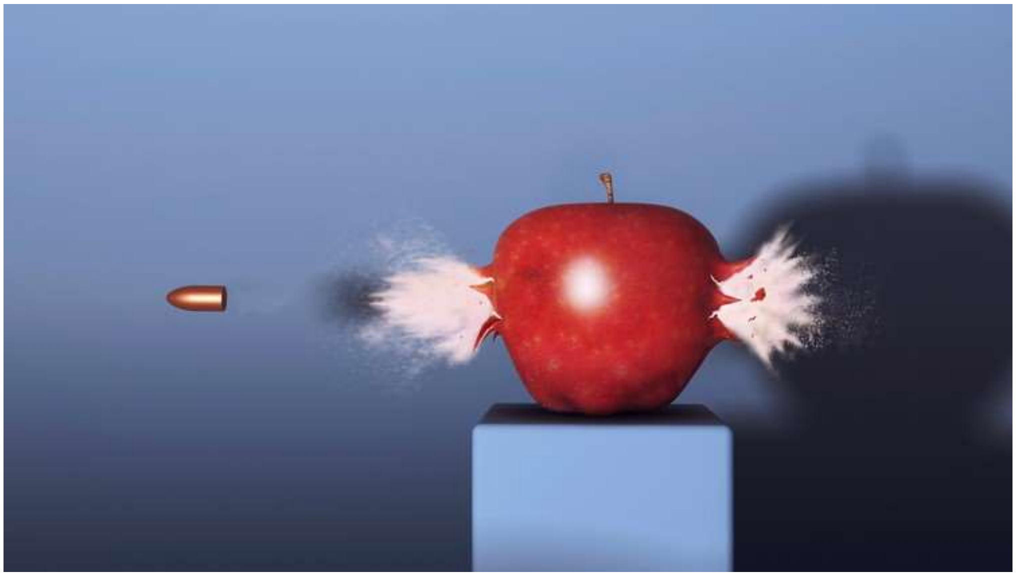
Physics Unit 1- Kinematics in One Dimension



This is the introductory unit for all of physics! The groundwork for the rest of your physics path begins here!

This course will specifically focus on one dimensional motion. You will learn how to describe, analyze, and model motion both conceptually and qualitatively.

Foundation topics for all of physics are introduced in this course such as:

- Vectors vs. Scalars
- Distance/Displacement
- Speed/Velocity
- Acceleration.
- kinematic equations
- uniform accelerated motion
- free-fall.

Course Homepage: https://www.physicscourseonline.com/p/kinematics-1d/

Course Curriculum

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Physics **Name:**

Displacement, Velocity, and Acceleration MC inclass **Date:**

1. What is the average velocity of a car that travels 30. kilometers due west in 0.50 hour?

   A) 15 km/hr B) 60. km/hr
   C) 15 km/hr west D) 60. km/hr west

2. The average speed of a plane was 600 kilometers per hour. How long did it take the plane to travel 120 kilometers?

   A) 0.2 hour B) 0.5 hour
   C) 0.7 hour D) 5 hours

3. A baseball pitcher throws a fastball at 42 meters per second. If the batter is 18 meters from the pitcher, approximately how much time does it take for the ball to reach the batter?

   A) 1.9 s B) 2.3 s
   C) 0.86 s D) 0.43 s

4. A blinking light of constant period is situated on a lab cart. Which diagram best represents a photograph of the light as the cart moves with constant velocity?

   A)
   B)
   C)
   D)

5. What is the distance traveled by an object that moves with an average speed of 6.0 meters per second for 8.0 seconds?

   A) 0.75 m B) 1.3 m
   C) 14 m D) 48 m

6. A skater increases her speed uniformly from 2.0 meters per second to 7.0 meters per second over a distance of 12 meters. The magnitude of her acceleration as she travels this 12 meters is

   A) 1.9 m/s^2 B) 2.2 m/s^2
   C) 2.4 m/s^2 D) 3.8 m/s^2

7. An object with an initial speed of 4.0 meters per second accelerates uniformly at 2.0 meters per second ^{2} in the direction of its motion for a distance of 5.0 meters. What is the final speed of the object?

   A) 6.0 m/s B) 10. m/s
   C) 14 m/s D) 36 m/s

8. A car, initially traveling east with a speed of 5.0 meters per second, is accelerated uniformly at 2.0 meters per second^2 east for 10. seconds along a straight line. During this 10.-second interval the car travels a total distance of

   A) 50. m B) 60. m
   C) 1.0×10^2 m D) 1.5×10^2 m

9. A roller coaster, traveling with an initial speed of 15 meters per second, decelerates uniformly at –7.0 meters per second^2 to a full stop. Approximately how far does the roller coaster travel during its deceleration?

   A) 1.0 m B) 2.0 m C) 16 m D) 32 m

10. A child riding a bicycle at 15 meters per second accelerates at -3.0 meters per second^2 for 4.0 seconds. What is the child's speed at the end of this 4.0-second interval?

    A) 12 m/s B) 27 m/s
    C) 3.0 m/s D) 7.0 m/s

AP Physics Name_____________________________Date______

Describing Motion: Kinematics in One Dimension

Conceptual Questions – Answer all problems on separate paper. Please use complete sentences!

1. Does a car speedometer measure speed, velocity, or both? Explain.
2. When an object moves with constant velocity, does its average velocity during any time interval differ from its instantaneous velocity at any instant? Explain.
3. If one object has a greater speed than a second object, does the first necessarily have a greater acceleration? Explain, using examples.
4. Compare the acceleration of a motorcycle that accelerates from 80 km/h to 90 km/h with the acceleration of a bicycle that accelerates from rest to 10 km/h in the same time.
5. Can an object have a northward velocity and a southward acceleration? Explain.
6. Can the velocity of an object be negative when its acceleration is positive? What about vice versa? If yes, give examples in each case.
7. Give an example where both the velocity and acceleration are negative.
8. Can an object be increasing in speed as its acceleration decreases? If so, give an example. If not, explain.
9. Two cars emerge side by side from a tunnel. Car A is traveling with a speed of 60 km/h and has an acceleration of 40 km/h/min. Car B has a speed of 40 km/h and has an acceleration of 60 km/h/min. Which car is passing the other as they come out of the tunnel? Explain your reasoning.
10. A baseball player hits a ball straight up into the air. It leaves the bat with a speed of 120 km/h. In the absence of air resistance, how fast would the ball be traveling when it is caught at the same height above the ground as it left the bat? Explain.
11. As a freely falling object speeds up, what is happening to its acceleration—does it increase, decrease, or stay the same? (*a*) Ignore air resistance. (*b*) Consider air resistance.
12. You travel from point A to point B in a car moving at a constant speed of 70 km/h. Then you travel the same distance from point B to another point C, moving at a constant speed of 90 km/h. Is your average speed for the entire trip from A to C equal to 80 km/h? Explain why or why not.
13. Can an object have zero velocity and nonzero acceleration at the same time? Give examples.
14. Can an object have zero acceleration and nonzero velocity at the same time? Give examples.
15. Which of these motions is *not* at constant acceleration: a rock falling from a cliff, an elevator moving from the second floor to the fifth floor making stops along the way, a dish resting on a table? Explain your answers.
16. Describe in words the motion plotted in Fig. 2–32 in terms of velocity, acceleration, etc. [*Hint:* First try to duplicate the motion plotted by walking or moving your hand.]
17. Describe in words the motion of the object graphed in Fig. 2–33.

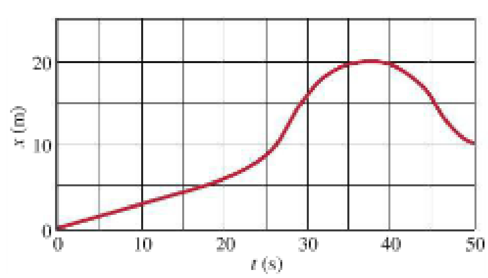

FIGURE 2–32

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Responses to Questions

1. A car speedometer measures only speed. It does not give any information about the direction, so it does not measure velocity.

2. If the velocity of an object is constant, then the speed and the direction of travel must also be constant. If that is the case, then the average velocity is the same as the instantaneous velocity, because nothing about its velocity is changing. The ratio of displacement to elapsed time will not be changing, no matter the actual displacement or time interval used for the measurement.

3. There is no general relationship between the magnitude of speed and the magnitude of acceleration. For example, one object may have a large but constant speed. The acceleration of that object is then zero. Another object may have a small speed but be gaining speed and therefore have a positive acceleration. So in this case the object with the greater speed has the lesser acceleration.

   Consider two objects that are dropped from rest at different times. If we ignore air resistance, then the object dropped first will always have a greater speed than the object dropped second, but both will have the same acceleration of $9.80\ \mathrm{m/s^2}$.

4. The accelerations of the motorcycle and the bicycle are the same, assuming that both objects travel in a straight line. Acceleration is the change in velocity divided by the change in time. The magnitude of the change in velocity in each case is the same, 10 km/h, so over the same time interval the accelerations will be equal.

5. Yes. For example, a car that is traveling northward and slowing down has a northward velocity and a southward acceleration.

6. The velocity of an object can be negative when its acceleration is positive. If we define the positive direction to be to the right, then an object traveling to the left that is having a reduction in speed will have a negative velocity with a positive acceleration.

   If again we define the positive direction to be to the right, then an object traveling to the right that is having a reduction in speed will have a positive velocity and a negative acceleration.

7. If north is defined as the positive direction, then an object traveling to the south and increasing in speed has both a negative velocity and a negative acceleration. Or if up is defined as the positive direction, then an object falling due to gravity has both a negative velocity and a negative acceleration.

8. Yes. Remember that acceleration is a *change in velocity* per unit time, or a *rate of change* in velocity. So velocity can be increasing while the rate of increase goes down. For example, suppose a car is traveling at 40 km/h and one second later is going 50 km/h. One second after that, the car's speed is 55 km/h. The car's speed was increasing the entire time, but its acceleration in the second time interval was lower than in the first time interval. Thus its acceleration was decreasing even as the speed was increasing.

   Another example would be an object falling WITH air resistance. Let the downward direction be positive. As the object falls, it gains speed, and the air resistance increases. As the air resistance increases, the acceleration of the falling object decreases, and it gains speed less quickly the longer it falls.

9. If the two cars emerge side by side, then the one moving faster is passing the other one. Thus car A is passing car B. With the acceleration data given for the problem, the ensuing motion would be that car A would pull away from car B for a time, but eventually car B would catch up to and pass car A.

10. If there were no air resistance, the ball's only acceleration during flight would be the acceleration due to gravity, so the ball would land in the catcher's mitt with the same speed it had when it left the bat, 120 km/h. Since the acceleration is the same through the entire flight, the time for the ball's speed to change from 120 km/h to 0 on the way up is the same as the time for its speed to change from 0 to 120 km/h on the way down. In both cases the ball has the same magnitude of displacement.

11. (*a*) If air resistance is negligible, the acceleration of a freely falling object stays the same as the object falls toward the ground. That acceleration is $9.80\ \mathrm{m/s^2}$. Note that the object's speed increases, but since that speed increases at a constant rate, the acceleration is constant.

    (*b*) In the presence of air resistance, the acceleration decreases. Air resistance increases as speed increases. If the object falls far enough, the acceleration will go to zero and the velocity will become constant. That velocity is often called the terminal velocity.

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12. Average speed is the displacement divided by the time. Since the distances from A to B and from B to C are equal, you spend more time traveling at 70 km/h than at 90 km/h, so your average speed should be less than 80 km/h. If the distance from A to B (or B to C) is x km, then the total distance traveled is $2x$. The total time required to travel this distance is $x/70$ plus $x/90$. Then $\bar{v} = \frac{d}{t} = \frac{2x}{x/70 + x/90} = \frac{2(90)(70)}{90+70} = 78.75 \text{ km/h} \approx 79 \text{ km/h}.$

$\boxed{13.}$ Yes. For example, a rock thrown straight up in the air has a constant, nonzero acceleration due to gravity for its entire flight. However, at the highest point it momentarily has zero velocity. A car, at the moment it starts moving from rest, has zero velocity and nonzero acceleration.

14. Yes. Any time the velocity is constant, the acceleration is zero. For example, a car traveling at a constant 90 km/h in a straight line has nonzero velocity and zero acceleration.

15. A rock falling from a cliff has a constant acceleration IF we neglect air resistance. An elevator moving from the second floor to the fifth floor making stops along the way does NOT have a constant acceleration. Its acceleration will change in magnitude and direction as the elevator starts and stops. The dish resting on a table has a constant (zero) acceleration.

16. The slope of the position versus time curve is the object's velocity. The object starts at the origin with a constant velocity (and therefore zero acceleration), which it maintains for about 20 s. For the next 10 s, the positive curvature of the graph indicates the object has a positive acceleration; its speed is increasing. From 30 s to 45 s, the graph has a negative curvature; the object uniformly slows to a stop, changes direction, and then moves backwards with increasing speed. During this time interval, the acceleration is negative, since the object is slowing down while traveling in the positive direction and then speeding up while traveling in the negative direction. For the final 5 s shown, the object continues moving in the negative direction but slows down, which gives it a positive acceleration. During the 50 s shown, the object travels from the origin to a point 20 m away, and then back 10 m to end up 10 m from the starting position.

17. Initially, the object moves in the positive direction with a constant acceleration, until about $t = 45$ s, when it has a velocity of about 37 m/s in the positive direction. The acceleration then decreases, reaching an instantaneous acceleration of 0 at about t = 50 s, when the object has its maximum speed of about 38 m/s. The object then begins to slow down but continues to move in the positive direction. The object stops moving at t = 90 s and stays at rest until about t = 108 s. Then the object begins to move in the positive direction again, at first with a larger acceleration, and then with a lesser acceleration. At the end of the recorded motion, the object is still moving to the right and gaining speed.

AP Physics Name____________________________Date______

Describing Motion: Kinematics in One Dimension

MisConceptual Questions

[List all answers that are valid.]

1. Which of the following should be part of solving any problem in physics? Select all that apply:
   (a) Read the problem carefully.
   (b) Draw a picture of the situation.
   (c) Write down the variables that are given.
   (d) Think about which physics principles to apply.
   (e) Determine which equations can be used to apply the correct physics principles.
   (f) Check the units when you have completed your calculation.
   (g) Consider whether your answer is reasonable.

2. In which of the following cases does a car have a negative velocity and a positive acceleration? A car that is traveling in the
   (a) $-x$ direction at a constant 20 m/s.
   (b) $-x$ direction increasing in speed.
   (c) $+x$ direction increasing in speed.
   (d) $-x$ direction decreasing in speed.
   (e) $+x$ direction decreasing in speed.

3. At time $t = 0$ an object is traveling to the right along the $+x$ axis at a speed of 10.0 m/s with acceleration $-2.0\ \text{m/s}^2$. Which statement is true?
   (a) The object will slow down, eventually coming to a complete stop.
   (b) The object cannot have a negative acceleration and be moving to the right.
   (c) The object will continue to move to the right, slowing down but never coming to a complete stop.
   (d) The object will slow down, momentarily stopping, then pick up speed moving to the left.

4. A ball is thrown straight up. What are the velocity and acceleration of the ball at the highest point in its path?
   (a) $v = 0$, $a = 0$.
   (b) $v = 0$, $a = 9.8\ \text{m/s}^2$ up.
   (c) $v = 0$, $a = 9.8\ \text{m/s}^2$ down.
   (d) $v = 9.8$ m/s up, $a = 0$.
   (e) $v = 9.8$ m/s down, $a = 0$.

5. You drop a rock off a bridge. When the rock has fallen 4 m, you drop a second rock. As the two rocks continue to fall, what happens to their velocities?
   (a) Both increase at the same rate.
   (b) The velocity of the first rock increases faster than the velocity of the second.
   (c) The velocity of the second rock increases faster than the velocity of the first.
   (d) Both velocities stay constant.

6. You drive 4 km at 30 km/h and then another 4 km at 50 km/h. What is your average speed for the whole 8-km trip?
   (a) More than 40 km/h.
   (b) Equal to 40 km/h.
   (c) Less than 40 km/h.
   (d) Not enough information.

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7. A ball is dropped from the top of a tall building. At the same instant, a second ball is thrown upward from the ground level. When the two balls pass one another, one on the way up, the other on the way down, compare the magnitudes of their acceleration:

(a) The acceleration of the dropped ball is greater.
(b) The acceleration of the ball thrown upward is greater.
(c) The acceleration of both balls is the same.
(d) The acceleration changes during the motion, so you cannot predict the exact value when the two balls pass each other.
(e) The accelerations are in opposite directions.

8. A ball is thrown downward at a speed of 20 m/s. Choosing the $+y$ axis pointing up and neglecting air resistance, which equation(*s*) could be used to solve for other variables? The acceleration due to gravity is $g = 9.8\ \mathrm{m/s^2}$ downward.

(a) $v = (20\ \mathrm{m/s}) - gt$.
(b) $v = y_0 + (-20\ \mathrm{m/s})\ t - (1/2)gt^2$.
(c) $v^2 = (20\ \mathrm{m/s})^2 - 2g(y - y_0)$.
(d) $(20\ \mathrm{m/s}) = (v + v_0)/2$.
(e) All of the above.

9. A car travels along the x axis with increasing speed. We don't know if to the left or the right. Which of the graphs in Fig. 2–34 most closely represents the motion of the car?

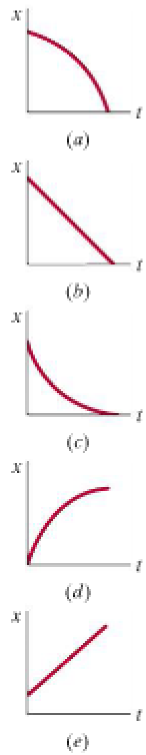

FIGURE 2–34 MisConceptual Question 9.

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1. (*a*, *b*, *c*, *d*, *e*, *f*, *g*) All of these actions should be a part of solving physics problems.

2. (*d*) It is a common misconception that a positive acceleration always increases the speed, as in (*b*) and (*c*). However, when the velocity and acceleration are in opposite directions, the speed will decrease.

3. (*d*) Since the velocity and acceleration are in opposite directions, the object will slow to a stop. However, since the acceleration remains constant, it will stop only momentarily before moving toward the left.

4. (*c*) Students commonly confuse the concepts of velocity and acceleration in free-fall motion. At the highest point in the trajectory, the velocity is changing from positive (upward) to negative (downward) and therefore passes through zero. This changing velocity is due to a constant downward acceleration.

5. (*a*) Since the distance between the rocks increases with time, a common misconception is that the velocities are increasing at different rates. However, both rocks fall under the influence of gravity, so their velocities increase at the same rate.

6. (*c*) Since the distances are the same, a common error is to assume that the average speed will be halfway between the two speeds, or 40 km/h. However, it takes the car much longer to travel the 4 km at 30 km/h than at 50 km/h. Since more time is spent at 30 km/h, the average speed will be closer to 30 km/h than to 50 km/h.

7. (*c*) A common misconception is that the acceleration of an object in free fall depends upon the motion of the object. If there is no air resistance, the accelerations for the two balls have the same magnitude and direction throughout both of their flights.

8. (*b*, *c*) Each of the given equations is based on Eqs. 2–11a–d. Answer (*a*) has the acceleration replaced properly with $-g$, but the initial velocity is downward and as such should be negative. Answer (*d*) is incorrect because the initial velocity has been inserted for the average velocity. Answers (*b*) and (*c*) have the correct signs for each variable and the known values are inserted properly.

9. (*a*) Increasing speed means that the slope must be getting steeper over time. In graphs (*b*) and (*e*), the slope remains constant, so these are cars moving at constant speed. In graph (*c*), as time increases x decreases. However, the rate at which it decreases is also decreasing. This is a car slowing down. In graph (*d*), the car is moving away from the origin, but again it is slowing down. The only graph in which the slope is increasing with time is graph (*a*).

Name: ________________________ **Class:** ___________________ **Date:** __________ **ID: A**

AP Conceptual - Kinematics - Introduction to Motion MC

____ 1) If the acceleration of an object is zero, then that object cannot be moving.
- A) True
- B) False

____ 2) If the velocity of an object is zero at some point, then its acceleration must also be zero at that point.
- A) True
- B) False

____ 3) When is the average velocity of an object equal to the instantaneous velocity?
- A) only when the velocity is increasing at a constant rate
- B) only when the velocity is decreasing at a constant rate
- C) when the velocity is constant
- D) always
- E) never

____ 4) An auto manufacturer advertises that their car can go "from zero to sixty in eight seconds." This is a description of what characteristic of the car's motion?
- A) average speed
- B) instantaneous speed
- C) average acceleration
- D) instantaneous acceleration
- E) displacement

____ 5) Suppose that an object travels from one point in space to another. Make a comparison between the magnitude of the displacement and the distance traveled by this object.
- A) The displacement is either greater than or equal to the distance traveled.
- B) The displacement is always equal to the distance traveled.
- C) The displacement is either less than or equal to the distance traveled.
- D) The displacement can be either greater than, smaller than, or equal to the distance traveled.

____ 6) Consider a car that travels between points A and B. The car's average speed can be greater than the magnitude of its average velocity, but the magnitude of its average velocity can never be greater than its average speed.
- A) True
- B) False

____ 7) An object moving in the $+x$ direction experiences an acceleration of $+2.0\ m/s^2$. This means the object
- A) travels 2.0 m in every second.
- B) is traveling at 2.0 m/s.
- C) is decreasing its velocity by 2.0 m/s every second.
- D) is increasing its velocity by 2.0 m/s every second.

Name: ________________________ **ID: A**

____ 8) Suppose that a car traveling to the east (+*x* direction) begins to slow down as it approaches a traffic light. Which statement concerning its acceleration must be correct?

A) Its acceleration is in the +*x* direction.
B) Its acceleration is in the -*x* direction.
C) Its acceleration is zero.
D) Its acceleration is decreasing in magnitude as the car slows down.

____ 9) Suppose that an object is moving with a constant velocity. Which statement concerning its acceleration must be correct?

A) The acceleration is constantly increasing.
B) The acceleration is constantly decreasing.
C) The acceleration is a constant non-zero value.
D) The acceleration is equal to zero.

____ 10) An object moves 15.0 m north and then 11.0 m south. Find both the distance it has traveled and the magnitude of its displacement.

A) 4.0 m, 26.0 m
B) 26.0 m, 4.0 m
C) 26.0 m, 26.0 m
D) 4.0 m, 4.0 m

____ 11) Which of the following situations is *impossible*?

A) An object has velocity directed east and acceleration directed west.
B) An object has velocity directed east and acceleration directed east.
C) An object has zero velocity but non-zero acceleration.
D) An object has constant non-zero acceleration and changing velocity.
E) An object has constant non-zero velocity and changing acceleration.

____ 12) If the velocity of an object is zero, then that object cannot be accelerating.

A) True
B) False

____ 13) Suppose that a car traveling to the west begins to slow down as it approaches a traffic light. Which of the following statements about its acceleration is correct?

A) The acceleration is toward the east.
B) Since the car is slowing down, its acceleration must be negative.
C) The acceleration is zero.
D) The acceleration is toward the west.

____ 14) Consider a deer that runs from point A to point B. The distance the deer runs can be greater than the magnitude of its displacement, but the magnitude of the displacement can never be greater than the distance it runs.

A) True
B) False

Name: ________________________ **ID: A**

____ 15) Suppose that a car traveling to the west ($-x$ direction) begins to slow down as it approaches a traffic light. Which statement concerning its acceleration must be correct?

A) Its acceleration is positive.
B) Its acceleration is negative.
C) Its acceleration is zero.
D) Its acceleration is decreasing in magnitude as the car slows down.

____ 16) If the velocity of an object is zero at one instant, what is true about the acceleration of that object? (There could be more than one correct choice.)

A) The acceleration could be positive.
B) The acceleration could be negative.
C) The acceleration could be zero.
D) The acceleration must be zero.

AP Conceptual - Kinematics - Introduction to Motion MC
Answer Section

1)	ANS: B	PTS: 1	REF: Var: 1
2)	ANS: B	PTS: 1	REF: Var: 1
3)	ANS: C	PTS: 1	REF: Var: 1
4)	ANS: C	PTS: 1	REF: Var: 1
5)	ANS: C	PTS: 1	REF: Var: 1
6)	ANS: A	PTS: 1	REF: Var: 1
7)	ANS: D	PTS: 1	REF: Var: 1
8)	ANS: B	PTS: 1	REF: Var: 1
9)	ANS: D	PTS: 1	REF: Var: 1
10)	ANS: B	PTS: 1	REF: Var: 1
11)	ANS: E	PTS: 1	REF: Var: 1
12)	ANS: B	PTS: 1	REF: Var: 1
13)	ANS: A	PTS: 1	REF: Var: 1
14)	ANS: A	PTS: 1	REF: Var: 1
15)	ANS: A	PTS: 1	REF: Var: 1
16)	ANS: A, B, C	PTS: 1	REF: Var: 1

Name: ___________________________________

1.
A car travels a distance of 98 meters in 10. seconds. What is the average speed of the car during this 10.-second interval?

A. 4.9 m/s C. 49 m/s
B. 9.8 m/s D. 98 m/s

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2.
A boat initially traveling at 10. meters per second accelerates uniformly at the rate of 5.0 meters per second squared for 10. seconds. How far does the boat travel during this time?

A. 50. m C. 350 m
B. 250 m D. 500 m

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3.
An object accelerates uniformly from rest to a speed of 50. meters per second in 5.0 seconds. The average speed of the object during the 5.0 second interval is

A. 5.0 m/s C. 25 m/s
B. 10. m/s D. 50. m/s

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4.
The velocity of a car changes from 60. meters per second north to 45 meters per second north in 5.0 seconds. The magnitude of the car's acceleration is

A. 9.8 m/s^2 C. 3.0 m/s^2
B. 15 m/s^2 D. 53 m/s^2

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5.
Which two terms represent a vector quantity and the scalar quantity of the vector's magnitude, respectively?

A. acceleration and velocity
B. weight and force
C. speed and time
D. displacement and distance

- - - - - - - - - - - - - -

6.
A group of bike riders took a 4.0 hour trip. During the first 3.0 hours, they traveled a total of 50. kilometers, but during the last hour, they traveled only 10. kilometers. What was the group's average speed for the entire trip?

A. 15 km/hr C. 40. km/hr
B. 30. km/hr D. 60. km/hr

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7.
A locomotive starts at rest and accelerates at 0.12 meters per second squared to a speed of 2.4 meters per second in 20. seconds. This motion could be best described as

A. constant acceleration and constant velocity
B. increasing acceleration and constant velocity
C. constant acceleration and increasing velocity
D. increasing acceleration and increasing velocity

- - - - - - - - - - - - - -

8.
Which of the following is a scalar quantity?

A. displacement C. force
B. distance D. acceleration

- - - - - - - - - - - - - -

9.
A runner completed the 100.-meter dash in 10.0 seconds. Her average speed was

A. 0.100 m/s C. 100. m/s
B. 10.0 m/s D. 1,000 m/s

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10.
A child riding a bicycle at 15 meters per second decelerates at the rate of 3.0 meters per second squared for 4.0 seconds. What is the child's speed at the end of 4.0 seconds?

A. 12 m/s C. 3.0 m/s
B. 27 m/s D. 7.0 m/s

- - - - - - - - - - - - - -

11.
A cart starting from rest travels a distance of 3.6 meters in 1.8 seconds. The average speed of the cart is

A. 0.20 m/s C. 0.50 m/s
B. 2.0 m/s D. 5.0 m/s

12.
An object has a constant acceleration of 2.0 meters per second squared. The time required for the object to accelerate from 8.0 meters per second to 28 meters per second is

A. 20. s C. 10. s
B. 16 s D. 4.0 s

13.
A student walks 3 blocks south, 4 blocks west, and 3 blocks north. What is the displacement of the student?

A. 10 blocks east C. 4 blocks east
B. 10 blocks west D. 4 blocks west

14.
If an object's velocity changes from 25 meters per second to 15 meters per second in 2.0 seconds, the magnitude of the object's acceleration is

A. 5.0 m/s^2 C. 13 m/s^2
B. 7.5 m/s^2 D. 20. m/s^2

15.
A car travels 20. meters east in 1.0 second. The displacement of the car at the end of this 1.0-second interval is

A. 20. m C. 20. m east
B. 20. m/s D. 20. m/s east

16.
Which is a vector quantity?

A. distance C. speed
B. time D. acceleration

17.
A car is traveling at a constant speed of 14 meters per second along a straight highway. A tree and a speed limit sign are beside the highway. As it passes the tree, the car starts to accelerate. The car is accelerated uniformly at 2.0 meters per second per second until it reaches the speed limit sign, 5.0 seconds later.

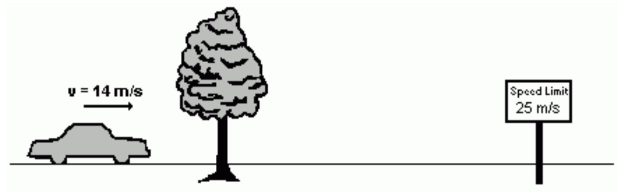
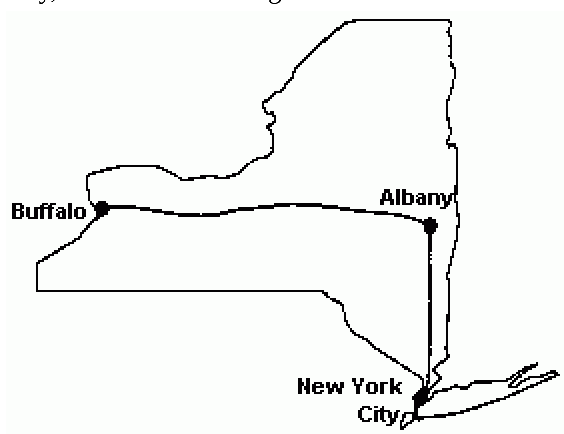


Figure 1

When the car reached the sign, the car's speed is

A. less than the speed limit
B. greater than the speed limit
C. equal to the speed limit

18.
A car is driven from Buffalo to Albany and on to New York City, as shown in the diagram.



Compared to the magnitude of the car's total displacement, the distance driven is

A. shorter
B. longer
C. the same

19.

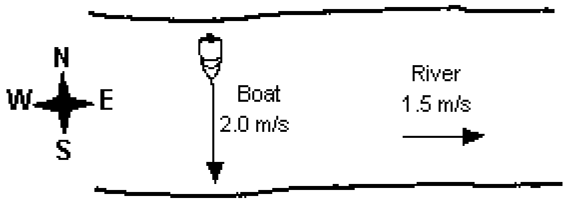
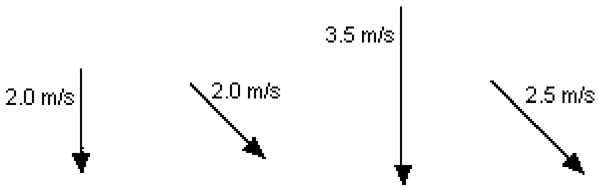


Figure 2

A river flows due east at 1.5 meters per second. A motorboat leaves the north shore of the river and heads due south at 2.0 meters per second, as shown in the diagram above. Which vector below best represents the resultant of the velocity of the boat relative to the riverbank?



1. 2. 3. 4.

20.

Oil drips at 0.4 seconds intervals from a car that has an oil leak. Which pattern best represents the spacing of oil drops as the car accelerates uniformly from rest?

A. . . . .

B. . . . .

C. . . . .

D. . .. .

21.

A 4.0-kilogram rock and a 1.0-kilogram stone fall freely from rest from a height of 100. meters. After they fall for 2.0 seconds, the ratio of the rock's speed to the stone's speed is

A. 1:1 C. 1:2

B. 2:1 D. 4:1

22.

What is the total displacement of a student who walks 3 blocks east, 2 blocks north, 1 block west, and then 2 blocks south?

A. 0 C. 2 blocks west

B. 2 blocks east D. 8 blocks

Answer Key for: Motion Diagrams

1. B	12. C
2. C	13. D
3. C	14. A
4. C	15. C
5. D	16. D
6. A	17. A
7. C	18. B
8. B	19. D
9. B	20. B
10. C	21. A
11. B	22. B

Name: ___________________________________

1.

A rock falls freely from rest near the surface of a planet where acceleration due to gravity is 4.0 meters per second per second. What is the speed of this rock after it falls 32 meters?

A. 8.0 m/s C. 25 m/s

B. 16 m/s D. 32 m/s

2.

A car is traveling at a constant speed of 14 meters per second along a straight highway. A tree and a speed limit sign are beside the highway. As it passes the tree, the car starts to accelerate. The car is accelerated uniformly at 2.0 meters per second per second until it reaches the speed limit sign, 5.0 seconds later.

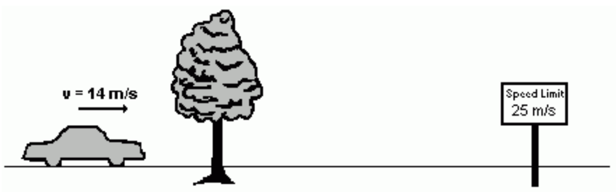


Figure 1

When the car reached the sign, the car's speed is

A. less than the speed limit

B. greater than the speed limit

C. equal to the speed limit

3.

[Refer to figure 1 in question 2]

What is the distance between the tree and the sign?

A. 10. m C. 70. m

B. 25 m D. 95 m

4.

A car travels between the 100. meter and 250. meter highway markers in 10. seconds. The average speed of the car during this interval is

A. 10. m/s C. 25 m/s

B. 15 m/s D. 35 m/s

5.

How far will a brick starting from rest fall freely in 3.0 seconds?

A. 15 m C. 44 m

B. 29 m D. 88 m

6.

A car initially traveling at a speed of 16 meters per second accelerates uniformly to a speed of 20. meters per second over a distance of 36 meters. What is the magnitude of the car's acceleration?

A. 0.11 m/s^2 C. 0.22 m/s^2

B. 2.0 m/s^2 D. 9.0 m/s^2

7.

A skater increases her speed uniformly from 2.0 meters per second to 7.0 meters per second over a distance of 12 meters. The magnitude of her acceleration as she travels this 12 meters is

A. 1.9 m/s^2 C. 2.4 m/s^2

B. 2.2 m/s^2 D. 3.8 m/s^2

8.

During a 5.0-second interval, an object's velocity changes from 25 meters per second east to 15 meters per second east.

a Determine the magnitude of the object's acceleration. Round your answer to the nearest tenth of a meter per second^2.

Answer: ______ m/s^2

b What is the direction of the acceleration? [N, E, S, W]?

______

9.
A rocket initially at rest on the ground lifts off vertically with a constant acceleration of 2.0×10^1 meters per second^2. How long will it take the rocket to reach an altitude of 9.0×10^3 meters?

A. 3.0×10^1 s

B. 4.3×10^1 s

C. 4.5×10^2 s

D. 9.0×10^2 s

10.
Base your answer to the question on the information below.
A car on a straight road starts from rest and accelerates at 1.0 meter per second^2 for 10. seconds. Then the car continues to travel at constant speed for an additional 20. seconds.

Figure 2

a) Determine the speed of the car at the end of the first 10. seconds.

Answer: ______ m/s

b) Calculate the average speed of the car during the first 10. seconds.

Answer: ______ m/s

11.

[Refer to figure 2 in question 10]
Calculate the distance the car travels in the first 10. seconds.

Answer: d = ______ m

12.
A car increases its speed from 9.6 meters per second to 11.2 meters per second in 4.0 seconds. The average acceleration of the car during this 4.0-second interval is

A. 0.40 m/s²   C. 2.8 m/s²
B. 2.4 m/s²   D. 5.2 m/s²

13.
What is the speed of a 2.5-kilogram mass after it has fallen freely from rest through a distance of 12 meters?

A. 4.8 m/s   C. 30. m/s
B. 15 m/s   D. 43 m/s

14.
An observer recorded the following data for the motion of a car undergoing constant acceleration.

Time (s)	Speed (m/s)
3.0	4.0
5.0	7.0
6.0	8.5

What was the magnitude of the acceleration of the car?

A. 1.3 m/s^2 C. 1.5 m/s^2
B. 2.0 m/s^2 D. 4.5 m/s^2

15.
A rock falls from rest a vertical distance of 0.72 meter to the surface of a planet in 0.63 second. The magnitude of the acceleration due to gravity on the planet is

A. 1.1 m/s^2 C. 3.6 m/s^2
B. 2.3 m/s^2 D. 9.8 m/s^2

16.
The speed of an object undergoing constant acceleration increases from 8.0 meters per second to 16.0 meters per second in 10. seconds. How far does the object travel during the 10. seconds?

A. 3.6×10^2 m

B. 1.6×10^2 m

C. 1.2×10^2 m

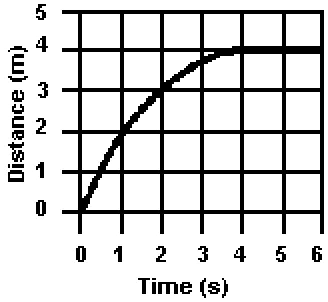
D. 8.0×10^1 m

Answer Key for: Kinematics Equations

1. B	9. A
2. A	10. 10, 5
3. D	11. 50.
4. B	12. A
5. C	13. B
6. B	14. C
7. A	15. C
8. -2.0 or 2.0, W	16. C

Name: ___________________________________

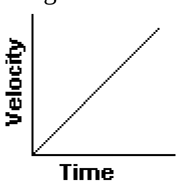
1.
The graph represents the relationship between distance and time for an object.



What is the instantaneous speed of the object at t = 5.0 seconds?

A. 0 m/s C. 5.0 m/s
B. 2.0 m/s D. 4.0 m/s

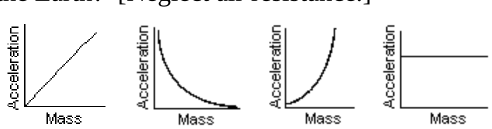
2.
The graph represents the motion of a body moving along a straight line.



According to the graph, which quantity related to the motion of the body is constant?

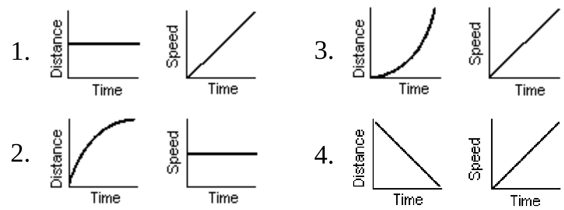
A. speed C. acceleration
B. velocity D. displacement

3.
Which graph best represents the relationship between mass and acceleration due to gravity for objects near the surface of the Earth? [Neglect air resistance.]

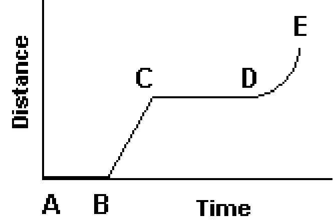


1. 2. 3. 4.

4.
Which pair of graphs represent the same motion?



5.
The graph represents the relationship between distance and time for an object in motion.



During which interval is the speed of the object changing?

A. *AB* C. *CD*
B. *BC* D. *DE*

6.
The graph represents the linear motion of a car.

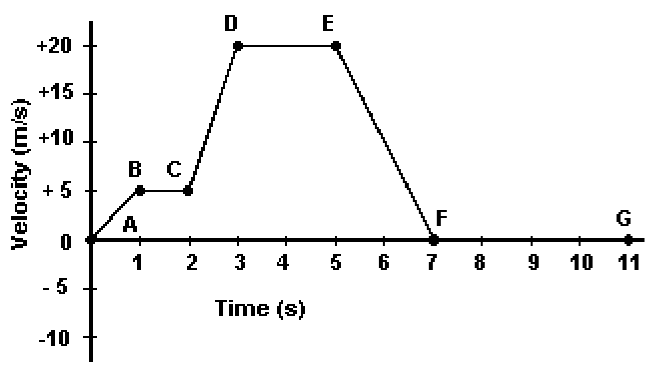


Figure 1

The average velocity of the car during interval *DE* is

A. 0 m/s C. 20. m/s
B. 10. m/s D. 40. m/s

7.

[Refer to figure 1 in question 6]

The acceleration of the car at $t = 6.0$ seconds is

A. $-20.\ m/s^2$ C. $5.0\ m/s^2$

B. $-10.\ m/s^2$ D. $10.\ m/s^2$

8.

[Refer to figure 1 in question 6]

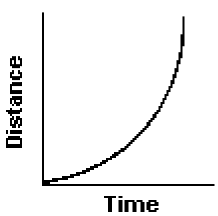
The car has the largest displacement during interval

A. *FG* C. *EF*

B. *BD* D. *DE*

9.

The diagram shows a graph of distance as a function of time for an object in straight-line motion.



According to the graph, the object most likely has

A. a constant momentum

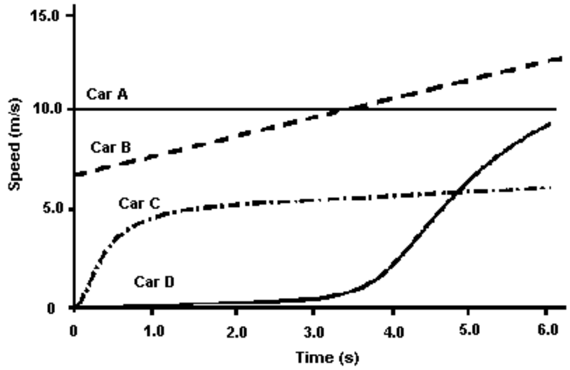
B. a decreasing acceleration

C. a decreasing mass

D. an increasing speed

10.

The graph shows speed as a function of time for four cars, *A*, *B*, *C*, and *D* , in straight-line motion.



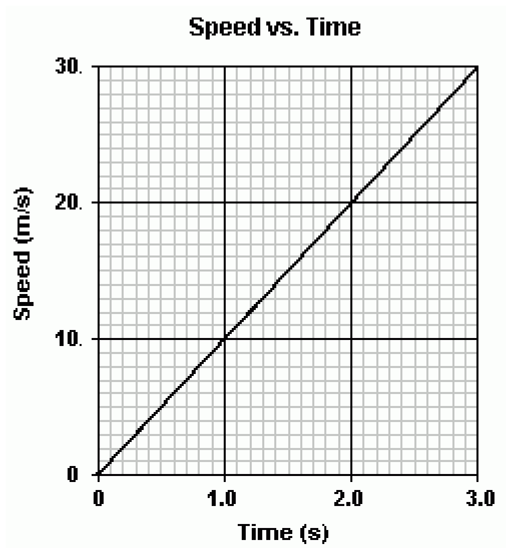
Which car experienced the greatest average acceleration during this 6.0-second interval?

A. car *A* C. car *C*

B. car *B* D. car *D*

11.

The graph represents the relationship between the speed and time for a car moving in a straight line.



The magnitude of the car's acceleration is

A. $1.0\ m/s^2$ C. $10.\ m/s^2$

B. $0.10\ m/s^2$ D. $0.0\ m/s^2$

12.

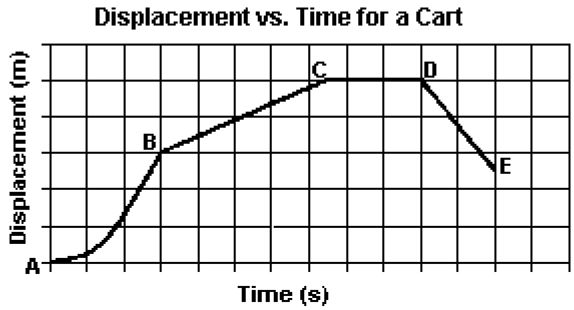


Figure 2

The displacement-time graph shows the motion of a cart along a straight line. During which interval was the cart accelerating?

A. *AB* C. *CD*
B. *BC* D. *DE*

13.

The graph represents the relationship between the displacement of an object and its time travel along a straight line.

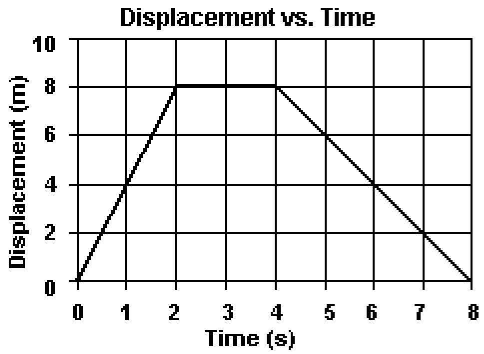


Figure 3

What is the magnitude of the object's total displacement after 8.0 seconds?

A. 0 m C. 8 m
B. 2 m D. 16 m

14.

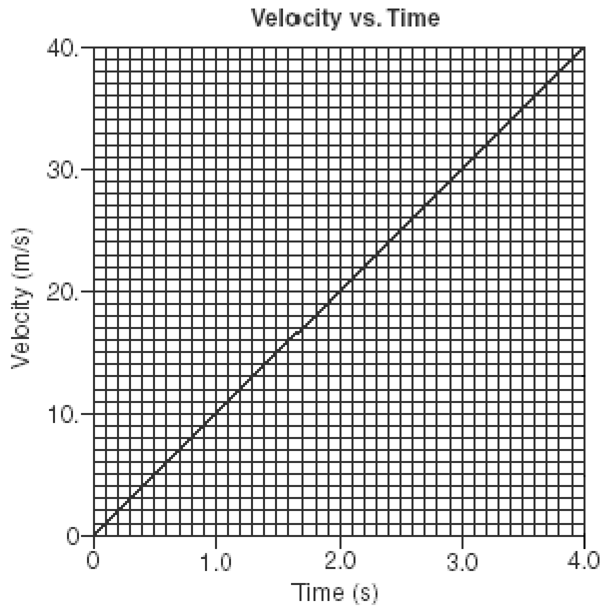
[Refer to figure 3 in question 13]

What is the average speed of the object during the first 4.0 seconds?

A. 0 m/s C. 8 m/s
B. 2 m/s D. 4 m/s

15.

The graph below shows the velocity of a race car moving along a straight line as a function of time.

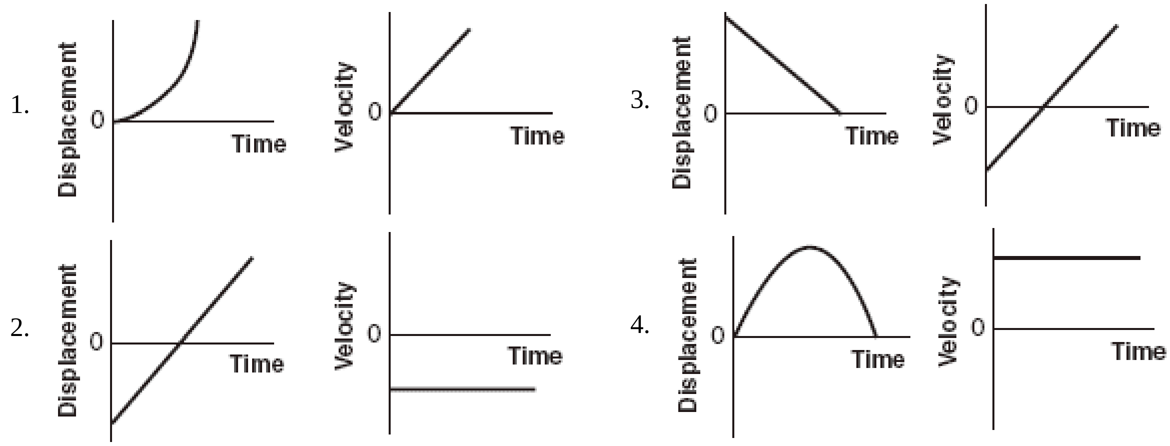


What is the magnitude of the displacement of the car from t = 2.0 seconds to t = 4.0 seconds?

A. 20. m C. 60. m
B. 40. m D. 80. m

16.

Which pair of graphs represents the same motion of an object?



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Answer Key for: Motion Graphs

1. A	9. D
2. C	10. D
3. D	11. C
4. C	12. A
5. D	13. A
6. C	14. B
7. B	15. C
8. D	16. A

1D Kinematics FR

Name: ______________________ **Date:** __________

1. Base your answer(s) to the following question(s) on the information.

   A hiker walks 5.00 kilometers due north and then 7.00 kilometers due east.

   What is the magnitude of her resultant displacement?

2. During a 5.0-second interval, an object's velocity changes from 25 meters per second east to 15 meters per second east. Determine the magnitude and direction of the object's acceleration.

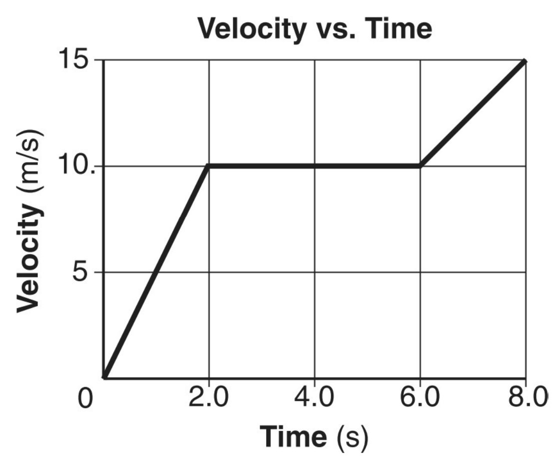
   Examples of 2-Credit Responses $2.0\,\mathrm{m/s^2}$ west
   $-2.0\,\mathrm{m/s^2}$ east

3. Base your answer(s) to the following question(s) on the information below

   A 747 jet, traveling at a velocity of 70. meters per second north, touches down on a runway. The jet slows to rest at the rate of 2.0 meters per second^2.

   Calculate the total distance the jet travels on the runway as it is brought to rest. [Show all work, including the equation and substitution with units.]

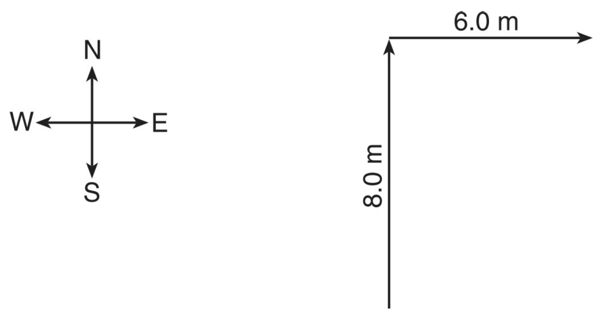
4. The graph below represents the velocity of an object traveling in a straight line as a function of time.



   Determine the magnitude of the total displacement of the object at the end of the first 6.0 seconds.

5. Base your answer(s) to the following question(s) on the information and vector diagram below.

A dog walks 8.0 meters due north and then 6.0 meters due east.



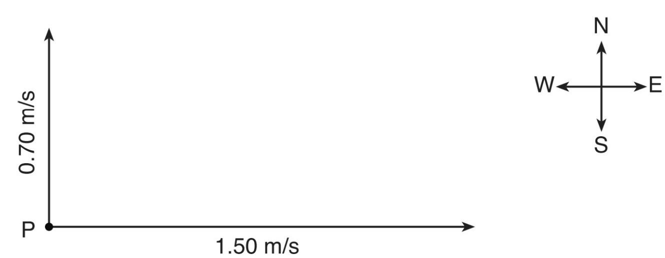
Determine the magnitude of the dog's total displacement.

6. A person walks 150. meters due east and then walks 30. meters due west. The entire trip takes the person 10. minutes. Determine the magnitude and the direction of the person's total displacement.

7. A cart travels 4.00 meters east and then 4.00 meters north. Determine the magnitude of the cart's resultant displacement. [1]

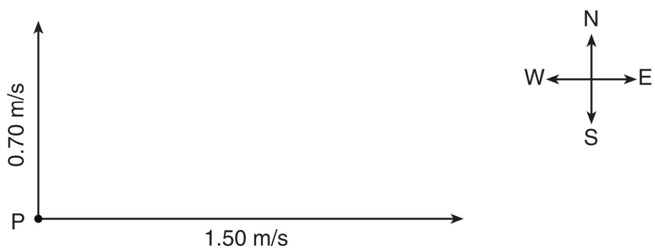
8. Base your answer(s) to the following question(s) on the information and diagram below.

A model airplane heads due east at 1.50 meters per second, while the wind blows due north at 0.70 meter per second. The scaled diagram below represents these vector quantities.



Using a ruler, determine the scale used in the vector diagram.

9. On the diagram provided below, use a protractor and a ruler to construct a vector to represent the resultant velocity of the airplane. Label the vector *R*.

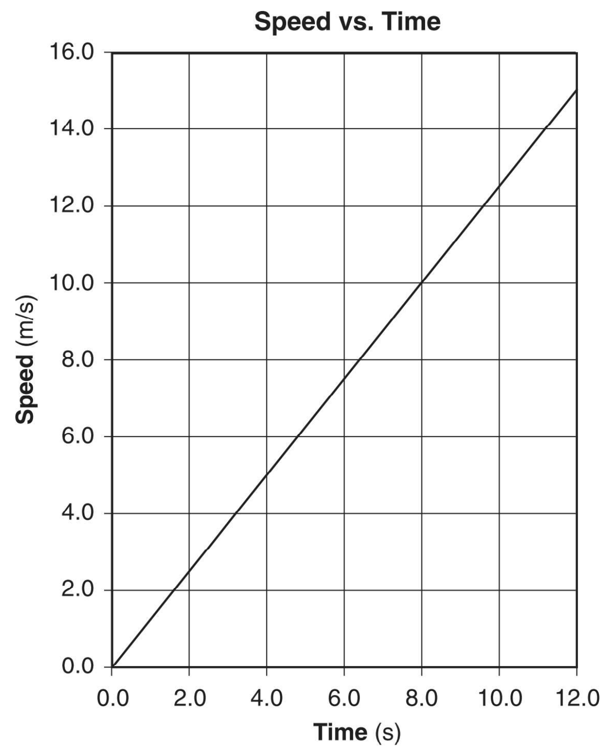


10. Determine the magnitude of the resultant velocity.

11. Determine the angle between north and the resultant velocity.

12. Base your answer(s) to the following question(s) on the information on the graph below.

The graph shows the relationship between speed and elapsed time for a car moving in a straight line.



Calculate the total distance the car traveled during the time interval 4.0 seconds to 8.0 seconds.

13. Base your answer(s) to the following question(s) on the information below.

A girl rides her bicycle 1.40 kilometers west, 0.70 kilometer south, and 0.30 kilometer east in 12 minutes. The vector diagram below represents the girl's first two displacements in sequence from point *P*. The scale used in the diagram is 1.0 centimeter = 0.20 kilometer.

Calculate the girl's average speed for the entire bicycle trip.

14. Determine the magnitude of the girl's resultant displacement for the entire bicycle trip, in kilometers.

15. Base your answer(s) to the following question(s) on the information below.

A manufacturer's advertisement claims that their 1,250-kilogram (12,300-newton) sports car can accelerate on a level road from 0 to 60.0 miles per hour (0 to 26.8 meters per second) in 3.75 seconds.

Determine the acceleration, in meters per second^2, of the car according to the advertisement.

16. Base your answer(s) to the following question(s) on the information below.

The combined mass of a race car and its driver is 600. kilograms. Traveling at constant speed, the car completes one lap around a circular track of radius 160 meters in 36 seconds.

Calculate the speed of the car. [Show all work, including the equation and substitution with units.]

17. Base your answer(s) to the following question(s) on the information below.

A car traveling at a speed of 13 meters per second accelerates uniformly to a speed of 25 meters per second in 5.0 seconds.

Calculate the magnitude of the acceleration of the car during this 5.0-second time interval. [Show all work, including the equation and substitution with units.]

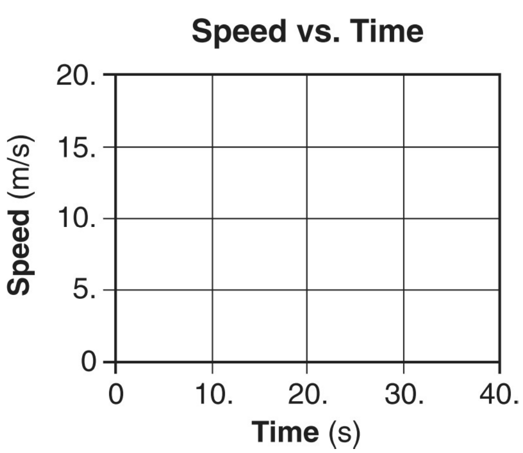
18. A truck traveling at a constant speed covers the same total distance as the car in the same 5.0-second time interval. Determine the speed of the truck.

19. Base your answer(s) to the following question(s) on the information below.

A car on a straight road starts from rest and accelerates at 1.0 meter per second^2 for 10. seconds. Then the car continues to travel at constant speed for an additional 20. seconds.

Determine the speed of the car at the end of the first 10. seconds.

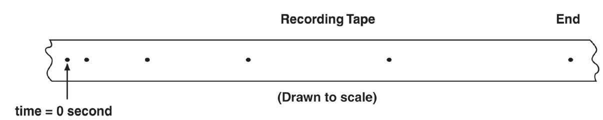
20. On the grid below, use a ruler or straightedge to construct a graph of the car's speed as a function of time for the entire 30.-second interval.



21. Calculate the distance the car travels in the first 10. seconds. [Show all work, including the equation and substitution with units.]

22. Base your answer(s) to the following question(s) on the information and diagram below.

A spark timer is used to record the position of a lab cart accelerating uniformly from rest. Each 0.10 second, the timer marks a dot on a recording tape to indicate the position of the cart at that instant, as shown.



Using a metric ruler, measure the distance the cart traveled during the interval t = 0 second to t = 0.30 second. Record your answer to the nearest tenth of a centimeter.

23. Calculate the magnitude of the acceleration of the cart during the time interval t = 0 second to t = 0.30 second. [Show all work, including the equation and substitution with units.]

24. Calculate the average speed of the cart during the time interval t = 0 second to t = 0.30 second. [Show all work, including the equation and substitution with units.]

25. On the diagram below, mark at least four dots to indicate the position of a cart traveling at a constant velocity.

26. Base your answer(s) to the following question(s) on the information below.

A 75-kilogram athlete jogs 1.8 kilometers along a straight road in 1.2×10^3 seconds.

Determine the average speed of the athlete in meters per second.

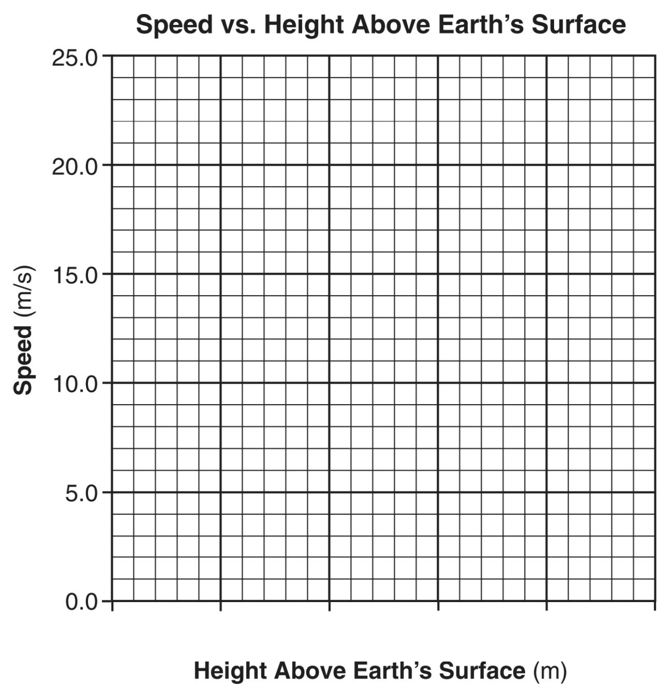
27. Base your answer(s) to the following question(s) on the information and data table below.

A 1.00-kilogram mass was dropped from rest from a height of 25.0 meters above Earth's surface. The speed of the mass was determined at 5.0-meter intervals and recorded in the data table below.

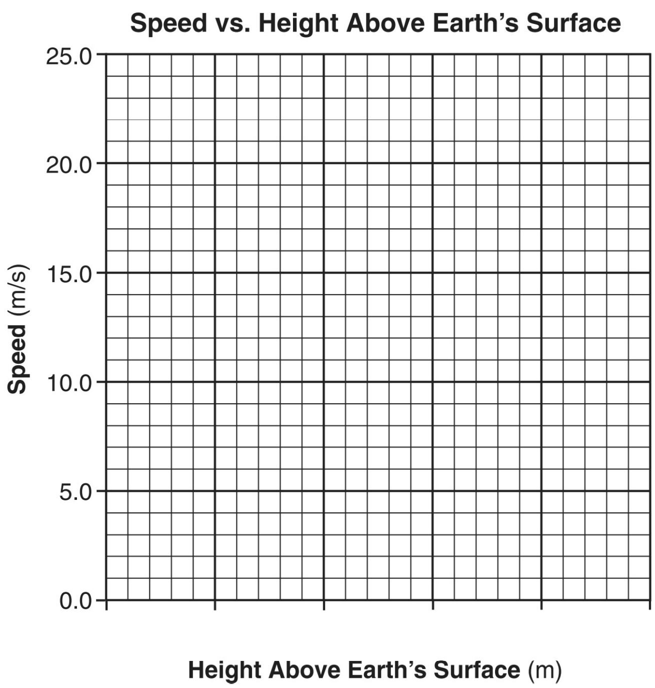
Data Table

Height Above Earth's Surface (m)	Speed (m/s)
25.0	0.0
20.0	9.9
15.0	14.0
10.0	17.1
5.0	19.8
0	22.1

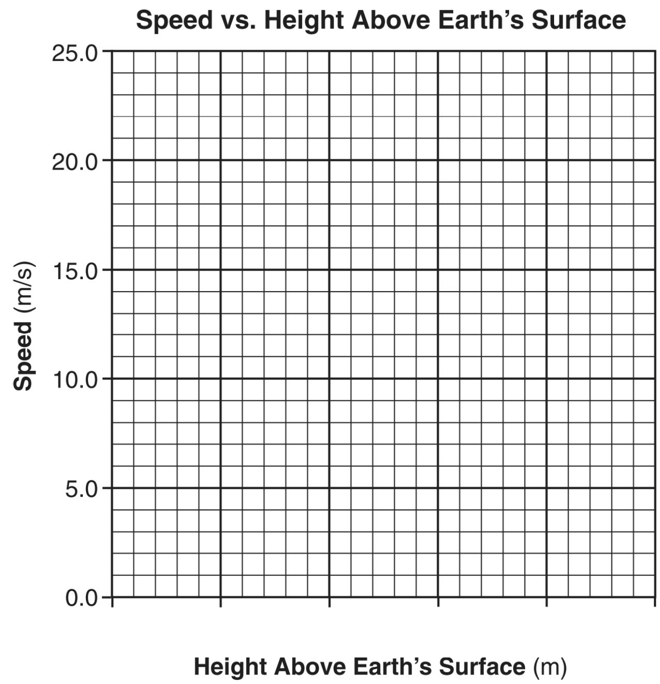
Mark an appropriate scale on the axis labeled "Height Above Earth's Surface (m)."



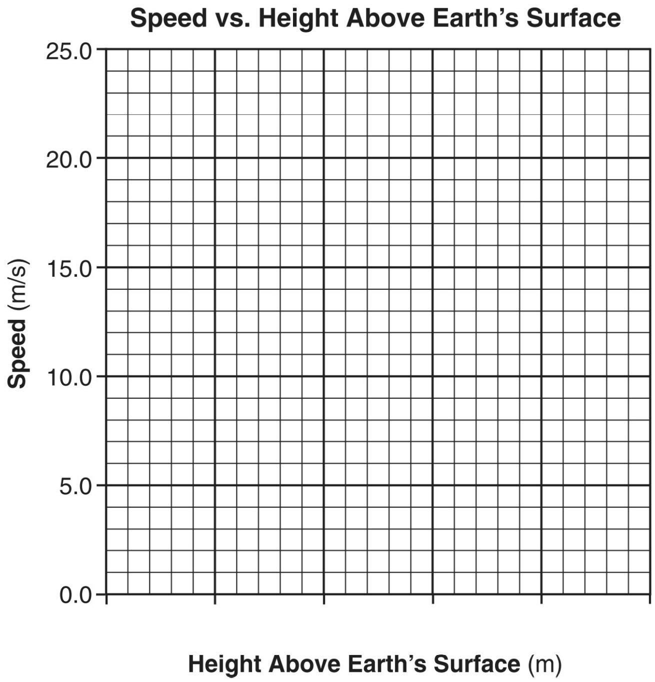
28. Plot the data points for speed versus height above Earth's surface.



29. Draw the line or curve of best fit.

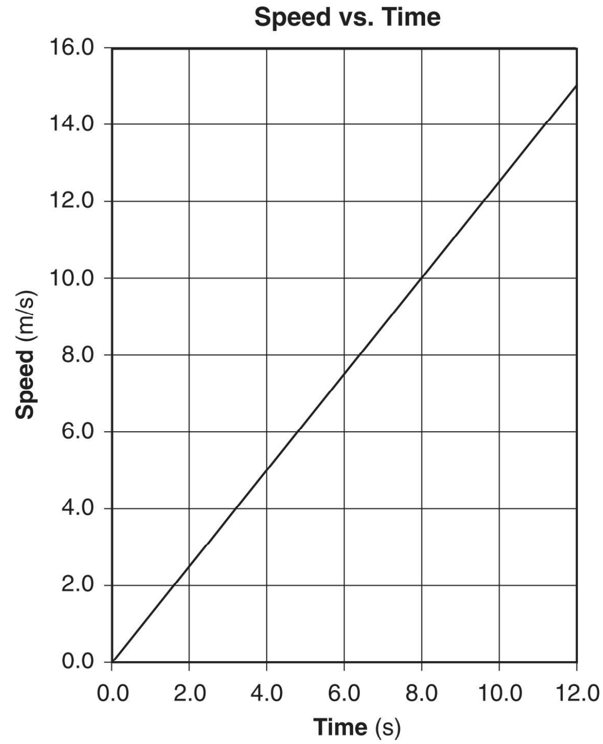


30. Using your graph, determine the speed of the mass after it has fallen a vertical distance of 12.5 meters.



31. Base your answer(s) to the following question(s) on the information on the graph below.

The graph shows the relationship between speed and elapsed time for a car moving in a straight line.



Determine the magnitude of the acceleration of the car.

1D Kinematics FR 9/28/2017

1.
Answer: 8.60 km or 8.6 km.

2.
Answer: $2.0\,\mathrm{m/s^2}$ east, $-2.0\,\mathrm{m/s^2}$ west

3.
Answer:

$$v_f^{\,2} = v_i^{\,2} + 2ad$$

$$d = \frac{v_f^{\,2} - v_i^{\,2}}{2a}$$

$$d = \frac{(0\ \mathrm{m/s})^2 - (70.\ \mathrm{m/s})^2}{2(-2.0\ \mathrm{m/s^2})}$$

$$d = 1200\ \mathrm{m}$$

4.
Answer: 50. m

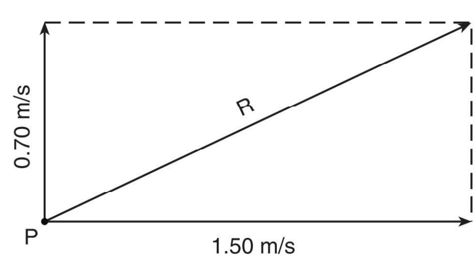
5.
Answer: 10. m ±0.4 m. Note: Allow credit for an answer that is consistent with the student's response to questions 55 and/or 56.

6.
Answer: 120. m east

7.
Answer: 5.66 m.

8.
Answer: 1.0 cm=0.20 m/s ±0.04 m/s

9.
Answer:



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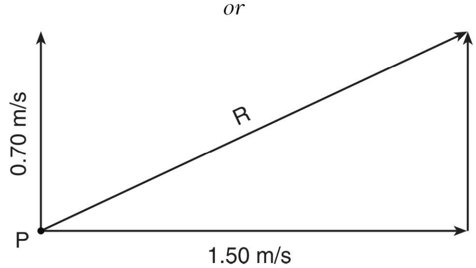


10.
Answer: 1.7 m/s

11.
Answer: 65° ±2°

12.
Answer:

$$-\ d = \left(\frac{5.0m/s + 10.0m/s}{2}\right)4.0s$$

$$-\ d = 30.\mathrm{m}$$

13.
Answer: $\bar{v} = 3.3\,\mathrm{m/s}$

14.
Answer: 1.3 km ± 0.2 km

15.
Answer: $7.15\,\mathrm{m/s^2}$

16.
Answer:

$$\bar{v} = \frac{d}{t}$$

$$\bar{v} = \frac{2\pi r}{t}$$

$$\bar{v} = \frac{2\pi(160\ \mathrm{m})}{36\ \mathrm{s}}$$

$$\bar{v} = 28\ \mathrm{m/s} \quad or \quad 27.9\ \mathrm{m/s}$$

17.
Answer:

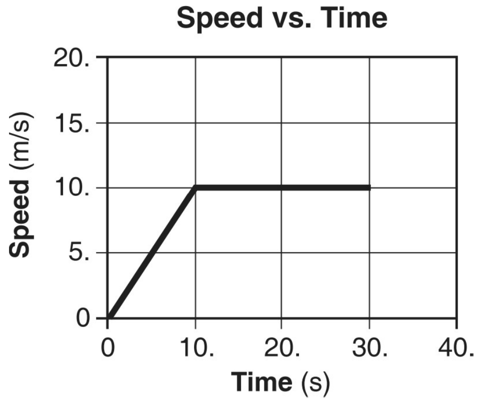
$$a = \frac{\Delta v}{t} \quad a = \frac{25m/s - 13m/s}{5.0s}$$

$$a = 2.4m/s^2$$

18.
Answer: 19 m/s

19.
Answer: 10. m/s

20.
Answer: line segment from 0 to 10. s.
line segment from 10. to 30. s.



21.
Answer: $d = .50\text{ m}$

22.
Answer: 5.4 cm ±0.2 cm.

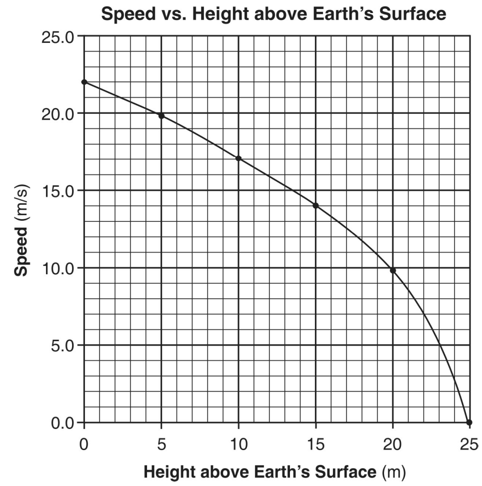
23.
Answer:
$$d = v_i t + \tfrac{1}{2}at^2$$
$$a = \frac{2d}{t^2}$$
$$a = \frac{2(5.4\text{ cm})}{(0.30\text{ s})^2}$$
$$a = 120\text{ cm/s}^2 \textit{ or } 1.2\text{ m/s}^2$$

24.
Answer:
$$\bar{v} = \frac{d}{t}$$
$$\bar{v} = \frac{5.4\text{ cm}}{0.30\text{ s}}$$
$$\bar{v} = 18\text{ cm/s} \textit{ or } 0.18\text{ m/s}$$

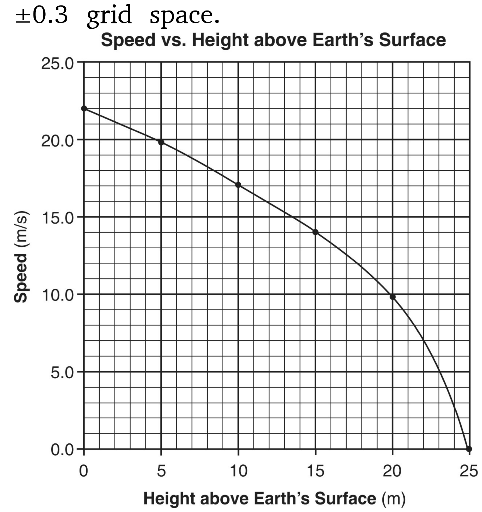
25.
Answer:

26.
Answer: 1.5 m/s.

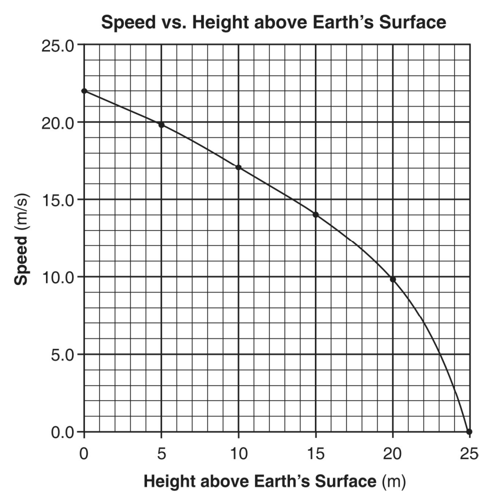
27.
Answer:



28.
Answer: ±0.3 grid space.



29.
Answer:



30.
Answer: 15.7 m/s ±0.3 m/s or an answer that is consistent with the student's graph.

31.
Answer: $1.25\text{ m/s}^2 \pm 0.05\text{ m/s}^2$

1D Kinematics FR 9/28/2017

1.
Answer: 8.60 km or 8.6 km.

2.
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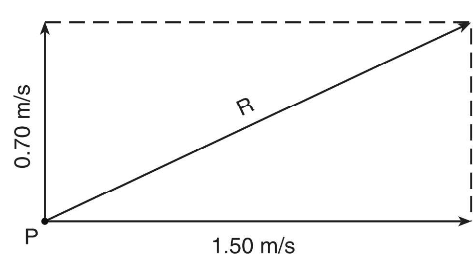

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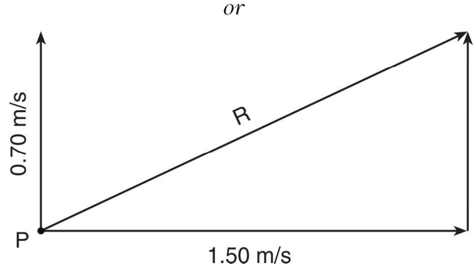

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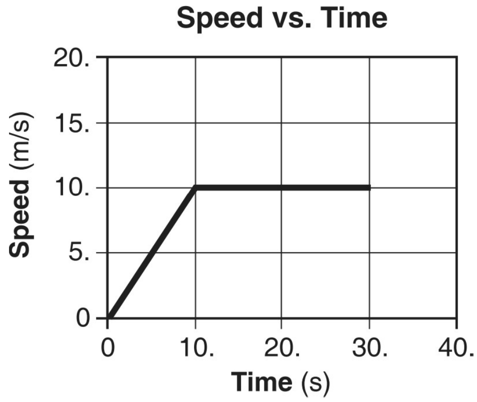

21.
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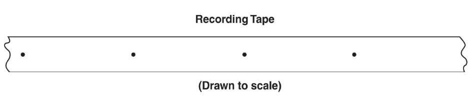

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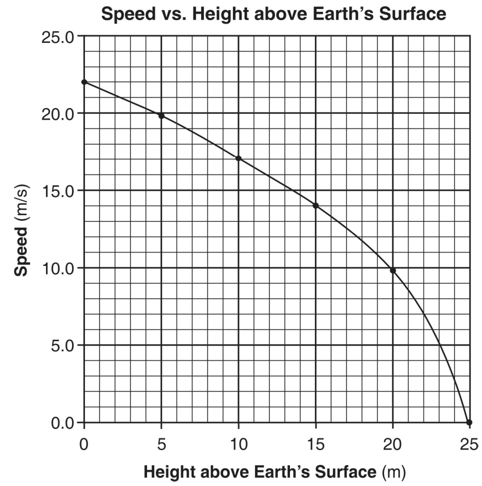

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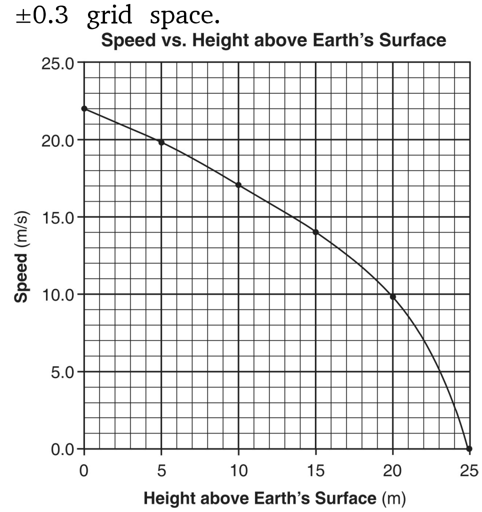

29.
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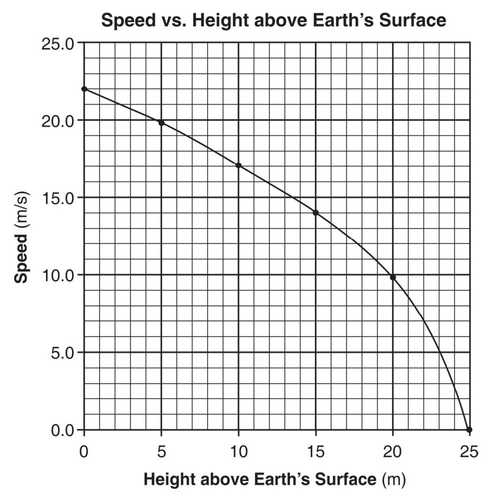

30.
Answer: 15.7 m/s ±0.3 m/s or an answer that is consistent with the student's graph.

31.
Answer: $1.25\,\text{m/s}^2 \pm 0.05\,\text{m/s}^2$

Name: ________________________ **Class:** ___________________ **Date:** __________ **ID: A**

AP Conceptual - Kinematics - UAM Problems MC

____ 1) A car is traveling north at 17.7 m/s. After 12 s its velocity is 14.1 m/s in the same direction. Find the magnitude and direction of the car's average acceleration.
- A) 0.30 m/s^2, south
- B) 2.7 m/s^2, south
- C) 0.30 m/s^2, north
- D) 2.7 m/s^2, north

____ 2) A racquetball strikes a wall with a speed of 30 m/s and rebounds in the opposite direction with a speed of 26 m/s. The collision takes 20 ms. What is the average acceleration of the ball during the collision with the wall?
- A) 0 m/s^2
- B) 200 m/s^2
- C) 2800 m/s^2
- D) 1500 m/s^2
- E) 1300 m/s^2

____ 3) A certain test car can go from rest to 32.0 m/s in 3.88 s. The same car can come to a full stop from that speed in 4.14 s. What is the ratio of the magnitude of the starting acceleration to the stopping acceleration?
- A) 0.937
- B) 1.07
- C) 0.878
- D) 1.14

____ 4) A car initially traveling at 60 km/h accelerates at a constant rate of 2.0 m/s^2. How much time is required for the car to reach a speed of 90 km/h?
- A) 15 s
- B) 30 s
- C) 45 s
- D) 4.2 s

____ 5) A cart starts from rest and accelerates uniformly at 4.0 m/s^2 for 5.0 s. It next maintains the velocity it has reached for 10 s. Then it slows down at a steady rate of 2.0 m/s^2 for 4.0 s. What is the final speed of the car?
- A) 20 m/s
- B) 16 m/s
- C) 12 m/s
- D) 10 m/s

Name: ________________________ **ID: A**

____ 6) A car travels at 15 m/s for 10 s. It then speeds up with a constant acceleration of 2.0 m/s^2 for 15 s. At the end of this time, what is its velocity?

A) 15 m/s
B) 30 m/s
C) 45 m/s
D) 375 m/s

____ 7) A cart with an initial velocity of 5.0 m/s to the right experiences a constant acceleration of 2.0 m/s^2 to the right. What is the cart's displacement during the first 6.0 s of this motion?

A) 10 m
B) 55 m
C) 66 m
D) 80 m

____ 8) A jet plane is launched from a catapult on an aircraft carrier. In 2.0 s it reaches a speed of 42 m/s at the end of the catapult. Assuming the acceleration is constant, how far did it travel during those 2.0 s?

A) 16 m
B) 24 m
C) 42 m
D) 84 m

____ 9) A car accelerates from 5.0 m/s to 21 m/s at a constant rate of 3.0 m/s^2. How far does it travel while accelerating?

A) 69 m
B) 207 m
C) 41 m
D) 117 m

____ 10) A car starts from rest and accelerates at a steady 6.00 m/s^2. How far does it travel in the first 3.00 s?

A) 9.00 m
B) 18.0 m
C) 27.0 m
D) 36.0 m
E) 54.0 m

ID: A

AP Conceptual - Kinematics - UAM Problems MC
Answer Section

1)	ANS: A	PTS: 1	REF: Var: 50+
2)	ANS: C	PTS: 1	REF: Var: 1
3)	ANS: B	PTS: 1	REF: Var: 1
4)	ANS: D	PTS: 1	REF: Var: 1
5)	ANS: C	PTS: 1	REF: Var: 1
6)	ANS: C	PTS: 1	REF: Var: 1
7)	ANS: C	PTS: 1	REF: Var: 1
8)	ANS: C	PTS: 1	REF: Var: 1
9)	ANS: A	PTS: 1	REF: Var: 50+
10)	ANS: C	PTS: 1	REF: Var: 1

Name: ________________________ **Class:** ___________________ **Date:** __________ **ID: A**

AP Kinematics - UAM MC 2

____ 1) Speed is
- A) a measure of how fast something is moving.
- B) always measured in terms of a unit of distance divided by a unit of time.
- C) the distance covered per unit time.
- D) all of the above.
- E) none of the above.

____ 2) A car is moving with a constant acceleration. At time $t = 5.0$ s its velocity is 8.0 m/s in the forward direction, and at time $t = 8.0$ s its velocity is 12.0 m/s forward. What is the distance traveled in that interval of time?
- A) 10 m
- B) 20 m
- C) 30 m
- D) 40 m
- E) 50 m

____ 3) Suppose you are in a car that is going around a curve. The speedometer reads a constant 30 miles per hour. Which of the following is NOT true?
- A) You and the car are accelerating.
- B) Your acceleration is constantly changing.
- C) Your velocity is constant.
- D) Your direction is constantly changing.
- E) Your speed is constant.

____ 4) When you look at the speedometer in a moving car, you can see the car's
- A) average distance traveled.
- B) instantaneous acceleration.
- C) average speed.
- D) instantaneous speed.
- E) average acceleration.

____ 5) An airplane starts from rest and accelerates at a constant 10.8 m/s^2. What is its speed at the end of a 400 m-long runway?
- A) 37.0 m/s
- B) 93.0 m/s
- C) 65.7 m/s
- D) 4320 m/s
- E) 186 m/s

____ 6) A train travels 6 meters in the first second of travel, 6 meters again during the second second of travel, and 6 meters again during the third second. Its acceleration is
- A) 0 m/s^2.
- B) 6 m/s^2.
- C) 12 m/s^2.
- D) 18 m/s^2.
- E) none of the above

Name: ________________________ **ID: A**

____ 7) A car starts from rest and after 7 seconds it is moving at 42 m/s. What is the car's average acceleration?
A) 0.17 m/s^2
B) 1.67 m/s^2
C) 6 m/s^2
D) 7 m/s^2
E) none of the above

____ 8) A car accelerates at 2 m/s^2. Assuming the car starts from rest, how much time does it need to accelerate to a speed of 20 m/s?
A) 2 seconds
B) 10 seconds
C) 20 seconds
D) 40 seconds
E) none of the above

____ 9) Acceleration is sometimes expressed in multiples of g, where $g = 9.8\ \mathrm{m/s^2}$ is the acceleration of an object due to the earth's gravity. In a car crash, the car's forward velocity may go from $29\ \mathrm{m/s}$ to $0\ \mathrm{m/s}$ in $0.15\ \mathrm{s}$. How many g's are experienced, on average, by the driver?
A) 20 g
B) 14 g
C) 24 g
D) 26 g

____ 10) An airplane needs to reach a forward velocity of $203.0\ \mathrm{km/h}$ to take off. On a $2000\text{-}\mathrm{m}$ runway, what is the minimum uniform acceleration necessary for the plane to take flight if it starts from rest?
A) 0.79 m/s^2
B) 0.87 m/s^2
C) 0.95 m/s^2
D) 1.0 m/s^2

____ 11) One possible unit of speed is
A) miles per hour.
B) light years per century.
C) kilometers per hour.
D) all of the above.
E) none of the above.

____ 12) A car is moving with a speed of 32.0 m/s. The driver sees an accident ahead and slams on the brakes, causing the car to slow down with a uniform acceleration of magnitude 3.50 m/s^2. How far does the car travel after the driver put on the brakes until it comes to a stop?
A) 4.57 m
B) 9.14 m
C) 112 m
D) 146 m
E) 292 m

ID: A

AP Kinematics - UAM MC 2
Answer Section

1)	ANS:	D	PTS:	1	DIF:	L2	OBJ:	4.2 Speed
	KEY:	speed | distance | time			BLM:	comprehension		
2)	ANS:	C	PTS:	1	REF:	Var: 1		
3)	ANS:	C	PTS:	1	DIF:	L2	OBJ:	4.3 Velocity | 4.4 Acceleration
	KEY:	velocity | constant | speedometer			BLM:	analysis		
4)	ANS:	D	PTS:	1	DIF:	L1	OBJ:	4.2 Speed
	KEY:	speedometer | speed			BLM:	knowledge		
5)	ANS:	B	PTS:	1	REF:	Var: 1		
6)	ANS:	A	PTS:	1	DIF:	L2	OBJ:	4.4 Acceleration
	KEY:	acceleration	BLM:	application				
7)	ANS:	C	PTS:	1	DIF:	L2	OBJ:	4.4 Acceleration
	KEY:	acceleration	BLM:	application				
8)	ANS:	B	PTS:	1	DIF:	L2	OBJ:	4.4 Acceleration
	KEY:	acceleration	BLM:	application				
9)	ANS:	A	PTS:	1	REF:	Var: 11		
10)	ANS:	A	PTS:	1	REF:	Var: 50+		
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	KEY:	speed | unit	BLM:	comprehension				
12)	ANS:	D	PTS:	1	REF:	Var: 1		

Name: ________________________ **Class:** ___________________ **Date:** __________ **ID: A**

AP Physics - Free-fall Conceptual MC

____ 1) When a ball is thrown straight up with no air resistance, the acceleration at its highest point
A) is upward
B) is downward
C) is zero
D) reverses from upward to downward
E) reverses from downward to upward

____ 2) A rock from a volcanic eruption is launched straight up into the air with no appreciable air resistance. Which one of the following statements about this rock while it is in the air is correct?
A) On the way up, its acceleration is downward and its velocity is upward, and at the highest point both its velocity and acceleration are zero.
B) On the way down, both its velocity and acceleration are downward, and at the highest point both its velocity and acceleration are zero.
C) Throughout the motion, the acceleration is downward, and the velocity is always in the same direction as the acceleration.
D) The acceleration is downward at all points in the motion.
E) The acceleration is downward at all points in the motion except that is zero at the highest point.

____ 3) A ball is thrown straight up, reaches a maximum height, then falls to its initial height. Which of the following statements about the direction of the velocity and acceleration of the ball as it is *going up* is correct?
A) Both its velocity and its acceleration point upward.
B) Its velocity points upward and its acceleration points downward.
C) Its velocity points downward and its acceleration points upward.
D) Both its velocity and its acceleration points downward.

____ 4) A 10-kg rock and a 20-kg rock are thrown upward with the same initial speed $v0$ and experience no significant air resistance. If the 10-kg rock reaches a maximum height h, what maximum height will the 20-kg ball reach?
A) $h/4$
B) $h/2$
C) h
D) $2h$
E) $4h$

____ 5) A 10-kg rock and 20-kg rock are dropped from the same height and experience no significant air resistance. If it takes the 20-kg rock a time T to reach the ground, what time will it take the 10-kg rock to reach the ground?
A) $4T$
B) $2T$
C) T
D) $T/2$
E) $T/4$

Name: ________________________ **ID: A**

____ 6) A 10-kg rock and a 20-kg rock are dropped at the same time and experience no significant air resistance. If the 10-kg rock falls with acceleration *a*, what is the acceleration of the 20-kg rock?
A) $4a$
B) $2a$
C) a
D) $a/2$
E) $a/4$

____ 7) Two objects are dropped from a bridge, an interval of 1.0 s apart. Air resistance is negligible. During the time that both objects continue to fall, their separation
A) increases.
B) decreases.
C) stays constant.
D) increases at first, but then stays constant.
E) decreases at first, but then stays constant.

____ 8) From the edge of a roof top you toss a green ball upwards with initial speed $v0$ and a blue ball downwards with the same initial speed. Air resistance is negligible. When they reach the ground below
A) the green ball will be moving faster than the blue ball.
B) the blue ball will be moving faster than the green ball.
C) the two balls will have the same speed.

____ 9) Ball A is dropped from the top of a building. One second later, ball B is dropped from the same building. Neglect air resistance. As time progresses, the difference in their speeds
A) increases.
B) remains constant.
C) decreases.
D) cannot be determined from the information given.

____ 10) Brick A is dropped from the top of a building. Brick B is thrown straight down from the same building, and neither one experiences appreciable air resistance. Which statement about their accelerations is correct?
A) The acceleration of A is greater than the acceleration of B.
B) The acceleration of B is greater than the acceleration of A.
C) The two bricks have exactly the same acceleration.
D) Neither brick has any acceleration once it is released.

ID: A

AP Physics - Free-fall Conceptual MC
Answer Section

1)	ANS: B	PTS: 1	REF: Var: 1
2)	ANS: D	PTS: 1	REF: Var: 1
3)	ANS: B	PTS: 1	REF: Var: 1
4)	ANS: C	PTS: 1	REF: Var: 1
5)	ANS: C	PTS: 1	REF: Var: 1
6)	ANS: C	PTS: 1	REF: Var: 1
7)	ANS: A	PTS: 1	REF: Var: 1
8)	ANS: C	PTS: 1	REF: Var: 1
9)	ANS: B	PTS: 1	REF: Var: 1
10)	ANS: C	PTS: 1	REF: Var: 1

AP Physics **Name:**

Free Fall In class work **Date:**

1. On another planet a ball is dropped and falls 10 meters in 4 seconds. Assuming uniform acceleration, what is the acceleration neglecting air resistance?

   A) 0.625 m/s^2 B) 1.25 m/s^2 C) 2.5 m/s^2 D) 5 m/s^2 E) 10 m/s^2

2. Object A and B are near the surface of the moon. When object A is released from rest, it falls a distance d in 2.0 seconds. Object B is twice the mass of object A. How far would object B fall in 1.0 second if released from rest?

   A) $\frac{1}{8}d$ B) $\frac{1}{4}d$ C) $\frac{1}{2}d$ D) d E) $2d$

3. A softball is thrown straight up, reaching a maximum height of 20 meters. Neglecting air resistance, the vertical speed of the ball when it hits the ground is

   A) 10 m/s B) 15 m/s C) 20 m/s D) 30 m/s E) 40 m/s

4. An object is dropped of a cliff with a height of 8 m. When the rock has been falling for 4 m, its velocity is most nearly

   A) 9 m/s B) 12 m/s C) 18 m/s D) 80 m/s E) 320 m/s

AP Physics **Name:**

Free Fall In class work **Date:**

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   A) 9 m/s B) 12 m/s C) 18 m/s D) 80 m/s E) 320 m/s

Answer Key

Free Fall In Class

1. **B**
2. **B**
3. **C**
4. **A**