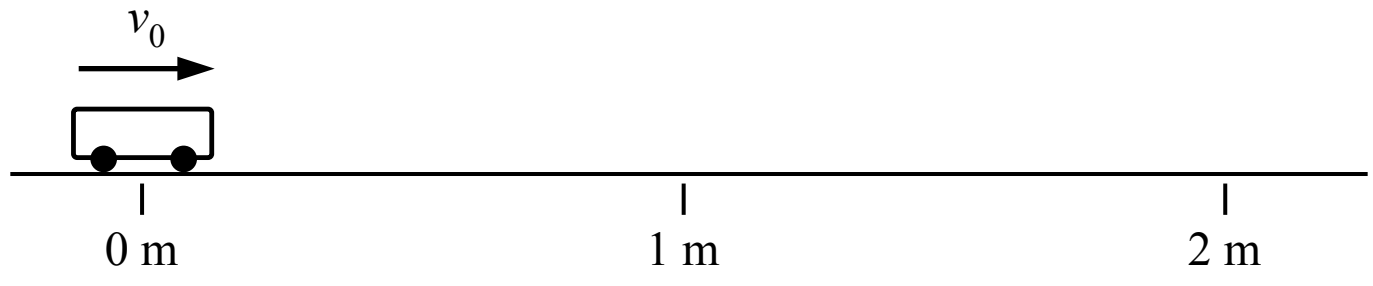
1D MOTION



1. A car is placed on a track as shown in the figure above and given an initial velocity. The car passes the 1 m mark with a speed of 2 m/s and it passes the 2 m mark with a speed of 1 m/s. The acceleration of the car is most nearly

   (A) 0.75 m/s²

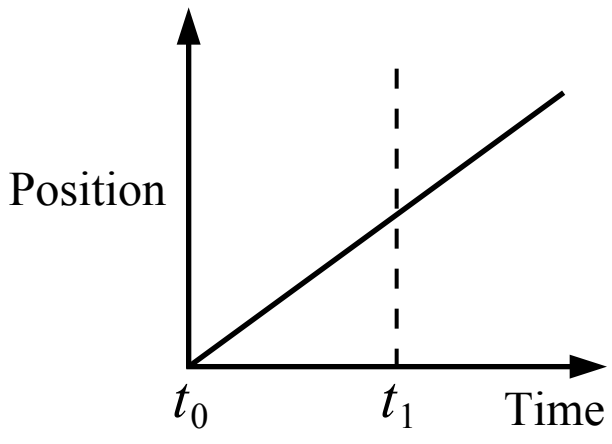
   (B) -0.75 m/s²

   (C) 1.5 m/s²

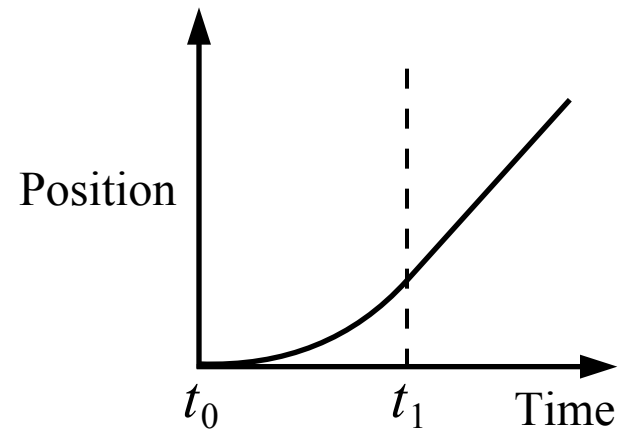
   (D) -1.5 m/s²

2. A train is stopped at a station. From time t_0 to time t_1 the train accelerates and then after time t_1 the train moves at a constant speed. Which of the following graphs could represent the motion of the train?

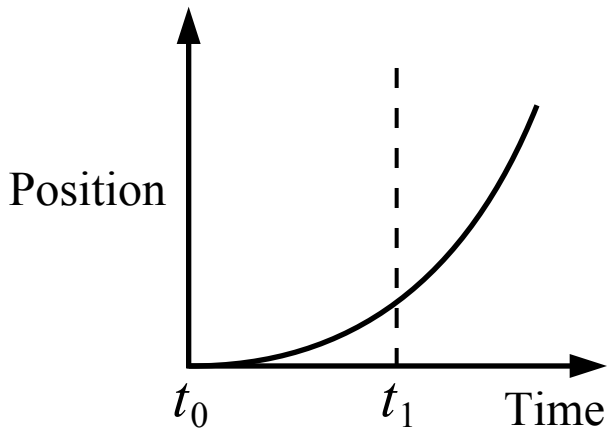
(A)



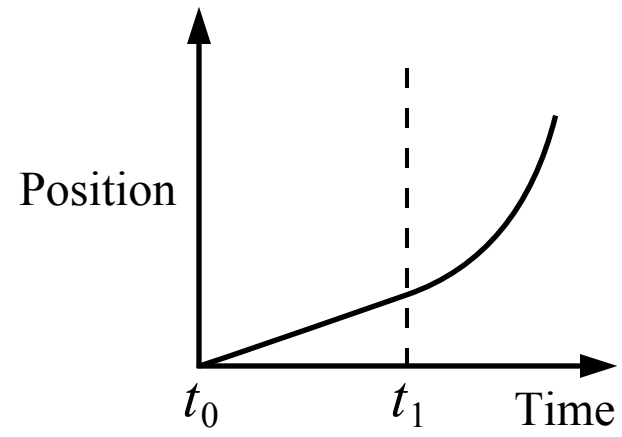
(B)

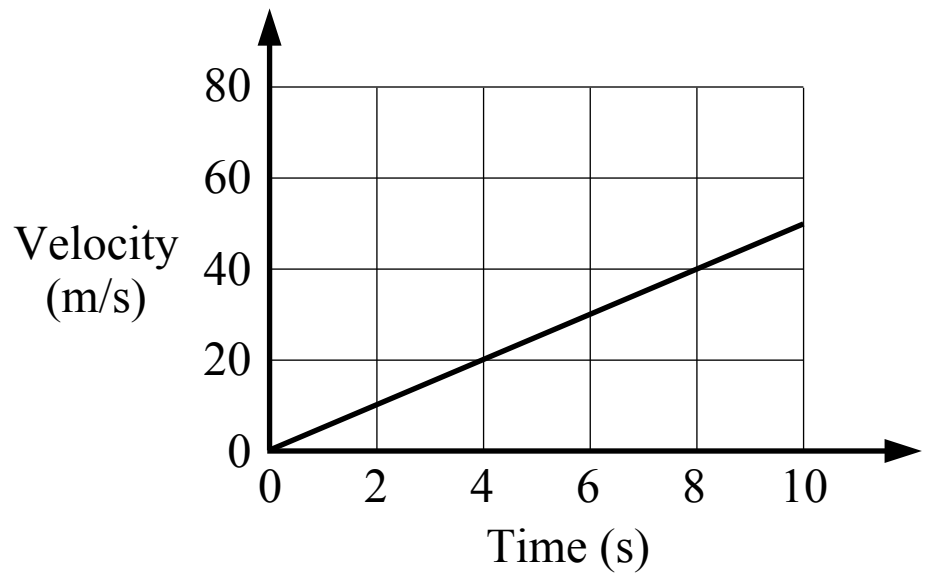


(C)



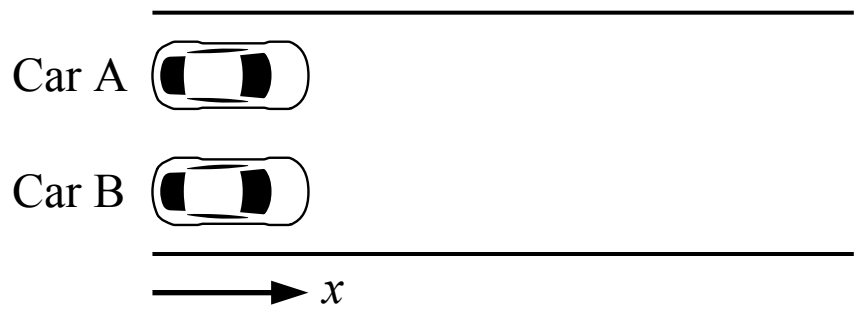
(D)





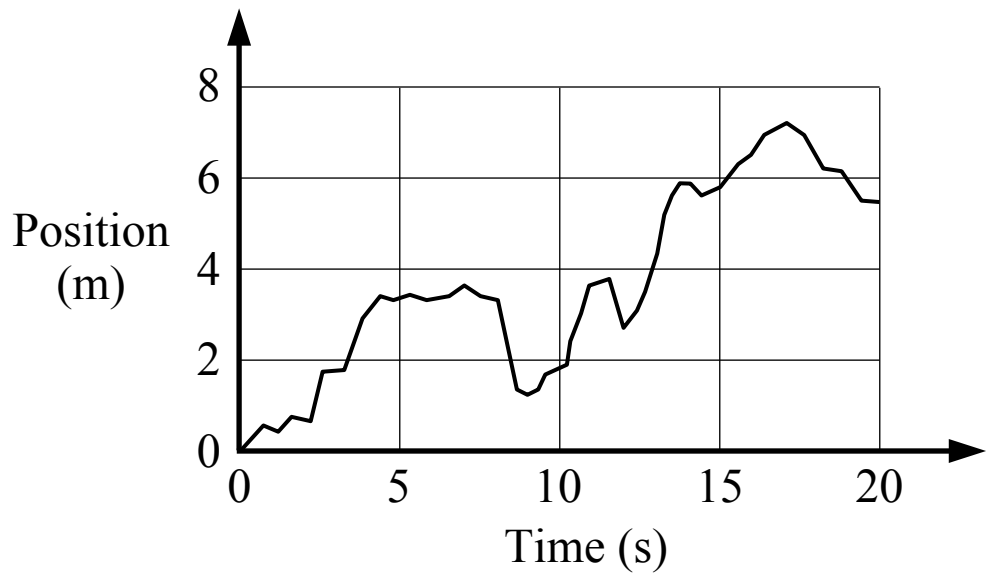
3. A racing team wants to determine the maximum acceleration of their car on a straight track. They record the motion of the car during a period of time, which is shown in the graph above, and they calculate the acceleration. The car then participates in a 250 m long race on a straight track. If the car starts from rest and accelerates at this rate the entire time, the time it takes the car to finish the race is most nearly

(A) 7 s
(B) 14 s
(C) 10 s
(D) 50 s



4. Two cars are stopped next to each other on a straight road as shown in the figure above. At the same starting time, car A drives forward with a constant speed of 10 m/s and car B accelerates forward at 2 m/s². How far apart are the two cars (in the x direction) after 5 seconds?

(A) 115 m
(B) 25 m
(C) 40 m
(D) 100 m



5. A group of students want to make a graph that shows their position over time while walking. They set up a detector in a hallway which measures their position relative to the detector, and they take turns walking in the hallway. One student's motion is shown in the graph above. Which of the following is the best approximation of the student's average velocity for the period of time between 10 seconds and 15 seconds?

(A) 0.8 m/s
(B) 0.4 m/s
(C) 1.2 m/s
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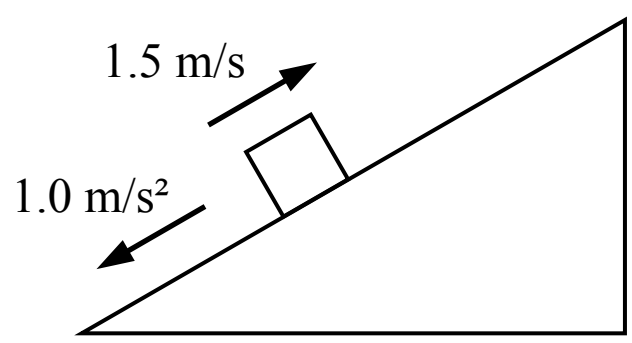


6. A block is sliding on an incline with negligible friction as shown in the figure above. At time $t = 0$ s the block is moving up the incline with a speed of 1.5 m/s. The magnitude of the acceleration of the block is a constant 1.0 m/s² down the incline. At $t = 3$ s, what is the direction of the block's motion and is the speed increasing or decreasing?

(A)

Direction of motion	Speed
Down the incline	Decreasing

(B)

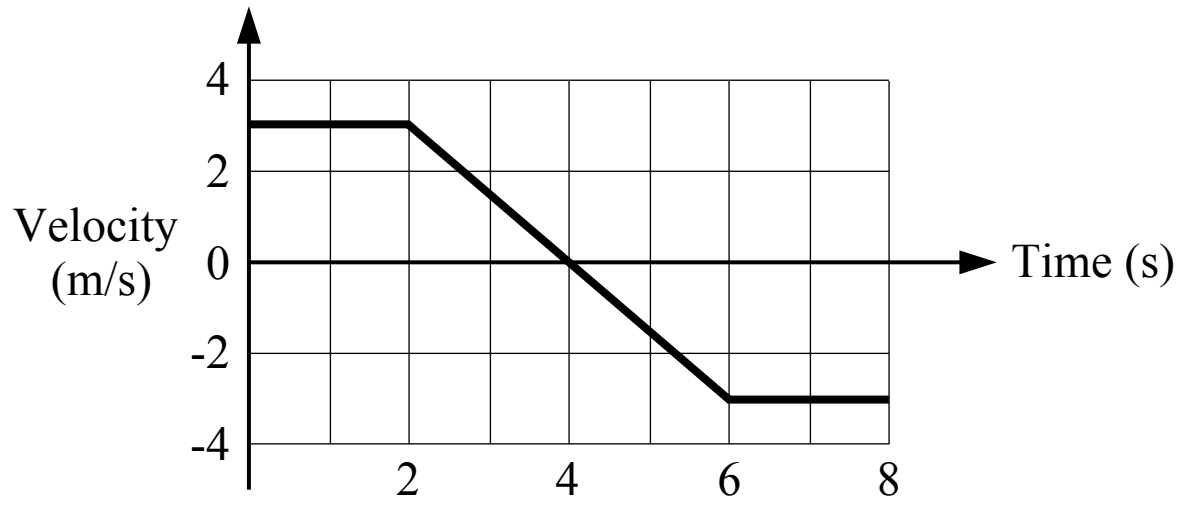
Direction of motion	Speed
Up the incline	Decreasing

(C)

Direction of motion	Speed
Down the incline	Increasing

(D)

Direction of motion	Speed
Up the incline	Increasing



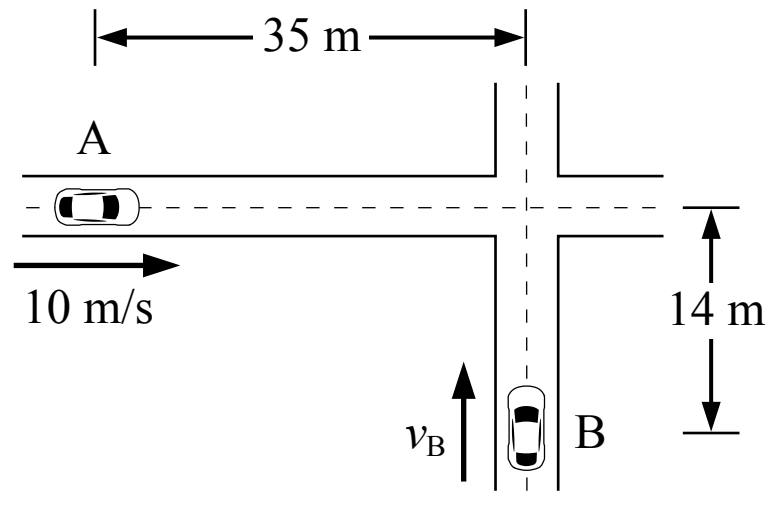
7. A cart is sliding on a horizontal track and its motion is shown in the figure above. Which of the following statements about the cart's motion is true?

   (A) The cart is not moving between 2 s and 6 s

   (B) The speed of the cart is decreasing between 4 s and 6 s

   (C) The cart is not moving between 0 s and 2 s

   (D) The speed of the cart is increasing between 4 s and 6 s



Note: Figure not drawn to scale.

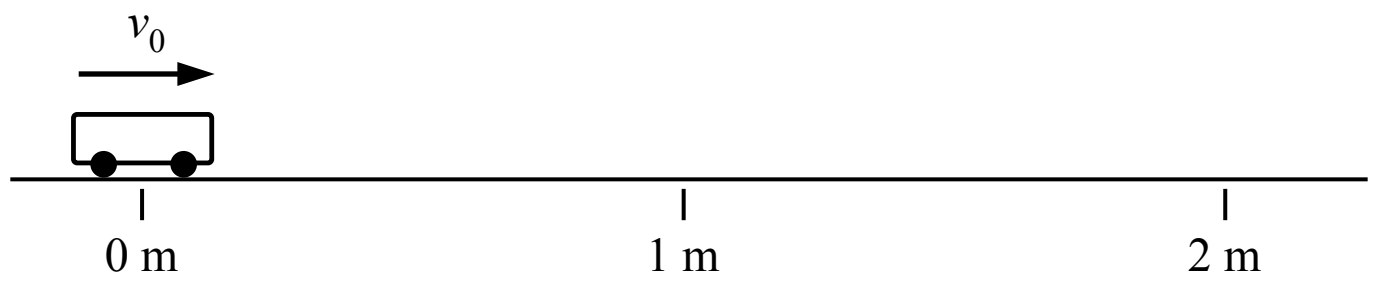
8. Two cars are approaching an intersection as shown in the figure above. Car A is moving at a constant speed of 10 m/s and car B is moving at a constant speed v_B. At time t_0 car A is 35 m from the middle of the intersection and car B is 14 m from the middle of the intersection. What constant speed v_B would result in the cars colliding in the intersection? You may disregard the width and length of each car and treat the cars at point masses.

   (A) 4 m/s

   (B) 10 m/s

   (C) 3.5 m/s

   (D) 8 m/s



1. A car is placed on a track as shown in the figure above and given an initial velocity. The car passes the 1 m mark with a speed of 2 m/s and it passes the 2 m mark with a speed of 1 m/s. The acceleration of the car is most nearly

(A) 0.75 m/s²

(B) -0.75 m/s²

(C) 1.5 m/s²

(D) -1.5 m/s²

A Incorrect

This answer incorrectly uses 2 m for the displacement instead of 1 m. It also has the incorrect sign, which may result from switching the initial and final velocities.

B Incorrect

This answer incorrectly uses 2 m for the displacement instead of 1 m.

C Incorrect

This answer has the correct magnitude but the incorrect sign which may result from switching the initial and final velocities.

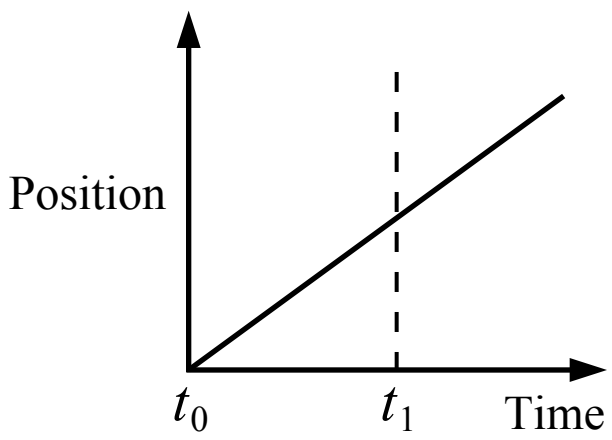
D Correct

The acceleration of the car between the 1 m and 2 m mark can be found using the kinematic equation below.

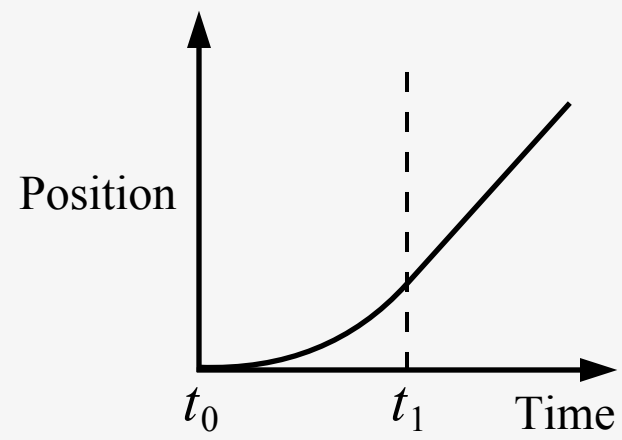
$v^2 = v_0^2 + 2a\Delta x \qquad (1\ \text{m/s})^2 = (2\ \text{m/s})^2 + 2a(2\ \text{m} - 1\ \text{m}) \qquad a = \text{-}1.5\ \text{m/s}^2$

2. A train is stopped at a station. From time t_0 to time t_1 the train accelerates and then after time t_1 the train moves at a constant speed. Which of the following graphs could represent the motion of the train?

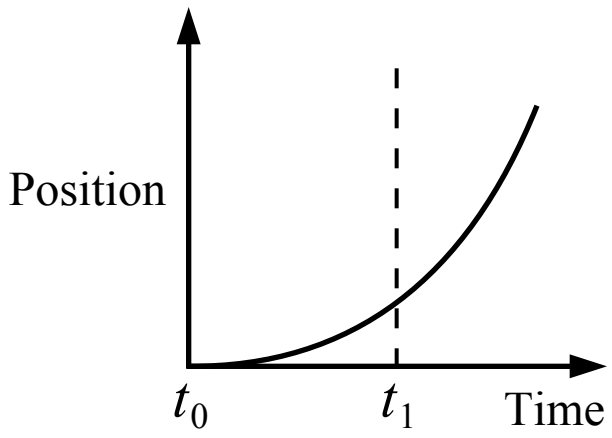
(A)



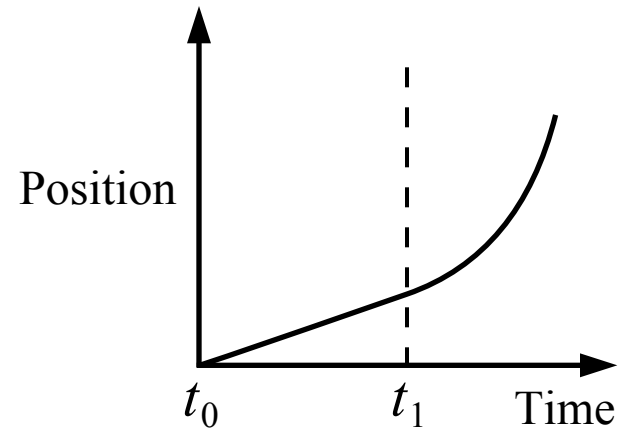
(B)



(C)



(D)

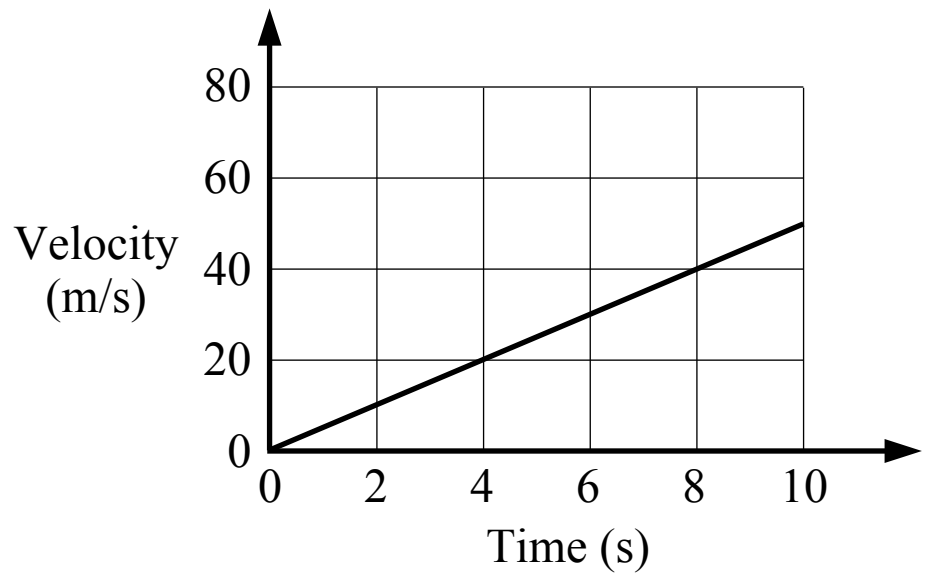


A Incorrect
This graph is a straight line with a constant slope and would represent a train that is moving at a constant speed for the entire period.

B Correct
The slope of the position-time graph represents the speed of the train. The train starts from rest so it begins with a speed of zero and the graph starts with a slope of zero. During the first period the train accelerates which is shown as a curved line with an increasing slope. During the second period the train maintains a constant speed so the line is straight and has a constant, positive slope.

C Incorrect
This graph is a curved line with an increasing slope and would represent a train that is accelerating for the entire period.

D Incorrect
This graph is a straight line with a constant slope during the first period, and a curved line with an increasing slope during the second period. This would represent a train that is moving at a constant speed during the first period and then accelerating during the second period.



3. A racing team wants to determine the maximum acceleration of their car on a straight track. They record the motion of the car during a period of time, which is shown in the graph above, and they calculate the acceleration. The car then participates in a 250 m long race on a straight track. If the car starts from rest and accelerates at this rate the entire time, the time it takes the car to finish the race is most nearly

(A) 7 s

(B) 14 s

(C) 10 s

(D) 50 s

A Incorrect

This answer incorrectly uses a value of 10 m/s² for the acceleration.

B Incorrect

This answer incorrectly uses a value of 2.5 m/s² for the acceleration.

C **Correct**

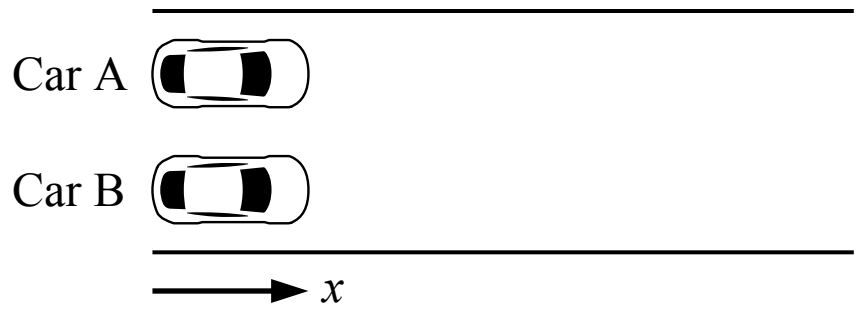
The acceleration of the car is the slope of the velocity-time graph which can be found using several pairs of points, such as the points at 0 s and 8 s. That acceleration can be used to find the time it takes the car to travel a displacement of 250 m when starting with an initial velocity of zero. The value of t can be found using the quadratic formula if needed.

$$a = \frac{\Delta v}{\Delta t} = \frac{40\text{ m/s} - 0\text{ m/s}}{8\text{ s} - 0\text{ s}} = 5\text{ m/s}^2$$

$$\Delta x = v_0 t + \frac{1}{2} a t^2 \qquad (250\text{ m}) = (0\text{ m/s})t + \frac{1}{2}(5\text{ m/s}^2)t^2 \qquad t = 10.0\text{ s}$$

D Incorrect

This answer incorrectly divides the displacement by the acceleration to find the time.



4. Two cars are stopped next to each other on a straight road as shown in the figure above. At the same starting time, car A drives forward with a constant speed of 10 m/s and car B accelerates forward at 2 m/s². How far apart are the two cars (in the x direction) after 5 seconds?

(A) 115 m

(B) 25 m

(C) 40 m

(D) 100 m

A Incorrect

This answer incorrectly switches the value of car A's speed and car B's acceleration.

B Correct

The final positions of the cars can be found using the kinematic equation below.

Car A: $x = x_0 + v\Delta t = (0\text{ m}) + (10\text{ m/s})(5\text{ s}) = 50\text{ m}$

Car B: $x = x_0 + v_0 t + \frac{1}{2}at^2 = (0\text{ m}) + (0\text{ m/s})(5\text{ s}) + \frac{1}{2}(2\text{ m/s}^2)(5\text{ s})^2 = 25\text{ m}$

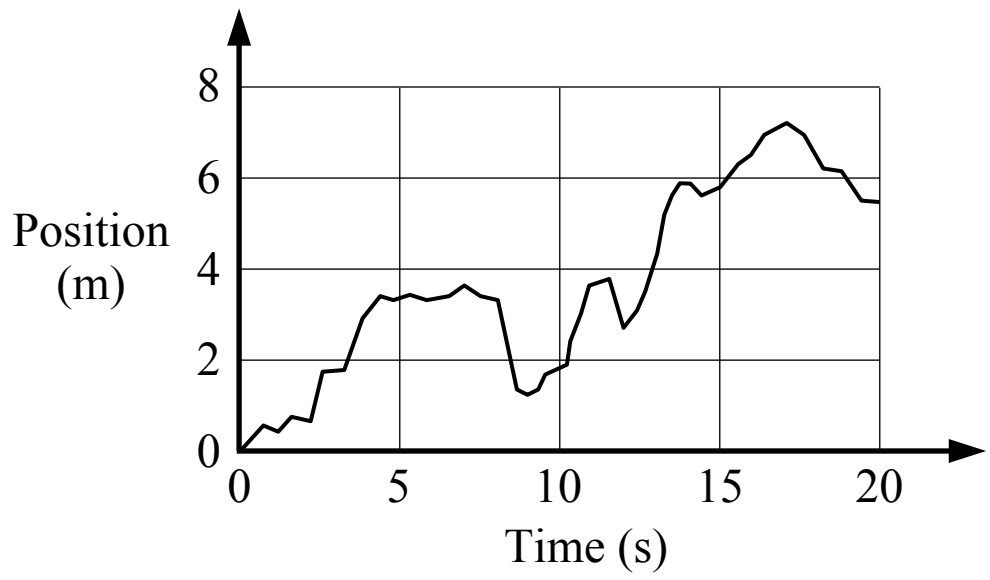
Distance between the cars: $(50\text{ m}) - (25\text{ m}) = 25\text{ m}$

C Incorrect

This answer incorrectly uses the value of car B's acceleration as a constant speed of 2 m/s.

D Incorrect

This answer incorrectly uses the value of car A's constant speed as an acceleration of 10 m/s².



5. A group of students want to make a graph that shows their position over time while walking. They set up a detector in a hallway which measures their position relative to the detector, and they take turns walking in the hallway. One student's motion is shown in the graph above. Which of the following is the best approximation of the student's average velocity for the period of time between 10 seconds and 15 seconds?

(A) 0.8 m/s
(B) 0.4 m/s
(C) 1.2 m/s
(D) 1.4 m/s

A **Correct**

The average velocity can be found by dividing the displacement by the period of time, and approximating the position at 10 seconds (2 m) and 15 seconds (6 m). This is the average slope during that time.

$$v = \frac{\Delta x}{\Delta t} = \frac{6\text{ m} - 2\text{ m}}{15\text{ s} - 10\text{ s}} = 0.8\text{ m/s}$$

B Incorrect

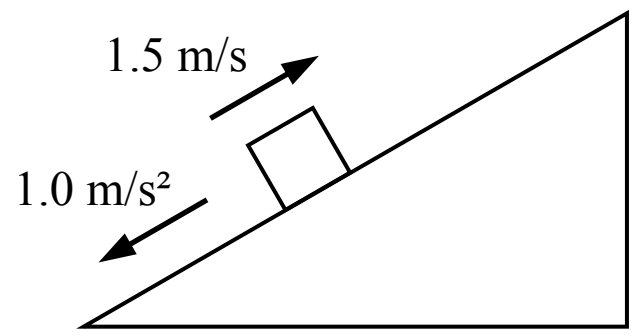
This answer incorrectly uses 6 m as the displacement and 15 seconds as the duration, or 2 m as the displacement and 5 seconds as the duration.

C Incorrect

This answer incorrectly uses 6 m as the displacement during that period.

D Incorrect

This answer incorrectly uses 7 m as the displacement during that period.



6. A block is sliding on an incline with negligible friction as shown in the figure above. At time $t = 0$ s the block is moving up the incline with a speed of 1.5 m/s. The magnitude of the acceleration of the block is a constant 1.0 m/s² down the incline. At $t = 3$ s, what is the direction of the block's motion and is the speed increasing or decreasing?

(A)

Direction of motion	Speed
Down the incline	Decreasing

(B)

Direction of motion	Speed
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(C)

Direction of motion	Speed
Down the incline	Increasing

(D)

Direction of motion	Speed
Up the incline	Increasing

A Incorrect

B Incorrect

C Correct

The motion of the block can be analyzed using 1D kinematics in the direction of the incline (along an axis parallel to the incline). If we choose up the incline to be the positive direction, the initial velocity is positive, the acceleration is negative, and the velocity at 3 s can be found using the equation below. The final velocity is negative so the block is moving down the incline, and the final velocity is in the same direction as the acceleration so the speed (the magnitude of velocity) is increasing.

$v_f = v_i + at = (1.5 \text{ m/s}) + (-1.0 \text{ m/s}^2)(3 \text{ s}) = -1.5 \text{ m/s}$

D Incorrect

7. A cart is sliding on a horizontal track and its motion is shown in the figure above. Which of the following statements about the cart's motion is true?

(A) The cart is not moving between 2 s and 6 s

(B) The speed of the cart is decreasing between 4 s and 6 s

(C) The cart is not moving between 0 s and 2 s

(D) The speed of the cart is increasing between 4 s and 6 s

A Incorrect

The cart has a constant negative acceleration between 2 s and 6 s and it is moving (it has a non-zero velocity) during that period, except exactly at 4 s when the velocity is momentarily 0 m/s.

B Incorrect

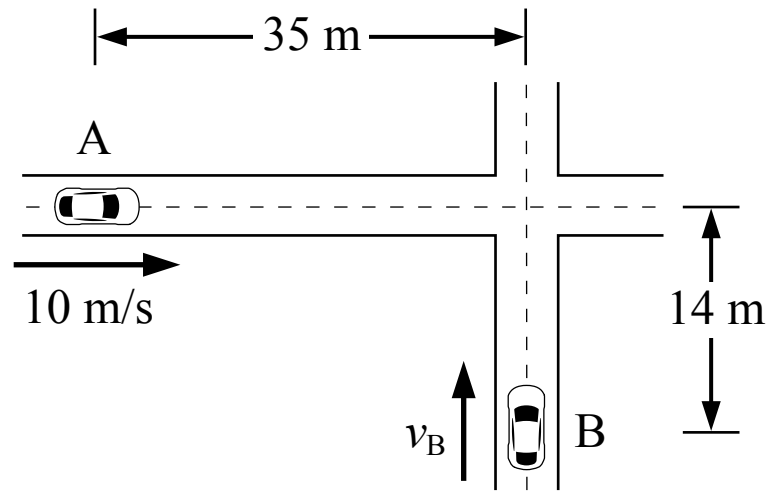
The velocity is in the negative direction between 4 s and 6 s and the speed of the cart (the magnitude or absolute value of the velocity) is increasing.

C Incorrect

The cart has a constant positive velocity from 0 s to 2 s so the cart is moving.

D Correct

The velocity is in the negative direction between 4 s and 6 s and the speed of the cart (the magnitude or absolute value of the velocity) is increasing.



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8. Two cars are approaching an intersection as shown in the figure above. Car A is moving at a constant speed of 10 m/s and car B is moving at a constant speed v_B. At time t_0 car A is 35 m from the middle of the intersection and car B is 14 m from the middle of the intersection. What constant speed v_B would result in the cars colliding in the intersection? You may disregard the width and length of each car and treat the cars at point masses.

(A) 4 m/s
(B) 10 m/s
(C) 3.5 m/s
(D) 8 m/s

A **Correct**

The time when car A is at the intersection can be found from its speed and distance from the intersection, then that time can be used to find the speed of car B which would result in a collision.

Car A: $v_A = \frac{\Delta x}{\Delta t} \qquad 10 \text{ m/s} = \frac{35 \text{ m}}{\Delta t} \qquad \Delta t = 3.5 \text{ s}$

Car B: $v_B = \frac{\Delta x}{\Delta t} = \frac{14 \text{ m}}{3.5 \text{ s}} = 4 \text{ m/s}$

B Incorrect

This is the speed of car A. The cars are different distances from the intersection so this would not be the speed of car B.

C Incorrect

This is the time that the cars would collide (3.5 s) using the unit of m/s.

D Incorrect