Physics 11
Kinematics Retest 2 Solutions

	a.	b.	c.	d.
1.	X			
2.	X			
3.		X		
4.	X			
5.		X		
6.				X
7.		X		
8.			X	
9.			X	
10.		X		
11.			X	
12.			X	
13.				X
14.	X			
15.	X	X	X	X
16.				X
17.			X	
18.		X		
19.			X	
20.	X			
21.		X		
22.			X	
23.		X		
24.	X			
25.		X		

1. **Problem**
   True or false? When a ball is thrown straight up, its velocity at the top is zero.

   a. True
   b. False

   Solution
   True. The velocity must be zero for an instant at the top as the velocity changes from up to down.

2. **Problem**
   True or false? The area under a velocity-time graph is the displacement.

   a. True
   b. False

   Solution
   True.

3. **Problem**
   True or false? If an object is moving to the right, then its acceleration must also be to the right.

   a. True
   b. False

   Solution
   False. An object that is moving to the right at a constant speed has zero acceleration and an object that is moving right and slowing down has a leftward acceleration.

4. **Problem**
   True or false? If the position-time graph of an object is a horizontal line, then the object must be at rest.

   a. True
   b. False

   Solution
   True. The slope of the position time graph is the object's velocity and the slope of a horizontal line is zero. Therefore, the object must have a velocity of zero and be at rest.

5. **Problem**
   True or false? When you throw a ball over to your friend, the ball's velocity is zero when it reaches its maximum height.

   a. True
   b. False

   Solution
   False. The vertical velocity is zero at the maximum height, but the horizontal velocity is not.

6. **Problem**
   An object is moving to the left and speeding up. Which choice best describes its velocity and acceleration? (Assume right is positive.)

   a. velocity is positive; acceleration is negative.
   b. velocity is negative; acceleration is positive.
   c. velocity and acceleration are both positive.
   d. velocity and acceleration are both negative.

   Solution
   Velocity is positive if the object is moving to the right.
   Velocity is negative if the object is moving to the left.
   Acceleration is positive if the object is moving to the right and speeding up or moving to the left and slowing down.
   Acceleration is negative if the object is moving to the right and slowing down or moving to the left and speeding up.

7. **Problem**
   Suppose that several projectiles are launched. Which one will be in the air for the longest time?

   a. The one with the furthest horizontal range.
   b. The one with the greatest maximum height.
   c. The one with the greatest initial speed.
   d. None of the above.

   Solution
   Since horizontal and vertical motions can be analyzed separately, only the vertical motion matters for the longest air time. The projectile with the greatest maximum height will stay up in the air for the longest time.

8. **Problem**
   A car traveling at speed v is able to stop in a distance d. Assuming the same constant acceleration, what distance does this car require to stop when it is traveling at speed $4v$?

   a. $4d$
   b. d
   c. $16d$
   d. $\sqrt{4}d$

   Solution
   Solve $v_f^2 = v_i^2 + 2ad$ for d and set $v_f = 0$ to get

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

   Therefore, the braking distance is proportional to the square of the initial velocity. If the initial velocity is multiplied by 4, then the car would need 4^2 times the distance to stop.

9. **Problem**
   The gravitational acceleration on Mars is about one-third of that on Earth. If you hit a baseball on Mars with the same speed and angle that you do on Earth, the ball would land

   a. 1/9 times as far
   b. 1/3 times as far
   c. 3 times as far
   d. 9 times as far

   Solution
   The hang time of the ball can be calculated from the formula $v_f = v_i + at$ with $v_f = -v_i$.

$$t = -\frac{2v_i}{a}$$

   On Earth, the time is $t_{Earth} = -2v_i/g_{Earth}$. On Mars, $g_{Mars} = g_{Earth}/3$ so

$$t_{Mars} = -\frac{2v_i}{g_{Earth}/3} = 3 \times \frac{-2v_i}{g_{Earth}} = 3t_{Earth}$$

   The ball is in the air 3 times longer on Mars than on Earth. Since the horizontal velocity is the same, the ball will travel 3 times as far.

10. **Problem**
   The gravitational acceleration on the Moon is about one-sixth of that on Earth. If you throw a baseball straight up with the same speed on the Moon as you do on Earth, the ball would be in the air for

   a. the same amount of time as on Earth.
   b. 6 times longer than on Earth
   c. 12 times longer than on Earth
   d. 36 times longer than on Earth

   Solution
   The hang time of the ball can be calculated from the formula $v_f = v_i + at$ with $v_f = -v_i$.

$$t = -\frac{2v_i}{a}$$

   On Earth, the time is $t_{Earth} = -2v_i/g_{Earth}$. On the Moon, $g_{Moon} = g_{Earth}/6$ so

$$t_{Moon} = -\frac{2v_i}{g_{Earth}/6} = 6 \times \frac{-2v_i}{g_{Earth}} = 3t_{Earth}$$

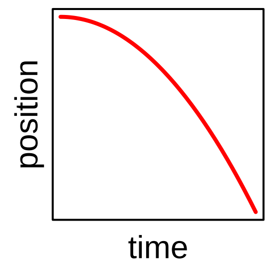
   The ball would be in the air 6 times longer on the Moon than on Earth.

11. **Problem**
   What is the magnitude of the slope of a position-time graph?

   a. pace
   b. acceleration
   c. speed
   d. distance

   Solution
   The magnitude of the slope of a position-time graph is the speed of the object.

12. **Problem**
Which choice best matches the given position-time graph?

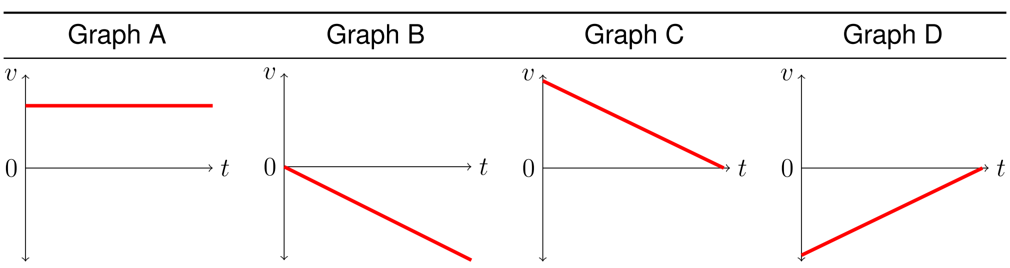


a. moving to the right and speeding up.
b. moving to the right and slowing down.
c. moving to the left and speeding up.
d. moving to the left and slowing down.

Solution
The object is moving to the right if its position is increasing and moving to the left if its position is decreasing. The object is speeding up if the tangent line is becoming more vertical and slowing down if the tangent line is becoming more horizontal.

This graph describes an object that is moving to the left and speeding up.

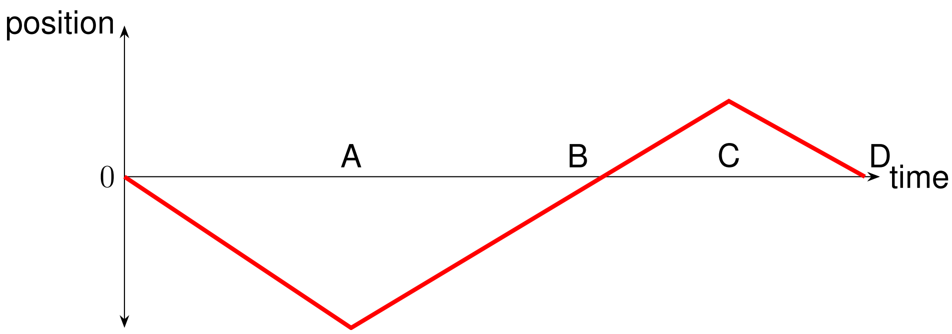
13. **Problem**
Which velocity-time graph represents motion with constant positive acceleration?



a. Graph A
b. Graph B
c. Graph C
d. Graph D

Solution
Acceleration is the slope of the velocity-time graph. Therefore, the correct answer is the graph with the positive slope. Note that for positive acceleration it does not matter if the velocity is always negative as long as the slope is positive.

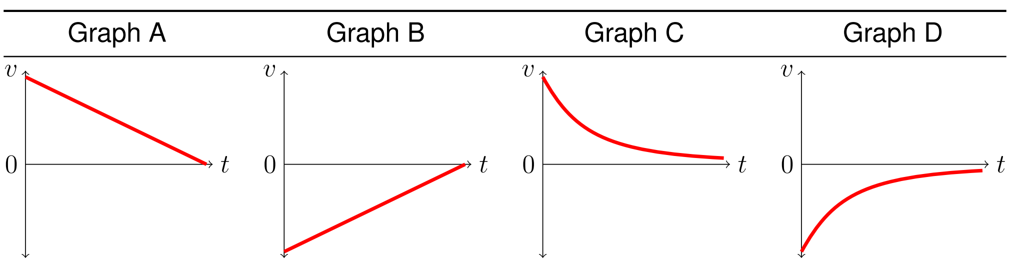
14. **Problem**
The motion of an object is described by the following position-time graph. At which point in time is the magnitude of the object's displacement at a maximum?



a. Point A
b. Point B
c. Point C
d. Point D

Solution
The displacement is maximum when the position is furthest away from the starting position.

15. **Problem**
Which velocity-time graphs represent the motion of an object that is slowing down? *Select all that apply.*



a. Graph A
b. Graph B
c. Graph C
d. Graph D

Solution
Slowing down is represented by a line approaching the time axis on a velocity-time graph.

16. **Problem**
Suppose an object travels at a constant velocity of $54.0\,\mathrm{km/h}$. What distance would it travel in $19.0\,\mathrm{minutes}$?

a. 3.99 km
b. 8.32 km
c. 16.1 km
d. 17.1 km

Solution
Use the formula for constant velocity motion making sure to convert to the proper units.

$$d = vt = (54.0\,\mathrm{km/h})(19.0\,\mathrm{min})\left(\frac{1\,\mathrm{h}}{60\,\mathrm{min}}\right) = 17.1\,\mathrm{km}$$

17. **Problem**
An F1 car accelerates from 0 to 60 miles per hour in $2.71\,\mathrm{s}$. What is the acceleration of the car in SI units? $(1\,\mathrm{mile} = 1609.34\,\mathrm{m})$

 a. $22.1\,\mathrm{m/s^2}$
 b. $14.9\,\mathrm{m/s^2}$
 c. $9.9\,\mathrm{m/s^2}$
 d. $20.9\,\mathrm{m/s^2}$

Solution
First, convert 60 mph to m/s.

$$60\,\mathrm{mph} \times \frac{1609.34\,\mathrm{m}}{1\,\mathrm{mi}} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} = 26.8223\,\mathrm{m/s}$$

Then, divide by the time.

$$a = \frac{v_f - v_i}{t} = \frac{26.8223\,\mathrm{m/s} - 0}{2.71\,\mathrm{s}} = 9.9\,\mathrm{m/s^2}$$

18. **Problem**
A car accelerates from 39 km/h to 110 km/h, at an average rate of $2\,\mathrm{m/s^2}$. How much time does it take to complete this speed increase?

 a. 44.8 s
 b. 9.86 s
 c. 35.5 s
 d. 4.96 s

Solution
First, convert the speeds from km/h to m/s.

$$v_i = 39\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 10.8\,\mathrm{m/s}$$
$$v_f = 110\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 30.6\,\mathrm{m/s}$$

Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{30.6\,\mathrm{m/s} - 10.8\,\mathrm{m/s}}{2\,\mathrm{m/s^2}} = 9.86\,\mathrm{s}$$

19. **Problem**
How many seconds would it take the Sun's light to reach Earth? The speed of light in vacuum is 3.00×10^8 m/s. The Sun is 1.5×10^{11} m from the Earth.

    a. 0 s
    b. 2.0×10^{-3} s
    c. 5.0×10^2 s
    d. 4.5×10^{19} s

Solution
Use the formula for constant velocity motion.

$$t = \frac{d}{v} = \frac{1.5 \times 10^{11}\,\mathrm{m}}{3 \times 10^8\,\mathrm{m/s}} = 5.0 \times 10^2\,\mathrm{s}$$

20. **Problem**
A light-year (ly) is the distance that light travels in vacuum in one year.
The speed of light is 3.00×10^8 m/s. How many miles are there in a light-year?
($1\,\mathrm{mile} = 1.609 \times 10^3\,\mathrm{m}$, $1\,\mathrm{year} = 365\,\mathrm{days}$)

    a. 5.88×10^{12} mi
    b. 9.46×10^{12} mi
    c. 5.88×10^{15} mi
    d. 9.46×10^{15} mi

Solution
Use the formula for constant velocity motion and convert to the desired units.

$$(1\,\mathrm{yr})\left(\frac{365\,\mathrm{days}}{1\,\mathrm{yr}}\right)\left(\frac{24\,\mathrm{h}}{1\,\mathrm{day}}\right)\left(\frac{60\,\mathrm{min}}{1\,\mathrm{h}}\right)\left(\frac{60\,\mathrm{s}}{1\,\mathrm{min}}\right) = 3.1536 \times 10^7\,\mathrm{s}$$

$$d = vt = (3.00 \times 10^8\,\mathrm{m/s})(3.1536 \times 10^7\,\mathrm{s}) = 9.4608 \times 10^{15}\,\mathrm{m}$$
$$(9.4608 \times 10^{15}\,\mathrm{m})\left(\frac{1\,\mathrm{mi}}{1.609 \times 10^3\,\mathrm{m}}\right) = 5.88 \times 10^{12}\,\mathrm{mi}$$

21. **Problem**
A ball is thrown straight up with an initial velocity of 15.5 m/s. How long does it take the ball to return to its starting point? Assume that the ball is thrown on the surface of the Earth and that it is undergoing constant acceleration due to gravity (ignore air resistance).

    a. 5.65 s
    b. 3.16 s
    c. 4.06 s
    d. 0.59 s

Solution
Use the formula for constant acceleration motion using $a = g = -9.8\,\mathrm{m/s^2}$. Also, since the motion is

symmetric, the final speed is equal to the initial speed (but the velocity points in the opposite direction) so $v_f = -v_i$.

$$t = \frac{v_f - v_i}{a} = \frac{-v_i - v_i}{g} = \frac{-15.5\,\mathrm{m/s} - 15.5\,\mathrm{m/s}}{-9.8\,\mathrm{m/s^2}} = 3.16\,\mathrm{s}$$

22. **Problem**
What is the maximum height reached by a ball thrown straight up with an initial velocity of 23 m/s? Assume that the ball is thrown on the surface of the Earth and that it undergoes constant acceleration due to gravity (ignore air resistance).

  a. 52.9 m
  b. 44.8 m
  c. 27 m
  d. 24.6 m

Solution
Use the formula $v_f^2 = v_i^2 + 2ad$ with $a = g = -9.8\,\mathrm{m/s^2}$ and $v_f = 0$ (the velocity of the ball at its maximum height is zero). Solve for d:

$$d = \frac{-v_i}{2a} = \frac{-23\,\mathrm{m/s}}{2(-9.8\,\mathrm{m/s^2})} = 27\,\mathrm{m}$$

23. **Problem**
A person throws a rock horizontally, with an initial velocity of 16.1 m/s, from a bridge. It falls 2.73 m to the water below. How far does it travel horizontally before striking the water?

  a. 6.5 m
  b. 12 m
  c. 7.5 m
  d. 10.1 m

Solution
First analyze the vertical motion to find the time it takes the rock to hit the water using the formula $d = \frac{1}{2}at^2$

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(2.73\,\mathrm{m})}{9.8\,\mathrm{m/s^2}}} = 0.746\,42\,\mathrm{s}$$

Then, use the time to figure out how far the rock travels horizontally (recall that the horizontal velocity is constant).

$$d_x = v_x t = (16.1\,\mathrm{m/s})(0.746\,42\,\mathrm{s}) = 12\,\mathrm{m}$$

24. **Problem**
A golf ball is hit with an initial velocity of 18 m/s at an angle of 23° above the horizontal. What is its range (horizontal distance before hitting the ground)? Ignore air resistance and assume a flat golf course.

    a. 24 m
    b. 13 m
    c. 19 m
    d. 21 m

    Solution
First, analyze the vertical motion to find the time it takes the ball to hit the ground using the formula $v_f = v_i + at$ with $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(18\,\mathrm{m/s})\sin(23°)}{-9.8\,\mathrm{m/s^2}} = 1.435\,338\,8\,\mathrm{s}$$

Then, use the time to figure out how far the ball travels horizontally (recall that the horizontal velocity is constant).

$$d_x = v_x t = (18\,\mathrm{m/s})(\cos(23°))(1.435\,338\,8\,\mathrm{s}) = 23.8\,\mathrm{m}$$

25. **Problem**
A ball tossed straight up returns to its starting point in 7.57 s. What was its initial speed? Ignore air resistance.

    a. 35.2 m/s
    b. 37.1 m/s
    c. 31.6 m/s
    d. 19.3 m/s

    Solution
The final velocity is equal to the initial velocity, but in the opposite direction ($v_f = -v_i$). Substitute this into the equation $v_f = v_i + at$ and solve for vi:

$$-v_i = v_i + at$$
$$-2v_i = at$$
$$vi = -\frac{at}{2} = -\frac{(-9.8\,\mathrm{m/s^2})(7.57\,\mathrm{s})}{2} = 37.1\,\mathrm{m/s}$$