Acids & Bases
The Basics

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Presented by
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The Brønstead-Lowry Theory of Acids and bases

- Acids are proton (H^+) donators
- Bases are proton (H^+) acceptors
- Acid-base reactions involve transfer of a proton from an acid to a base

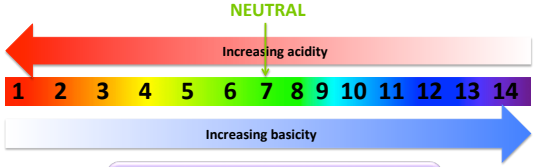
e.g. HCl + H_2O → Cl^- + H_3O^+

Acid base conj base conj acid

Conj = conjugate

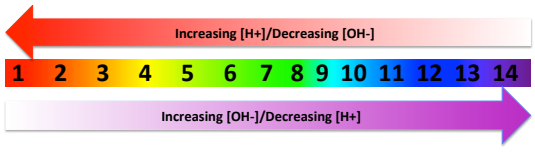
The pH scale

- A solution's acidity is measured by the pH scale, which is logarithmic



$pH = -\log_{10}[H^+]$
or $[H^+] = 10^{-pH}$

The pH Scale



$K_w = [H^+].[OH^-] = 10^{-14}\ M^2$

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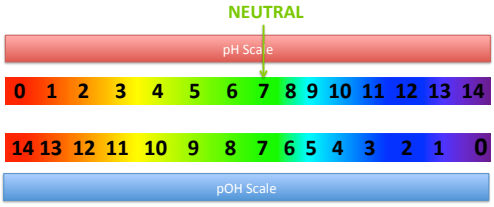
pH & pOH Scales



pH + pOH = 14

$pH = -\log_{10}[H^+]$ or $[H^+] = 10^{-pH}$

$pOH = -\log_{10}[OH^-]$ or $[OH^-] = 10^{-pOH}$

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Terminology

- Monoprotic acids: Have one acidic H
- Diprotic acids: Have two acidic H's
- Triprotic acids: Have three acidic H's
- Polyprotic acids: Have many acidic H's

$H_3PO_{4(aq)} \rightleftharpoons H^+_{(aq)} + H_2PO_4^-{}_{(aq)}$

$H_2PO_4^-{}_{(aq)} \rightleftharpoons H^+_{(aq)} + HPO_4^{2-}{}_{(aq)}$

$HPO_4^{2-}{}_{(aq)} \rightleftharpoons H^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

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Terminology

- Amphiprotic substances: can act as either an acid or a base

Acting as an acid:

$H_2PO_4^-{}_{(aq)} + OH^-{}_{(aq)} \rightarrow HPO_4^{2-}{}_{(aq)}$

Acting as a base:

$H_2PO_4^-{}_{(aq)} + H^+{}_{(aq)} \rightarrow H_3PO_{4(aq)}$

Strong & Weak Acids & Bases

- Strong acids & bases completely dissociate in water
- Weak acids and bases partially dissociate in water

Strong acids: Complete dissociation

$HX_{(l)} \rightarrow H^+{}_{(aq)} + X^-{}_{(aq)}$ NO Ka value

Weak acids: Partial dissociation

$HX_{(l)} \rightleftharpoons H^+{}_{(aq)} + X^-{}_{(aq)}$ HAS Ka value

Strong and weak acids

Strong acids

- Hydrochloric acid (HCl)
- Hydrobromic acid (HBr)
- Hydroiodic acid (HI)
- Nitric acid (HNO_3)
- Perchloric acid ($HClO_4$)
- Sulfuric acid (H_2SO_4)

Weak acids

- Hydrofluoric acid (HF)
- Acetic or ethanoic acid (CH_3COOH)
- Carbonic acid (H_2CO_3)
- Phosphoric acid (H_3PO_4)
- Ammonium ions (NH_4^+)
- Anything ending in –oic acid (e.g. benzoic acid)

Strong and weak bases

Strong bases

- Hydroxides:
  - Lithium (LiOH)
  - Sodium (NaOH)
  - Potassium (KOH)
  - Calcium ($Ca(OH)_2$)
  - Barium ($Ba(OH)_2$)
  - Strontium ($Sr(OH)_2$)
  - Cesium (CsOH)
  - Rubidium (RbOH)

Weak bases

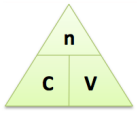
- Ammonia (NH_3)
- Sodium carbonate (Na_2CO_3)
- Calcium carbonate ($CaCO_3$)
- Ethylamine ($(C_2H_5)NH_2$)
- Urea $(NH_2)_2CO$

Acids & bases: Equations you might need

Acids & Bases

$pH = -\log_{10}[H^+]$ or $[H^+] = 10^{-pH}$	$[H^+]$: Hydrogen ion concentration, in mol/L or molar (M)
$[H^+].[OH^-] = 10^{-14}$	$[OH^-]$: Hydroxide ion concentration, in mol/L or molar (M)

Concentration



n	number of moles (mol)
C	Concentration, in mol/L or molar (M)
V	Volume, in Litres (L)

Dilution

$C_i V_i = C_f V_f$

OR

$C_f V_f = C_i V_i$

C_i	Initial concentration
V_i	Initial volume
C_f	Final concentration
V_f	Final volume

Some common reactions of acids

Acid + metal	Salt + H_2
Acid + metal hydroxide	Salt + H_2O
Acid + metal oxide	Salt + H_2O
Acid + metal carbonate	Salt + H_2O + CO_2
Acid + metal hydrogen carbonate	Salt + H_2O + CO_2
Acidic oxide + base	Salt + H_2O

Indicators

Indicator	Acidic colour	Basic Colour	pH range of colour change
Methyl violet	Yellow	Purple	0.0-2.0
Methyl orange	Red	Yellow	3.1-4.4
Bromothymol blue	Yellow	Violet	6.0-7.6
Phenolphthalein	Colourless	Pink	8.3-10.0

Universal Indicator
A mixture of different indicators which allows colour analysis of all pH values between 1-14

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