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? 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? 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.

4. **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.

5. **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.

6. **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. d
   b. $49d$
   c. $\sqrt{7}d$
   d. $7d$

   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.

7. **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.

8. **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.

9. **Problem**
   An object is moving to the right 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.

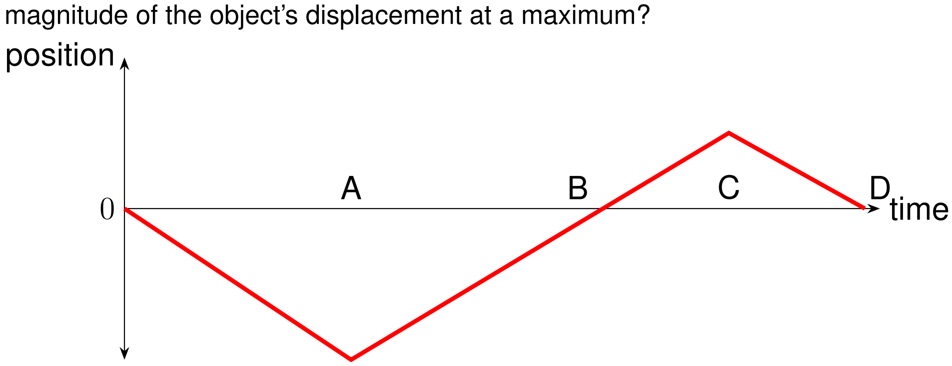
   Solution
   Velocity is positive if the object is moving to the right.
   Velocity is negative if the object is moving to the left.
   Acceleration is positive if the object is moving to the right and speeding up or moving to the left and slowing down.
   Acceleration is negative if the object is moving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

10. **Problem**
    Which has the greater acceleration: a car that increases its speed from 50 to 60 km/h, or a bike that goes from 0 to 10 km/h in the same time?

    a. The car has the greater acceleration.
    b. The bike has the greater acceleration.
    c. The car and the bike have the same acceleration.
    d. Not enough information given to determine the answer.

    Solution
    Acceleration is the change in velocity over time. The change in velocity is the same (+10 km/h) in both cases. Therefore, both the car and the bike have the same acceleration.

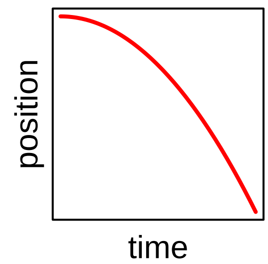
11. **Problem**
    The motion of an object is described by the following position-time graph. At which point in time is the magnitude of the object's displacement at a maximum?



    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.

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.

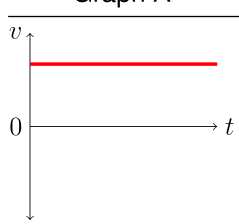
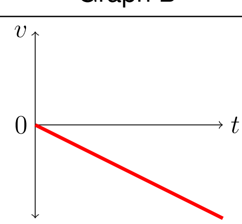
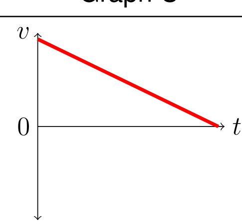
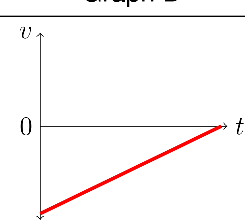
This graph describes an object that is moving to the left and speeding up.

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

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

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

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

Graph A	Graph B	Graph C	Graph D
			

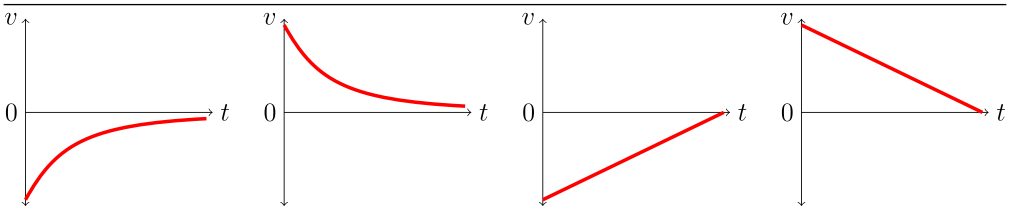
a. Graph A
b. Graph B
c. Graph C
d. Graph D

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.

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**
A car travels 38 km at 45 km/h and 209 km at 114 km/h. What is the average speed for this trip?

a. 92 km/h
b. 102 km/h
c. 67 km/h
d. 106 km/h

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

$$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{d_1 + d_2}{d_1/v_1 + d_2/v_2} = \frac{38\,\mathrm{km} + 209\,\mathrm{km}}{\frac{38\,\mathrm{km}}{45\,\mathrm{km/h}} + \frac{209\,\mathrm{km}}{114\,\mathrm{km/h}}} = 92\,\mathrm{km/h}$$

17. **Problem**
A car accelerates from 43 km/h to 114 km/h, at an average rate of 6 m/s^2. How much time does it take to complete this speed increase?

a. 1.02 s
b. 11.8 s
c. 2.33 s
d. 3.29 s

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

$$v_i = 43\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 11.9\,\mathrm{m/s}$$
$$v_f = 114\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 31.7\,\mathrm{m/s}$$

Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{31.7\,\mathrm{m/s} - 11.9\,\mathrm{m/s}}{6\,\mathrm{m/s^2}} = 3.29\,\mathrm{s}$$

18. **Problem**
An F1 car accelerates from 0 to 60 miles per hour in $2.1\,\mathrm{s}$. What is the acceleration of the car in SI units? $(1\,\mathrm{mile} = 1609.34\,\mathrm{m})$

   a. 12.8 m/s^2
   b. 10.6 m/s^2
   c. 23.1 m/s^2
   d. 28.6 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.

$$a = \frac{v_f - v_i}{t} = \frac{26.8223\,\mathrm{m/s} - 0}{2.1\,\mathrm{s}} = 12.8\,\mathrm{m/s^2}$$

19. **Problem**
A runner completes a marathon (42.195 km) with an average pace of 8 minutes and 55 seconds per kilometre. What is the runner's time for the marathon? (Answers are formatted as hours:minutes:seconds)

   a. 06:16:14
   b. 04:34:06
   c. 04:29:53
   d. 05:03:40

Solution
First, calculate the speed in kilometres per second.

$$v = \frac{1\,\mathrm{km}}{480\,\mathrm{s} + 55\,\mathrm{s}} = 0.001\,869\,2\,\mathrm{km/s}$$

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

$$t = \frac{d}{v} = \frac{42.195\,\mathrm{km}}{0.001\,869\,2\,\mathrm{km/s}} = 22\,574\,\mathrm{s}$$

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

$$22\,574\,\mathrm{s} = 6\,\text{hours}, 16\,\text{minutes}, 14\,\text{seconds}$$

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

Solution
The velocities can be calculated separately.

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

21. **Problem**
A person throws a rock straight down from a bridge with an initial speed of 25.9 m/s. It falls 10.2 m to the water below. How much time does it take for the rock to hit the water?

   a. 0.24 s
   b. 0.34 s
   c. 0.37 s
   d. 0.36 s

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

$$\frac{1}{2}gt^2 + v_i t - h = 0$$
$$a = \frac{1}{2}g = \frac{1}{2}(9.8\,\mathrm{m/s^2}) = 4.9\,\mathrm{m/s^2}, b = v_i = 25.9\,\mathrm{m/s}, c = -h = -10.2\,\mathrm{m}$$
$$t = \frac{-b + \sqrt{b^2 - 4ac}}{2a} = 0.37\,\mathrm{s}$$

22. **Problem**
A ball is thrown straight up with an initial velocity of 16.8 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. 4.41 s
b. 2.13 s
c. 3.43 s
d. 3.93 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 $v_f = -v_i$.

$$t = \frac{v_f - v_i}{a} = \frac{-v_i - v_i}{g} = \frac{-16.8\,\mathrm{m/s} - 16.8\,\mathrm{m/s}}{-9.8\,\mathrm{m/s^2}} = 3.43\,\mathrm{s}$$

23. **Problem**
What is the maximum height reached by a ball thrown straight up with an initial velocity of 20 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. 16 m
b. 20.4 m
c. 21.9 m
d. 12.9 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:

$$d = \frac{-v_i}{2a} = \frac{-20\,\mathrm{m/s}}{2(-9.8\,\mathrm{m/s^2})} = 20.4\,\mathrm{m}$$

24. **Problem**
A ball tossed straight up returns to its starting point in 5.42 s. What was its initial speed? Ignore air resistance.

a. 26.6 m/s
b. 22.6 m/s
c. 24.3 m/s
d. 21.5 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:

$$-v_i = v_i + at$$

$$-2v_i = at$$
$$vi = -\frac{at}{2} = -\frac{(-9.8\,\mathrm{m/s^2})(5.42\,\mathrm{s})}{2} = 26.6\,\mathrm{m/s}$$

25. **Problem**
A golf ball is hit with an initial velocity of 38 m/s at an angle of 73° 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. 82 m
   c. 67 m
   d. 122 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 $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(38\,\mathrm{m/s})\sin(73^\circ)}{-9.8\,\mathrm{m/s^2}} = 7.416\,241\,\mathrm{s}$$

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

$$d_x = v_x t = (38\,\mathrm{m/s})(\cos(73^\circ))(7.416\,241\,\mathrm{s}) = 82.4\,\mathrm{m}$$