFRACTION.
- subregion.** . One of the subdivisions of the earth based on the NGA chart numbering system.
- subsattellite point.** . The point at which a line from the satellite perpendicular to the ellipsoid intersects the surface of the earth.
- subsidence.** , *n.* Decrease in the elevation of land without removal of surface material due to tectonic, seismic, or artificial forces.
- subsidiary light.** . A light placed on or near the support of a main light and having a special use in navigation. See also PASSING LIGHT.
- subsolar point.** . The geographical position of the sun; the point on the earth at which the sun is in the zenith at a specified time.
- substellar point.** . The geographical position of a star; that point on the earth at which the star is in the zenith at a specified time. Also called SUBASTRAL POINT.
- substratosphere.** , *n.* A region of indefinite lower limit just below the stratosphere.
- subsurface current.** . An underwater current which is not present at the surface. See also SURFACE CURRENT, UNDERCURRENT, UNDERTOW.
- subtend.** , *v., t.* To be opposite, as an arc of a circle subtends an angle at the center of the circle, the angle being formed by the radii joining the ends of the arc with the center.
- subtrack.** , *n.* See ORBITAL PATH.
- subtropical anticyclones.** . High pressure belts which prevail on the poleward sides of the trade winds characterized by calms, light breezes, and dryness.
- sudden ionospheric disturbances (SID's).** . Sudden increases in the ionization density in the lower part of the ionosphere caused by very sudden and large increases in X-ray flux emitted from the sun, usually during a solar flare. SID's also occur during flares called X-ray flares that produce large X-ray flux, but which have no components in the visible light spectrum. The effect, which is restricted to sunlit propagation paths, causes a phase advance in certain radionavigation systems and is known as a SUDDEN PHASE ANOMALY (SPA). The SID effects are related to solar zenith angle, and consequently, occur mostly in lower latitude regions. Usually there is a phase advance over a period of 5 to 10 minutes followed by a recovery over a period of 30 to 60 minutes. See also POLAR CAP DISTURBANCE, MODAL INTERFERENCE.
- sudden phase anomaly.** . See under SUDDEN IONOSPHERIC DISTURBANCES.
- Suestado.** , *n.* A storm with southeast gales, caused by intense cyclonic activity off the coasts of Argentina and Uruguay, which affects the southern part of the coast of Brazil in the winter.
- sugarloaf sea.** . A sea characterized by waves that rise into sugarloaf (conical) shapes, with little wind, resulting from intersecting waves.
- sugg.** , *v., i.* To roll with the action of the sea when aground.
- sumatra.** , *n.* A squall with violent thunder, lightning, and rain, which blows at night in the Malacca Straits, especially during the southwest monsoon. It is intensified by strong mountain breezes.
- Summary of Corrections.** . A cumulative summary of corrections to charts, *Sailing Directions*, and *United States Coast Pilots* previously published in *Notice to Mariners*, published by the National Geospatial-Intelligence Agency.
- summer.** , *n.* In the Northern Hemisphere summer begins astronomically at the summer solstice and ends at the autumnal equinox. In the Southern Hemisphere the limits are the winter solstice and the vernal equinox. The meteorological limits vary with the locality and the year. See also INDIAN SUMMER.
- summer noon.** . Daylight saving noon. The expression applies where summer time is used, particularly in Europe.
- summer solstice.** . 1. The point on the ecliptic occupied by the sun at maximum northerly declination. Sometimes called JUNE SOL-  
STICE, FIRST POINT OF CANCER. 2. That instant at which the sun reaches the point of maximum northerly declination, about June 21.
- summer time.** . A variation of standard time in which the clocks are advanced 1 hour. The variation when the clocks are advanced 2 hours is called double summer time. The expression is used principally in Europe. See also DAYLIGHT SAVING TIME.
- Sumner line.** . A line of position established by the Sumner method or, loosely, any celestial line of position.
- Sumner method.** . The establishing of a line of position from the observation of the altitude of a celestial body by assuming two latitudes (or longitudes) and calculating the longitudes (or latitudes) through which the line of position passes. The line of position is the straight line connecting these two points (extended if necessary). This method, discovered by Thomas H. Sumner, an American sea captain, is seldom used by modern navigators, an adaptation of it, called ST. HILAIRE METHOD, being favored. See also LONGITUDE METHOD, HIGH ALTITUDE METHOD.
- Sumner point.** . See COMPUTED POINT.
- sun.** , *n.* The luminous celestial body at the center of the solar system, around which the planets asteroids, and comets revolve. It is an average star in terms of size and age. The sun visible in the sky is called apparent or true sun. A fictitious sun conceived to move eastward along the celestial equator at a rate that provides a uniform measure of time equal to the average apparent time is called mean sun or astronomical mean sun; a fictitious sun conceived to move eastward along the ecliptic at the average rate of the apparent sun is called dynamical mean sun. When the sun is observable at midnight, in high latitudes, it is called midnight sun.
- sun cross.** . A rare halo phenomenon in which horizontal and vertical shafts of light intersect at the sun. It is probably due to the simultaneous occurrence of a sun pillar and a parhelic circle.
- sun dog.** . See PARHELION.
- sun line.** , *n.* A line of position determined from a sextant observation of the sun.
- sun pillar.** . A glittering shaft of light, white or reddish, extending above and below the sun, most frequently observed at sunrise or sunset. If a parhelic circle is observed at the same time, a SUN CROSS results. See also HALO.
- sun relay.** . See DAYLIGHT CONTROL.
- sunrise.** , *n.* The crossing of the visible horizon by the upper limb of the rising sun.
- sunset.** , *n.* The crossing of the visible horizon by the upper limb of the setting sun.
- sunspot.** , *n.* Dark spots on the sun's surface. These spots are apparently magnetic in character and exert a disturbing influence on radio propagation on the earth.
- sun's way.** . The path of the solar system through space.
- sun switch.** . See DAYLIGHT CONTROL.
- super.** - A prefix meaning over, more, greater. The opposite is SUB-.
- super-buoy.** . A very large buoy, generally more than 5 meters in diameter, used for navigation, offshore mooring, or data acquisition.
- superheterodyne receiver.** . A receiver in which the incoming radio frequency signals are normally amplified before being fed into a mixer (first detector) for conversion into a fixed, lower carrier (the intermediate frequency). The intermediate frequency signals undergo very high amplification in the intermediate frequency amplifier stages and are then fed into a detector (second detector) for demodulation. The resulting audio or video signals are then usually further amplified before use.
- super high frequency.** . Radio frequency of 3,000 to 30,000 megahertz.
- superior conjunction.** . The conjunction of an inferior planet and the sun when the sun is between the earth and the other planet.



- superior planets.** . The planets with orbits outside that of the Earth: Mars, Jupiter, Saturn Uranus, Neptune, and Pluto. See also PLANET.
- superior transit.** . See UPPER TRANSIT.
- super-refraction.** , *n.* Greater than normal refraction, particularly as related to the atmosphere. Less than normal refraction is called SUB-REFRACTION.
- supersaturation.** , *n.* Beyond the usual point of saturation. As an example, if saturated air is cooled, condensation takes place only if nuclei are present. If they are not present, the air continues to hold more water than required for saturation until the temperature is increased or until a nucleus is introduced.
- supersonic.** , *adj.* Faster than sound. Formerly this term was also applied to a frequency above the audible range, but in this usage it has been replaced by the term ULTRASONIC.
- superstructure.** , *n.* See CAGE.
- supplement.** , *n.* An angle equal to 180° minus a given angle. Two angles which equal 180° supplementary. See also COMPLEMENT, EXPLEMENT.
- supplementary angles.** . Two angles whose sum is 180°.
- supplementary information.** . In ECDIS, non-chart hydrographic office information, such as SAILING DIRECTIONS, TIDE TABLES, and LIGHT LISTS.
- supplementary units.** . See under INTERNATIONAL SYSTEM OF UNITS.
- surf.** , *n.* The region of breaking waves near a beach or over a detached reef.
- surface.** , *v., i.* To rise to the surface. The opposite is SUBMERGE.
- surface boundary layer.** . That thin layer of air adjacent to the earth's surface extending up to a level of about 10 to 100 meters. Within this layer the wind distribution is determined largely by the vertical temperature gradient and the nature and contours of the underlying surface; shearing stresses are approximately constant. Also called FRICTION LAYER.
- surface chart.** . Short for SYNOPTIC SURFACE CHART.
- surface current.** . A current which does not extend more than about 3 meters below the surface. See also SUBSURFACE CURRENT, UNDERCURRENT, UNDERTOW.
- surfaced.** , *adj. & adv.* Having come to the surface from below the water. The opposite is SUBMERGED. See also AFLOAT, UNCOVERED.
- surface duct.** . A tropospheric radio duct in which the lower boundary is the surface of the earth. Also called GROUND-BASED DUCT.
- surface front.** . See under FRONT.
- surface of position.** . A surface on some point of which a craft is located. See also LINE OPPOSITION, FIX.
- surface wave.** . A radio wave which is propagated along the boundary between two media in a manner determined by the properties of the two media in the vicinity of the boundary.
- surf zone.** . The area between the outermost limit of breakers and the limit of wave uprush.
- surge.** , *n.* 1. The bodily motion of a vessel in a seaway forward and backward along the longitudinal axis, caused by the force of the sea acting alternately on the bow and stern. Also called SURGING. See also SHIP MOTIONS. 2. See as STORM SURGE.
- surging.** , *n.* See SURGE, *n.*, definition.
- surveillance.** , *n.* The observation of an area or space for the purpose of determining the position and movements of craft or vehicles in that area or space. Surveillance can be either dependent, independent, or pseudo-independent.
- surveillance radar.** . A primary radar installation at a land station used to display at that station the position of vessels within its range, usually for advisory purposes.
- survey.** , *n.* 1. The act or operation of making measurements for determining the relative positions of points on, above, or beneath the earth's surface. 2. The results of operations as in definition 1. 3. An organization for making surveys. See also GEODETIC SURVEY, HYDROGRAPHIC SURVEY, OCEANOGRAPHIC SURVEY, TOPOGRAPHIC SURVEY.
- surveying.** , *n.* The branch of applied mathematics which teaches the art of determining accurately the area of any part of the earth's surface, the lengths and directions of bounding lines, the contour of the surface, etc., and accurately delineating the whole on a map or chart for a specified datum.
- survey mile (U.S.).** . A unit of distance equal to 5,280 feet. This mile is generally used on land, and is sometimes called LAND MILE. It is commonly used to express navigational distances by navigators of river and lake vessels, particularly those navigating the Great Lakes.
- surveying sextant.** . See HYDROGRAPHIC SEXTANT.
- swamp.** , *n.* An area of spongy land saturated with water. It may have a shallow covering of water, usually with a considerable amount of vegetation appearing above the surface. Sometimes called SLOUGH.
- swash.** , *n.* 1. A narrow channel or sound within a sand bank, or between a sand bank and the shore. 2. A bar over which the sea washes. 3. The rush of water up onto the beach following the breaking of a wave.
- sway.** , *n.* The side-to-side bodily motion of a vessel in a seaway, independent of rolling, caused by uniform pressure being exerted all along one side of the hull. Also called LATERAL DRIFTING, SWAYING. See also SHIP MOTIONS.
- swaying.** , *n.* See SWAY.
- sweep.** , *v., t.* To tow a line or object below the surface, to determine the least depth in an area or to insure that a given area is free from navigational dangers to a certain depth; or the removal of such dangers. See also DRAG, *v., t.*
- sweep.** (of radarscope), *n.* As determined by the time base or range calibration, the radial movement of the stream of electrons impinging on the face of the cathode-ray tube.
- sweeping.** , *n.* 1. The process of towing a line or object below the surface, to determine whether an area is free from isolated submerged dangers to vessels and to determine the position of any dangers that exist, or to determine the least depth of an area. 2. The process of clearing an area or channel of mines or other dangers to navigation.
- sweep rate.** . The number of times a radar radiation pattern rotates during 1 minute of time. Sometimes expressed as the duration of one complete rotation in seconds of time.
- swell.** , *n.* A relatively long wind wave, or series of waves, that has traveled out of the generating area. In contrast the term SEA is applied to the waves while still in the generating area. As these waves travel away from the area in which they are formed, the shorter ones die out. The surviving waves exhibit a more regular and longer period with flatter crests. When these waves reach shoal water, they become more prominent in height and of decreased wave length and are then known as ground swell.
- swell direction.** . The direction from which swell is moving.
- swept-frequency racon.** . An in-band racon which sweeps through the marine radar band (2920-3100 MHz in the 10-centimeter band and 9220-9500 MHz in the 3-centimeter band) in order that it may be triggered at the frequency of the interrogating radar transmitting at a given frequency within the band. Almost all such racons operate in the 3-centimeter band only. There are two types of swept-frequency racons: the slow-sweep racon sweeps through the 180 MHz frequency band in 10s of seconds (1.5 to 3.0 MHz per second); the fast-sweep racon sweeps through the band in microseconds.
- swept gain.** . See SENSITIVITY TIME CONTROL.
- swinger.** , *n.* See REVOLVER.
- swinging buoy.** . A buoy placed at a favorable location to assist a vessel to adjust its compass or swing ship. The bow of the vessel is made fast to one buoy and the vessel is swung by means of lines to a tug or to additional buoys. Also called COMPASS ADJUSTMENT BUOY.
- swinging ship.** . The process of placing a vessel on various headings and comparing magnetic compass readings with the corresponding magnetic directions, to determine deviation. This usually follows compass adjustment or compass compensation, and is done to obtain information for making a deviation table.
- swinging the arc.** . The process of rotating a sextant about the line of sight to the horizon to determine the foot of the vertical circle through a body being observed. Also called ROCKING THE SEXTANT.
- swirl error.** . The additional error in the reading of a magnetic compass during a turn, due to friction in the compass liquid.
- symmetrical.** , *adj.* Being equal or identical on each side of a center line or middle value. The opposite is ASYMMETRICAL.
- synchronism.** , *n.* The relationship between two or more periodic quantities of the same frequency when the phase difference between them is zero or constant at a predetermined value.
- synchronization error.** . In radionavigation, the error due to imperfect timing of two operations.
- synchronize.** , *v., t.* To bring into synchronization.

**synchronous**, *adj.* Coincident in time, phase, rate, etc.

**synchronous lights**, *n.* Two or more lights the characteristics of which are in synchronism.

**synchronous satellite**, *n.* A satellite whose period of rotation is equal to the period of rotation of the primary about its axis. The orbit of a synchronous satellite must be equatorial if the satellite is to remain fixed over a point on the primary's equator. See also GEOSYNCHRONOUS SATELLITE, GEOSTATIONARY SATELLITE.

**synodical month**, *n.* The average period of revolution of the moon about the earth with respect to the sun, a period of 29 days, 12 hours, 44 minutes, 2.8 seconds. This is sometimes called the MONTH OF THE PHASES, since it extends from new moon to the next new moon. Also called LUNATION.

**synodical period**, *n.* See SYNODIC PERIOD.

**synodic period**, *n.* The interval of time between any planetary configuration of a celestial body, with respect to the sun, and the next successive same configuration of that body, as from inferior conjunction to inferior conjunction. Also called SYNODICAL PERIOD.

**synoptic chart**, *n.* In meteorology, any chart or map on which data and analyses are presented that describe the state of the atmosphere over a large area at a given moment of time. A synoptic surface chart is an analyzed synoptic chart of surface weather observations.

**synoptic surface chart**, *n.* See under SYNOPTIC CHART.

**system accuracy**, *n.* The expected accuracy of a navigation system expressed in  $d_{rms}$  units, not including errors which may be introduced by the user, or geodetic or cartographic errors.

**systematic error**, *n.* One of the two categories of errors of observation, measurement and calculation, the other category being random error. Systematic errors are characterized by an orderly trend, and are usually predictable once the cause is known. They are divided into three classes: (1) errors resulting from changing or nonstandard natural physical conditions, sometimes called theoretical errors, (2) personal (nonaccidental) errors, and (3) instrument errors. Also called REGULAR ERROR. See also ERROR.

**System Electronic Navigation Chart (SENC)**, *n.* 1. The electronic chart data base actually accessed aboard ship for the display of electronic charts. It is developed from the ENC provided by hydrographic authorities, but is specific to the shipboard system. When corrected, it is the equivalent of a paper chart. 2. In ECDIS, a database in the manufacturer's internal ECDIS format, resulting from the errorless transformation of the entire ENC contents and its updates. It is this database that is accessed by ECDIS for the display generation and other navigational functions, and is equivalent to an up-to-date paper chart. The SENC may also contain information added by the mariner and information from other sources.

**System Raster Navigation Chart (SRNC)**, *n.* In ECDIS, a database resulting from the transformation of the RNC by the RCDS to include updates to the RNC by appropriate means.

**syzygy**, *n.* 1. A point of the orbit of a planet or satellite at which it is in conjunction or opposition. The term is used chiefly in connection with the moon at its new and full phase. 2. A west wind on the seas between New Guinea and Australia preceding the summer north-west monsoon.

## T

**table**, *n.* An orderly, condensed arrangement of numerical or other information, usually in parallel rows or columns. A table in which values of the quantity to be found are tabulated for limiting values of the entering argument is called critical table. See also CALIBRATION TABLE, CONVERSION TABLE, CURRENT TABLES, TIDE TABLES, TRAVERSE TABLE.

**tablemount**, *n.* A seamont having a comparatively smooth, flat top. Also called GUYOT.

**tabular altitude**, *n.* See TABULATED ALTITUDE.

**tabular azimuth**, *n.* See TABULATED AZIMUTH.

**tabular azimuth angle**, *n.* See TABULATED AZIMUTH ANGLE.

**tabular iceberg**, *n.* A flat-topped iceberg with length-to-height ratio greater than 5:1. Most tabular bergs form by calving from an ice shelf and show horizontal banding. See also ICE ISLAND, BLOCKY ICEBERG.

**tabulated altitude**, *n.* In navigational sight reduction tables, the altitude taken directly from a table for the entering arguments. After interpolation for argument increments, i.e., the difference between each entering argument and the actual value, it is called COMPUTED ALTITUDE. Also called TABULAR ALTITUDE.

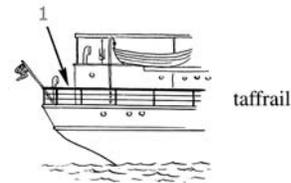
**tabulated azimuth**, *n.* Azimuth taken directly from a table, before interpolation. After interpolation, it becomes COMPUTED AZIMUTH.

**tabulated azimuth angle**, *n.* Azimuth angle taken directly from a table, before interpolation. After interpolation, it becomes COMPUTED AZIMUTH ANGLE.

**Tacan**, *n.* An ultra high frequency aeronautical radionavigation system which provides a continuous indication of bearing and distance to a Tacan station. The term is derived from Tactical Air Navigation.

**tactical diameter**, *n.* The distance gained to the right or left of the original course when a turn of  $180^\circ$  with a constant rudder angle has been completed. See also STANDARD TACTICAL DIAMETER.

**taffrail**, *n.* The after rail at the stern of a vessel.



**taffrail log**, *n.* A log consisting of a rotator towed through the water by a braided log line attached to a distance-registering device usually secured at the taffrail. Also called PATENT LOG.

**tail wind**, *n.* A wind from behind the vessel. See FOLLOWING WIND.

**take departure**, *n.* See under DEPARTURE, definition 2.

**take the ground**, *v.* To become stranded by the tide.

**Taku wind**, *n.* A strong, gusty, east-northeast wind, occurring in the vicinity of Juneau, Alaska, between October and March. At the mouth of the Taku River, after which it is named, it sometimes attains hurricane force.

**tangent**, *adj.* Touching at a single point.

**tangent**, *n.* 1. The ratio of the side opposite an acute angle of a plane right triangle to the shorter side adjacent to the same angle. The expression NATURAL TANGENT is sometimes used to distinguish the tangent from its logarithm (called LOGARITHMIC TANGENT). 2. A straight line, curve, or surface touching a curve or surface at one point.

**tangent arc**, *n.* 1. An arc touching a curve or surface at one point. 2. A halo tangent to a circular halo.

**tangent latitude error**, *n.* On a nonpendulous gyrocompass where damping is accomplished by offsetting the point of application of the force of a mercury ballistic, the angle between the local meridian and the settling position or spin axis. Where the offset of the point of application of a mercury ballistic is to the east of the vertical axis of the gyrocompass, the settling position is to the east of the meridian in north latitudes and to the west of the meridian in south latitudes. The error is so named because it is approximately proportional to the tangent of the latitude in which the gyrocompass is operating. The tangent latitude error varies from zero at the equator to a maximum at high northern and southern latitudes.

**tank**, *n.* An elevated water tank, indicated on a chart by a position circle.

**tape gage**, *n.* See ELECTRIC TAPE GAGE.

**tapper**, *n.* A heavy pendulum suspended outside a bell which rings it.

**target**, *n.* In navigation, an object observed on a radar screen. See also CONTACT.

**target angle**, *n.* The relative bearing of own ship from a target vessel, measured clockwise through  $360^\circ$ . See also ASPECT.

**target tail**, *n.* The display of diminishing luminance seen to follow a target on a radar display which results from afterglow and the progress of the target between successive scans of the radar. Also called TARGET TRAIL.

**target trail**, *n.* See TARGET TAIL.

**tehuantepecer**, *n.* A violent squally wind from north or north-northeast in the Gulf of Tehuantepec (south of southern Mexico) in winter. It originates in the Gulf of Mexico as a norther which crosses the isthmus and blows through the gap between the Mexican and Guatemalan mountains. It may be felt up to 100 miles out to sea. See also PAPAGAYO.

**telecommunication**, *n.* Any transmission, emission, sound, or intelli-

gence of any nature by wire, radio, or other electromagnetic system. If the transfer is by radio, it may be called radiocommunication.

**telegraph buoy.** . A buoy used to mark the position of a submarine telegraph cable.

**telemeter.** , *n.* The complete equipment for measuring any quantity, transmitting the results electrically to a distant point, and there recording the values measured.

**telemetry.** , *n.* The science of measuring a quantity or quantities, transmitting the measured value to a distant station, and there interpreting, indicating, or recording the quantities measured.

**telemotor.** , *n.* A device for controlling the application of power at a distance, especially one by which the steering gear of a vessel is controlled from the wheel house.

**telescope.** , *n.* An optical instrument used as an aid in viewing or photographing distant objects, particularly celestial objects. A reflecting telescope collects light by means of a concave mirror; a refracting telescope by means of a lens or system of lenses. A Cassegrainian telescope is a reflecting telescope in which the immergent light is reflected from the main mirror onto a secondary mirror, where it is reflected through a hole in the main mirror to an eyepiece; a Newtonian telescope is a reflecting telescope in which the immergent beam is reflected from the main mirror onto a small plane mirror, and from there to an eyepiece at the side of the telescope.

**telescopic alidade.** . See ALIDADE.



telescopic alidade

**telescopic meteor.** . See under METEOR.

**telltale compass.** . A marine magnetic compass, usually of the inverted type, frequently installed in the master's cabin for his convenience.

**temperate zone.** . Either of the two zones between the frigid and torrid zones, called the north temperate zone and the south temperate zone.

**temperature.** , *n.* Intensity or degree of heat. Fahrenheit temperature is based upon a scale in which water freezes at 32°F and boils at about 212°F; Celsius temperature upon a scale in which water freezes at 0°C and boils at 100°C. Absolute temperature is measured from absolute zero which is zero on the Kelvin scale, -273.16° on the Celsius scale, and 459.69°F on the Fahrenheit scale. Absolute temperature based upon degrees Fahrenheit is called Rankine temperature and that based upon degrees Celsius is called Kelvin temperature.

**temperature error.** . That instrument error due to nonstandard temperature of the instrument.

**temperature inversion.** . An atmospheric condition in which the usual lapse rate is inverted, i.e., the temperature increases with increasing altitude.

**temporal.** , *adj.* Pertaining to or limited by time.

**temporary light.** . A light put into service for a limited period.

**temporary units.** . See under INTERNATIONAL SYSTEM OF UNITS.

**tend.** , *v.* , *i.* To extend in a stated direction, as an anchor cable.

**tera-** . A prefix meaning one trillion (10<sup>12</sup>).

**terdiurnal.** , *adj.* Occurring three times per day. A terdiurnal tidal constituent has three periods in a constituent day.

**terminator.** , *n.* The line separating illuminated and dark portions of a non-self-luminous body, as the moon.

**terrace.** , *n.* On the sea floor, a relatively flat horizontal or gently inclined surface, sometimes long and narrow, which is bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.

**terrestrial.** , *adj.* Of or pertaining to the earth.

**terrestrial coordinates.** . See GEOGRAPHICAL COORDINATES.

**terrestrial equator.** . 1. The earth's equator, 90° from its geographical poles. 2. See ASTRONOMICAL EQUATOR.

**terrestrial latitude.** . Latitude on the earth; angular distance from the equator, measured northward or southward through 90° and labeled N or S to indicate the direction of measurement. See also LATI-

TUDE.

**terrestrial longitude.** . Longitude on the earth, the arc of a parallel, or the angle at the pole, between the prime meridian and the meridian of a point on the earth, measured eastward or westward from the prime meridian through 180°, and labeled E or W to indicate the direction of measurement. See also LONGITUDE.

**terrestrial magnetism.** . See GEOMAGNETISM.

**terrestrial meridian.** . See ASTRONOMICAL MERIDIAN.

**terrestrial perturbations.** . The largest gravitational perturbations of artificial satellites which are caused by the fact that the gravity field of the earth is not spherically symmetrical.

**terrestrial pole.** . One of the poles of the earth. See also GEOGRAPHICAL POLE, GEOMAGNETIC POLE, MAGNETIC POLE.

**terrestrial radiation.** . The total infrared radiation emitted from the earth's surface.

**terrestrial refraction.** . Atmospheric refraction of a ray of radiant energy emanating from a point on or near the surface of the earth, as contrasted with ASTRONOMICAL REFRACTION of a ray passing through the earth's atmosphere from outer space.

**terrestrial sphere.** . The earth.

**terrestrial triangle.** . A triangle on the surface of the earth, especially the navigational triangle.

**territorial sea.** . The zone off the coast of a nation immediately seaward from a base line. Sovereignty is maintained over this coastal zone by the coastal nation, subject to the right of innocent passage to the ships of all nations. The United States recognizes this zone as extending 4.8 kilometers from the base line. See also FISHING ZONE, FISHERY CONSERVATION ZONE.

**tertiary tide station.** . A tide station at which continuous observations have been made over a minimum period of 30 days but less than 1 year. The series is reduced by comparison with simultaneous observations from a secondary control tide station. This station provides for a 29-day harmonic analysis. See also PRIMARY CONTROL TIDE STATION; SECONDARY CONTROL TIDE STATION; SUBORDINATE TIDE STATION, definition 2; TIDE STATION.

**tesla.** , *n.* The derived unit of magnetic flux density in the International System of Units; it is equal to 1 weber per square meter.

**Texas norther.** . See under NORTHER.

**textual HO information.** . In ECDIS, information presently contained in separate publications (e.g. SAILING DIRECTIONS) which may be incorporated in the ENC and also textual information contained in explanatory attributes of specific objects.

**thaw holes.** . Vertical holes in sea ice formed when surface puddles melt through to the underlying water.

**thematic map.** . See TOPICAL MAP.

**theoretical error.** . See under SYSTEMATIC ERROR.

**thermocline.** . A transition layer between warmer mixed water at the ocean's surface and cooler deep water below in which temperature decreases more rapidly with depth than it does in the layers above or below.

**thermometer.** , *n.* An instrument for measuring temperature. A maximum thermometer automatically registers the highest temperature and a minimum thermometer the lowest temperature since the last thermometer setting.

**thermostat.** , *n.* A device for automatically regulating temperature or detecting temperature changes.

**thick first-year ice.** . First-year ice over 120 centimeters thick.

**thick weather.** . Condition of greatly reduced visibility, as by fog, snow, rain, etc.

**thin first-year ice.** . First-year ice 30 to 70 centimeters thick. Also called WHITE ICE.

**thin overcast.** . An overcast sky cover which is predominantly transparent.

**thorofare.** , *n.* This shortened form of thoroughfare has become standard for a natural waterway in marshy areas. It is the same type of feature as a slough or bayou.

**thoroughfare.** , *n.* A public waterway such as a river or strait. See also THOROFARE.

**three-arm protractor.** . An instrument consisting of a circle graduated in degrees, to which is attached one fixed arm and two arms pivoted at the center and provided with clamps so that they can be set at any angle to the fixed arm, within the limits of the instrument. It is used for finding a ship's position when the horizontal angles between three fixed and known points are measured.

**three-point problem.** . From the observation of two horizontal angles

- between three objects or points of known (charted) positions, to determine the position of the point of observation. The problem is solved graphically by means of the three-arm protractor and analytically by trigonometrical calculation.
- threshold signal.** . The smallest signal capable of being detected above the background noise level.
- threshold speed.** . The minimum speed of current at which a particular current meter will measure at its rated reliability.
- thundercloud.** , *n.* See CUMULONIMBUS.
- thunderhead.** , *n.* See CUMULONIMBUS.
- thundersquall.** , *n.* Strictly, the combined occurrence of a thunderstorm and a squall, the squall usually being associated with the downrush phenomenon typical of a well-developed thunderstorm.
- thunderstorm.** , *n.* A local storm invariably produced by a cumulonimbus cloud and always accompanied by lightning and thunder, usually with strong gusts of wind, heavy rain, and sometimes with hail. It is usually of short duration. Sometimes called ELECTRICAL STORM.
- thunderstorm cirrus.** . See FALSE CIRRUS.
- thunder sky.** . A sky with an overcast and chaotic aspect, a general absence of wind except during showers, a mammatus appearance of the lower clouds, and dense cirrostratus and altocumulus above.
- tick.** , *n.* A short, audible sound or beat, as that of a clock. A time signal in the form of one or more ticks is called a TIME TICK.
- tickle.** , *n.* A narrow channel, as used locally in the Arctic and Newfoundland.
- tidal.** , *adj.* Of or pertaining to tides.
- tidal amplitude.** . One-half the range of a constituent tide.
- tidal basin.** . A basin without a caisson or gate in which the level of water rises and falls with the tides. Also called OPEN BASIN. See also TIDAL HARBOR, NON-TIDAL BASIN.
- tidal bench mark.** . See under BENCH MARK.
- tidal bench mark description.** . A published, concise description of the location, stamped number of designation, date established, and elevation (referred to a tidal datum) of a specific bench mark.
- tidal bench mark state index map.** . A state map which indicates the locations for which tidal datums and tidal bench mark descriptions are available.
- tidal bore.** . A tidal wave that propagates up a relatively shallow and sloping estuary or river in a solitary wave. The leading edge presents an abrupt rise in level, frequently with continuous breaking and often immediately followed by several large undulations. An uncommon phenomenon, the tidal bore is usually associated with very large ranges in tide as well as wedge-shaped and rapidly shoaling entrances. Also called EAGRE, EAGER, MASCARET, POROROCA, BORE.
- tidal constants.** . Tidal relations that remain practically constant for any particular locality. Tidal constants are classified as harmonic and nonharmonic. The harmonic constants consist of the amplitudes and epochs of the harmonic constituents, and the nonharmonic constants include the ranges and intervals derived directly from the high and low water observations.
- tidal constituent.** . See CONSTITUENT.
- tidal current.** . A horizontal movement of the water caused by gravitational interactions between the sun, moon, and earth. The horizontal component of the particulate motion of a tidal wave. Part of the same general movement of the sea that is manifested in the vertical rise and fall, called tide. Also called TIDAL STREAM. See also CURRENT, TIDAL WAVE, TIDE.
- tidal current charts.** . 1. Charts on which tidal current data are depicted graphically. 2. *Tidal Current Chart*, as published by the National Ocean Survey, part of a set of charts which depict, by means of arrows and figures, the direction and velocity of the tidal current for each hour of the tidal cycle. The charts, which may be used for any year, present a comprehensive view of the tidal current movement in the respective waterways as a whole and also supply a means for readily determining for any time the direction and velocity of the current at various localities throughout the water area covered.
- tidal current constants.** . See CURRENT CONSTANTS.
- tidal current diagrams.** . Monthly diagrams which are used with tidal current charts to provide a convenient method to determine the current flow on a particular day.
- tidal current station.** . See CURRENT STATION.
- tidal current tables.** . 1. Tables which give the predicted times of slack water and the predicted times and velocities of maximum current flood and ebb for each day of the year at a number of reference stations, together with time differences and velocity ratios for obtaining predictions at subordinate stations. 2. *Tidal Current Tables*, published annually by the National Ocean Survey.
- tidal cycle.** . A complete set of tidal conditions as those occurring during a tidal day, lunar month, or Metonic cycle.
- tidal datum.** . See VERTICAL DATUM.
- tidal day.** . See LUNAR DAY, definition 1.
- tidal difference.** . Difference in time or height of a high or low water at a subordinate station and at a reference station for which predictions are given in the *Tide Tables*. The difference, when applied according to sign to the prediction at the reference station, gives the corresponding time or height for the subordinate station.
- tidal epoch.** . See EPOCH, definition 3.
- tidal estuary.** . See under ESTUARY, definition 1.
- tidal flats.** . See FLAT.
- tidal harbor.** . A harbor affected by the tides, distinct from a harbor in which the water level is maintained by caissons or gates. See also NON-TIDAL BASIN.
- tidal lights.** . Lights shown at the entrance of a harbor, to indicate tide and tidal current conditions within the harbor.
- tidal lock.** . See ENTRANCE LOCK.
- tidal marsh.** . Any marsh the surface of which is covered and uncovered by tidal flow. See also FLAT.
- tidal platform ice foot.** . An ice foot between high and low water levels, produced by the rise and fall of the tide.
- tidal quay.** . A quay in an open harbor or basin with sufficient depth alongside to enable ships lying alongside to remain afloat at any state of the tide.
- tidal range.** . See RANGE OF TIDE.
- tidal rise.** . See RISE OF TIDE.
- tidal stream.** . See TIDAL CURRENT.
- tidal water.** . Any water subject to tidal action. See also TIDEWATER.
- tidal wave.** . 1. A wave caused by the gravitational interactions between the sun, moon and earth. Essentially, high water is the crest of a tidal wave and low water is the trough. Tide is the vertical component of the particulate motion and tidal current is the horizontal component. The observed tide and tidal current can be considered the result of the combination of several tidal waves, each of which may vary from nearly pure progressive to nearly pure standing and with differing periods, heights, phase relationships, and directions. 2. Any unusually high and destructive water level along a shore. It usually refers to either a storm surge or tsunami.
- tide.** , *n.* The periodic rise and fall of the water resulting from gravitational interactions between the sun, moon, and earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate this motion as TIDAL CURRENT. See also TIDAL WAVE definition 1.
- tide-bound.** , *adj.* Unable to proceed because of insufficient depth of water due to tidal action.
- tide crack.** . A crack at the line of junction between an immovable icefoot or ice wall and fast ice the latter subject to rise and fall of the tide.
- tide curve.** . A graphic representation of the rise and fall of the tide in which time is usually represented by the abscissa and height by the ordinate of the graph. For a normal tide the graphic representation approximates a cosine curve. See also MARIGRAM.
- tide datum.** . See VERTICAL DATUM.
- tide gage.** . An instrument for measuring the rise and fall of the tide. See also AUTOMATIC TIDE GAGE, ELECTRIC TAPE GAGE, PRESSURE GAGE, TIDE STAFF.
- tide gate.** . 1. A restricted passage through which water runs with great speed due to tidal action. 2. An opening through which water may flow freely when the tide sets in one direction, but which closes automatically and prevents the water from flowing in the other direction when the direction of flow is reversed.
- tidehead.** , *n.* Inland limit of water affected by a tide.
- tide hole.** . A hole made in ice to observe the height of the tide.
- tide indicator.** . The part of a tide gage which indicates the height of tide at any time. The indicator may be in the immediate vicinity of the tidal water or at some distance from it.
- tideland.** , *n.* Land which is under water at high tide and uncovered at low tide.
- tidemark.** , *n.* 1. A high water mark left by tidal water. 2. The highest point reached by a high tide. 3. A mark placed to indicate the highest

- point reached by a high tide, or, occasionally, any specified state of tide.
- tide notes.** . Notes included on nautical charts which give information on the mean range or the diurnal range of the tide, mean tide level, and extreme low water at key places on the chart.
- tide pole.** . A graduated spar used for measuring the rise and fall of the tide. Also called TIDE STAFF.
- tide pool.** . A pool left by an ebb tide.
- tide predicting machine.** . A mechanical analog machine especially designed to handle the great quantity of constituent summations required in the harmonic method. William Ferrel's Maxima and Minima Tide Predictor was the first such machine used in the United States. Summing only 19 constituents, but giving direct readings of the predicted times and heights of the high and low waters, the Ferrel machine was used for the predictions of 1885 through 1914. A second machine was used for the predictions of 1912 through 1965. Predictions are now prepared using a computer.
- tide-producing force.** . The part of the gravitational attraction of the moon and sun which is effective in producing the tides on the earth. The force varies approximately as the mass of the attracting body and inversely as the cube of its distance. The tide-producing force exerted by the sun is a little less than one-half as great as that of the moon.
- tide producing potential.** . Tendency for particles on the earth to change their positions as a result of the gravitational interactions between the sun, moon, and earth. Although the gravitational attraction varies inversely as the square of the distance of the tide-producing body, the resulting potential varies inversely as the cube of the distance.
- tide race.** . A very rapid tidal current through a comparatively narrow channel. Also called RACE.
- tide rips.** . Small waves formed on the surface of water by the meeting of opposing tidal currents or by a tidal current crossing an irregular bottom. Vertical oscillation, rather than progressive waves, is characteristic of tide rips. See also RIPS.
- tide rode.** . The condition of a ship at anchor heading into the tidal current. See also WIND RODE.
- tide signals.** . Signals showing to navigators the state or change of the tide according to a prearranged code, or by direct display on a scale.
- tide staff.** . A tide gage consisting of a vertical graduated staff from which the height of the tide can be read directly. See also ELECTRIC TAPE GAGE.
- tide station.** . The geographic location at which tidal observations are conducted. Also, the facilities used to make tidal observations. These may include a tide house, tide gage, tide staff, and tidal bench marks. See also PRIMARY CONTROL TIDE STATION, SECONDARY CONTROL TIDE STATION, SUBORDINATE TIDE STATION, TERTIARY TIDE STATION.
- tide tables.** . 1. Tables which give the predicted times and heights of high and low water for every day in the year for a number of reference stations, and tidal differences and ratios by which additional predictions can be obtained for subordinate stations. From these values it is possible to interpolate by a simple procedure the height of the tide at any hour of the day. See also TIDAL CURRENT TABLES.
- tidewater.** . *n.* Water affected by tides or sometimes that part of it which covers the tideland. The term is sometimes used broadly to designate the seaboard. See also TIDAL WATER.
- tide wave.** . See TIDAL WAVE, definition 1.
- tideway.** . *n.* A channel through which a tidal current runs.
- tilt.** . *n.* The angle which anything makes with the horizontal.
- tilted blocky iceberg.** . A blocky iceberg which has tilted to present a triangular shape from the side.
- tilt correction.** . The correction due to tilt error.
- tilt error.** . The error introduced in the reading of an instrument when it is tilted, as a marine sextant held so that its frame is not perpendicular to the horizon.
- time.** . *n.* 1. The interval between two events. 2. The date or other designated mark on a time scale. See also TIME SCALE, APPARENT TIME MEAN TIME, SIDEREAL TIME.
- time and altitude azimuth.** . An azimuth determined by solution of the navigational triangle with meridian angle, declination, and altitude given. A TIME AZIMUTH is computed with meridian angle, declination, and latitude given. An ALTITUDE AZIMUTH is computed with altitude, declination, and latitude given.
- time azimuth.** . An azimuth determined by solution of the navigational triangle, with meridian angle, declination, and latitude given. An ALTITUDE AZIMUTH is computed with altitude, declination, and latitude given. A TIME AND ALTITUDE AZIMUTH is computed with meridian angle, declination, and altitude given.
- time ball.** . A visual time signal in the form of a ball. Before the widespread use of radio time signals, time balls were dropped, usually at local noon, from conspicuously-located masts in various ports. The accuracy of the signal was usually controlled by a telegraphic time signal from an observatory.
- time base.** . A motion, of known but not necessarily of constant speed, used for measuring time intervals, particularly the sweep of a cathode-ray tube. In a linear time base the speed is constant in an expanded time base a selected part is of increased speed, and in a delayed time base the start is delayed. See also SWEEP.
- time diagram.** . A diagram in which the celestial equator appears as a circle, and celestial meridians and hour circles as radial lines; used to facilitate solution of time problems and others involving arcs of the celestial equator or angles at the pole, by indicating relations between various quantities involved. Conventionally the relationships are given as viewed from a point over the south pole westward direction being counterclockwise. Also called DIAGRAM ON THE PLANE OF THE CELESTIAL EQUATOR, DIAGRAM ON THE PLANE OF THE EQUINOCTIAL.
- time line.** . A line joining the heads of two vectors which represent successive courses and speeds of a ship in passing from one point to another in a known time via a specified intermediate point.
- time meridian.** . Any meridian used as a reference for reckoning time, particularly a zone or standard meridian.
- timepiece.** . *n.* An instrument for measuring time. See also CHRONOMETER, CLOCK, WATCH.
- time scale.** . A system of assigning dates to events. There are three fundamental scales: Ephemeris Time, time based upon the rotation of the earth, and atomic time or time obtained by counting the cycles of a signal in resonance with certain kinds of atoms. Ephemeris Time (ET), the independent variable in the gravitational theories of the solar system, is the scale used by astronomers as the tabular argument of the precise, fundamental ephemerides of the sun, moon, and planets. Universal Time (UT1), time based on the rotation of the earth, is the scale used by astronomers as the tabular argument for most other ephemerides, e.g., the *Nautical Almanac*. Although ET and UT1 differ in concept, both are determined in arrears from astronomical observations and are extrapolated into the future based on International Atomic Time (TAI). Coordinated Universal Time (UTC) is the scale disseminated by most broadcast time services; it differs from TAI by an integral number of seconds.
- time sight.** . Originally, an observation of the altitude of a celestial body, made for the purpose of determining longitude. Now, the expression is applied primarily to the common method of reducing such an observation.
- time signal.** . An accurate signal marking a specified time or time interval. It is used primarily for determining errors of timepieces; usually sent from an observatory by radio. As defined by the International Telecommunications Union (ITU), a radiocommunication service for the transmission of time signals of stated high precision, intended for general reception.
- time switch.** . A device for lighting or extinguishing a light at predetermined times, controlled by a timing device.
- time tick.** . A time signal consisting of one or more short audible sounds or beats.
- time varying object.** . In ECDIS, an OBJECT which has one or more ATTRIBUTES, the value or values of which vary with time.
- time zone.** . An area in all parts of which the same time is kept. In general, each zone is 15° of longitude in width with the Greenwich meridian (0° longitude) designated as the central meridian of zone 0 and the remaining zones centered on a meridian whose longitude is exactly divisible by 15. The zone boundary may vary considerably to conform to political and geographic boundaries. See also STANDARD TIME.
- Tokyo datum.** . A geodetic datum that has its origin in Tokyo. It is defined in terms of the Bessel ellipsoid and is oriented by means of a single astronomic station. Using triangulation ties through Korea, the Tokyo datum is connected with the Manchurian datum. Unfortunately, since Tokyo is situated on a steep geoidal slope, the single station orientation has resulted in large systematic geoidal separations as the system is extended from its initial point.

**tombolo**, *n.* An islet and a shoal connecting it to a larger land area.



tombolo

**tonnage**. . A measure of the weight, size or capacity of a vessel. Dead-weight tonnage refers to the number of tons of 2240 lbs. that a vessel will carry in salt water loaded to summer marks. It may also be considered the difference between loaded and light displacement tonnage. Displacement tonnage refers to the amount of water displaced by a vessel afloat, and is thus a measure of actual weight. Gross tonnage or gross register tonnage refers to the total measured cubic volume (100 cubic feet per ton of 2240 lbs.), based on varying formulas. Net tonnage or net registered tonnage refers to the gross tonnage minus spaces generally not used for cargo, according to varying formulas. Register tonnage is the tonnage listed on the ship's registration certificate, usually gross and/or net. Cargo tonnage refers to the weight of the cargo, independent of the vessel. Merchant ships are normally referred to by their gross or dead-weight tonnage, warships by their displacement tonnage.

**tongue**, *n.* 1. A projection of the ice edge up to several kilometers in length, caused by wind or current. 2. An elongated extension of flat sea floor into an adjacent higher feature.

**topical map**. . A map portraying a special subject. Also called SPECIAL SUBJECT MAP, THEMATIC MAP.

**topmark**, *n.* One or more objects of characteristic shape and color placed on top of a beacon or buoy to aid in its identification.

**topographical latitude**. . See GEODETIC LATITUDE.

**topographic feature**. . See under TOPOGRAPHY definition 1.

**topographic map**. . A map which presents the vertical position of features in measurable form as well as their horizontal positions.

**topography**, *n.* 1. The configuration of the surface of the earth, including its relief and the position of features on it; the earth's natural and physical features collectively. 2. The science of delineation of natural and man-made features of a place or region especially in a way to show their positions and elevations.

**topology**. . In ECDIS and digital data, the set of properties of geometric forms (such as connectivity, neighborhood) which is defined with the DATA MODEL remaining invariant when subject to a continuous transformation.

**toponym**, *n.* A name applied to a physical or cultural topographic feature. For U.S. Government usage, policies and decisions governing place names on earth are established by the Board on Geographic Names. Also called PLACE NAME.

**toponymy**, *n.* 1. The study and treatment of toponyms. 2. A body of toponyms.

**topple**, *n.* 1. The vertical rotation of the spin axis of a gyroscope about the topple axis. 2. The vertical component of real precession or apparent precession, or the algebraic sum of the two. See also DRIFT, *n.* definition 6; TOTAL DRIFT.

**topple axis**. . Of a gyroscope, the horizontal axis perpendicular to the horizontal spin axis, around which topple occurs. See also DRIFT AXIS, SPIN AXIS.

**tornado**, *n.* A violently rotating column of air, pendant from a cumulonimbus cloud, and nearly always observable as a funnel cloud. On a local scale, it is the most destructive of all atmospheric phenomena. Its vortex, commonly several hundreds of yards in diameter, whirls usually cyclonically with wind speeds estimated at 100 to more than 200 miles per hour. Its general direction of travel is governed by the motion of its parent cloud. Tornadoes occur on all continents, but are most common in Australia and the United States where the average number is 140 to 150 per year. They occur throughout the year and at any time of day, but are most frequent in spring and in middle and late afternoon. In the United States, tornadoes often develop several hundred miles southeast of a deep low centered in the central or north-central states. However, they may appear in any sector of the low, and/or be associated with fronts, instability lines, troughs, and even form within high-pressure

ridges. A distinction sometimes is made between cyclonic tornadoes and convective tornadoes, the former occurring within the circulation of a well-developed parent cyclone, and the latter referring to all others. A tornado over water is called WATERSPOUT.

**tornado cloud**. . See FUNNEL CLOUD.

**torque**, *n.* That which effects or tends to effect rotation or torsion and which is measured by the product of the applied force and the perpendicular distance from the line of action of the force to the axis of rotation.

**torrid zone**. . The region of the earth between the Tropic of Cancer and the Tropic of Capricorn. Also called the TROPICS.

**total current**. . The combination of the tidal and nontidal current. See also CURRENT.

**total drift**. . The algebraic sum of drift due to real precession and that due to apparent precession.

**total eclipse**. . An eclipse in which the entire source of light is obscured.

**tower**, *n.* A tall, slender structure, which may be charted with a position circle.

**towering**, *n.* Apparent increase in the vertical dimension of an object near the horizon, due to large inequality of atmospheric refraction in the line of sight to the top and bottom of the object. The opposite is STOOPING.

**towing light**. . A yellow light having the same characteristics as a STERN LIGHT.

**trace**, *n.* The luminous line resulting from the radial movement of the points of impingement of the electron stream on the face of the cathode-ray tube of a radar indicator. See also SWEEP.

**track**, *n.* 1. The intended or desired horizontal direction of travel with respect to the earth. The track as expressed in degrees of the compass may be different from the course due to such factors as making allowance for current or sea or steering to resume the TRACK, definition 2. 2. The path of intended travel with respect to the earth as drawn on the chart. Also called INTENDED TRACK, TRACK-LINE. 3. The actual path of a vessel over the ground, such as may be determined by tracking.

**track**, *v., t.* To follow the movements of an object such as by radar or an optical system.

**track angle**. . See TRACK, definition 1.

**track chart**. . A chart showing recommended, required, or established tracks, and usually indicating turning points, courses, and distances. A distinction is sometimes made between a TRACK CHART and a ROUTE CHART, the latter generally showing less specific information, and sometimes only the area for some distance each side of the great circle or rhumb line connecting two terminals.

**tracking**, *n.* In the operation of automated radar plotting aids, the process of observing the sequential changes in the position of a target to establish its motion.

**track-line**, *n.* See TRACK, definition 2.

**track made good**. . The single resultant direction from a point of departure to a point of arrival at any given time. The use of this term to indicate a single resultant direction is preferred to the use of the misnomer course made good. See also COURSE, TRACK.

**trade winds**. . Relatively permanent winds on each side of the equatorial doldrums, blowing from the northeast in the Northern Hemisphere and from the southeast in the Southern Hemisphere. See also ANTI-TRADES.

**traffic control signals**. . Visual signals placed in a harbor or waterway to indicate to shipping the movements authorized or prohibited at the time at which they are shown. Also called DOCKING SIGNALS.

**traffic lane**. . An area of defined limits in which one-way traffic is established. See also TWO-WAY ROUTE, ROUTING SYSTEM.

**traffic separation scheme**. . A routing measure designed for separating opposing streams of traffic in congested areas by the establishment of traffic lanes, precautionary areas, and other measures. See also ROUTING SYSTEM.

**train**, *v., t.* To control motion in bearing.

**training wall**. . A wall, bank, or jetty, often submerged, built to direct or confine the flow of a river or tidal current.

**tramontana**, *n.* A northeasterly or northerly wind occurring in winter off the west coast of Italy. It is a fresh wind of the fine weather mistral type.

**transceiver**, *n.* A combination transmitter and receiver in a single housing, with some components being used by both parts. See also TRANSPONDER.

**transducer**, *n.* A device that converts one type of energy to another, such

- as the part of a depth sounder that changes electrical energy into acoustical energy.
- transfer**, *n.* 1. The distance a vessel moves perpendicular to its initial direction in making a turn of 90° with a constant rudder angle. 2. The distance a vessel moves perpendicular to its initial direction for turns of less than 90°. See also ADVANCE.
- transit**, *n.* 1. The passage of a celestial body across a celestial meridian, usually called MERIDIAN TRANSIT. 2. The apparent passage of a celestial body across the face of another celestial body or across any point, area, or line. 3. An instrument used by an astronomer to determine the exact instant of meridian transit of a celestial body. 4. A reversing instrument used by a surveyor for accurately measuring horizontal and vertical angles; a theodolite which can be reversed in its supports without being lifted from them.
- transit**, *v., t.* To cross. In navigation the term is generally used with reference to the passage of a celestial body over a meridian, across the face of another celestial body, or across the reticle of an optical instrument.
- TRANSIT**, *n.* See NAVY NAVIGATION SATELLITE SYSTEM.
- transition buoy**. A buoy indicating the transition between the lateral and cardinal systems of buoyage.
- transition mark**. A navigation mark indicating the transition between the lateral and cardinal systems of marking.
- translocation**, *n.* The determination of the relative positions of two points by simultaneous Doppler satellite observations from each point.
- translunar**, *adj.* Of or pertaining to space outside the moon's orbit about the earth.
- transmit-receive tube**. See as TR TUBE.
- transponder**, *n.* A component of a secondary radar system capable of accepting the interrogating signal, received from a radar set or interrogator, and in response automatically transmitting a signal which enables the transponder to be identified by the interrogating station. Also called TRANSPONDER BEACON. See also RADAR BEACON, RACON.
- transponder beacon**. See TRANSPONDER.
- transpose**, *v., t.* To change the relative place or position of, as to move a term from one side of an equation to the other with a change of sign.
- transverse bar**. A bar which extends approximately normal to the shoreline.
- transverse chart**. A chart on a transverse map projection. Also called INVERSE CHART.
- transverse cylindrical orthomorphic chart**. See TRANSVERSE MERCATOR CHART.
- transverse cylindrical orthomorphic projection**. See TRANSVERSE MERCATOR MAP PROJECTION.
- transverse equator**. The plane which is perpendicular to the axis of a transverse map projection. Also called INVERSE EQUATOR. See also FICTITIOUS EQUATOR.
- transverse graticule**. A fictitious graticule based upon a transverse map projection.
- transverse latitude**. Angular distance from a transverse equator. Also called INVERSE LATITUDE. See also FICTITIOUS LATITUDE.
- transverse longitude**. Angular distance between a prime transverse meridian and any given transverse meridian. Also called INVERSE LONGITUDE. See also FICTITIOUS LONGITUDE.
- transverse map projection**. A map projection with its axis in the plane of the equator.
- transverse Mercator chart**. A chart on the transverse Mercator projection. Also called TRANSVERSE CYLINDRICAL ORTHOMORPHIC CHART, INVERSE MERCATOR CHART, INVERSE CYLINDRICAL ORTHOMORPHIC CHART. See also MERCATOR CHART.
- transverse Mercator map projection**. A conformal cylindrical map projection, being in principle equivalent to the regular Mercator map projection turned (transversed) 90° in azimuth. In this projection, the central meridian is represented by a straight line, corresponding to the line which represents the equator on the regular Mercator projection. Neither the geographic meridians (except the central meridian) nor the geodetic parallels (except the equator) are represented by straight lines. Also called INVERSE MERCATOR MAP PROJECTION, TRANSVERSE CYLINDRICAL ORTHOMORPHIC MAP PROJECTION, INVERSE CYLINDRICAL ORTHOMORPHIC MAP PROJECTION. See also MERCATOR MAP PROJECTION.
- transverse meridian**. A great circle perpendicular to a transverse equator. The reference transverse meridian is called prime transverse meridian. Also called INVERSE MERIDIAN. See also FICTITIOUS MERIDIAN.
- transverse parallel**. A circle or line parallel to a transverse equator connecting all points of equal transverse latitude. Also called INVERSE PARALLEL. See also FICTITIOUS PARALLEL.
- transverse pole**. One of the two points 90° from a transverse equator.
- transverse rhumb line**. A line making the same oblique angle with all fictitious meridians of a transverse Mercator map projection. Transverse parallels and meridians may be considered special cases of the transverse rhumb line. Also called INVERSE RHUMB LINE. See also FICTITIOUS RHUMB LINE.
- transverse wave**. A wave in which the vibration is perpendicular to the direction of propagation, as in light waves. This is in contrast with a LONGITUDINAL WAVE, in which the vibration is in the direction of propagation.
- trapezoid**, *n.* A quadrilateral having two parallel sides and two nonparallel sides.
- traverse**, *n.* A series of directions and distances, such as when a sailing vessel beats into the wind, a steam vessel zigzags, or a surveyor makes measurements for determination of position.
- traverse sailing**. A method of determining the equivalent course and distance made good by a craft following a track consisting of a series of rhumb lines. The solution is usually made by means of traverse tables.
- traverse table**. A table giving relative values of various parts of plane right triangles, for use in solving such triangles, particularly in connection with various sailings.
- TR box**. See TR SWITCH.
- trench**, *n.* A long, narrow, characteristically very deep and asymmetrical depression of the sea floor, with relatively steep sides. See also TROUGH.
- triad**, *n.* Three radionavigation stations operated as a group for the determination of positions. Also called TRIPLET. See also STAR CHAIN.
- triangle**, *n.* A closed figure having three sides. The triangle is plane, spherical, or curvilinear as the sides are straight lines, arcs of great circles, or curves, respectively. See also EQUILATERAL TRIANGLE, ISOSCELES TRIANGLE, NAVIGATIONAL TRIANGLE, RIGHT TRIANGLE.
- triangulation**, *n.* A method of surveying in which the stations are points on the ground, located on the vertices of a chain or network of triangles. The angles of the triangles are measured instrumentally, and the sides are derived by computation from selected sides which are called BASE LINES, the lengths of which are obtained from direction measurements on the ground. See also TRILATERATION.
- triaxial ellipsoid**. A reference ellipsoid having three unequal axes; the shortest is the polar axis, and the two longer ones lie in the plane of the equator.



- tributary**. Any body of water that flows into a larger body, i.e., a creek in relation to a river, or a river in relation to a bay.
- trigger**, *n.* In a radar set, a sharp voltage pulse which is applied to the modulator tubes to fire the transmitter, applied simultaneously to the sweep generator to start the electron beam moving radially from the sweep origin to the edge of the face of the cathode-ray tube.
- triggering**, *n.* The process of causing a transponder to respond.
- trigonometric functions**. The ratios of the sides of a plane right triangle, as related to one of its angles. If  $a$  is the side opposite an acute angle,  $b$  the adjacent side, and  $c$  the hypotenuse the trigonometric functions are: sine =  $a/c$ , cosine =  $b/c$ , tangent =  $a/b$ , cotangent =  $b/a$ , secant =  $c/b$ , cosecant =  $c/a$ . The expression NATURAL TRIGONOMETRIC FUNCTION is sometimes used to distinguish a trigonometric function from its logarithm (called LOGARITHMIC TRIGONOMETRIC FUNCTION).

- trigonometry.** . A branch of mathematics dealing with the relations among the angles and sides of triangles.
- trihedral reflector.** . See CORNER REFLECTOR.
- trilateration.** , *n.* A method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths. See also TRIANGULATION.
- trim.** , *n.* The relation of the draft of a vessel at the bow and stern. See also DOWN BY THE HEAD; DOWN BY THE STERN; DRAG, *n.*, definition 3; SQUAT, *n.*
- triple interpolation.** . Interpolation when there are three arguments or variables.
- triples.** , *n.* See TRIAD.
- trochoid.** , *n.* In relation to wave motion, a curve described by a point on a radius of a circle that rolls along a straight line. Also called PROLATE CYCLOID.
- tropic.** , *adj.* Of or pertaining to a tropic or the tropics.
- tropic.** , *n.* Either of the two parallels of declination (north or south), approximately 23°27' from the celestial equator, reached by the sun at its maximum declination, or the corresponding parallels on the earth. The northern of these is called the TROPIC OF CANCER and the southern, the TROPIC OF CAPRICORN. The region of the earth between these two parallels is called the TORRID ZONE, or often the TROPICS.
- tropical.** , *adj.* 1. Of or pertaining to the vernal equinox. See also SIDE-REAL. 2. Of or pertaining to the Tropics.
- tropical air.** . Warm air of an air mass originating in subtropical anticyclones, further classified as tropical continental air and tropical maritime air, as it originates over land or sea, respectively.
- tropical continental air.** . Air of an air mass originating over a land area in low latitudes, such as the Sahara desert. Tropical continental air is characterized by high surface temperature and low specific humidity.
- tropical cyclone.** . The general term for cyclones originating in the tropics or subtropics. These cyclones are classified by form and intensity as follows: A tropical disturbance is a discrete system of apparently organized convection generally 100 to 300 miles in diameter, having a nonfrontal migratory character, having maintained its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field. It has no strong winds and no closed isobars, i.e., isobars that completely enclose the low. In successive stages of intensification, the tropical cyclone are classified as tropical disturbance, tropical depression, tropical storm, and hurricane or typhoon. The tropical depression has one or more closed isobars and some rotary circulation at the surface. The highest sustained (1-minute mean) surface wind speed is 33 knots. The tropical storm has closed isobars and a distinct rotary circulation. The highest sustained (1-minute mean) surface wind speed is 34 to 63 knots. The hurricane or typhoon has closed isobars, a strong and very pronounced rotary circulation, and a sustained (1-minute mean) surface wind speed of 64 knots or higher. Tropical cyclones occur almost entirely in six rather distinct areas, four in the Northern Hemisphere and two in the Southern Hemisphere. The name by which the tropical cyclone is commonly known varies somewhat with locality as follows: North Atlantic: A tropical cyclone with winds of 64 knots or greater is called a HURRICANE. Eastern North Pacific: The name HURRICANE is used as in the North Atlantic. Western North Pacific: A fully developed storm with winds of 64 knots or greater is called a TYPHOON or, locally in the Philippines, a BAGUIO. North Indian Ocean: A tropical cyclone with winds of 34 knots or greater is called a CYCLONIC STORM. South Indian Ocean: A tropical storm with winds of 34 knots or greater is called a CYCLONE. Southwest Pacific and Australian Area: The name CYCLONE is used as in the South Indian Ocean. A severe tropical cyclone originating in the Timor Sea and moving southwestward and then southeastward across the interior of northwestern Australia is called a WILLY-WILLY. Tropical cyclones have not been observed in the South Atlantic Ocean or in the South Pacific Ocean east of longitude 140°W.
- tropical depression.** . See under TROPICAL CYCLONE.
- tropical disturbance.** . See under TROPICAL CYCLONE.
- tropical maritime air.** . Air of an air mass originating over an ocean area in low latitudes. Tropical maritime air is characterized by high surface temperature and high specific humidity.
- tropical month.** . The average period of the revolution of the moon about the earth with respect to the vernal equinox, a period of 27 days, 7 hours, 43 minutes, 4.7 seconds. This is almost the same length as the sidereal month.
- tropical storm.** . See under TROPICAL CYCLONE.
- tropical year.** . The period of one revolution of the earth around the sun, with respect to the vernal equinox. Because of precession of the equinoxes, this is not 360° with respect to the stars, but 50.3" less. A tropical year is about 20 minutes shorter than a sidereal year, averaging 365 days, 5 hours, 48 minutes, and 46 seconds in 1900, decreasing at the rate of 0.00530 second annually. Also called ASTRONOMICAL, EQUINOCTIAL, NATURAL, or SOLAR YEAR.
- tropic currents.** . Tidal currents occurring semimonthly when the effect of the moon's maximum declination is greatest. At these times the tendency of the moon to produce a diurnal inequality in the current is at a maximum.
- tropic higher high water.** . The higher high water of tropic tides. See also TROPIC TIDES.
- tropic higher high water interval.** . The lunitidal interval pertaining to the higher high waters at the time of the tropic tides. See also TROPIC LOWER LOW WATER INTERVAL.
- tropic higher low water.** . The higher low water of tropic tides. See also TROPIC TIDES.
- tropic high water inequality.** . The average difference between the two high waters of the day at the times of the tropic tides. Applicable only when the tide is semidiurnal or mixed. See also TROPIC TIDES, TROPIC LOW WATER INEQUALITY.
- tropic inequalities.** . See TROPIC HIGH WATER INEQUALITY, TROPIC LOW WATER INEQUALITY.
- tropic intervals.** . See TROPIC HIGH WATER INTERVAL, TROPIC LOWER LOW WATER INTERVAL.
- tropic lower high water.** . The lower high water of tropic tides. See also TROPIC TIDES.
- tropic lower low water.** . The lower low water of tropic tides. See also TROPIC TIDES.
- tropic lower low water interval.** . The lunitidal interval pertaining to the lower low waters at the time of tropic tides. See also TROPIC HIGHER HIGH WATER INTERVAL.
- tropic low water inequality.** . The average difference between the two low waters of the day at the times of the tropic tides. Applicable only when the type of tide is semidiurnal or mixed. See also TROPIC TIDES, TROPIC HIGH WATER INEQUALITY.
- Tropic of Cancer.** . The northern parallel of declination, approximately 23°27' from the celestial equator, reached by the sun at its maximum northerly declination, or the corresponding parallel on the earth. It is named for the sign of the zodiac in which the sun reached its maximum northerly declination at the time the parallel was so named.
- Tropic of Capricorn.** . The southern parallel of declination, approximately 23°27' from the celestial equator, reached by the sun at its maximum southerly declination, or the corresponding parallel on the earth. It is named for the sign of the zodiac in which the sun reached its maximum southerly declination at the time the parallel was so named.
- tropic ranges.** . See GREAT TROPIC RANGE, MEAN TROPIC RANGE, SMALL TROPIC RANGE.
- tropics.** , *n.* See TORRID ZONE.
- tropic speed.** . The greater flood or greater ebb speed at the time of tropic currents.
- tropic tides.** . Tides occurring semimonthly when the effect of the moon's maximum declination is greatest. At these times there is a tendency for an increase in the diurnal range. The tidal datums pertaining to the tropic tides are designated as tropic higher high water, tropic lower high water, tropic higher low water, and tropic lower low water.
- tropopause.** , *n.* The boundary between the troposphere and the stratosphere.
- troposphere.** , *n.* The portion of the atmosphere from the earth's surface to the tropopause, i.e., the lowest 10 to 20 kilometers of the atmosphere. It is characterized by decreasing temperature with height, appreciable vertical wind motion, appreciable water vapor content, and variable weather.
- tropospheric radio duct.** . A quasi-horizontal layer in the troposphere between the boundaries of which radio energy of sufficiently high frequency is substantially confined and propagated with abnormally low attenuation. The duct may be formed in the lower portion of the atmosphere when there is a marked temperature inversion or

a sharp decrease in water vapor with increased height. See also SURFACE DUCT, ELEVATED DUCT.

- tropospheric wave.** . A radio wave traveling between points on or near the surface of the earth by one or more paths lying wholly within the troposphere. The propagation of this wave is determined primarily by the distribution of the refractive index in the troposphere.
- trough.** , *n.* 1. A long depression of the sea floor, characteristically flat bottomed and steep sided, and normally shallower than a trench. 2. In meteorology, an elongated area of relatively low pressure. The opposite of a trough is called RIDGE. The term trough is commonly used to distinguish the above elongated area from the closed circulation of a low (or cyclone). But a large-scale trough may include one or more lows. 3. The lowest part of a wave between two crests.
- TR switch.** (*from transmit/receive*). A switch used to automatically decouple the receiver from the antenna during transmission when there is a common transmitting and receiving antenna. Also called TR BOX.
- TR tube.** . An electronic switch capable of rapid switching between transmit and receive functions, used to protect the receiver from damage from energy generated by the transmitter. Another device called the anti-TR tube is used to block the passage of echoes to the receiver during the relatively long periods when the transmitter is inactive. See also TR SWITCH, ATR TUBE.
- true.** , *adj.* 1. Related to true north. 2. Actual, as contrasted with fictitious, such as the true sun. 3. Related to a fixed point, either on the earth or in space, such as true wind, in contrast with RELATIVE, which is related to a moving point. 4. Corrected, as in the term true altitude.
- true altitude.** . See OBSERVED ALTITUDE.
- true amplitude.** . Amplitude relative to true east or west.
- true anomaly.** . See under ANOMALY, definition 2.
- true azimuth.** . Azimuth relative to true north.
- true bearing.** . Bearing relative to true north; compass bearing corrected for compass error.
- true course.** . Course relative to true north.
- true direction.** . Horizontal direction expressed as angular distance from true north.
- true heading.** . Heading relative to true north.
- true meridian.** . A meridian through the geographical pole; compare with MAGNETIC MERIDIAN, COMPASS MERIDIAN, or GRID MERIDIAN, the north-south lines according to magnetic, compass, or grid direction, respectively.
- true motion display.** . 1. A type of radarscope display in which own ship and other moving targets move on the plan position indicator in accordance with their true courses and speeds. All fixed targets appear as stationary echoes. However, uncompensated set and drift of own ship may result in some movement of the echoes of stationary targets. This display is similar to a navigational (geographical) plot. 2. In ECDIS, a DISPLAY in which OWN SHIP and each target moves with its own true motion, while the position of all charted information remains fixed. See also RELATIVE MOTION DISPLAY.
- true motion radar.** . A radar set which provides a true motion display as opposed to the relative motion display most commonly used. The true motion radar requires own ship's speed input, either log or manual, in addition to own ship's course input.
- true north.** . The direction of the north geographical pole; the reference direction for measurement of true directions.
- true plot.** . See GEOGRAPHICAL PLOT.
- true prime vertical.** . See under PRIME VERTICAL CIRCLE.
- true solar time.** . See APPARENT TIME.
- true sun.** . The actual sun as it appears in the sky. Usually called APPARENT SUN. See also MEAN SUN, DYNAMICAL MEAN SUN.
- true track of target.** . The motion of a radar target on a true motion display. When the true motion display is ground stabilized, i.e., allowance is made for the set and drift of current, the motion displayed is called GROUND TRACK. Without such stabilization the motion displayed is called WATER TRACK.
- true wind.** . Wind relative to a fixed point on the earth. Wind relative to a moving point is called APPARENT or RELATIVE WIND.
- trumpet.** , *n.* See HORN.
- tsunami.** , *n.* A long-period sea wave, potentially catastrophic, produced by a submarine earthquake or volcanic eruption. It may travel unnoticed across the ocean for thousands of miles from its point of

origin, building up to great heights over shoal water. Also called SEISMIC SEA WAVE, TIDAL WAVE.

- Tsushima Current.** . That part of the Kuroshio flowing northeastward through Korea Strait and along the Japanese coast in the Japan Sea; it flows strongly eastward through Tsugaru Strait at speeds to 7 knots. The Tsushima Current is strong most of the time, averaging about 1 knot; however, it may weaken somewhat during autumn. In Western Channel, between Tsushima and southeastern Korea, tidal currents retard the general northeastward flowing Tsushima Current during the southwest-setting flood and reinforce it during the northeast-setting ebb. Resultant current speeds range from 1/4 knot during flood to 3 knots during ebb. In the strait between Tsushima and Kyushu, the current flows northeastward throughout the year. Current speeds in Korea Strait also are affected by the seasonal variations of the monsoons. The strongest currents usually occur from July through November. The Tsushima Current divides after flowing through Korea Strait, a small branch flowing northward along the east coast of Korea as far as Vladivostok in summer. During this season the current is strongest and overcomes the weak southward flowing, coastal Liman Current. When the current combines with the ebb current, the resultant speed may reach 2 knots. During winter this branch of the Tsushima Current is weakest and is influenced by the stronger southward flowing Liman Current which normally extends as far south as 39°N, with speeds from 1/4 to 3/4 knot. The main body of the Tsushima Current flows northeastward off the northeast coast of Honshu. In summer, after entering the Japan Sea, its speed is about 1/2 to 1 knot. In winter the current is relatively weak, although near the islands and headlands speeds may exceed 1 knot, especially after northwesterly gales.
- tuba.** , *n.* See FUNNEL CLOUD.
- tufa.** , *n.* A porous rocky deposit formed in streams and in the ocean near the mouths of rivers.
- tumble.** , *v., i.* The tendency of a gyroscope to precess suddenly and to an extreme extent as a result of exceeding its operating limits of bank or pitch.
- tune.** , *v., t.* To adjust the frequency of a circuit or system to obtain optimum performance, commonly to adjust to resonance.
- turbidity.** , *n.* A measure of the amount of suspended material in water.
- turbulent.** , *n.* Agitated or disturbed fluid motion, not flowing smoothly or uniformly.
- turbulent flow.** . Fluid motion in which random motions of parts of the fluid are superimposed upon a simple pattern of flow. All or nearly all fluid flow displays some degree of turbulence. The opposite is STREAMLINE FLOW.
- turning basin.** . A water area, usually dredged to well-defined limits, used for turning vessels.
- turning buoy.** . A buoy marking a turn in a channel.
- turning circle.** . The path described by the pivot point of the vessel as it makes a turn of 360° with constant rudder and speed.
- turn of the tide.** . See CHANGE OF TIDE.
- twenty-four hour satellite.** . See GEOSYNCHRONOUS SATELLITE.
- twilight.** , *n.* The period of incomplete darkness following sunset (evening twilight) or preceding sunrise (morning twilight). Twilight is designated as civil, nautical, or astronomical, as the darker limit occurs when the center of the sun is 6°, 12°, or 18° below the celestial horizon, respectively. See also DAWN, DUSK.
- twinkle.** , *v., i.* To flicker randomly, or vary in intensity.
- two-body orbit.** . The motion of a point mass in the presence of the gravitational attraction of another point mass, and in the absence of other forces. This orbit is usually an ellipse, but may be a parabola or hyperbola.
- two-degree-of-freedom gyro.** . A gyroscope the spin axis of which is free to rotate about two orthogonal axes, not counting the spin axis. See also DEGREE-OF-FREEDOM.
- two-tone diaphone.** . See under DIAPHONE.
- two-way route.** . A route within defined limits in which two-way traffic is established, aimed at providing safe passage of ships through waters where navigation is difficult or dangerous. See also ROUTING SYSTEM.
- tyfon.** , *n.* See TYPHON.
- type of tide.** . A classification based on characteristic forms of a tide curve. Qualitatively, when the two high waters and two low waters of each tidal day are approximately equal in height, the tide is said to be semidiurnal; when there is a relatively large diurnal inequality in the high or low waters or both, it is said to be mixed; and when there

is only one high water and one low water in each tidal day, it is said to be diurnal.

**typhon**, *n.* A diaphragm horn which operates under the influence of compressed air or steam. Also called TYFON.

**typhoon**, *n.* See under TROPICAL CYCLONE.

## U

**Ulloa's ring**. See BOUGUER'S HALO.

**ultra high frequency**. Radio frequency of 300 to 3,000 megahertz.

**ultra quick light**. A navigation light flashing at a rate of not less than 160 flashes per minute. See also CONTINUOUS ULTRA QUICK LIGHT, INTERRUPTED ULTRA QUICK LIGHT.

**ultrashort wave**. A radio wave shorter than 10 meters. A wave shorter than 1 meter is called a MICROWAVE. See also WAVE.

**ultrasonic**, *adj.* Having a frequency above the audible range. Frequencies below the audible range are called INFRASONIC. See also SUPERSONIC.

**ultrasonic depth finder**. A direct-reading instrument which determines the depth of water by measuring the time interval between the emission of an ultrasonic signal and the return of its echo from the bottom. A similar instrument utilizing signals within the audible range is called a SONIC DEPTH FINDER. Both instruments are also called ECHO SOUNDERS.

**umbra**, *n.* 1. The darkest part of a shadow in which light is completely cut off by an intervening object. A lighter part surrounding the umbra, in which the light is only partly cut off, is called the PEN-UMBRA. 2. The darker central portion of a sun spot, surrounded by the lighter PENUMBRA.

**uncorrecting**, *n.* The process of converting true to magnetic, compass, or gyro direction, or magnetic to compass direction. The opposite is CORRECTING.

**uncovered**, *adj. & adv.* Above water. The opposite is SUBMERGED. See also AFLOAT; AWASH.

**undercurrent**, *n.* A current below the surface, particularly one flowing in a direction or at a speed differing from the surface current. See UNDERTOW, SUBSURFACE CURRENT, SURFACE CURRENT.

**underscale**. In ECDIS, the condition where data displayed is not the largest scale NAVIGATIONAL PURPOSE data available for that area.

**under the lee**. To leeward.

**undertow**, *n.* Receding water below the surface of breakers on a beach. See also UNDERCURRENT, SUBSURFACE CURRENT, SURFACE CURRENT, BACKRUSH, RIP CURRENT.

**underway, under way**, *adv.* Not moored or anchored. See also ADRIFT. See also MAKING WAY.

**undevelopable**, *adj.* A surface not capable of being flattened without distortion. The opposite is DEVELOPABLE.

**undisturbed orbit**. See NORMAL ORBIT.

**undulating**, *adj.* Having the form of more or less regular waves.

**undulating light**. See under FIXED AND FLASHING LIGHT.

**undulation of the geoid**. See GEOIDAL HEIGHT.

**undulatus**, *adj.* Having undulations, referring to a cloud composed of elongated and parallel elements resembling ocean waves.



undulatus

**unfavorable current**. A current flowing in such a direction as to decrease the speed of a vessel over the ground. The opposite is FAVORABLE CURRENT.

**unfavorable wind**. A wind which delays the progress of a craft in a desired direction. Usually used in plural and chiefly in connection with sailing vessels. A wind which aids the progress of a craft is called a FAIR or FAVORABLE WIND. See also FOLLOWING WIND, HEAD WIND.

**Uniform State Waterway Marking System**. An aids to navigation

system developed jointly by the U.S. Coast Guard and state boating administrators to assist the small craft operator in inland state waters marked by states. It consists of two categories of aids to navigation. One is a system of aids to navigation, generally compatible with the Federal lateral system of buoyage, to supplement the federal system in state waters. The other is a system of regulatory markers to warn the small craft operator of dangers or to provide general information and directions.

**unipole antenna**, *n.* See ISOTROPIC ANTENNA.

**unique sanctuary**. A marine sanctuary established to protect a unique geologic, oceanographic, or living feature. See also MARINE SANCTUARY.

**unit**, *n.* A value, quantity, or magnitude in terms of which other values, quantities, or magnitudes are expressed. In general, a unit is fixed by definition and is independent of such physical conditions as temperature. See also STANDARD, definition 2; INTERNATIONAL SYSTEM OF UNITS.

**United States Coast Pilot**. One of a series of SAILING DIRECTIONS published by the National Ocean Service, that cover a wide variety of information important to navigators of U.S. coastal and intra-coastal waters, and waters of the Great Lakes. Most of this information cannot be shown graphically on the standard nautical charts and is not readily available elsewhere. This information includes navigation regulations, outstanding landmarks, channel and anchorage peculiarities, dangers, weather, ice, currents, and port facilities. Each *Coast Pilot* is corrected through the dates of *Notices to Mariners* shown on the title page and should not be used without reference to the *Notices to Mariners* issued subsequent to those dates.

**United States National Map Accuracy Standards**. A set of standards which define the accuracy with which features of U.S. maps are to be portrayed. 1. Horizontal accuracy: For maps at publication scales larger than 1:20,000, 90 percent of all well-defined features, with the exception of those unavoidably displaced by exaggerated symbolization, will be located within 0.85 mm of their geographic positions as referred to the map projection; for maps at publication scales of 1:20,000 or smaller, 0.50 mm. 2. Vertical accuracy: 90 percent of all contours will be accurate within one-half of the basic contour interval. Discrepancies in the accuracy of contours and elevations beyond this tolerance may be decreased by assuming a horizontal displacement within 0.50 mm. Also called MAP ACCURACY STANDARDS.

**universal plotting sheet**. See under SMALL AREA PLOTTING SHEET.

**Universal Polar Stereographic grid**. A military grid system based on the polar stereographic map projection, applied to maps of the earth's polar regions north of 84°N and south of 80°S.

**Universal Time**. Conceptually, time as determined from the apparent diurnal motion of a fictitious mean sun which moves uniformly along the celestial equator at the average rate of the apparent sun. Actually, Universal Time (UT) is related to the rotation of the earth through its definition in terms of sidereal time. Universal Time at any instant is derived from observations of the diurnal motions of the stars. The time scale determined directly from such observations is slightly dependent on the place of observation; this scale is designated UT0. By removing from UT0 the effect of the variation of the observer's meridian due to the observed motion of the geographic pole, the scale UT1 is established. A scale designated UT2 results from applying to UT1 an adopted formula for the seasonal variation in the rate of the earth's rotation. UT1 and UT2 are independent of the location of the observer. UT1 is the same as Greenwich mean time used in navigation. See also TIME SCALE.

**Universal Transverse Mercator (UTM) grid**. A military grid system based on the transverse Mercator map projection, applied to maps of the earth's surface extending to 84°N and 80°S.

**unlighted buoy**. A buoy not fitted with a light, whose shape and color are the defining features; may have a sound signal.

**unlighted sound buoy**. See under SOUND BUOY.

**unmanned light**. A light which is operated automatically and may be maintained in service automatically for extended periods of time, but with routine visits for maintenance purposes. Also called UNWATCHED LIGHT.

**unperturbed orbit**. See NORMAL ORBIT.

**unsettled**, *adj.* Pertaining to fair weather which may at any time become rainy, cloudy, or stormy. See also SETTLED.

**unstabilized display.** . A radarscope display in which the orientation of the relative motion presentation is set to the ship's heading and changes with it.

**unstabilized in azimuth.** . See under STABILIZATION OF RADAR-SCOPE DISPLAY.

**unwatched light.** . See UNMANNED LIGHT.

**update.** . See UPDATE INFORMATION. (Verb) applying the UPDATE MECHANISM. See also OFFICIAL UPDATES.

**update information.** . In ECDIS, the data which is needed to update the TARGET DATA automatically. Update information is comprised of one or more UPDATE RECORDS.

**update mechanism.** . In ECDIS, the defined sequence of update operations necessary to update the TARGET DATA by applying the UPDATE INFORMATION to the content of the TARGET DATA so that no operator interaction is involved.

**update record.** . In ECDIS, a generic term for FEATURE or SPATIAL RECORDS containing update instructions.

**upper branch.** . That half of a meridian or celestial meridian from pole to pole which passes through a place or its zenith.

**upper culmination.** . See UPPER TRANSIT.

**upper limb.** . The upper edge of a celestial body, in contrast with the LOWER LIMB, the lower edge.

**upper transit.** . Transit of the upper branch of the celestial meridian. Transit of the lower branch is called LOWER TRANSIT. Also called SUPERIOR TRANSIT, UPPER CULMINATION.

**uprush.** . *n.* 1. The rush of the water onto the foreshore following the breaking of a wave. 2. See RUN-UP.

**upstream.** . *adj. & adv.* Toward the source of a stream. The opposite is DOWNSTREAM.

**up-the-scope echo.** . See CLASSIFICATION OF RADAR ECHOES.

**upwelling.** . *n.* The process by which water rises from a lower to a higher depth, usually as a result of divergence and offshore currents. Upwelling is most prominent where persistent wind blows parallel to a coastline so that the resultant wind-driven current sets away from the coast. Over the open ocean, upwelling occurs whenever the wind circulation is cyclonic, but is appreciable only in areas where that circulation is relatively permanent. It is also observable when the southern trade winds cross the equator.

**upwind.** . *adj. & adv.* In the direction from which the wind is blowing. The opposite is DOWNWIND.

**U.S. Survey foot.** . The foot used by the National Ocean Service in which 1 inch is equal to 2.540005 centimeters. The foot equal to 0.3048 meter, exactly, adopted by Australia, Canada, New Zealand, South Africa, the United Kingdom, and the United States in 1959 was not adopted by the National Ocean Service because of the extensive revisions which would be necessary to their charts and measurement records.

**UTC.** . *n.* See under COORDINATED UNIVERSAL TIME.

**UT0.** . *n.* See under UNIVERSAL TIME.

**UT1.** . *n.* See under UNIVERSAL TIME.

**UT2.** . *n.* See under UNIVERSAL TIME.

## V

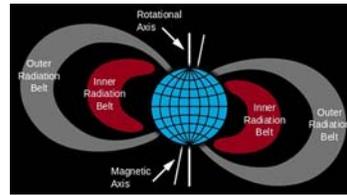
**vacuum.** . *n.* A space containing no matter.

**valley.** . *n.* On the sea floor, a relatively shallow, wide depression, the bottom of which usually has a continuous gradient. This term is generally not used for features that have canyon-like characteristics for a significant portion of their extent.

**valley breeze.** . A gentle wind blowing up a valley or mountain slope in the absence of cyclonic or anticyclonic winds, caused by the warming of the mountainside and valley floor before the sun. See also KATABATIC WIND, MOUNTAIN BREEZE.

**Van Allen Radiation Belts.** . . Popular term for regions of high energy charged particles trapped in the earth's magnetic field. Definition of size and shape of these belts depends on selection of an arbitrary standard of radiation intensity and the predominant particle component. Belts known to exist are: a proton region centered at about 2,000 miles altitude at the geomagnetic equator; an electron region centered at about 12,000 miles altitude at the geomagnetic equator; overlapping electron and proton regions centered at about 20,000 miles altitude at the geomagnetic equator. Trapped radiation regions from artificial sources also exist. These belts were first

reported by Dr. James A. Van Allen of Iowa State University.



Van Allen  
Radiation Belt

**vane.** . *n.* 1. A device to sense or indicate the direction from which the wind blows. Also called WEATHER VANE, WIND VANE. See also ANEMOMETER. 2. A sight on an instrument used for observing bearings, as on a pelorus, azimuth circle, etc. That vane nearest the observer's eye is called near vane and that on the opposite side is called far vane. Also called SIGHTING VANE. 3. In current measurements, a device to indicate the direction toward which the current flows.

**vanishing tide.** . . In a mixed tide with very large diurnal inequality, the lower high water (or higher low water) frequently becomes indistinct (or vanishes) at time of extreme declinations. During these periods the diurnal tide has such overriding dominance that the semi-diurnal tide, although still present, cannot be readily seen on the tide curve.

**vapor pressure.** . . 1. The pressure exerted by the vapor of a volatile liquid. Each component of a mixed-gas vapor has its own pressure, called partial pressure.

**vardar.** . *n.* A cold fall wind blowing from the northwest down the Vardar valley in Greece to the Gulf of Salonica. It occurs when atmospheric pressure over eastern Europe is higher than over the Aegean Sea, as is often the case in winter. Also called VARDARAC.

**vardarac.** . *n.* See VARDAR.

**variable.** . *n.* A quantity to which a number of values can be assigned.

**variable parameters of satellite orbit.** . . See under FIXED AND VARIABLE PARAMETERS OF SATELLITE ORBIT.

**variable range marker.** . An adjustable range ring on the radar display.

**variable star.** . A star which is not of constant magnitude.

**variance.** . *n.* The square of the standard deviation.

**variation.** . *n.* 1. The angle between the magnetic and geographic meridians at any place, expressed in degrees and minutes east or west to indicate the direction of magnetic north from true north. The angle between magnetic and grid meridians is called GRID MAGNETIC ANGLE, GRID VARIATION, or GRIVATION. Called MAGNETIC VARIATION when a distinction is needed to prevent possible ambiguity. Also called MAGNETIC DECLINATION. 2. Change or difference from a given value.

**variation of latitude.** . A small change in the astronomical latitude of points on the earth due to polar motion.

**variation of the poles.** . See POLAR MOTION.

**variometer.** . *n.* An instrument for comparing magnetic forces, especially of the earth's magnetic field.

**vast floe.** . See under FLOE.

**V-band.** . A radio-frequency band of 46.0 to 56.0 kilomegahertz. See also FREQUENCY, FREQUENCY BAND.

**vector.** . *n.* Any quantity, such as a force, velocity, or acceleration, which has both magnitude and direction, as opposed to a SCALAR which has magnitude only. Such a quantity may be represented geometrically by an arrow of length proportional to its magnitude, pointing in the given direction.

**vector.** . *adj.* A type of computerized display which consists of layers of differentiated data, each with discreet features. Individual data files can be independently manipulated. See RASTER, BIT-MAP.

**vector addition.** . The combining of two or more vectors in such manner as to determine the equivalent single vector. The opposite is RESOLUTION OF VECTORS. Also called COMPOSITION OF VECTORS.

**vector diagram.** . A diagram of more than one vector drawn to the same scale and reference direction and in correct position relative to each other. A vector diagram composed of vectors representing the actual courses and speeds of two craft and the relative motion vector of either one in relation to the other may be called a SPEED TRIANGLE.

**vector quantity.** . A quantity having both magnitude and direction and

- hence capable of being represented by a vector. A quantity having magnitude only is called a SCALAR.
- veer**, *v., i.* 1. For the wind to change direction in a clockwise direction in the Northern Hemisphere and a counterclockwise direction in the Southern Hemisphere. Change in the opposite direction is called BACK. 2. Of the wind, to shift aft. The opposite motion is to HAUL forward.
- veer**, *v., t.* To pay or let out, as to veer anchor chain.
- vehicle location monitoring**. . A service provided to maintain the orderly and safe movement of platforms or vehicles. It encompasses the systematic observation of airspace, surface, or subsurface areas by electronic, visual, and other means to locate, identify, and control the movement of vehicles.
- velocity**, *n.* A vector quantity equal to speed in a given direction.
- velocity meter**. . See INTEGRATING ACCELEROMETER.
- velocity of current**. . Speed and set of the current.
- velocity ratio**. . The ratio of two speeds, particularly the ratio of the speed of tidal current at a subordinate station to the speed of the corresponding current at the reference station.
- Venus**, *n.* The planet whose orbit is next nearer the sun than that of the earth.
- verglas**, *n.* See GLAZE.
- vernal**, *adj.* Pertaining to spring. The corresponding adjectives for summer, fall, and winter are aestival, autumnal, and hibernal.
- vernal equinox**. . 1. The point of intersection of the ecliptic and the celestial equator, occupied by the sun as it changes from south to north declination, on or about March 21. Also called MARCH EQUINOX, FIRST POINT OF ARIES. 2. That instant the sun reaches the point of zero declination when crossing the celestial equator from south to north.
- vernier**, *n.* A short, auxiliary scale situated alongside the graduated scale of an instrument, by which fractional parts of the smallest division of the primary scale can be measured with greater accuracy by a factor of ten. If 10 graduations on a vernier equal 9 graduations on the micrometer drum of a sextant, when the zero on the vernier lies one-tenth of a graduation beyond zero on the micrometer drum, the first graduation beyond zero on the vernier coincides with a graduation on the micrometer drum. Likewise, when the zero on the vernier lies five-tenths of a graduation beyond zero on the micrometer drum, the fifth graduation beyond zero on the vernier coincides with a graduation on the micrometer drum.
- vernier error**. . Inaccuracy in the graduations of the scale of a vernier.
- vernier sextant**. . A marine sextant providing a precise reading by means of a vernier used directly with the arc, and having either a clamp screw or an endless tangent screw for controlling the position of the index arm. The micrometer drum on a micrometer drum sextant may include a vernier to enable a more precise reading.
- vertex**. . (*pl. vertices*), *n.* 1. The highest point. See also APEX. 2. The point at which tow lines meet to form an angle.
- vertical**. . *adj.* In the direction of gravity, or perpendicular to the plane of the horizon.
- vertical**. . *n.* A vertical line, plane, etc.
- vertical axis**. . The line through the center of gravity of a craft, perpendicular to both the longitudinal and lateral axes, around which it yaws.
- vertical beam width**. . The beam width measured in a vertical plane.
- vertical circle**. . A great circle of the celestial sphere through the zenith and nadir. Vertical circles are perpendicular to the horizon. The prime vertical circle or prime vertical passes through the east and west points of the horizon. The principal vertical circle passes through the north and south points of the horizon and coincides with the celestial meridian.
- vertical control datum**. . See VERTICAL GEODETIC DATUM.
- vertical danger angle**. . The maximum or minimum angle between the top and bottom of an object of known height, as observed from a craft, indicating the limit of safe approach to an offlying danger. See also DANGER ANGLE.
- vertical datum**. . 1. A base elevation used as a reference from which to reckon heights or depths. It is called TIDAL DATUM when defined by a certain phase of the tide. Tidal datums are local datums and should not be extended into areas which have differing topographic features without substantiating measurements. In order that they may be recovered when needed, such datums are referenced to fixed points known as bench marks. See also CHART SOUNDING DATUM. 2. See VERTICAL GEODETIC DATUM.
- vertical earth rate**. . To compensate for the effect of earth rate, the rate at which a gyroscope must be turned about its vertical axis for the spin axis to remain in the meridian. Vertical earth rate is maximum at the poles, zero at the equator and varies as the sine of the latitude. See also EARTH RATE, HORIZONTAL EARTH RATE.
- vertical force instrument**. . See HEELING ADJUSTER.
- vertical geodetic datum**. . A surface derived by geodetic means and taken as a surface of reference from which to reckon geodetic elevations. See also DATUM. Also called VERTICAL DATUM, VERTICAL CONTROL DATUM.
- vertical intensity of the earth's magnetic field**. . The strength of the vertical component of the earth's magnetic field.
- vertical lights**. . Two or more lights disposed vertically, or geometrically to form a triangle, square or other figure. If the individual lights serve different purposes, those of lesser importance are called AUXILIARY LIGHTS.
- vertically polarized wave**. . A plane polarized electromagnetic wave in which the electric field vector is in a vertical plane.
- very close pack ice**. . Pack ice in which the concentration is 9/10 to less than 10/10.
- very high frequency**. . Radio frequency of 30 to 300 megahertz.
- very low frequency**. . Radio frequency below 30 kilohertz.
- very open pack ice**. . Pack ice in which the concentration is 1/10 to 3/10.
- very quick flashing light**. . A navigation light flashing 80-160 flashes per minute. See also CONTINUOUS VERY QUICK LIGHT, GROUP VERY QUICK LIGHT, INTERRUPTED VERY QUICK LIGHT.
- very small fracture**. . See under FRACTURE.
- very weathered ridge**. . A ridge with tops very rounded, the slopes of the sides usually being about 20° to 30°.
- vessel**, *n.* Any type of craft which can be used for transportation on water.
- Vessel Traffic Services**. . A system of regulations, communications, and monitoring facilities established to provide active position monitoring, collision avoidance services, and navigational advice for vessels in confined and busy waterways. There are two main types of VTS, surveilled and non-surveilled. Surveilled systems consist of one or more land-based radar sites which output their signals to a central location where operators monitor and to a certain extent control traffic flows. Non-surveilled systems consist of one or more calling-in points at which ships are required to report their identity, course, speed, and other data to the monitoring authority.
- viaduct**. . *n.* A type of bridge which carries a roadway or railway across a ravine; distinct from an aqueduct, which carries water over a ravine. See also BRIDGE, definition 2; CAUSEWAY.
- vibrating needle**. . A magnetic needle used in compass adjustment to find the relative intensity of the horizontal components of the earth's magnetic field and the magnetic field at the compass location. Also called HORIZONTAL FORCE INSTRUMENT.
- vibration**. . *n.* 1. Periodic motion of an elastic body or medium in alternately opposite directions from equilibrium; oscillation. 2. The motion of a vibrating body during one complete cycle; two oscillations.
- video**. . *n.* In the operation of a radar set, the demodulated receiver output that is applied to the indicator. Video contains the relevant radar information after removal of the carrier frequency.
- violent storm**. . Wind of force 11 (56 to 63 knots or 64 to 72 miles per hour) on the Beaufort wind scale. See also STORM, definition 1.
- virga**. . *n.* Wisps or streaks of water or ice particles falling out of a cloud but evaporating before reaching the earth's surface as precipitation. Virga is frequently seen trailing from altocumulus and altostratus clouds, but also is discernible below the bases of high-level cumuliform clouds from which precipitation is falling into a dry subcloud layer. It typically exhibits a hooked form in which the streaks descend nearly vertically just under the precipitation source but appear to be almost horizontal at their lower extremities. Such curvature of virga can be produced simply by effects of strong vertical windshear, but ordinarily it results from the fact that droplet or crystal evaporation decreases the particle terminal fall velocity near the ends of the streaks. Also called FALL STREAKS, PRECIPITATION TRAILS.
- virtual image**. . An image that cannot be shown on a surface but is visible, as in a mirror.
- virtual meridian**. . The meridian in which the spin axis of a gyrocompass will settle as a result of speed-course-latitude error.
- viscosity**. . The property of resistance to flow.

**visibility** . . . *n.* A measure of the ability of an observer to see objects at a distance through the atmosphere. A measure of this property is expressed in units of distance. This term should not be confused with VISUAL RANGE. See also METEOROLOGICAL VISIBILITY.

**visible horizon** . . . The line where earth and sky appear to meet, and the projection of this line upon the celestial sphere. If there were no terrestrial refraction, VISIBLE and GEOMETRICAL HORIZONS would coincide. Also called APPARENT HORIZON.

**visual aid to navigation** . . . An aid to navigation which transmits information through its visible characteristics. It may be lighted or unlighted.

**visual bearing** . . . A bearing obtained by visual observation.

**visual range** . . . The maximum distance at which a given object can be seen, limited by the atmospheric transmission. The distance is such that the contrast of the object with its background is reduced by the atmosphere to the contrast threshold value for the observer. This term should not be confused with VISIBILITY. See also CONTRAST THRESHOLD, VISUAL RANGE OF A LIGHT.

**visual range of light** . . . The predicted range at which a light can be observed. The predicted range is the lesser of either the luminous range or the geographic range. If the luminous range is less than the geographic range, the luminous range must be taken as the limiting range. The luminous range is the maximum distance at which a light can be seen under existing visibility conditions. This luminous range takes no account of the elevation of the light, the observer's height of eye, the curvature of the earth, or interference from background lighting. The luminous range is determined from the nominal range and the existing visibility conditions, using the Luminous Range Diagram. The nominal range is the maximum distance at which a light can be seen in clear weather as defined by the International Visibility Code (meteorological visibility of 10 nautical miles). The geographic range is the maximum distance at which the curvature of the earth and terrestrial refraction permit a light to be seen from a particular height of eye without regard to the luminous intensity of the light. The geographic range sometimes printed on charts or tabulated in light lists is the maximum distance at which the curvature of the earth and refraction permit a light to be seen from a height of eye of 15 feet above the water when the elevation of the light is taken above the height datum of the largest scale chart of the locality.) See also VISUAL RANGE, CONTRAST THRESHOLD.

**volcano** . . . *n.* An opening in the earth from which hot gases, smoke, and molten material issue, or a hill or mountain composed of volcanic material. A volcano is characteristically conical in shape with a crater in the top.

**volt** . . . *n.* A derived unit of electric potential in the International System of Units, it is the difference of electric potential between two points of a conducting wire carrying a constant current of 1 ampere, when the power dissipated between these points is equal to 1 watt.

**volt per meter** . . . The derived unit of electric field strength in the International System of Units.

**volume** . . . *n.* 1. A measure of the amount of space contained within a solid. 2. Loudness of a sound, usually measured in decibels.

**voyage** . . . *n.* 1. A trip by sea.

**vulgar establishment** . . . See under ESTABLISHMENT OF THE PORT.

## W

**wandering of the poles** . . . See EULERIAN MOTION.

**waning moon** . . . The moon between full and new when its visible part is decreasing. See also PHASES OF THE MOON.

**warble tone** . . . A tone whose frequency varies periodically about a mean value.

**warm air mass** . . . An air mass that is warmer than surrounding air. The expression implies that the air mass is warmer than the surface over which it is moving.

**warm brow** . . . A foehn in the Schouten Islands north of New Guinea. A foehn is a type of dry, warm, down-slope wind that occurs in the lee or downwind side of a mountain range.

**warm front** . . . Any non-occluded front, or portion thereof, which moves in such a way that warmer air replaces colder air. While some occluded fronts exhibit this characteristic, they are more properly called WARM OCCLUSIONS.

**warm occlusion** . . . See under OCCLUDED FRONT.

**warm sector** . . . An area at the earth's surface bounded by the warm and cold fronts of a cyclone.

**warning** . . . In ECDIS, an ALARM or INDICATION.

**warning beacon** . . . See WARNING RADIOBEACON.

**warning radiobeacon** . . . An auxiliary radiobeacon located at a lightship to warn vessels of their proximity to the lightship. It is of short range and sounds a warbling note for 1 minute immediately following the main radiobeacon on the same frequency. Also called WARNING BEACON.

**warp** . . . *v., t.* To move, as a vessel, from one place to another by means of lines fastened to an object, such as a buoy, wharf, etc., secured to the ground. See also KEDGE.

**warp** . . . *n.* A heavy line used in warping or mooring.

**warping buoy** . . . A buoy located so that lines to it can be used for the movement of ships.

**wash** . . . *n.* The dry channel of an intermittent stream.

**watch** . . . *n.* A small timepiece of a size convenient to be carried on the person. A hack or comparing watch is used for timing observations of celestial bodies. A stop watch can be started, stopped, and reset at will, to indicate elapsed time. A chronometer watch is a small chronometer, especially one with an enlarged watch-type movement.

**watch buoy** . . . See STATION BUOY.

**watch error** . . . The amount by which watch time differs from the correct time. It is usually expressed to an accuracy of 1 second and labeled fast (F) or slow (S) as the watch time is later or earlier, respectively, than the correct time. See also CHRONOMETER ERROR.

**watching properly** . . . The state of an aid to navigation on charted position and exhibiting its proper characteristics.

**watch rate** . . . The amount gained or lost by a watch or clock in a unit of time. It is usually expressed in seconds per 24 hours, to an accuracy of 0.1<sup>s</sup>, and labeled gaining or losing, as appropriate, when it is sometimes called DAILY RATE.

**watch time** . . . The hour of the day as indicated by a watch or clock. Watches and clocks are generally set approximately to zone time. Unless a watch or clock has a 24-hour dial, watch time is usually expressed on a 12-hour cycle and labeled AM or PM.

**watch tower** . . . See LOOKOUT STATION.

**water-borne** . . . *adj.* Floating on water; afloat. See also SEA-BORNE.

**watercourse** . . . *n.* 1. A stream of water. 2. A natural channel through which water runs. See also GULLY, WASH.

**waterfall** . . . *n.* A perpendicular or nearly perpendicular descent of river or stream water.

**waterline** . . . *n.* The line marking the junction of water and land. See also HIGH WATER LINE, LOW WATER LINE, SHORELINE.

**water sky** . . . Dark streaks on the underside of low clouds, indicating the presence of water features in the vicinity of sea ice.

**water smoke** . . . See STEAM FOG.

**water stabilization** . . . In ECDIS, the reference system relative to the water based on course and speed-through-water sensors.

**waterspout** . . . *n.* 1. A tornado occurring over water; most common over tropical and subtropical waters. 2. A whirlwind over water comparable in intensity to a dust devil over land.

**water tower** . . . A structure erected to store water at an elevation above the surrounding terrain; often charted with a position circle and label.

**water track** . . . 1. See under TRACK, definition 2. 2. See under TRUE TRACK OF TARGET.

**waterway** . . . *n.* A water area providing a means of transportation from one place to another, principally one providing a regular route for water traffic, such as a bay, channel, passage, or the regularly traveled parts of the open sea. The terms WATERWAY, FAIRWAY, and THOROUGHFARE have nearly the same meanings. WATERWAY refers particularly to the navigable part of a water area. FAIRWAY refers to the main traveled part of a waterway. A THOROUGHFARE is a public waterway. See also CANAL.

**watt** . . . *n.* A derived unit of power in the International System of Units; it is that power which in 1 second gives rise to energy of 1 joule.

**wave** . . . *n.* 1. An undulation or ridge on the surface of a fluid. See also STORM SURGE, TIDAL WAVE, TSUNAMI. 2. A disturbance propagated in such a manner that it may progress from point to point. See also ELECTROMAGNETIC WAVES, RADIO WAVES, SKYWAVE, GROUNDWAVE, DIRECT WAVE, INDIRECT WAVE, MODULATED WAVE, MICROWAVE,

SPHERICAL WAVE, TRANSVERSE WAVE, LONGITUDINAL WAVE.

**wave basin.** . . A basin close to the inner entrance of a harbor in which the waves from the outer entrance are absorbed, thus reducing the size of the waves entering the inner harbor. See also WAVE TRAP.

**wave crest.** . . The highest part of a wave.

**wave cyclone.** . . A cyclone which forms and moves along a front. The circulation about the cyclone center tends to produce a wavelike deformation of the front. The wave cyclone is the most frequent form of extratropical cyclone (or low). Also called WAVE DEPRESSION. See also FRONTAL CYCLONE.

**wave depression.** . . See WAVE CYCLONE.

**wave direction.** . . The direction from which waves are coming.

**waveguide.** . . *n.* A transmission line for electromagnetic waves consisting of a hollow conducting tube within which electromagnetic waves may be propagated; or a solid dielectric or dielectric-filled conductor designed for the same purpose.

**wave height.** . . The distance from the trough to the crest of a wave, equal to double the amplitude, and measured perpendicular to the direction of advance.

**wave height correction.** . . A correction due to the elevation of parts of the sea surface by wave action, particularly such a correction to a sextant altitude because of altered dip.

**wave interference.** . . See INTERFERENCE, definition 2.

**wavelength.** . . *n.* The distance between corresponding points in consecutive cycles in a wave train, measured in the direction of propagation at any instant.

**wave of translation.** . . A wave in which the individual particles of the medium are shifted in the direction of wave travel, as ocean waves in shoal waters; in contrast with an OSCILLATORY WAVE, in which only the form advances, the individual particles moving in closed orbits, as ocean waves in deep water.

**wave period.** . . The time interval between passage of successive wave crests at a fixed point.

**wave train.** . . A series of waves moving in the same direction. See also SOLITARY WAVE.

**wave trap.** . . Breakwaters situated close within the entrance used to reduce the size of waves from sea or swell which enter a harbor before they penetrate into the harbor. See also WAVE BASIN.

**wave trough.** . . The lowest part of a wave form between successive wave crests.

**waxing moon.** . . The moon between new and full when its visible part is increasing. See also PHASES OF THE MOON.



waxing  
moon

**waypoint.** . . *n.* 1. A reference point on the track. 2. In ECDIS, in conjunction with ROUTE PLANNING, a geographical location (e.g. latitude and longitude) indicating a significant event on a vessel's planned route (e.g. course alteration point, calling in point, etc).

**weak fix.** . . A fix determined from horizontal sextant angles between objects poorly located.

**weather.** . . *adj.* Pertaining to the windward side, or the side in the direction from which the wind is blowing. LEE pertains to the leeward or sheltered side.

**weather.** . . *n.* 1. The state of the atmosphere as defined by various meteorological elements, such as temperature, pressure, wind speed and direction, humidity, cloudiness, precipitation, etc. This is in contrast with CLIMATE, the prevalent or characteristic meteorological conditions of a place or region. 2. Bad weather. See also THICK WEATHER.

**weathered.** . . *adj.* Eroded by action of the weather.

**weathered berg.** . . An irregularly shaped iceberg. Also called GLACIER BERG.

**weathered ridge.** . . An ice ridge with peaks slightly rounded, the slopes of the sides usually being about 30° to 40°. Individual fragments are not discernible.

**weathering.** . . *n.* Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

**weather map.** . . See under SYNOPTIC CHART.

**weather shore.** . . As observed from a vessel, the shore lying in the direction from which the wind is blowing. See also LEE SHORE.

**weather side.** . . The side of a ship exposed to the wind or weather.

**weather vane.** . . A device to indicate the direction from which the wind blows. Also called WIND DIRECTION INDICATOR, WIND VANE. See also ANEMOMETER.

**weber.** . . *n.* A derived unit of magnetic flux in the International System of Units; it is that magnetic flux which, linking a circuit of one turn, would produce in it an electromotive force of 1 volt if it were reduced to zero at a uniform rate in 1 second.

**wedge.** . . See RIDGE, definition 3.

**weight.** . . *n.* A quantity of the same nature as a force; the weight of a body is the product of its mass and the acceleration due to gravity; in particular, the standard weight of a body is the product of its mass and the standard acceleration due to gravity. The value adopted in the International Service of Weights and Measures for the standard acceleration due to gravity is 980.665 centimeters per second, per second.

**weighted mean.** . . A value obtained by multiplying each of a series of values by its assigned weight and dividing the sum of those products by the sum of the weights. See also WEIGHT OF OBSERVATION.

**weight of observation.** . . The relative value of an observation, source, or quantity when compared with other observations, sources, or quantities of the same or related quantities. The value determined by the most reliable method is assigned the greatest weight. See also WEIGHTED MEAN.

**wellhead.** . . *n.* A submarine structure projecting some distance above the seabed and capping a temporarily abandoned or suspended oil or gas well. See also SUBMERGED PRODUCTION WELL.

**west.** . . *n.* The direction 90° to the left or 270° to the right of north. See also CARDINAL POINT.

**West Australia Current.** . . An Indian Ocean current which generally first flows northward and then northwestward off the west coast of Australia. This current varies seasonally with the strength of the wind and is most stable during November, December, and January, and least stable during May, June, and July, when it may set in any direction. North of 20°S the main part of this current flows northward into the Indian South Equatorial Current.

**westerlies.** . . *n., pl.* Winds blowing from the west on the poleward sides of the subtropical high-pressure belts.

**West Greenland Current.** . . The ocean current flowing northward along the west coast of Greenland into Davis Strait. It is a continuation of the East Greenland Current. Part of the West Greenland Current turns around when approaching the Davis Strait and joins the Labrador Current; the rest rapidly loses its character as a warm current as it continues into Baffin Bay.

**westing.** . . *n.* The distance a craft makes good to the west. The opposite is EASTING.

**westward motion.** . . The motion in a westerly direction of the subtrack of a satellite, including the motion due to the earth's rotation and the nodical precession of the orbital plane.

**West Wind Drift.** . . An ocean current that flows eastward through all the oceans around the Antarctic Continent, under the influence of the prevailing west winds. On its northern edge it is continuous with the South Atlantic Current, the South Pacific Current, and the South Indian Current. Also called ANTARCTIC CIRCUMPOLAR CURRENT.

**wet-bulb temperature.** . . The lowest temperature to which air can be cooled at any given time by evaporating water into it at constant pressure, when the heat required for evaporation is supplied by the cooling of the air. This temperature is indicated by a well-ventilated wet-bulb thermometer. See also FREE-AIR TEMPERATURE.

**wet-bulb thermometer.** . . A thermometer having the bulb covered with a cloth, usually muslin or cambric, saturated with water. See also PSYCHROMETER.

**wet compass.** . . See LIQUID COMPASS.

**wet dock.** . . See NON-TIDAL BASIN.

**wharf.** . . *n.* A structure of open pilings covered with a deck along a shore or a bank which provides berthing for ships and which generally provides cargo-handling facilities. A similar facility of solid construction is called QUAY. See also PIER, definition 1; DOCK;

LANDING; MOLE, definition 1.

**whirlpool**. . . *n.* Water in rapid rotary motion. See also EDDY.

**whirlwind**. . . *n.* A general term for a small-scale, rotating column of air. More specific terms include DUST WHIRL, DUST DEVIL, WATERSPOUT, and TORNADO.

**whirly**. . . *n.* A small violent storm, a few yards to 100 yards or more in diameter, frequent in Antarctica near the time of the equinoxes.

**whistle**. . . *n.* A sound signal emitter comprising a resonator having an orifice of suitable shape such that when a jet of air is passed through the orifice the turbulence produces a sound.

**whistle buoy**. . . A sound buoy equipped with a whistle operated by wave action. The whistle makes a loud moaning sound as the buoy rises and falls in the sea.

**whitecap**. . . *n.* A crest of a wave which becomes unstable in deep water, toppling over or "breaking." The instability is caused by the too rapid addition of energy from a strong wind. A wave which becomes unstable due shallow water is called a BREAKER.

**white ice**. . . See THIN FIRST-YEAR ICE.

**white squall**. . . A sudden, strong gust of wind coming up without warning, noted by whitecaps or white, broken water; usually seen in whirlwind form in clear weather in the tropics.

**white water**. . . 1. Frothy water as in whitecaps or breakers. 2. Light-colored water over a shoal.

**whole gale**. . . A term once used by seamen for what is now called STORM on the Beaufort wind scale.

**wide berth**. . . A generous amount of room given to a navigational danger.

**williwaw**. . . *n.* A sudden blast of wind descending from a mountainous coast to the sea, especially in the vicinity of either the Strait of Magellan or the Aleutian Islands.

**willy-willy**. . . *n.* See under TROPICAL CYCLONE.

**wind**. . . Air in horizontal motion over the earth.

**wind cone**. . . See WIND SOCK.

**wind direction**. . . The direction from which wind blows.

**wind direction indicator**. . . See WEATHER VANE.

**wind drift current**. . . See DRIFT CURRENT.

**wind driven current**. . . A current created by the action of the wind.

**wind indicator**. . . A device to indicate the direction or speed of the wind. See also ANEMOMETER.

**wind rode**. . . A ship riding at anchor is said to be wind rode when it is heading into the wind. See also TIDE RODE.

**wind rose**. . . A diagram showing the relative frequency and sometimes the average speed of the winds blowing from different directions in a specified region.

**winds aloft**. . . Wind speeds and directions at various levels beyond the domain of surface weather observations.

**wind shear**. . . A change in wind direction or speed in a short distance, resulting in a shearing effect. It can act in a horizontal or vertical direction and, occasionally, in both. The degree of turbulence increases as the amount of wind shear increases.

**wind-shift line**. . . In meteorology, a line or narrow zone along which there is an abrupt change of wind direction.

**wind sock**. . . A tapered fabric sleeve mounted so as to catch and swing with the wind, thus indicating the wind direction. Also called WIND CONE.

**wind speed**. . . The rate of motion of air. See also ANEMOMETER.

**wind storm**. . . See under STORM, definition 2.

**wind vane**. . . See WEATHER VANE.

**wind velocity**. . . The speed and direction of wind.

**windward**. . . *adj. & adv.* In the general direction from which the wind blows; in the wind; on the weather side. The opposite is LEEWARD.

**windward**. . . *n.* The weather side. The opposite is LEEWARD.

**windward tide**. . . A tidal current setting to windward. One setting in the opposite direction is called a LEEWARD TIDE or LEE TIDE.

**wind wave**. . . A wave generated by friction between wind and a fluid surface. Ocean waves are produced principally in this way.

**winged headland**. . . A seacliff with two bays or spits, one on either side.

**winter**. . . *n.* The coldest season of the year. In the Northern Hemisphere, winter begins astronomically at the winter solstice and ends at the vernal equinox. In the Southern Hemisphere the limits are the summer solstice and the autumnal equinox. The meteorological limits vary with the locality and the year.

**winter buoy**. . . An unlighted buoy which is maintained in certain areas during winter months when other aids to navigation are temporarily removed or extinguished.

**Winter Coastal Countercurrent**. . . See DAVIDSON CURRENT.

**winter light**. . . A light which is in service during the winter months when the regular light is out of service. It has lower intensity than the regular light but usually has the same characteristic.

**winter marker**. . . An unlighted buoy or small lighted buoy which is established as a replacement during the winter months when other aids are out of service or withdrawn.

**winter solstice**. . . The point on the ecliptic occupied by the sun at maximum southerly declination. During the winter solstice the northern regions of the earth remain dark, while the southern regions bathe though 24 hours of sunshine. Sometimes called DECEMBER SOLSTICE, FIRST POINT OF CAPRICORNUS.



winter solstice

**wiping**. . . *n.* The process of reducing the amount of permanent magnetism in a vessel by placing a single coil horizontally around the vessel and moving it, while energized, up and down along the sides of the vessel. If the coil remains stationary, the process is called FLASHING. See also DEPERMING.

**wire drag**. . . An apparatus for surveying rock areas where the normal sounding methods are insufficient to insure the discovery of all existing obstructions above a given depth, or for determining the least depth of an area. It consists of a buoyed wire towed at the desired depth by two vessels. Often shortened to DRAG. See also DRAG, *v., t.*

**withdrawn**. . . *adj.* Removed from service during severe ice conditions or for the winter season. Compare with the term disestablished, which means permanently removed. See also CLOSED, COMMISSIONED.

**WMO Sea-Ice Nomenclature (WMO/OMM/BMO No. 259. TP. 145)**. . . A publication of the World Meteorological Organization which is comprised of sea-ice terminology, ice reporting codes, and an illustrated glossary. This publication results from international cooperation in the standardization of ice terminology.

**working**. . . *n.* In sea ice navigation, making headway through an ice pack by boring, breaking, and slewing.

**World Geographic Reference System**. . . A worldwide position reference system that may be applied to any map or chart graduated in latitude and longitude (with Greenwich as prime meridian) regardless of projection. It is a method of expressing latitude and longitude in a form suitable for rapid reporting and plotting. Commonly referred to by use of the acronym GEOREF.

**World Geodetic System**. . . A consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the center of mass of the earth, transformations from major geodetic datums, and the potential of the earth (usually in terms of harmonic coefficients). It forms the common geodetic reference system for modern charts on which positions from electronic navigation systems can be plotted directly without correction.

**Worldwide Electronic Navigational Chart Data Base (WEND)**. . . In ECDIS, a common worldwide network of ENC datasets, based on IHO standards, designed specifically to meet the needs of international maritime traffic using ECDIS which conform to the IMO PERFORMANCE STANDARDS.

**Worldwide Marine Radiofacsimile Broadcasts Schedules**. . . A publication of the National Weather Service that provides information on marine weather broadcasts in all areas of the world. In general, English language broadcasts (or foreign language broadcasts repeated in English) are included in the publication. For areas where English language broadcasts are not available foreign language transmissions are also included.

**World Meteorological Organization**. . . A specialized agency of the United Nations which seeks to facilitate world-wide cooperation in the establishment of stations for meteorological and related geophysical observations of centers providing meteorological services, of systems of rapid exchange of weather information; and to

promote the standardization and publication of meteorological and hydrometeorological observations and statistics; to further the application of meteorology to aviation, shipping, agriculture, and other related activities; to encourage research and training in meteorology and their international coordination.

**World Port Index.** . . See *PUB. 150*.

**World Wide Navigational Warning Service.** . . Established through the joint efforts of the International Hydrographic Organization (IHO) and the Intergovernmental Maritime Consultative Organization (IMCO) now called the International Maritime Organization (IMO), the World Wide Navigational Warning Service (WWNWS) is a coordinated global service for the promulgation by radio of information on hazards to navigation which might endanger international shipping. The basic objective of the WWNWS is the timely promulgation by radio of information of concern to the ocean-going navigator. Such information includes failure and or changes to major navigational aids, newly discovered wrecks or natural hazards in or near main shipping lanes; areas where search and rescue, antipollution operations, cable-laying or other underway activities are taking place. For WWNWS purposes, the world is divided into 21 NAVAREAS. Within each NAVAREA one national authority, designated the Area Coordinator, has assumed responsibility for the coordination and promulgation of warnings. Designated "National Coordinators" of other coastal states in a NAVAREA are responsible for collecting and forwarding information to the Area Coordinator. In the Baltic, a Sub-Area Coordinator has been established to filter information prior to passing to the Area Coordinator. Coordinators are responsible for the exchange of information as appropriate with other coordinators, including that which should be further promulgated by charting authorities in *Notice to Mariners*. The language used is English, although warnings may also be transmitted in one or more of the official languages of the United Nations. Broadcast schedules appear in an Annex to the International Telecommunication Union *List of Radiodetermination and Special Service Stations Volume II*, and in the lists of radio signals published by various hydrographic authorities (for the U.S., *Pub 117, Radio Navigational Aids*.) Transmissions usually occur frequently enough during day to fall within at least one normal radio watch period, and the information is repeated with varying frequency as time passes until either the danger has passed or the information on it has appeared as a notice to mariners.

**worldwide system.** . . A term used to describe a navigation system providing positioning capability wherever the observer may be located. Also called GLOBAL SYSTEM.

**wreck.** . . *n.* The ruined remains of a vessel which has been rendered useless, usually by violent action by the sea and weather, on a stranded or sunken vessel. In hydrography the term is limited to a wrecked vessel, either submerged or visible, which is attached to or foul of the bottom or cast up on the shore. In nautical cartography wrecks are designated visible, dangerous, or non-dangerous according to whether they are above tidal datum, less than, or more than 20 meters (66 feet; 11 fathoms) below tidal datum, respectively.

**wreck buoy.** . . A buoy marking the position of a wreck. It is usually placed on the seaward or channel side of the wreck and as near to the wreck as conditions will permit. To avoid confusion in some situations, two buoys may be used to mark the wreck.

**wreck mark.** . . A navigation mark which marks the position of a wreck.

## X-Y-Z

**X-band.** . . A radio-frequency band of 5,200 to 10,900 megahertz. See also FREQUENCY, FREQUENCY BAND.

**yard.** . . *n.* A unit of length equal to 3 feet, 36 inches, or 0.9144 meter.

**yaw.** . . *n.* The oscillation of a vessel in a seaway about a vertical axis approximately through the center of gravity.

**Y-code.** . . *n.* The encrypted version of the P-code.

**yawing.** . . *n.* See YAW.

**year.** . . *n.* A period of one revolution of a planet around the sun. The period of one revolution of the earth with respect to the vernal equinox, averaging 365 days, 5 hours, 48 minutes, 46 seconds in 1900, is called a tropical, astronomical, equinoctial, or solar year. The period with respect to the stars, averaging 365 days, 6 hours, 9 minutes, 9.5 seconds in 1900, is called a sidereal year. The period

of revolution from perihelion to perihelion, averaging 365 days, 6 hours, 13 minutes, 53.0 seconds in 1900, is an anomalistic year. The period between successive returns of the sun to a sidereal hour angle of 80° is called a fictitious or Besselian year. A civil year is the calendar year of 365 days in common years, or 366 days in leap years. A light-year is a unit of length equal to the distance light travels in 1 year, about  $5.88 \times 10^{12}$  miles. The term year is occasionally applied to other intervals such as an eclipse year, the interval between two successive conjunctions of the sun with the same node of the moon's orbit, a period averaging 346 days, 14 hours, 52 minutes, 50.7 seconds in 1900, or a great or Platonic year, the period of one complete cycle of the equinoxes around the ecliptic, about 25,800 years.

**young coastal ice.** . . The initial stage of fast ice formation consisting of nilas or young ice, its width varying from a few meters up to 100 to 200 meters from the shoreline.

**young ice.** . . Ice in the transition stage between nilas and first-year ice, 10 to 30 centimeters in thickness. Young ice may be subdivided into GRAY ICE and GRAY-WHITE ICE.

**zenith.** . . *n.* The point on the celestial sphere vertically overhead. The point 180° from the zenith is called the NADIR.

**zenithal.** . . *adj.* Of or pertaining to the zenith.

**zenithal chart.** . . See AZIMUTHAL CHART.

**zenithal map projection.** . . See AZIMUTHAL MAP PROJECTION.

**zenith distance.** . . Angular distance from the zenith; the arc of a vertical circle between the zenith and a point on the celestial sphere, measured from the zenith through 90°, for bodies above the horizon. This is the same as COALTITUDE with reference to the celestial horizon.

**zephyr.** . . *n.* A warm, gentle breeze, especially one from the west.

**zodiac.** . . *n.* The band of the sky extending 9° either side of the ecliptic. The sun, moon, and navigational planets are always within this band, with the occasional exception of Venus. The zodiac is divided into 12 equal parts, called signs, each part being named for the principal constellation originally within it.

**zodiacal light.** . . A faint cone of light which extends upward from the horizon along the ecliptic after sunset or before sunrise, seen best in the tropics and believed to be the reflection of sunlight by extraterrestrial particles in the zodiac.



zodiacal light

**zone.** . . *n.* 1. A defined area or region. The surface of the earth is divided into climatic zones by the polar circles and the tropics; the parts between the poles and polar circles are called the north and south frigid zones; the parts between the polar circles and the tropics are the north and south temperate zones; the part between the two tropics is the torrid zone. 2. A time zone, within which the same time is kept.

**zone description.** . . The number, with its sign, that must be added to or subtracted from the zone time to obtain the Greenwich mean time. The zone description is usually a whole number of hours.

**zone meridian.** . . The meridian used for reckoning zone time. This is generally the nearest meridian whose longitude is exactly divisible by 15°. The DAYLIGHT SAVING MERIDIAN is usually 15° east of the zone meridian.

**zone noon.** . . Twelve o'clock zone time, or the instant the mean sun is over the upper branch of the zone meridian. Standard noon is 12 o'clock standard time.

**zone time.** . . The local mean time of a reference or zone meridian whose time is kept throughout a designated zone. The zone meridian is usually the nearest meridian whose longitude is exactly divisible by 15°. Standard time is a variation of zone time with irregular but well-defined zone limits. Daylight saving or summer time is usually 1 hour later than zone or standard time. See ZONE DESCRIPTION.

**Zones of Confidence.** . . An assessment of the limitations of the hydrographic data from which a chart was compiled and used to assess the

associated risk to navigate in a particular area.

**zoom** . . . In ECDIS, a method of enlarging (zoom in) or reducing (zoom

out) graphics displayed on a SCREEN.

**zulu** . . . See GREENWICH MEAN TIME.

# GLOSSARY OF ABBREVIATIONS AND ACRONYMS

## A

A. amplitude; augmentation; away (altitude intercept); Arctic/Antarctic (air mass).  
a. semimajor axis.  
a. altitude intercept (Ho~Hc); altitude factor (change of altitude in 1 minute of time from meridian transit); assumed.  
ABAND. abandoned.  
AC. alternating current; altocumulus.  
ACC. Antarctic Circumpolar Current.  
add'l. additional.  
ADF. automatic direction finder.  
ADIZ. air defense identification zone.  
ADLL. Admiralty Digital List of Lights.  
AEB. acquisition exclusion boundary.  
AERO. aeronautical.  
AF. audio frequency.  
AFC. automatic frequency control.  
AGC. automatic gain control.  
AIS-SART. AIS Search And Rescue Transmitter.  
AIS. Automatic Identification System.  
AISM. Association Internationale de Signalisation Maritime (International Association of Light-house Authorities).  
aL. assumed latitude.  
Al., Alt., alternating (light).  
*A.L.R.S.. Admiralty List of Radio Signals.*  
am. amber.  
AM. amplitude modulation.  
AM. ante meridian (before noon).  
AMHS. Automated Message Handling System.  
AMSL. Above Mean Sea Level.  
Anch. anchorage.  
antilog. antilogarithm.  
AP. assumed position.  
approx.. approximate, approximately.  
ARCS.. Admiralty Raster Chart System.  
ARPA. automatic radar plotting aid.  
ASAM. anti-ship activity message.  
ASF. Additional Secondary Phase Factor.  
ASM. Application Specific Message.  
ASP. Application Service Provider.  
AT. atomic time.  
ATON (AtoN). Aid(s) To Navigation.  
AUSREP. Australian Ships Reporting System.  
al. assumed longitude.

## B

B. atmospheric pressure correction (altitude); bearing,

bearing angle.  
BC. Bathymetric Contour Chart.  
Bdy Mon. boundary monument.  
BFO. beat frequency oscillator.  
BIH. Bureau Internationale de l'Heure.  
BIPM. International Bureau of Weights and Measures.  
bk. broken.  
bkw. breakwater.  
bl. blue.  
BM. bench mark.  
Bn. beacon.  
BNPC. Bathymetric Navigation Planning Chart.  
Bpgc. bearing per gyrocompass.  
br. breakers.  
Brg.. bearing (as distinguished from bearing angle).  
bu. blue.

## C

C. Celsius (centigrade); chronometer time; compass (direction); correction; course, course angle; can; cylindrical; cove.  
CALM. catenary anchor leg mooring.  
CB. compass bearing.  
CBDR. constant bearing, decreasing range.  
CC. compass course; chronometer correction.  
CCIR. International Radio Consultative Committee.  
CCU. Consultative Committee for Units of the International Committee of Weights and Measures (CIPM).  
CCZ. Coastal Confluence Zone.  
cd. candela, candelas.  
CD. chart datum.  
CD-ROM. compact disk-read only memory.  
CG. Coast Guard.  
CE. chronometer error- compass error.  
CFR. Code of Federal Regulations.  
cec. centicycle.  
cel. centilane.  
CEP. circular probable error.  
CES. coast earth station.  
CFR. Code of Federal Regulations.  
CGPM. General Conference of Weights and Measures.  
CH. Channel.  
CH. compass heading.  
CIPM. International Committee of Weights and Measures.  
Cl. clearance.  
cm. centimeter(s).  
CMG. course made good.  
Cn. course (as distinguished from course angle).  
CNO. Chief of Naval Operations, US Navy.  
co. coral.

co-. the complement of (90° minus).  
 COA. course of advance.  
 COE. Committee on ECDIS (IHO).  
 COG. course over ground.  
 coL. colatitude.  
 colog. cologarithm.  
 corr.. correction.  
 cos. cosine.  
 cot. cotangent.  
 COTP. Captain of the Port.  
 cov. coversine.  
 CPA. closest point of approach.  
 CPE. circular probable error.  
 Cpgc. course per gyrocompass.  
 CPRNW. Commission on the Promulgation of Radio Navigational Warnings.  
 cps. cycles per second.  
 Cpssc. course per standard compass.  
 Cp stg c. course per steering compass.  
 CPU. central processing unit.  
 crs. course.  
 CRT. cathode-ray tube.  
 csc. cosecant.  
 CSP. Communications Service Provider.  
 CSTDMA. Carrier-sense Time Division Multiple Access.  
 cup. cupola.  
 Cus Ho. customs house.  
 CW. continuous wave.  
 CZn. compass azimuth.

## D

D. deviation; dip (of horizon); distance; destroyed.  
 d. declination (astronomical); altitude difference.  
 d. declination change in 1 hour.  
 dA. difference of longitude (time units).  
 DAAS. Defense Automatic Addressing System.  
 DAC. Designated Area Code.  
 DC. direct current.  
 deg.. degree(s).  
 Dec.. declination.  
 Dec. Inc.. declination increment.  
 Dep.. departure.  
 destr. destroyed.  
 Dev.. deviation.  
 DG. degaussing.  
 DGIWG. Digital Geographic Information Working Group.  
 DGNSS. Differential Global Navigation Satellite Service.  
 DGPS. differential global positioning system.  
 DHQ. mean diurnal high water inequality.  
 DHS. Department of Homeland Security.  
 Dia. diaphone.  
 diff.. difference.  
 Dist.. distance.  
 DLA.. Defense Logistics Agency.  
 D. Lat.. difference of latitude.  
 DLo. difference of longitude (arc units).  
 DLQ. mean diurnal low water inequality.  
 dm. decimeters.  
 DNC. digital navigation chart.

dol. dolphin.  
 DOT. Department of Transportation.  
 DR. dead reckoning; dead reckoning position.  
 DRE. dead reckoning equipment.  
 DRM. direction of relative movement.  
 DRT. dead reckoning tracer.  
 Ds. dip short of horizon.  
 DSC. digital selective calling.  
 DSD. double second difference.  
 DSVL. doppler sonar velocity log.  
 dur.. duration.  
 DW. Deep Water Route.  
 DZ. danger zone.

## E

E. east.  
 e. base of Napierian logarithms; origin of own ship's true vector.  
 e. eccentricity.  
 EBL. electronic bearing line.  
 ECD. envelope to cycle difference; envelope to cycle discrepancy.  
 EC. electronic chart.  
 ECC. electronic chart correction.  
 ECDB. electronic chart data base.  
 ECDIS. electronic chart display and information system.  
 ECS. electronic chart system.  
 ED. existence doubtful.  
 EDD. estimated date of departure.  
 EEZ. exclusive economic zone.  
 EGC. enhanced group calling.  
 EHF. extremely high frequency.  
 E. Int.. equal interval; isophase.  
 EM. electromagnetic (underwater log).  
 em. other ship's true vector.  
 ENC. electronic navigation chart.  
 ENCDB. electronic navigation chart data base.  
 EP. estimated position.  
 EPFS. Electronic Position Fixing System.  
 EPIRB. Emergency Position Indicating Radio Beacon.  
 EPIRB-AIS. Emergency Position Indicating Radio Beacon - AIS enabled.  
 ePODS. electronic Product On Demand.  
 EPROM. erasable programmable read only memory.  
 Eq.T. equation of time.  
 er. own ship's true vector.  
 ET. Ephemeris Time.  
 ETA. estimated time of arrival.  
 ETD. estimated time of departure.  
 Exting. extinguished.

## F

F. Fahrenheit; fast; longitude factor; phase correction (altitude); fixed (light)  
 f. latitude factor.  
 f. flattening or ellipticity.  
 FATDMA. Fixed Access Time Division Multiple Access.  
 F.Fl.. fixed and flashing.

FI. Function Identifier.  
 Fl.. flashing (light).  
 Fl. (2). group flashing (light).  
 Fl. (2+1). composite group flashing (light).  
 FLO. Fleet Liaison Officer - a civilian NGA analyst of Navy Quartermaster (QM).  
 fm(s). fathom(s).  
 FM. frequency modulation.  
 Fog Det.. fog detector.  
 Fog Sig.. fog signal.  
 ft.. foot, feet.  
 FTC. fast time constant.

## G

G. Greenwich; Greenwich meridian (upper branch); grid (direction); gravel; green.  
 g. acceleration due to gravity; Greenwich meridian (lower branch).  
 GAT. Greenwich apparent time.  
 GB. grid bearing.  
 GC. grid course.  
 GCLWD. Gulf Coast Low Water Datum.  
 GDOP. geometric dilution of precision.  
 GE. gyro error.  
 GEOINT. Geospatial Intelligence.  
 GH. grid heading.  
 GHA. Greenwich hour angle.  
 GIS. Geographic Information System.  
 GMDSS. Global Maritime Distress and Safety System.  
 GMT. Greenwich mean time.  
 GNSS. Global Navigation Satellite System.  
 Gp. Fl.. group flashing.  
 GP. geographical position.  
 GPS. Global Positioning System.  
 Gr.. Greenwich.  
 GRI. group repetition interval.  
 GST. Greenwich sidereal time.  
 GV. grid variation.  
 GZn. grid azimuth.

## H

h. altitude (astronomical); height above sea level; hours.  
 ha. apparent altitude.  
 Hc. computed altitude.  
 Hdg.. heading.  
 HE. heeling error; height of eye.  
 HF. high frequency.  
 hf. height above sea level in feet.  
 HFL. Hydrographic Feature Layer.  
 HHW. higher high water.  
 HHWI. higher high water interval.  
 Hk. hulk.  
 HLW. higher low water.  
 HLWI. higher low water interval.  
 hm. height above sea level in meters.  
 Ho. observed altitude.  
 Hor. horizontal.  
 Hor Cl. horizontal clearance.

HP. horizontal parallax.  
 Hp. precomputed altitude.  
 Hpgc. heading per gyrocompass.  
 Hpssc. heading per standard compass.  
 Hp stg c. heading per steering compass.  
 hr. rectified (apparent) altitude.  
 hr.. hour, hrs., hours.  
 hs. sextant altitude.  
 HSD. high speed data.  
 ht. tabulated altitude.  
 HW. high water.  
 H.W.F.&C.. high water full and change.  
 HWI. high water interval, mean high water lunitidal interval.  
 HWQ. tropic high water inequality.  
 Hz. hertz.

## I

I. instrument correction.  
 i. inclination (of satellite orbit).  
 IALA. International Association of Marine Aids to Navigation and Lighthouse Authorities.  
 IAU. International Astronomical Union.  
 IC. index correction.  
 ICC. Intelligence Coordination Center.  
 ICW. Intracoastal Waterway.  
 IDC. International Data Center.  
 IEC. International Electrotechnical Commission.  
 IDE. International Data Exchange.  
 IGLD. International Great Lakes Datum.  
 IHB. International Hydrographic Bureau.  
 IHO. International Hydrographic Organization.  
 IIP. International Ice Patrol.  
 IMO. International Maritime Organization.  
 in.. inch, inches.  
 INM. International Nautical Mile.  
 INMARSAT. International Maritime Satellite Organization.  
 INS. inertial navigation system.  
 int.. interval.  
 Int. Qk.. Interrupted quick flashing.  
 ION. Institute of Navigation.  
 I.Q.. interrupted quick flashing.  
 IR. interference rejection.  
 IRP. image-retaining panel.  
 ISLW. Indian spring low water.  
 ISO. International Order of Standardization, International Organization for Standards; isophase (light).  
 ITDMA. Incremental Time Division Multiple Access.  
 ITU. International Telecommunications Union.  
 IUGG. International Union of Geodesy and Geophysics.  
 I.U.Q.. interrupted ultra quick flashing.  
 I.V.Q.. interrupted very quick flashing.  
 IWW. Intracoastal Waterway.

## J – K – L

J. irradiation correction (altitude).

JRCC. Joint Rescue Coordination Center.  
 K. Kelvin (temperature).  
 kHz. kilohertz.  
 km. kilometer, kilometers.  
 KML. Keyhole Markup Language  
 KMZ. Keyhole Markup Language Zipped  
 kn. knot, knots.  
 L. latitude; lower limb correction for moon.  
 l. difference of latitude; logarithm, logarithmic.  
 LAN. local apparent noon.  
 LANBY. large automatic navigational buoy.  
 LASH. lighter aboard ship.  
 LAT. local apparent time.  
 lat.. latitude.  
 LF. low frequency.  
 L.Fl.. long flashing.  
 LHA. local hour angle.  
 LHW. lower high water.  
 LHWI. lower high water interval.  
 LL. Light List.  
 LL. lower limb.  
 LLW. lower low water.  
 LLWD. lower low water datum.  
 LLWI. lower low water interval.  
 Lm. middle latitude; mean latitude.  
 LMT. local mean time.  
 LNB. large navigational buoy.  
 LNG. liquified natural gas.  
 LPC. Littoral Planning Chart.  
 LPG. liquified petroleum gas.  
 Log. logarithm, logarithmic.  
 Loge. natural logarithm (to the base e).  
 Log10. common logarithm (to the base 10).  
 LoL. List of Lights.  
 Long.. longitude.  
 LOP. line of position.  
 LRIT. Long-Range Identification and Tracking.  
 LSS. Logical AIS Shore Station.  
 LST. local sidereal time.  
 Lt.. light.  
 Lt Ho. light house.  
 Lt V. light vessel.  
 LW. low water.  
 LWD. low water datum.  
 LWI. low water interval; mean low water lunitidal interval.  
 LWQ. tropic low water inequality.

## M

M. celestial body; meridian (upper branch); magnetic (direction); meridional parts; nautical mile, miles; other ship.  
 m. meridian (lower branch); meridional difference; meter,(s); U.S. survey mile, miles; end of other ship's true vector; minutes.  
 MA.. Marine Analyst.  
 mag.. magnetic; magnitude.  
 MARAD. United States Maritime Administration.  
 MB. magnetic bearing.  
 mb. millibar(s).

MC. magnetic course.  
 mc. megacycle, megacycles; megacycles per second.  
 MC&G. mapping, charting and geodesy.  
 MCPA. minutes to closest point of approach.  
 MDA. Maritime Domain Awareness.  
 Mer. Pass.. meridian passage.  
 MF. medium frequency.  
 MGRS. military grid reference system.  
 MH. magnetic heading.  
 MHHW. mean higher high water.  
 MHHWL. mean higher high water line.  
 MHW. mean high water.  
 MHWI. mean high water lunitidal interval.  
 MHWL. mean high water line.  
 MHWN. neap high water or high water neaps.  
 MHSW. mean high water springs.  
 MHz. megahertz.  
 mi.. mile, miles.  
 MID. Maritime Identification Digit.  
 mid. middle.  
 min.. minute(s).  
 MISLE. Marine Information for Safety and Law Enforcement.  
 MLLW. mean lower low water.  
 MLLWL. mean lower low water line.  
 MLW. mean low water.  
 MLWI. mean low water lunitidal interval.  
 MLWL. mean low water line.  
 MLWN. neap low water or low water neaps.  
 MLWS. mean low water springs.  
 mm. millimeters.  
 MMSI. Maritime Mobile Service Identity.  
 Mn. mean range of tide.  
 mo(s). month(s).  
 MOB-AIS. Man Overboard AIS device.  
 MODU. mobile offshore drilling unit.  
 Mon. monument.  
 Mo.(U). Morse Uniform (light).  
 mph. miles per hour.  
 MPP. most probable position.  
 MRCC. Maritime Rescue Coordination Center.  
 MRI. mean rise interval.  
 MRM. miles of relative movement.  
 ms. millisecond(s).  
 MSC. IMO Maritime Safety Committee.  
 MSC. Military Sealift Command.  
 MSI. maritime safety information.  
 MSIWG. Maritime Safety Information Working Group.  
 MSL. mean sea level.  
 MSO. Maritime Safety Office (NGA).  
 MTI. moving target indication.  
 MTL. mean tide level.  
 MWL. mean water level.  
 MWLL. mean water level line.  
 MZn. magnetic azimuth.

## N

N. north; nun.  
 n. natural (trigonometric function).

Na. nadir.  
 NAD. North American Datum.  
 NASA. National Aeronautics and Space Administration.  
 NATO. North Atlantic Treaty Organization.  
 NAUTO. nautophone.  
 NAVAREA. Navigation Area.  
 NAVEX. Naval Exercise Chart.  
 NAVSAT. Navy Navigation Satellite System.  
 NAVSSI. navigation sensor system interface.  
 NAVO. Naval Oceanographic Office.  
 NBDP. narrow band direct printing.  
 NBS. National Bureau of Standards.  
 NCS. network coordination station.  
 NEPA. National Environmental Policy Act.  
 NESS. National Earth Satellite Service.  
 NGA. National Geospatial-Intelligence Agency.  
 NGVD. National Geodetic Vertical Datum.  
 NLT. not less than (used with danger bearing).  
 n. mi.. nautical mile(s).  
 NM. nautical mile, miles; notice to mariners.  
 NMEA. National Marine Electronics Association.  
 NMT. not more than (used with danger bearing).  
 NNSS. Navy Navigation Satellite System.  
 NOAA. Notice of Arrival.  
 NOAA. National Oceanic and Atmospheric Administration.  
 NOS. National Ocean Service.  
 NPRM. Notice of Proposed Rule Making.  
 NRML. new relative movement line.  
 NtM. notice to mariners.  
 NTTAA. National Technology Transfer and Advancement Act.  
 NVMC. National Vessel Movement Center.  
 NWS. National Weather Service.

**O**

Obsc. obscured.  
 Obs Spot. Observation spot.  
 Obstr. obstruction.  
 Oc.. occulting.  
 Oc.(2). group occulting.  
 Oc.(2+1). composite group occulting.  
 Occas. occasional.  
 OCS. Outer Continental Shelf.  
 ODAS. oceanographic data acquisition systems.  
 OMB. Office of Management and Budget.  
 ONI. Office of Naval Intelligence.  
 OPAREA. US Navy Operating Area Chart.  
 Or. orange.  
 OTC. officer in tactical command.  
 OTSR. Optimum Track Ship Routing.

**P**

P. atmospheric pressure; parallax; planet; pole; pillar.  
 p. departure; polar distance.  
 PA. position approximate.  
 PC. personal correction; personal computer.  
 PD. position doubtful.

PCA. polar cap absorption.  
 PCD. polar cap disturbance.  
 PCP. potential point of collision.  
 pgc. per gyrocompass.  
 PI. Presentation Interface.  
 P in A. parallax in altitude.  
 PM. pulse modulation.  
 PM. post meridian (after noon).  
 PMP. parallel motion protractor.  
 Pn. north pole; north celestial pole.  
 PPC. predicted propagation correction.  
 PPDB. point positioning data base.  
 PPI. plan position indicator.  
 PRF. pulse repetition frequency.  
 Priv. private; privately.  
 PROHIB. prohibited.  
 PRR. pulse repetition rate.  
 Ps. south pole; south celestial pole.  
 psc (p stg c). per standard compass.  
 PSS. Physical AIS Shore Station.  
 Pub.. publication.  
 PV. prime vertical.  
 Pyl. pylon.

**Q**

Q. quick flashing.  
 Q(3). group quick flashing (3 flashes).  
 Q(6)+L.Fl.. group quick flashing (6 flashes) plus a long flash.  
 Q. Polaris correction.  
 QM. US Navy Quartermaster.  
 QQ'. celestial equator.

**R**

r. end of own ship's true vector.  
 R. Rankine (temperature); refraction; own ship; red; rocky; coast radio station.  
 RA. right ascension.  
 RACON. radar transponder beacon.  
 rad. radian(s).  
 RATDMA. Random Access Time Division Multiple Access.  
 RB. relative bearing.  
 R Bn. radiobeacon.  
 RCC. Rescue Coordination Center.  
 RCDS. raster chart display system.  
 RDF. radio direction finder, RDF station.  
 Rep.. reported.  
 rev.. reversed.  
 RF (rf). radio frequency.  
 R Fix. running fix.  
 rk. rock, rocky.  
 RLG. ring laser gyro.  
 rm. relative DRM-SRM vector.  
 R Mast. radio mast.  
 RORO. roll-on/roll-off.  
 ROT. Rate of Turn.  
 RML. relative movement line.

RMS. root mean square.  
 RNC. raster navigation chart.  
 RSS. root sum square.  
 RTCM. Radio Technical Commission for Maritime Services.  
 Rx. reception.  
 RZn. relative azimuth.

## S

s. second(s).  
 S. sea-air temperature difference correction; slow; south; set; speed; sand.  
 SAIS. Synthetic AIS.  
 SALM. single anchor leg mooring.  
 SAM. system area monitor.  
 SAR. search and rescue.  
 SART. search and rescue radar transponder.  
 SBM. single buoy mooring.  
 SCP. SafetyNET Coordinating Panel.  
 SD. semidiameter; sounding doubtful.  
 sec. secant.  
 sec.. second, seconds.  
 semidur.. semiduration.  
 SENC. system electronic navigation chart.  
 SERS. Sea Floor Earth Data System.  
 SES. ship earth station.  
 SF. Secondary Phase Factor.  
 SH. ship's head (heading).  
 SHA. sidereal hour angle.  
 SHF. super high frequency.  
 SI. International System of Units.  
 SID. sudden ionospheric disturbance.  
 sin. sine.  
 SINS. Ships Inertial Navigation System.  
 SLD. sea level datum.  
 SME. Subject Matter Expert.  
 SMG. speed made good.  
 SNC. Standard Nautical Chart.  
 SNR. signal-to-noise ratio.  
 SOA. speed of advance.  
 SOG. speed over ground.  
 SoN. Safety of Navigation.  
 SOLAS. Safety of Life at Sea Convention.  
 SOTDMA. Self-Organizing Time Division Multiple Access.  
 SP. spire; spherical.  
 SPA. sudden phase anomaly.  
 SPM. single point mooring.  
 SRM. speed of relative movement.  
 SS. signal station.  
 SSAS. Ship Security Alert System.  
 sub, subm. submerged.  
 SVC. Sound Velocity Correction.

## T

T. air temperature correction (altitude); table; temperature; time; toward (altitude intercept); true (direction).

t. dry-bulb temperature; elapsed time; meridian angle.  
 t'. wet-bulb temperature.  
 tab.. table.  
 TAI. International Atomic Time.  
 tan. tangent.  
 TB. true bearing; turning bearing; air temperature atmospheric pressure correction (altitude).  
 TC. true course.  
 TCA. time of satellite closest approach.  
 T CPA. time to closest point of approach.  
 TcHHW. tropic higher high water.  
 TcHHWI. tropic higher high water interval.  
 TcHLW. tropic higher low water.  
 TcLLW. tropic lower high water.  
 TcLLWI. tropic lower low water interval.  
 TD. time difference (Loran C).  
 TDMA. Time Division Multiple Access.  
 Tel. telephone; telegraph.  
 TG. time difference of groundwaves from master and secondary stations (Loran).  
 TGS. time difference of groundwave from master and sky-wave from secondary station (Loran).  
 TH. true heading.  
 TMG. track made good.  
 TOD. time of day (clock), Tactical Ocean Data  
 Tk. tank.  
 TR. track.  
 Tr. transit; tower.  
 TRANSCOM. U.S. Transportation Command.  
 Ts. time difference of skywaves from master and secondary stations (Loran).  
 TSG. time difference of skywave from master and ground-wave from secondary station (Loran).  
 TSS. traffic separation scheme.  
 TZn. true azimuth.

## U

U. upper limb correction for moon.  
 UHF. ultra high frequency.  
 UK. United Kingdom.  
 UL. upper limb.  
 Uncov. uncovers.  
 UPS. Universal Polar Stereographic.  
 U.Q.. ultra quick flashing.  
 USGS. United States Geodetic Survey.  
 U.S. Sur M. U.S. Survey mile(s).  
 USWMS. Uniform State Waterway Marking System.  
 UT. Universal Time.  
 UT0. Universal Time 0.  
 UT1. Universal Time 1.  
 UT2. Universal Time 2.  
 UTC. Coordinated Universal Time or Universal Time Coordinated.  
 UTM. Universal Transverse Mercator.

## V

V. variation; vertex.

v. excess of GHA change from adopted value for 1 hour.  
 VAIS.. Virtual AIS.  
 var.. variation.  
 VDE. VHF Data Exchange.  
 VDES. VHF Data Exchange System.  
 VDU. Vector Product Format Database Update.  
 VDL . VHF Data Link.  
 vel. velocity.  
 Ver. vertical.  
 VHF. very high frequency.  
 VHSD. very high speed data.  
 Vi. violet.  
 VLCC. very large crude carrier.  
 VLF. very low frequency.  
 VMS. Voyage Management System.  
 VPF. vector product format.  
 vol. volcano; volcanic.  
 VPF. vector product format.  
 V.Q.. very quick flashing.  
 V.Q.(3). group very quick flashing.  
 VRM. variable range marker.  
 VTS. vessel traffic service.

## W

W. west; white.

WARC. World Administrative Radio Council.  
 WE. watch error.  
 WG. Working Group.  
 WGS. World Geodetic System.  
 Wk. wreck.  
 WMO. World Meteorological Organization.  
 WPI. World Port Index.  
 WT. watch time.  
 WTS. Worldwide Threat to Shipping.  
 WWNWS. World Wide Navigational Warning Service.

## X – Y – Z

X. parallactic angle.  
 XMTR. transmitter.  
 y.. yellow.  
 yd(s).. yard(s).  
 yr(s).. year(s).  
 z. zenith distance.  
 Z. azimuth angle; zenith; Zulu.  
 ZD. zone description.  
 Z Diff.. azimuth angle difference.  
 Zn. azimuth.  
 Znpgc. azimuth per gyrocompass.  
 ZOC. Zones of Confidence.

## A

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