

Physics 11

Kinematics Unit Test Solutions

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

1. Problem

True or false? When a ball is thrown straight up, its acceleration at the top is zero.

- a. True
- b. False

Solution

False. The acceleration of the ball is always 9.8 m/s^2 down.

2. Problem

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

- a. True
- b. False

Solution

False. The acceleration of the ball is always 9.8 m/s^2 down.

3. Problem

True or false? It is possible to have zero acceleration and still be moving.

- a. True
- b. False

Solution

True. An object with a constant nonzero velocity has zero acceleration and is still moving.

4. 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.

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

Can an object's velocity change direction when its acceleration is constant?

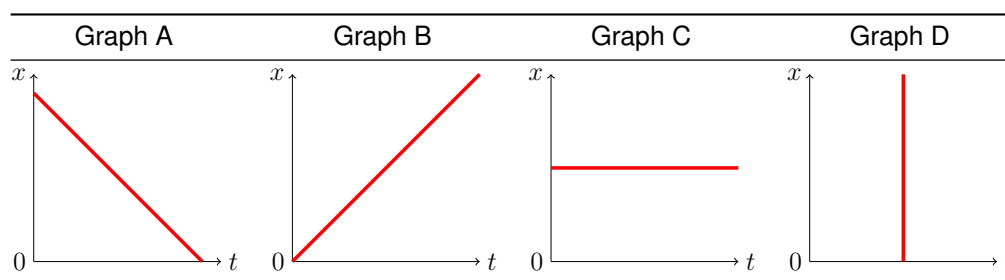
- a. No, because the object is always speeding up.
- b. No, because the object is always speeding up or slowing down, but it can never turn around.
- c. Yes, a rock thrown straight up is an example.
- d. Yes, a car that starts from rest, speeds up, slows to a stop, and then backs up is an example.

Solution

Yes, a rock thrown straight up is an example. The direction of the rock's velocity changes from up to down while its acceleration is always 9.8 m/s^2 down.

7. Problem

Which position-time graph represents an object at rest?



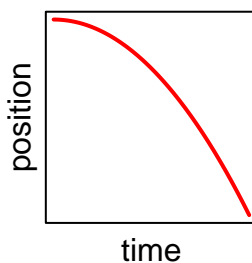
- a. Graph A
- b. Graph B
- c. Graph C
- d. Graph D

Solution

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

8. 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.

9. Problem

Consider a ball that is thrown upwards and which then falls back down. If up is the positive direction, then the ball's velocity

- a. is always positive.
- b. is always negative.
- c. starts positive, then becomes negative.
- d. starts negative, then becomes positive.

Solution

When the ball is moving upwards, its velocity is positive. When the ball is moving downwards, its velocity is negative.

10. Problem

Consider a ball that is thrown upwards and which then falls back down. If up is the positive direction, then the ball's acceleration

- a. is always positive.
- b. is always negative.
- c. starts positive, then becomes negative.
- d. starts negative, then becomes positive.

Solution

The acceleration due to gravity is always downwards, which is the negative direction.

11. Problem

Two balls are thrown from the top of a building. One is thrown straight up while the other is thrown straight down, both with same initial speed. If air resistance can be ignored, how do their speeds compare when they hit the ground?

- a. The ball thrown up is going faster.
- b. The ball thrown down is going faster.
- c. Both balls are going the same speed.
- d. It is impossible to determine with the given information.

Solution

The ball thrown straight up will have the same speed when it returns to the initial height. Therefore, both balls will be going the same speed when they hit the ground. (The ball thrown downward would hit the ground first because it did not travel the path up and back to the initial height. However, both balls still hit the ground with the same speed.)

12. Problem

The acceleration of gravity on the Moon is one-sixth of that on Earth. If you hit a baseball on the Moon with the same speed and angle that you would on Earth, the ball would land

- a. the same distance away
- b. one-sixth as far
- c. 6 times as far
- d. 36 times as far

Solution

The air 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

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

The air time of the ball is 6 times greater on the Moon than on Earth. Since the horizontal velocity is the same, the ball will travel six times as far.

13. 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.

14. Problem

A package of supplies is dropped from a plane flying at a constant velocity. Five seconds later, a second package is dropped. Neglecting air resistance, the horizontal distance between the falling packages will

- a. increase
- b. decrease
- c. be constant
- d. any of the above depending on the weight of the packages

Solution

Since vertical acceleration does not affect horizontal velocity, the two packages with the same constant horizontal velocity will remain the same horizontal distance apart (although the vertical distance will increase).

15. Problem

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

- a. velocity
- b. speed
- c. displacement
- 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. scalar
- c. vector
- d. vector

16. Problem

A fighter plane is launched from a catapult on an aircraft carrier. Starting from rest, it reaches a speed of 221 km/h in 2.35 s. Assuming constant acceleration, what is the length of the aircraft catapult?

- a. 36.5 m
- b. 65.4 m
- c. 72.1 m
- d. 144 m

Solution

First, convert the final speed to m/s:

$$v_f = 221 \text{ km/h} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{3600 \text{ s}} = 61.4 \text{ m/s}$$

Then, use the formula for constant acceleration:

$$d = \frac{1}{2}(v_i + v_f)t = \frac{1}{2}(0 + 61.4 \text{ m/s})(2.35 \text{ s}) = 72.1 \text{ m}$$

17. Problem

A truck travels at 39 km/h for 3 hours and at 92 km/h for 12 hours. What is the average speed for the trip?

- a. 43 km/h
- b. 78.4 km/h
- c. 65.5 km/h
- d. 81.4 km/h

Solution

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

$$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2} = \frac{(39 \text{ km/h})(3 \text{ h}) + (92 \text{ km/h})(12 \text{ h})}{3 \text{ h} + 12 \text{ h}} = 81.4 \text{ km/h}$$

18. Problem

An airplane increases its speed from 139 m/s to 214 m/s, at an average rate of 4 m/s². How much time does it take to complete this speed increase?

- a. 0.05 s
- b. 5.3 s
- c. 18.8 s
- d. 300 s

Solution

Use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{214 \text{ m/s} - 139 \text{ m/s}}{4 \text{ m/s}^2} = 18.8 \text{ s}$$

19. Problem

Suppose an object travels at a constant velocity of 24.0 km/h. What distance would it travel in 99.0 minutes?

- a. 10.8 km
- b. 2270 km
- c. 39.6 km
- d. 32.3 km

Solution

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

$$d = vt = (24.0 \text{ km/h})(99.0 \text{ min}) \left(\frac{1 \text{ h}}{60 \text{ min}} \right) = 39.6 \text{ km}$$

20. Problem

A car accelerates from 30 km/h to 80 km/h, at an average rate of 4 m/s². How much time does it take to complete this speed increase?

- a. 3.09 s
- b. 1.21 s
- c. 2.26 s
- d. 3.47 s

Solution

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

$$v_i = 30 \text{ km/h} \times \frac{1 \text{ h}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 8.33 \text{ m/s}$$
$$v_f = 80 \text{ km/h} \times \frac{1 \text{ h}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 22.2 \text{ m/s}$$

Then, use the formula for constant acceleration motion.

$$t = \frac{v_f - v_i}{a} = \frac{22.2 \text{ m/s} - 8.33 \text{ m/s}}{4 \text{ m/s}^2} = 3.47 \text{ s}$$

21. Problem

A person throws a rock straight down from a bridge with an initial speed of 1.19 m/s. It falls 19.8 m to the water below. How much time does it take for the rock to hit the water?

- a. 1.49 s
- b. 0.97 s
- c. 1.89 s
- d. 1.64 s

Solution

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

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

$$a = \frac{1}{2}g = \frac{1}{2}(9.8 \text{ m/s}^2) = 4.9 \text{ m/s}^2, b = v_i = 1.19 \text{ m/s}, c = -h = -19.8 \text{ m}$$

$$t = \frac{-b + \sqrt{b^2 - 4ac}}{2a} = 1.89 \text{ s}$$

22. Problem

A ball tossed straight up returns to its starting point in 5.54 s. What was its initial speed? Ignore air resistance.

- a. 22.8 m/s
- b. 18.4 m/s
- c. 36 m/s
- d. 27.1 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 v_i :

$$-v_i = v_i + at$$

$$-2v_i = at$$

$$v_i = -\frac{at}{2} = -\frac{(-9.8 \text{ m/s}^2)(5.54 \text{ s})}{2} = 27.1 \text{ m/s}$$

23. Problem

What is the maximum height reached by a ball thrown straight up with an initial velocity of 11.3 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. 6.5 m
- b. 10.3 m
- c. 9.3 m
- d. 9.9 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 :

$$d = \frac{-v_i}{2a} = \frac{-11.3 \text{ m/s}}{2(-9.8 \text{ m/s}^2)} = 6.51 \text{ m}$$

24. Problem

A person throws a rock horizontally, with an initial velocity of 12.4 m/s, from a bridge. It falls 2.14 m to the water below. How far does it travel horizontally before striking the water?

- a. 8.2 m
- b. 11.9 m
- c. 4.9 m
- d. 8.4 m

Solution

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

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(2.14 \text{ m})}{9.8 \text{ m/s}^2}} = 0.6608591 \text{ s}$$

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

$$d_x = v_x t = (12.4 \text{ m/s})(0.6608591 \text{ s}) = 8.19 \text{ m}$$

25. Problem

A golf ball is hit with an initial velocity of 32 m/s at an angle of 44° above the horizontal. What is its range (horizontal distance before hitting the ground)? Ignore air resistance and assume a flat golf course.

- a. 104 m
- b. 127 m
- c. 153 m
- d. 150 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 $v_f = -v_i$:

$$t = -\frac{2v_i}{a} = -\frac{2(32 \text{ m/s}) \sin(44^\circ)}{-9.8 \text{ m/s}^2} = 4.5365445 \text{ s}$$

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

$$d_x = v_x t = (32 \text{ m/s})(\cos(44^\circ))(4.5365445 \text{ s}) = 104 \text{ m}$$