# 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 | | | |
| 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? 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.

2. **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.

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

   a. True
   b. False

   **Solution**
   True.

4. **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.

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 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.

7. **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.

8. **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.

9. **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.

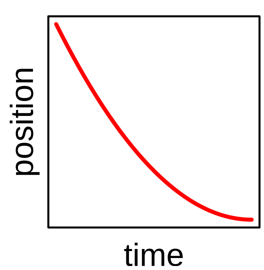
   Note that if air resistance is an important factor, then the difference would change until both balls are falling at their terminal velocity.

10. **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.

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.

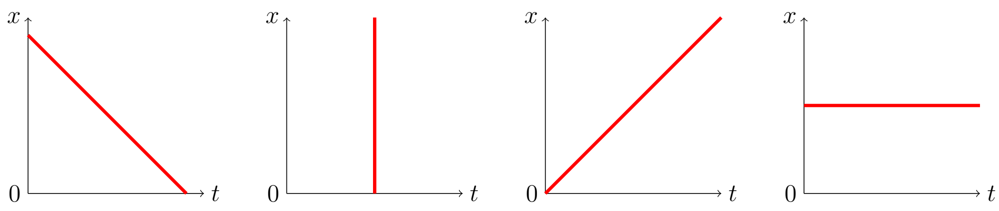
    **Solution**
    The object is moving to the right if its position is increasing and moving to the left if its position is

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 position-time graph represents an object at rest?

| Graph A | Graph B | Graph C | Graph D |
|---|---|---|---|

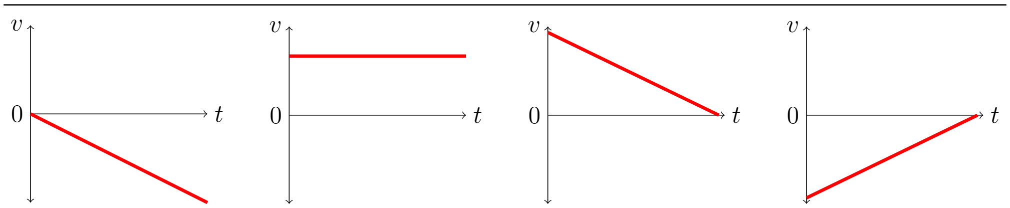



a. Graph A
b. Graph B
c. Graph C
d. Graph D

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

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

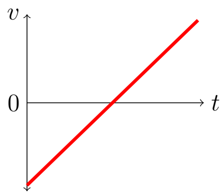
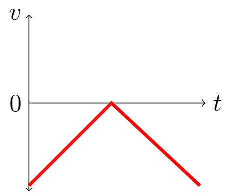
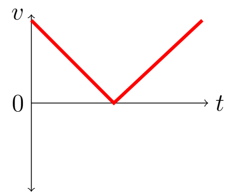
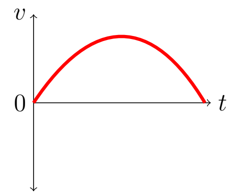
| Graph A | Graph B | Graph C | Graph D |
|---|---|---|---|




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.

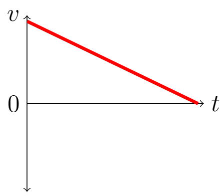
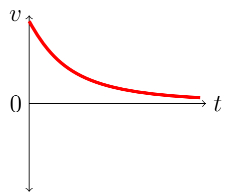
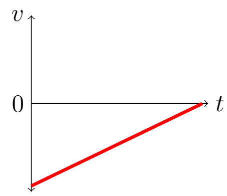
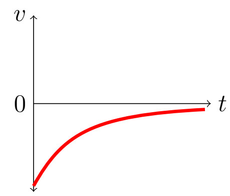
14. **Problem**
Which velocity-time graph represents the motion of an object that changes its direction?

| 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.

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**
Suppose an object travels at a constant velocity of 1.06 m/s. How much time would it take for the object to travel a distance of 94.5 m?

a. 89.2 s
b. 48.7 s
c. 100 s
d. 0.01 s

**Solution**
Use the formula for constant velocity motion.

$$t = \frac{d}{v} = \frac{94.5\,\mathrm{m}}{1.06\,\mathrm{m/s}} = 89.2\,\mathrm{s}$$

17. **Problem**
A car accelerates from 36 km/h to 106 km/h, at an average rate of 1 m/s$^2$. How much time does it take to complete this speed increase?

   a. 62.3 s
   b. 70 s
   c. 35.4 s
   d. 19.4 s

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

$$v_i = 36\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 10\,\mathrm{m/s}$$
$$v_f = 106\,\mathrm{km/h} \times \frac{1\,\mathrm{h}}{3600\,\mathrm{s}} \times \frac{1000\,\mathrm{m}}{1\,\mathrm{km}} = 29.4\,\mathrm{m/s}$$

   Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{29.4\,\mathrm{m/s} - 10\,\mathrm{m/s}}{1\,\mathrm{m/s^2}} = 19.4\,\mathrm{s}$$

18. **Problem**
A car travels 50 km at 42 km/h and 295 km at 108 km/h. What is the average speed for this trip?

   a. 56 km/h
   b. 88 km/h
   c. 42 km/h
   d. 80 km/h

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

$$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{d_1 + d_2}{d_1/v_1 + d_2/v_2} = \frac{50\,\mathrm{km} + 295\,\mathrm{km}}{\frac{50\,\mathrm{km}}{42\,\mathrm{km/h}} + \frac{295\,\mathrm{km}}{108\,\mathrm{km/h}}} = 88\,\mathrm{km/h}$$

19. **Problem**
An F1 car accelerates from $0$ to $60$ miles per hour in $2.79\,\mathrm{s}$. What is the acceleration of the car in SI units? $(1\,\mathrm{mile} = 1609.34\,\mathrm{m})$

   a. 9.61 m/s$^2$
   b. 21.5 m/s$^2$
   c. 5.48 m/s$^2$
   d. 6.55 m/s$^2$

   **Solution**
   First, convert 60 mph to m/s.

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

Then, divide by the time.

$$a = \frac{v_f - v_i}{t} = \frac{26.8223\,\text{m/s} - 0}{2.79\,\text{s}} = 9.61\,\text{m/s}^2$$

20. **Problem**
A runner completes a marathon (42.195 km) with an average pace of 7 minutes and 30 seconds per kilometre. What is the runner's time for the marathon? (Answers are formatted as hours:minutes:seconds)

  a. 07:16:57
  b. 04:44:04
  c. 05:16:28
  d. 05:08:00

**Solution**
First, calculate the speed in kilometres per second.

$$v = \frac{1\,\text{km}}{420\,\text{s} + 30\,\text{s}} = 0.002\,222\,2\,\text{km/s}$$

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

$$t = \frac{d}{v} = \frac{42.195\,\text{km}}{0.002\,222\,2\,\text{km/s}} = 18\,988\,\text{s}$$

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

$$18\,988\,\text{s} = 5\,\text{hours}, 16\,\text{minutes}, 28\,\text{seconds}$$

21. **Problem**
What is the maximum height reached by a ball thrown straight up with an initial velocity of 24.8 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. 31.4 m
  b. 47.7 m
  c. 39.5 m
  d. 33.7 m

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

$$d = \frac{-v_i}{2a} = \frac{-24.8\,\text{m/s}}{2(-9.8\,\text{m/s}^2)} = 31.4\,\text{m}$$

22. **Problem**
A person throws a rock horizontally, with an initial velocity of 20.5 m/s, from a bridge. It falls 5.63 m to the water below. How far does it travel horizontally before striking the water?

   a. 29.2 m
   b. 27.7 m
   c. 22 m
   d. 29.3 m

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

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(5.63\,\mathrm{m})}{9.8\,\mathrm{m/s^2}}} = 1.071\,904\,7\,\mathrm{s}$$

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

$$d_x = v_x t = (20.5\,\mathrm{m/s})(1.071\,904\,7\,\mathrm{s}) = 22\,\mathrm{m}$$

23. **Problem**
A ball tossed straight up returns to its starting point in 2.12 s. What was its initial speed? Ignore air resistance.

   a. 10.4 m/s
   b. 7 m/s
   c. 5.3 m/s
   d. 9.4 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 $vi$:

$$-v_i = v_i + at$$
$$-2v_i = at$$
$$vi = -\frac{at}{2} = -\frac{(-9.8\,\mathrm{m/s^2})(2.12\,\mathrm{s})}{2} = 10.4\,\mathrm{m/s}$$

24. **Problem**
A golf ball is hit with an initial velocity of 70 m/s at an angle of 79° above the horizontal. What is its range (horizontal distance before hitting the ground)? Ignore air resistance and assume a flat golf course.

   a. 261 m
   b. 131 m
   c. 220 m
   d. 187 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 $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(70\,\mathrm{m/s})\sin(79^\circ)}{-9.8\,\mathrm{m/s^2}} = 14.023\,245\,5\,\mathrm{s}$$

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

$$d_x = v_x t = (70\,\mathrm{m/s})(\cos(79^\circ))(14.023\,245\,5\,\mathrm{s}) = 187\,\mathrm{m}$$

25. **Problem**
A ball is thrown straight up with an initial velocity of 11.6 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. 1.92 s
b. 2.37 s
c. 4.4 s
d. 2.2 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 $v_f = -v_i$.

$$t = \frac{v_f - v_i}{a} = \frac{-v_i - v_i}{g} = \frac{-11.6\,\mathrm{m/s} - 11.6\,\mathrm{m/s}}{-9.8\,\mathrm{m/s^2}} = 2.37\,\mathrm{s}$$