Physics 11
Kinematics Retest 3 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	X	X	X
15.			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? 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.

2. **Problem**
   True or false? An object which is slowing down is represented on a velocity-time graph by a line with a negative slope.

   a. True
   b. False

   Solution
   False. An object that starts with a negative velocity is speeding up if the velocity-time graph has a negative slope. On a velocity-time graph, slowing down is represented by a line that gets closer to the time axis.

3. **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.

4. **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.

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

   a. True
   b. False

   Solution
   False. Unless the horizontal line is on the time axis, the object is moving with constant velocity.

6. **Problem**
   A football is kicked with a velocity of 25 m/s at an angle of 45° above the horizontal. What is the vertical component of its acceleration as it travels along its trajectory? (Ignore air resistance.)

   a. $g\sin(45^\circ)$ upward
   b. $g\sin(45^\circ)$ downward
   c. g upward
   d. g downward

   Solution
   For projectile motion on Earth, the acceleration is always g downward.

7. **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.

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 $7v$?

   a. $7d$
   b. $\sqrt{7}d$
   c. $49d$
   d. 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 7, then the car would need 7^2 times the distance to stop.

9. **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.

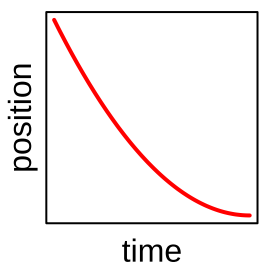
10. **Problem**
    Which of the following are scalars? *Select all that apply.*

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

    Solution
    A scalar quantity is fully described by magnitude only. A vector quantity is fully described by both magnitude and direction. Distance, speed, and time are scalars. Acceleration, displacement, and velocity are vectors.

    a. vector
    b. vector
    c. scalar
    d. vector

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



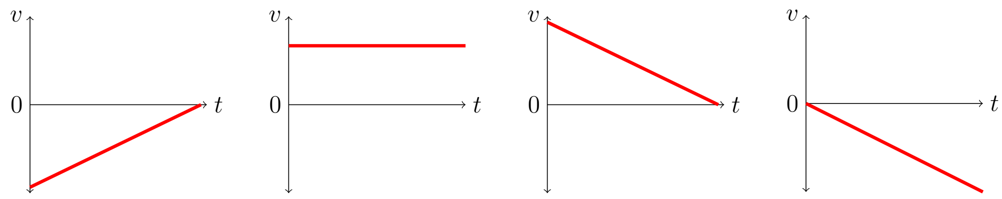
    a. moving to the right and speeding up.
    b. moving to the right and slowing down.
    c. moving to the left and speeding up.
    d. moving to the left and slowing down.

    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 slowing down.

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

Graph A	Graph B	Graph C	Graph D

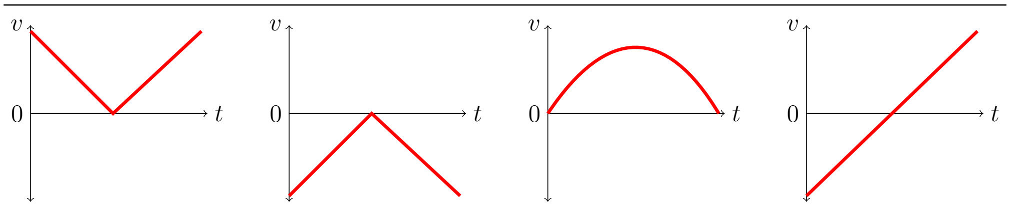


a. Graph A
b. Graph B
c. Graph C
d. Graph D

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.

13. **Problem**
Which velocity-time graph represents the motion of an object that changes its direction?

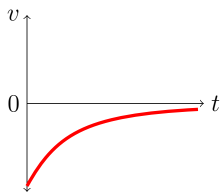
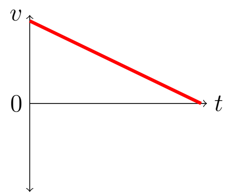
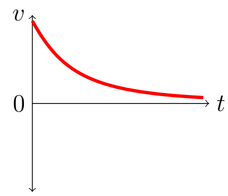
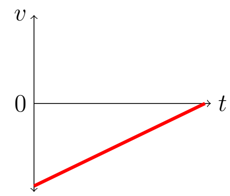
Graph A	Graph B	Graph C	Graph D



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

Solution
Changing direction on a velocity-time graph is represented by a line that crosses the time axis.

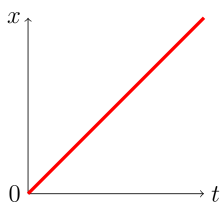
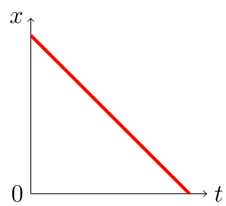
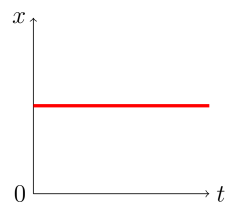
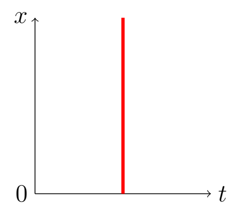
14. **Problem**
Which velocity-time graphs represent the motion of an object that is slowing down? *Select all that apply.*

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.

15. **Problem**
Which position-time graph represents an object at rest?

Graph A	Graph B	Graph C	Graph D
			

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

Solution
An object at rest has zero velocity so the slope of its position-time graph must have a slope of zero (horizontal line).

16. **Problem**
A car travels 36 km at 44 km/h and 226 km at 92 km/h. What is the average speed for this trip?

a. 80 km/h
b. 91 km/h
c. 74 km/h
d. 89 km/h

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

$$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{d_1 + d_2}{d_1/v_1 + d_2/v_2} = \frac{36\,\mathrm{km} + 226\,\mathrm{km}}{\frac{36\,\mathrm{km}}{44\,\mathrm{km/h}} + \frac{226\,\mathrm{km}}{92\,\mathrm{km/h}}} = 80\,\mathrm{km/h}$$

17. **Problem**
A runner completes a marathon (42.195 km) with an average pace of 3 minutes and 57 seconds per kilometre. What is the runner's time for the marathon? (Answers are formatted as hours:minutes:seconds)

   a. 02:46:40
   b. 03:21:32
   c. 01:45:36
   d. 02:13:49

Solution
First, calculate the speed in kilometres per second.

$$v = \frac{1\,\mathrm{km}}{180\,\mathrm{s} + 57\,\mathrm{s}} = 0.004\,219\,4\,\mathrm{km/s}$$

Then, calculate the time using the formula for constant velocity motion.

$$t = \frac{d}{v} = \frac{42.195\,\mathrm{km}}{0.004\,219\,4\,\mathrm{km/s}} = 10\,000\,\mathrm{s}$$

Finally, convert the number of seconds into hours, minutes, and seconds. (60 s = 1 minute and 60 minutes = 1 hour)

$$10\,000\,\mathrm{s} = 2\,\mathrm{hours}, 46\,\mathrm{minutes}, 40\,\mathrm{seconds}$$

18. **Problem**
A particle initially moving with a velocity of 2 m/s in the x-direction experiences a constant acceleration of 1 m/s^2 in the x-direction and –2 m/s^2 in the y-direction. What are the velocity components of the particle after 4 s?

   a. $v_x = 6\,\mathrm{m/s}, v_y = -8\,\mathrm{m/s}$
   b. $v_x = 3\,\mathrm{m/s}, v_y = -2\,\mathrm{m/s}$
   c. $v_x = -6\,\mathrm{m/s}, v_y = 4\,\mathrm{m/s}$
   d. $v_x = 4\,\mathrm{m/s}, v_y = -8\,\mathrm{m/s}$

Solution
The velocities can be calculated separately.

$$v_x = 2\,\mathrm{m/s} + (1\,\mathrm{m/s^2})(4\,\mathrm{s}) = 6\,\mathrm{m/s}$$
$$v_y = 0\,\mathrm{m/s} + (-2\,\mathrm{m/s^2})(4\,\mathrm{s}) = 8\,\mathrm{m/s}$$

19. **Problem**
Suppose an object travels at a constant velocity of 7.51 m/s. How much time would it take for the object to travel a distance of 51.5 m?

a. 387 s
b. 66 s
c. 0.15 s
d. 6.86 s

Solution
Use the formula for constant velocity motion.

$$t = \frac{d}{v} = \frac{51.5\,\mathrm{m}}{7.51\,\mathrm{m/s}} = 6.86\,\mathrm{s}$$

20. **Problem**
A car accelerates from 30 km/h to 100 km/h, at an average rate of 1 m/s^2. How much time does it take to complete this speed increase?

a. 37.4 s
b. 19.4 s
c. 38.6 s
d. 3.08 s

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

$$v_i = 30\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 8.33\,\mathrm{m/s}$$
$$v_f = 100\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 27.8\,\mathrm{m/s}$$

Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{27.8\,\mathrm{m/s} - 8.33\,\mathrm{m/s}}{1\,\mathrm{m/s^2}} = 19.4\,\mathrm{s}$$

21. **Problem**
What is the maximum height reached by a ball thrown straight up with an initial velocity of 27.7 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. 39.1 m
b. 20.6 m
c. 36.1 m
d. 25.4 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:

$$d = \frac{-v_i}{2a} = \frac{-27.7\,\mathrm{m/s}}{2(-9.8\,\mathrm{m/s^2})} = 39.1\,\mathrm{m}$$

22. **Problem**
A ball is thrown straight up with an initial velocity of 18.8 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. 2.23 s
    b. 0.41 s
    c. 2.39 s
    d. 3.84 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 $v_f = -v_i$.

$$t = \frac{v_f - v_i}{a} = \frac{-v_i - v_i}{g} = \frac{-18.8\,\mathrm{m/s} - 18.8\,\mathrm{m/s}}{-9.8\,\mathrm{m/s^2}} = 3.84\,\mathrm{s}$$

23. **Problem**
A person throws a rock horizontally, with an initial velocity of 39.1 m/s, from a bridge. It falls 6.32 m to the water below. How far does it travel horizontally before striking the water?

    a. 35 m
    b. 43.8 m
    c. 31.3 m
    d. 44.4 m

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

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(6.32\,\mathrm{m})}{9.8\,\mathrm{m/s^2}}} = 1.135\,691\,8\,\mathrm{s}$$

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

$$d_x = v_x t = (39.1\,\mathrm{m/s})(1.135\,691\,8\,\mathrm{s}) = 44.4\,\mathrm{m}$$

24. **Problem**
A person throws a rock straight down from a bridge with an initial speed of 10.6 m/s. It falls 12.7 m to the water below. How much time does it take for the rock to hit the water?

a. 0.55 s
b. 1.04 s
c. 0.86 s
d. 0.63 s

Solution
Use the quadratic formula to solve the equation $h = \frac{1}{2}gt^2 + v_i t$ for t.

$$\frac{1}{2}gt^2 + v_i t - h = 0$$

$$a = \frac{1}{2}g = \frac{1}{2}(9.8\,\mathrm{m/s^2}) = 4.9\,\mathrm{m/s^2}, b = v_i = 10.6\,\mathrm{m/s}, c = -h = -12.7\,\mathrm{m}$$

$$t = \frac{-b + \sqrt{b^2 - 4ac}}{2a} = 0.86\,\mathrm{s}$$

25. **Problem**
A golf ball is hit with an initial velocity of 34 m/s at an angle of 51 ° 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. 149 m
c. 151 m
d. 78 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 $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(34\,\mathrm{m/s})\sin(51°)}{-9.8\,\mathrm{m/s^2}} = 5.392\,441\,4\,\mathrm{s}$$

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

$$d_x = v_x t = (34\,\mathrm{m/s})(\cos(51°))(5.392\,441\,4\,\mathrm{s}) = 115\,\mathrm{m}$$