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? The area under a velocity-time graph is the displacement.

   a. True
   b. False

   Solution
   True.

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

   a. True
   b. False

   Solution
   True. The direction of velocity is always the same as the direction of motion.

3. **Problem**
   True or false? If an object changes direction, then the line on its velocity-time graph must have a changing slope.

   a. True
   b. False

   Solution
   False. An object that changes direction is represented by a line that crosses the time axis in a velocity-time graph.

4. **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.

5. **Problem**
   True or false? If the velocity vector and the acceleration vector both point in the same direction, then the object must be speeding up.

   a. True
   b. False

   Solution
   True. Acceleration is the change in velocity over time. If acceleration is in the same direction as velocity, then the velocity vector must be increasing and the object must be speeding up.

6. **Problem**
   Ball 1 is dropped from the top of a building. One second later, ball 2 is dropped from the same building. If air resistance can be ignored, then as time progresses (and while the balls are still in free fall), the distance between them

   a. increases.
   b. remains constant.
   c. decreases.
   d. cannot be determined from the given information.

   Solution
   The distance between the two balls increases over time since distance increases with time squared when acceleration is constant. Using the distance formula for constant acceleration, we see that

   $$\Delta d = d_1 - d_2 = \frac{1}{2}g(t_1^2 - t_2^2) = \frac{1}{2}g(t_1 - t_2)(t_1 + t_2)$$

   So even though $(t_1 - t_2)$ will remain constant at 1 second, $(t_1 + t_2)$ increases as time progresses.

7. **Problem**
   Ball 1 is dropped from the top of a building. One second later, ball 2 is dropped from the same building. If air resistance can be ignored, then as time progresses (and while the balls are still in free fall), the difference in their speeds

   a. increases.
   b. remains constant.
   c. decreases.
   d. cannot be determined from the given information.

   Solution
   Since both balls are accelerating at the same rate, the difference in their velocities will remain constant. Using the formula $v_f = v_i + at$, with $a = g$ and $v_i = 0$, we see that

   $$\Delta v = v_1 - v_2 = gt_1 - gt_2 = g(t_1 - t_2)$$

   and both $g = 9.8\,\mathrm{m/s^2}$ and $(t_1 - t_2) = 1$ s remain constant.

   Note that if air resistance is an important factor, then the difference would change until both balls are falling at their terminal velocity.

8. **Problem**
   Which of the following is an accurate statement about motion with constant acceleration?

   a. In equal times, speed increases by equal amounts.
   b. In equal times, displacement changes by equal amounts.
   c. In equal times, velocity changes by equal amounts.
   d. In equal times, acceleration changes by equal amounts.

   Solution
   Acceleration is the change in velocity over time. If acceleration is constant, then the velocity changes by equal amounts in equal times.

9. **Problem**
   An object is moving to the left and slowing down. 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.

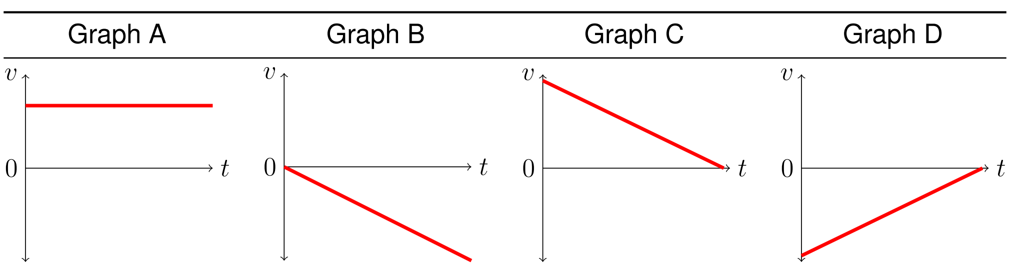
   Solution
   Velocity is positive if the object is moving to the right.
   Velocity is negative if the object is moving to the left.
   Acceleration is positive if the object is moving to the right and speeding up or moving to the left and slowing down.
   Acceleration is negative if the object is moving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

10. **Problem**
    You hit a volley ball over the net. When the ball reaches its maximum height, its speed is

    a. zero.
    b. less than its initial speed.
    c. equal to its initial speed.
    d. greater than its initial speed.

    Solution
    The vertical velocity is zero at the top while the horizontal velocity remains constant throughout. Therefore, the total speed at the top is less than the initial speed, but not zero.

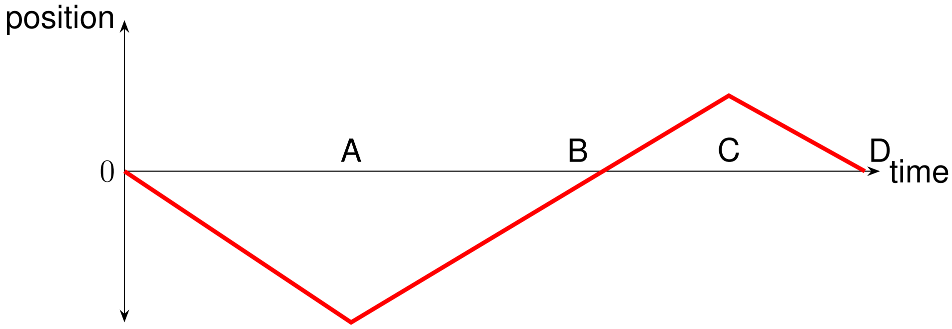
11. **Problem**
    Which velocity-time graph represents motion with constant positive acceleration?



    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.

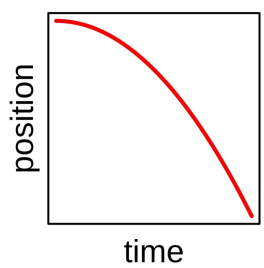
12. **Problem**
The motion of an object is described by the following position-time graph. At which point in time is the magnitude of the object's displacement at a maximum?



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.

13. **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.

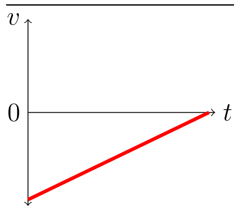
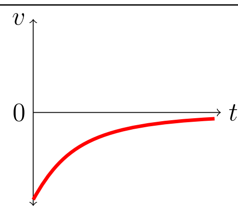
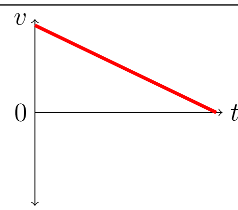
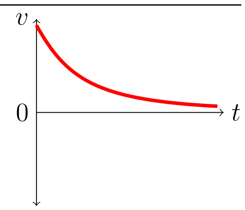
This graph describes an object that is moving to the left and speeding up.

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

    a. distance
    b. displacement
    c. velocity
    d. speed

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

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

Graph A	Graph B	Graph C	Graph D
			

    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**
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.

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

17. **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?
$(1\,\text{mile} = 1.609 \times 10^3\,\text{m},\ 1\,\text{year} = 365\,\text{days})$

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.

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

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

18. **Problem**
A car travels 49 km at 47 km/h and 172 km at 82 km/h. What is the average speed for this trip?

a. 70 km/h
b. 80 km/h
c. 68 km/h
d. 72 km/h

Solution
The average speed is the total distance divided by the total time.

$$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{d_1 + d_2}{d_1/v_1 + d_2/v_2} = \frac{49\,\text{km} + 172\,\text{km}}{\frac{49\,\text{km}}{47\,\text{km/h}} + \frac{172\,\text{km}}{82\,\text{km/h}}} = 70\,\text{km/h}$$

19. **Problem**
A car accelerates from 31 km/h to 103 km/h, at an average rate of 3 m/s^2. How much time does it take to complete this speed increase?

a. 24 s
b. 48.2 s
c. 5.6 s
d. 6.67 s

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

$$v_i = 31\,\text{km/h} \times \frac{1\,\text{h}}{3600\,\text{s}} \times \frac{1000\,\text{m}}{1\,\text{km}} = 8.61\,\text{m/s}$$

$$v_f = 103\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 28.6\,\mathrm{m/s}$$

Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{28.6\,\mathrm{m/s} - 8.61\,\mathrm{m/s}}{3\,\mathrm{m/s^2}} = 6.67\,\mathrm{s}$$

20. **Problem**
An F1 car accelerates from 0 to 60 miles per hour in $2.59\,\mathrm{s}$. What is the acceleration of the car in SI units? $(1\,\mathrm{mile} = 1609.34\,\mathrm{m})$

  a. $7.21\,\mathrm{m/s^2}$
  b. $10.4\,\mathrm{m/s^2}$
  c. $23.2\,\mathrm{m/s^2}$
  d. $9.15\,\mathrm{m/s^2}$

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.

$$a = \frac{v_f - v_i}{t} = \frac{26.8223\,\mathrm{m/s} - 0}{2.59\,\mathrm{s}} = 10.4\,\mathrm{m/s^2}$$

21. **Problem**
A golf ball is hit with an initial velocity of 53 m/s at an angle of 80° above the horizontal. What is its range (horizontal distance before hitting the ground)? Ignore air resistance and assume a flat golf course.

  a. 115 m
  b. 104 m
  c. 105 m
  d. 98 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 $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(53\,\mathrm{m/s})\sin(80^\circ)}{-9.8\,\mathrm{m/s^2}} = 10.652\,002\,2\,\mathrm{s}$$

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

$$d_x = v_x t = (53\,\mathrm{m/s})(\cos(80^\circ))(10.652\,002\,2\,\mathrm{s}) = 98\,\mathrm{m}$$

22. **Problem**
A ball tossed straight up returns to its starting point in 3 s. What was its initial speed? Ignore air resistance.

    a. 18.5 m/s
    b. 22 m/s
    c. 15.8 m/s
    d. 14.7 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:

$$-v_i = v_i + at$$
$$-2v_i = at$$
$$vi = -\frac{at}{2} = -\frac{(-9.8\,\mathrm{m/s^2})(3\,\mathrm{s})}{2} = 14.7\,\mathrm{m/s}$$

23. **Problem**
What is the maximum height reached by a ball thrown straight up with an initial velocity of 19.6 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. 19.6 m
    b. 24 m
    c. 19 m
    d. 17.5 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:

$$d = \frac{-v_i}{2a} = \frac{-19.6\,\mathrm{m/s}}{2(-9.8\,\mathrm{m/s^2})} = 19.6\,\mathrm{m}$$

24. **Problem**
A person throws a rock horizontally, with an initial velocity of 25.7 m/s, from a bridge. It falls 6.2 m to the water below. How far does it travel horizontally before striking the water?

    a. 28.7 m
    b. 22 m
    c. 28.9 m
    d. 17.9 m

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

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(6.2\,\mathrm{m})}{9.8\,\mathrm{m/s^2}}} = 1.124\,858\,3\,\mathrm{s}$$

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

$$d_x = v_x t = (25.7\,\mathrm{m/s})(1.124\,858\,3\,\mathrm{s}) = 28.9\,\mathrm{m}$$

25. **Problem**
A ball is thrown straight up with an initial velocity of 38.1 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. 0.91 s
b. 7.78 s
c. 1.49 s
d. 4.84 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 $v_f = -v_i$.

$$t = \frac{v_f - v_i}{a} = \frac{-v_i - v_i}{g} = \frac{-38.1\,\mathrm{m/s} - 38.1\,\mathrm{m/s}}{-9.8\,\mathrm{m/s^2}} = 7.78\,\mathrm{s}$$