Question:

Assuming that the quantities of motion have been established and understood, what is the first step in analyzing or describing the rectilinear motion of an object?

a. Determine if the object is moving.
b. Measure the object's distance or displacement.
c. Measure the object's speed or velocity.
d. Determine the object's acceleration.
e. None of the above

Answer:

e. The first step is to establish a frame of reference and to define the origin and the +/- direction of motion in that frame.

Question:

Which statement concerning the description of motion in rectilinear kinematics is correct?

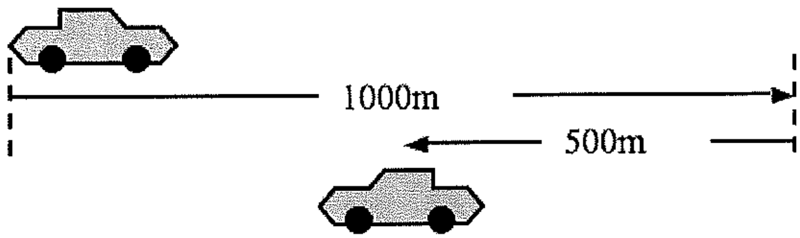
I. **In kinematics, absolute rest and absolute motion are the underlying foundations of describing motion.**
II. **In kinematics, the first thing to establish when defining motion is whether an object is moving.**
III. **In kinematics, a frame of reference is the environment or perspective used to judge or describe the motion of objects.**

a. I only
b. II only
c. III only
d. I and II only
e. II and III only

Answer:

c.

Question:



A car travels 1000 meters in the positive-x direction, then turns around and travels 500 m in the opposite direction as shown, and takes 100.0 seconds total for this movement. What is the average *velocity* of the car during this time?

a. 15.0 m/s
b. 15.0 m/s in the positive-x direction
c. 15.0 m/s in the negative-x direction
d. 5.00 m/s in the positive-x direction
e. 5.00 m/s in the negative-x direction

Answer:

The correct answer is *d*. The car has travelled a *distance* of 1500 meters total during its motion, but its *velocity* is based on *displacement*.

$$displacement\ \ \Delta x = x_f - x_i$$

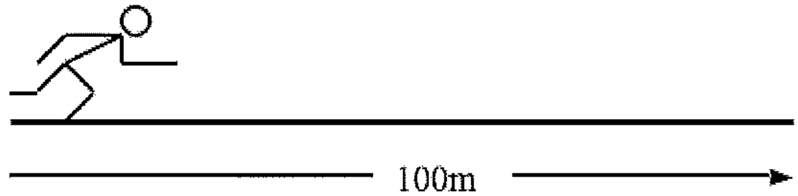
Remember that displacement is only determined based on initial and final positions of the car, and not its total distance travelled. Thus, the displacement is only 500 m in the positive-x direction, and velocity is:

$$velocity = \frac{displacement}{time}$$

$$v = \frac{\Delta x}{t} = \frac{x_f - x_i}{t} = \frac{+500m - 0m}{100.0s} = +5.00m/s$$

or "5.00 m/s in the positive-x direction."

Question:



A runner travels straight along a 100 meter track to the East as shown above, in 10.0 seconds. The runner has:

a. An average speed of 10.0 m/s, and an average velocity of 10.0 m/s.
b. An average speed of 10.0 m/s, and an average velocity of 10.0 m/s East.
c. An average speed of 10.0 m/s East, and an average velocity of 10.0 m/s.
d. An average speed of 10.0 m/s East, and an average velocity of 10.0m/s East.
e. An average speed of 10.0 m/s, and an average velocity of 10.0 m/s West.

Answer:

The correct answer is ***b***. Speed is a measure of distance traveled per time:

$$speed = \frac{distance}{time} \qquad s = \frac{d}{t}$$

In this case:

$$s = \frac{d}{t} = \frac{100m}{10.0s} = 10.0m/s$$

Because speed is a *scalar* quantity, it only has a magnitude for its value–no direction is required.

Velocity, on the other hand, is a *vector* quantity, which means that a magnitude and a direction are both necessary. The magnitude is calculated according to the *displacement* divided by *time*:

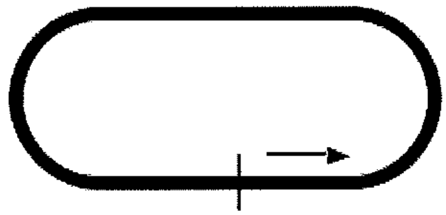
$$velocity = \frac{displacement}{time} \qquad \mathbf{v} = \frac{\Delta \mathbf{x}}{t} = \frac{x_f - x_i}{t}$$

In this case, the velocity is:

$$\mathbf{v} = \frac{x_f - x_i}{t} = \frac{+100m - 0m}{10.0s} = +10.0m/s, \text{ or } 10.0\text{m/s, East}$$

One can indicate the direction of the velocity as "East," or "in the positive-x direction." When solving vector problems in physics, we sometimes get a little sloppy–the direction of motion might be obvious from the problem statement, and so we might just indicate the magnitude of the velocity, and leave off the direction. It's important to remember, however, that *vector quantities* are always represented both by a *magnitude* and a *direction*, and if you're being careful, you'll want to specify both.

Question:



Start / Finish

A runner takes off from the starting line and runs 400 meters around a track to return to her original starting position. The runner:

a. ran a distance of 400 m, but had a displacement of 0.
b. ran a distance of 0 m, but had a displacement of 400m.
c. ran a distance of 400m and had a displacement of 400m.
d. ran a distance of 0m and had a displacement of 0 m.
e. ran a distance of 400m, but her displacement is undefined.

Answer:
The correct answer is ***a***. The runner travelled 400 meters around the track, and ***distance*** is defined as the length of the path travelled. ***Displacement*** is a vector quantity, typically with a magnitude and a direction, that is calculated based on the initial and final positions of an object that has moved:

$$displacement \quad \Delta x = x_{final} - x_{initial}$$

In this problem, because the runner starts and ends at the same location, the displacement is 0.

Question:

An car begins accelerating from rest, and reaches a final velocity of 30.0 m/s in the positive *x*-direction 5.0 seconds later. The average velocity of the car was

a. +30 m/s
b. -30 m/s
c. +6.0 m/s
d. -6.0 m/s
e. +15 m/s

Answer:

The correct answer is *e*. The average velocity of the car can be calculated in a number of different ways. In this case, based on knowing the initial velocity of the car–it was at rest at the beginning of the problem, so we can write $v_{initial} = 0$–and the final velocity of $v_{final} =$ +30.0 m/s, the average velocity is just the sum of those two velocities, divided by 2.

$$v_{average} = \frac{v_i + v_f}{2}$$

$$v_{average} = \frac{0 + 30 m/s}{2} = +15 m/s$$

Note that we've been careful to indicate direction with the plus-sign in our answer, because it's appropriate to indicate direction for velocities.

Question:

A speeding car is traveling at 20.0 m/s when it begins to accelerate at 2.5 m/s^2. How fast is the car traveling after accelerating for 6.0 seconds?

a. 15 m/s
b. 26 m/s
c. 35 m/s
d. 45 m/s
e. 59 m/s

Answer:

The correct answer is *c*. This problem is relatively easy to solve conceptually: if the car speeds up by 2.5 m/s ***every second*** for 6 seconds, it must be going... 2.5 + 2.5 + 2.5 + 2.5 + 2.5 + 2.5 + 2.5 = $6 \times 2.5 = 15$ m/s faster than it was before. Add this to the 20 m/s that was its original velocity, and we can see that the car is traveling at 35 m/s at the end of the problem.

We can also solve the problem using $v_f = v_i + at$, which is just the equation for the definition of acceleration $\left(a = \frac{v_f - v_i}{t}\right)$ rearranged. When first learning to use an equation like this, it may be helpful to identify the known and unknown values that have been specified in the problem. Writing these down formally will help you select an appropriate equation for helping to solve the problem:

$$v_{initial} = 20 m/s$$

$$a = 2.5 m/s^2$$

$$\Delta t = 6s$$

$$v_{final} = ?$$

$$v_{final} = v_{initial} + at$$

$$v_{final} = 20 + (2.5)(6) = 35 m/s$$

Question:

A skier slides down a constant slope with negligible friction. At one moment she's traveling at 4.0 m/s, and three seconds later she's traveling at 16 m/s. What distance does she travel during the three seconds of time?:

a. 30 m
b. 12 m
c. 36 m
d. 48 m
e. 40 m

Answer:

The correct answer is *a*. There are a number of ways to solve this problem, but perhaps the easiest is to determine the skier's average velocity during this time period:

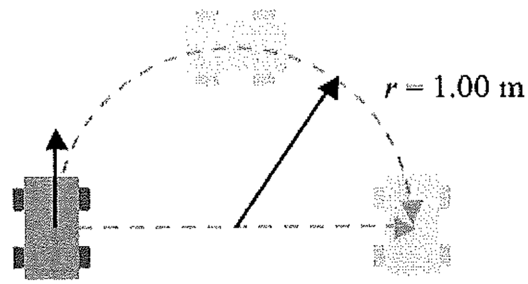
$$v_{avg} = \frac{v_i + v_f}{2} = \frac{4+16}{2} = 10m/s,$$

and then use this average velocity to get the distance covered in the 3.0 seconds:

$$d = vt = (10m/s)(3s) = 30m.$$

Another strategy would be to use the information given to calculate the skier's acceleration using $a = \frac{v_f - v_i}{t}$, and then use this with the formula $\Delta x = v_i t + \frac{1}{2}at^2$. This strategy arrives at the correct answer, but requires more calculation and more time to solve than the first technique.

Question:



A toy car travels in a semi-circular path from its starting point to a final position 2.00 meters away in the positive-*x* direction. The car's motion along the path of travel is 3.14 meters. Therefore:

a. the car's displacement was 3.14 meters.
b. the car's distance traveled was 2.00 meters.
c. the car's distance traveled was 2.00 meters in the positive-*x* direction.
d. the car's displacement was 2.00 meters in the positive-*x* direction.
e. none of the above statements are true.

Answer:
The correct answer is ***d***. While the car travels a *distance* (along its path) of 3.14 meters, its *displacement*—its final position relative to its initial position—is 2.00 meters in the positive-*x* direction.

Question:

A speeding car is traveling at 20.0 m/s when it begins to accelerate at 2.5 m/s^2. How fast is the car traveling after accelerating for 6.0 seconds?

a. 15 m/s
b. 26 m/s
c. 35 m/s
d. 45 m/s
e. 59 m/s

Answer:

The correct answer is *c*. This problem is relatively easy to solve conceptually: if the car speeds up by 2.5 m/s ***every second*** for 6 seconds, it must be going… 2.5 + 2.5 + 2.5 + 2.5 + 2.5 + 2.5 + 2.5 = 6×2.5 =15 m/s faster than it was before. Add this to the 20 m/s that was its original velocity, and we can see that the car is traveling at 35 m/s at the end of the problem.

We can also solve the problem using $v_f = v_i + at$, which is just the equation for the definition of acceleration $\left(a = \frac{v_f - v_i}{t}\right)$ rearranged. When first learning to use an equation like this, it may be helpful to identify the known and unknown values that have been specified in the problem. Writing these down formally will help you select an appropriate equation for helping to solve the problem:

$$v_{initial} = 20m/s$$

$$a = 2.5m/s^2$$

$$\Delta t = 6s$$

$$v_{final} = ?$$

$$v_{final} = v_{initial} + at$$

$$v_{final} = 20 + (2.5)(6) = 35m/s$$

Question:

A race car, starting from rest, accelerates at 30 feet/s^2 for 7 seconds. How far does the car travel during this time?

a. 735 feet
b. 105 feet
c. 6300 feet
d. 1470 feet
e. 210 feet

Answer:

The correct answer is *a*. One can arrive at this answer in a number of ways.

One solution involves carefully considering various aspects of the car's motion. It started at rest, and accelerated at 30 feet/s^2 for 7 seconds, so its final velocity must be 210 feet/s. Knowing this, we can determine that its average velocity is half that value, or 105 feet/s. And finally, knowing that the car traveled at that average velocity for 7 seconds:

$$d = v_{avg}t$$

$$d = (105 ft/s)(7s) = 735 ft$$

Another solution simply requires using a formula that is built upon this same thought process:

$$d = \frac{1}{2}at^2$$

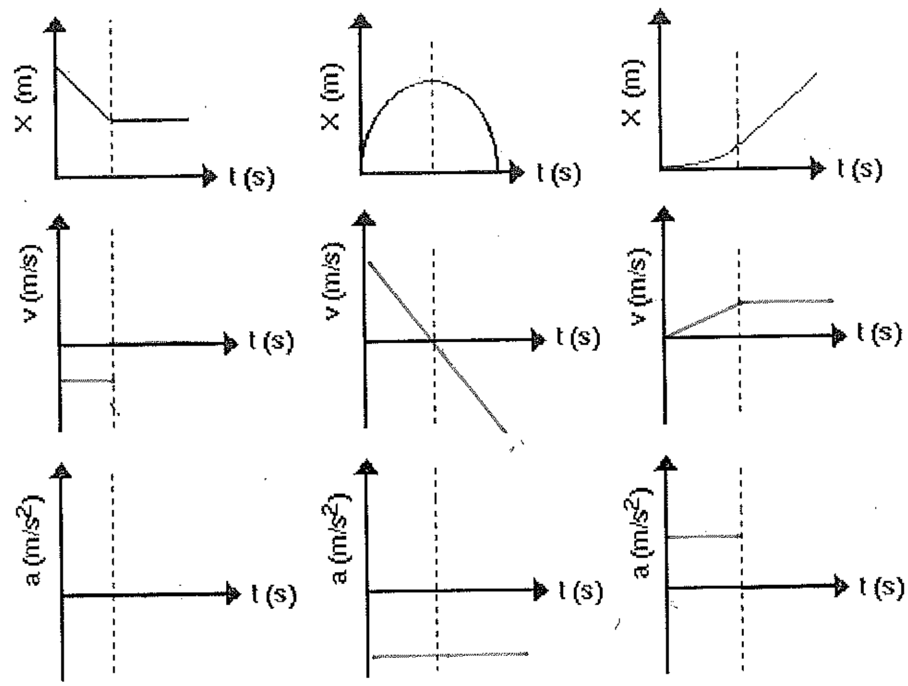
$$d = \frac{1}{2}(30 ft/s^2)(7s)^2 = 735 ft$$

While using the formula is more convenient and probably a faster way to get the answer, make sure that your understanding of physics goes beyond simply plugging numbers into an equation!

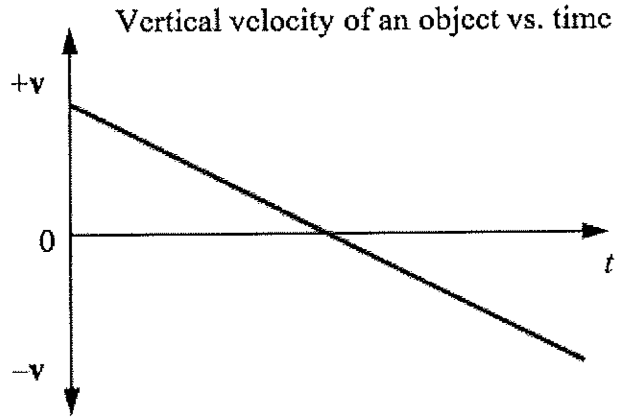
Note that some Conceptual Physics courses use a more complete version of the distance-acceleration formula. This version takes into account the initial velocity of the object, if it's moving: $d = v_i t + \frac{1}{2}at^2$

Focus Question:

Displacement graphs for three rectilinear motions are given below. Complete the corresponding *velocity* and *acceleration* graphs shown below each displacement graph.



Question:



The *vertical velocity* vs. *time* motion for an object is shown above, with positive velocity indicating a speed in the upward direction. Based on this graph,

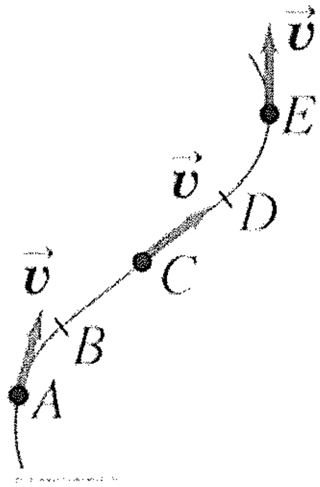
a. the object *must* be traveling in a negative direction throughout its motion
b. the object *must* be traveling with a constant velocity throughout its motion
c. the object has an acceleration that is changing
d. the object *must* have been thrown straight up into the air
e. the vertical motion of the object is consistent with that of a projectile

Answer:

The correct answer is *e*. A projectile that is thrown up into the air with some vertical velocity will have a velocity that decreases from +**v** to 0 to –**v** just as indicated in this graph. The other answers are incorrect because the object is initially traveling with a positive velocity, and hence in a positive direction; the object has a *changing* velocity, not a constant one; the constant slope of the velocity-time curve indicates a *constant* acceleration, not a changing one; and although the object might have been thrown straight up into the air, it might also have an initial horizontal component to its velocity—based on this graph of just the vertical velocity, we don't have any way of knowing for sure.

A3.3

The motion diagram shows an object moving along a curved path at constant speed. At which of the points *A*, *C*, and *E* does the object have *zero* acceleration?



A. point *A* only

B. point *C* only ✓

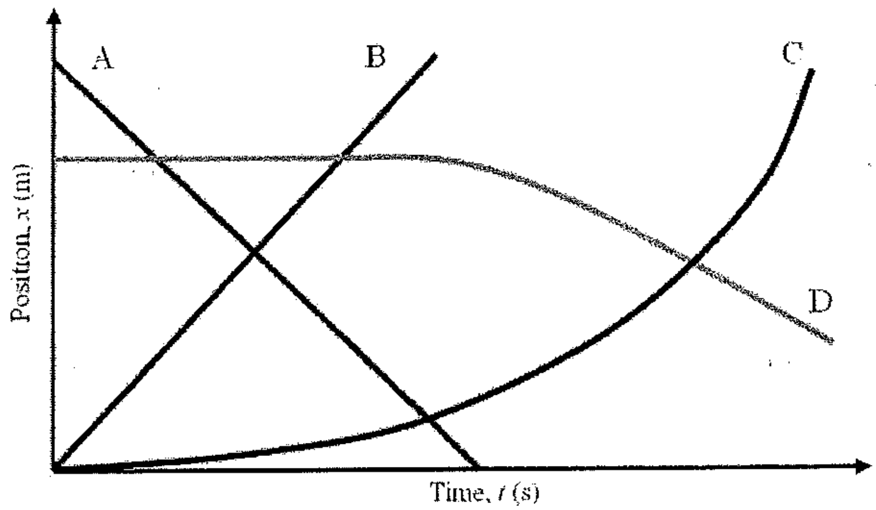
C. point *E* only

D. points *A* and *C* only

E. points *A*, *C*, and *E*

Question:

Which statement concerning the *position-time* graph below is correct?



I. **Curve A corresponds to an object slowing down.**

II. **Curve D describes and an object first at rest, then accelerating with negative velocity and increasing speed.**

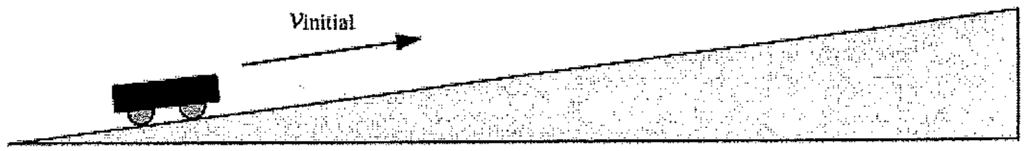
III. **Curve C represents an object that has a positive, increasing velocity and a positive acceleration.**

a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

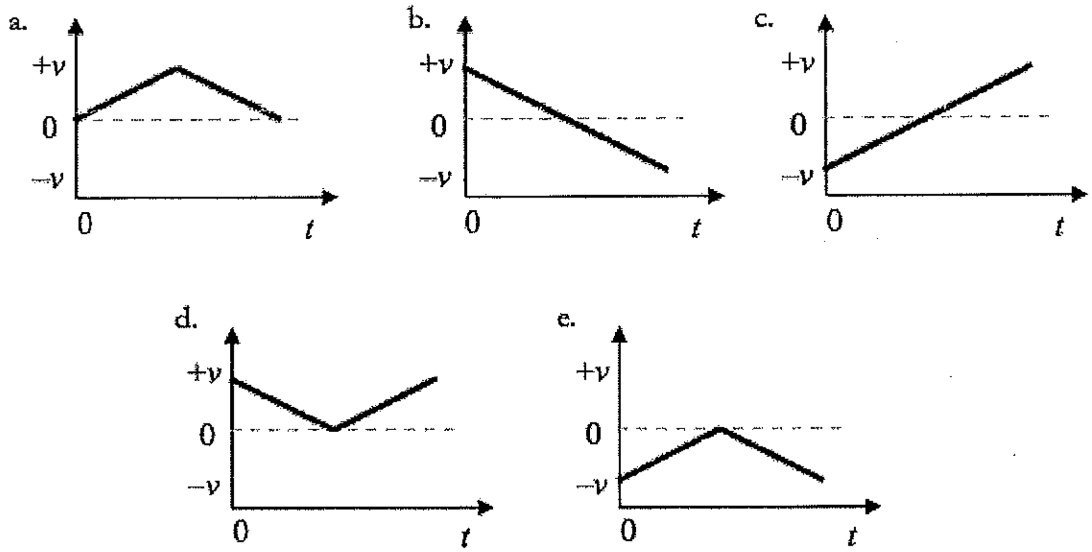
Answer:

d.

Question:



A "frictionless cart," with wheels that turn with negligible friction, is given an initial velocity up an inclined ramp as shown. The cart reaches a maximum height on the ramp before coming to a stop and then rolling back down the ramp. If the positive direction is considered "up the ramp," which motion graph correctly describes the motion of the cart on the ramp?

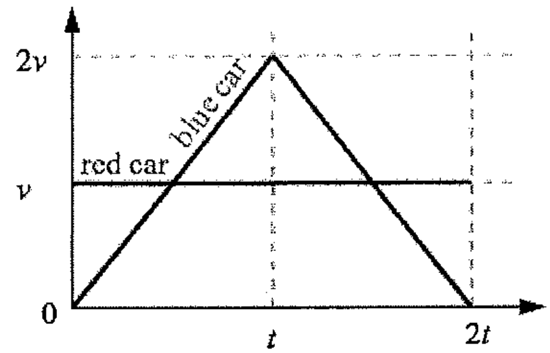


Answer:

The correct answer is *b*. The cart has an initial positive velocity up the ramp, and this velocity decreases to zero as the cart reaches its high point. As the cart begins to roll back down the ramp, its velocity is negative, and increases in the negative direction as it speeds up down the ramp.

If asked, we could identify the acceleration of the cart by examining the slope of this *velocity-time* graph, where the slope is the "rise over the run" of the graph. With velocity on the *y*-axis and time on the *x*-axis, $m = \frac{rise}{run} = \frac{\Delta v}{\Delta t} = a$ (acceleration).

Question:



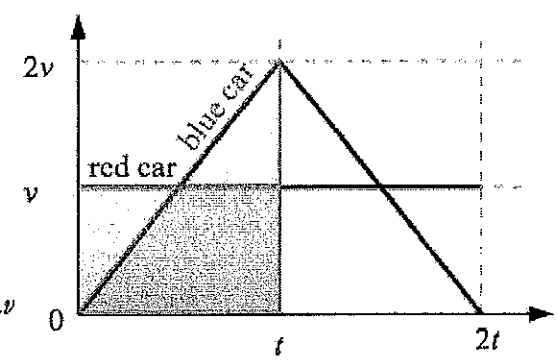
At time $t = 0$, a red car and a blue car are both located at $x = 0$, with the red car travelling at a constant speed v along the positive x-axis and the blue car at rest and just beginning to accelerate along a path parallel to the red car. The velocity of both cars from time 0 to $2t$ is graphed above. At time t:

a. the blue car has traveled farther, and both cars have the same velocity
b. both cars have traveled the same distance, and the blue car has a greater velocity
c. the red car has traveled farther, and both cars have the same velocity
d. both cars have traveled the same distance, and both cars have the same velocity
e. the blue car has traveled farther, and the blue car has a greater velocity

Answer:

The correct answer is *b*. The displacement of the cars can be determined by looking at the area under the curve of the velocity-time graph. The area under curve for the red car at time t is vt, while the area under the curve for the blue car is $\frac{1}{2}(2v)(t) = vt$, so both cars have the same displacement.

At time t, the blue car has the greater velocity—$2v$ compared with the red car's v.



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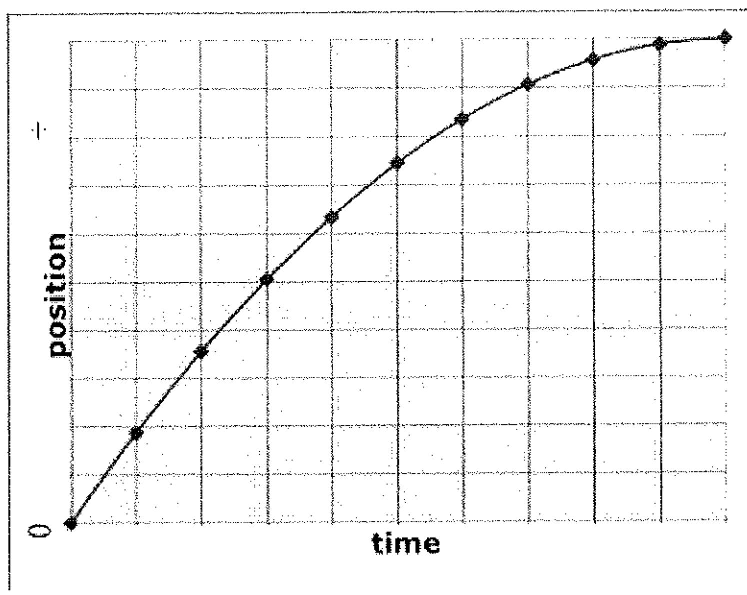


A student walks along a straight line according to the displacement-time graph shown here. Based on the graph, we can tell that the student must have been

a. Walking faster and faster, accelerating in the direction of travel
b. Walking with constant speed, and moving in the positive direction
c. Walking faster and faster, and moving in the negative direction
d. Walking slower and slower, accelerating in the direction of travel
e. Walking slower and slower, accelerating in the opposite direction of travel

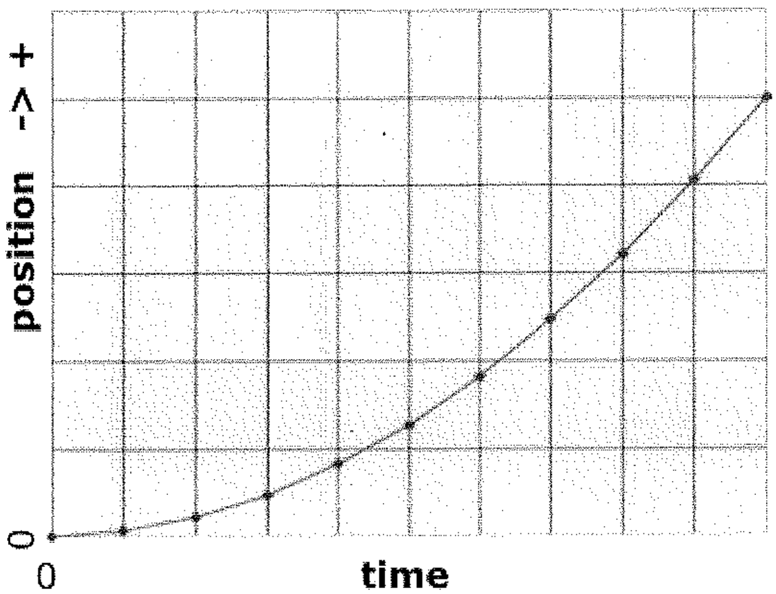
Answer:
The correct answer is *e*. From the graph of the student's motion, we can see that her position is changing by a smaller amount as each unit of time goes by. Therefore she is slowing down, and has an acceleration that is in the opposite direction of her travel.

We can also think about her motion in terms of the changing slope of the graph. Slope of a graph is defined as "rise over run," or "change in *y* over change in *x*." Here, the *y*-axis represents position, and the *x*-axis represents time, so "slope" of this graph is really "change in position over time," which is velocity.

$$slope\ m = \frac{\Delta y}{\Delta x} = \frac{\Delta\, position}{\Delta\, time} = velocity$$

We can see from the graph that the slope of the student's motion is changing over time: it starts out pretty steep (a positive velocity), and gets less and less steep over time (decreasing velocity). This represents a positive velocity that is changing (accelerating) in the negative direction.

Question:



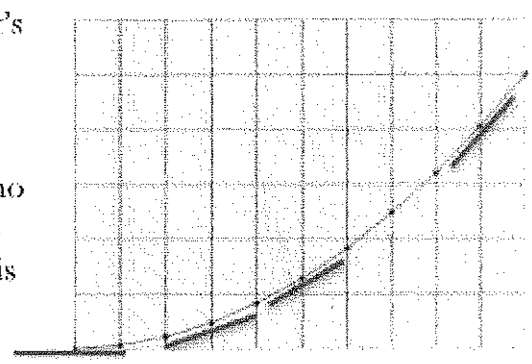
A student walks along a straight line according to the displacement-time graph shown here. Based on the graph, we can tell that the student

a. began at rest, then began to move faster and faster with acceleration in the positive direction
b. began at rest, then began to move in the positive direction with a negative acceleration
c. began with a positive velocity that increased over time
d. began with a positive velocity that decreased over time
e. moved with a constant positive speed the entire time

Answer:

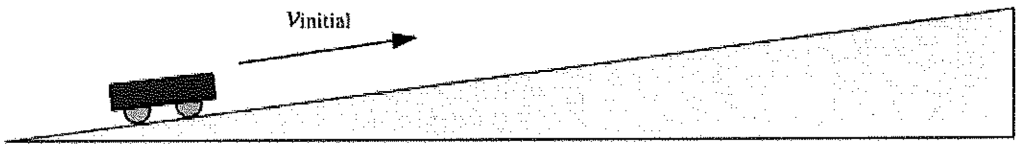
The correct answer is ***a***. We can determine the student's velocity at any point in time by looking at the slope of the graph at that point in time.

At the beginning, the slope of the line is 0, indicating no velocity. As time passes, the slope of the line begins to increase, revealing an increasing velocity. The student is covering greater and greater distances as each second passes. This is the very definition of acceleration, with an increasing velocity in the direction of motion.

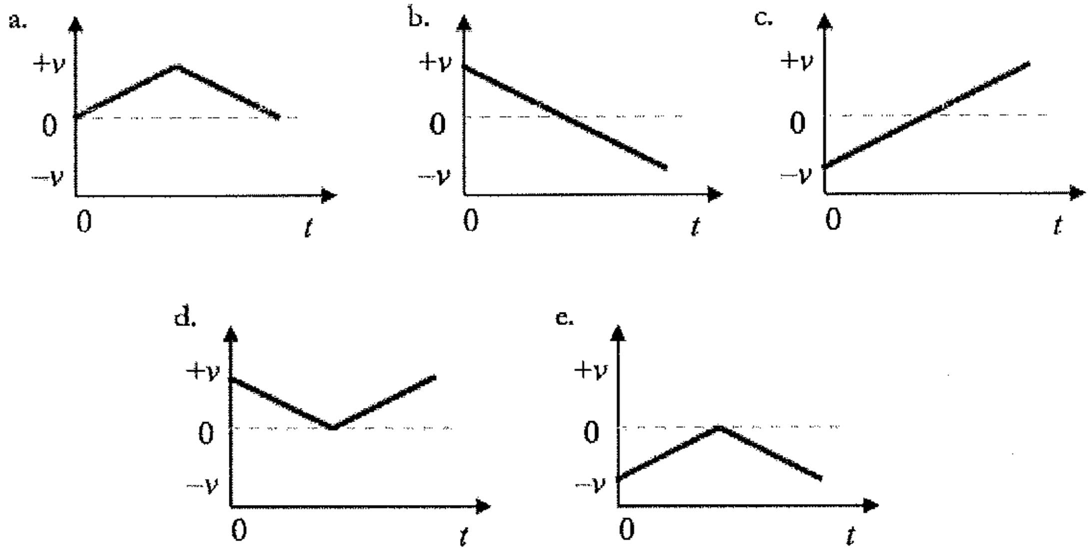


Green lines indicate increasing slope with time.

Question:



A "frictionless cart," with wheels that turn with negligible friction, is given an initial velocity up an inclined ramp as shown. The cart reaches a maximum height on the ramp before coming to a stop and then rolling back down the ramp. If the positive direction is considered "up the ramp," which motion graph correctly describes the motion of the cart on the ramp?



Answer:

The correct answer is *b*. The cart has an initial positive velocity up the ramp, and this velocity decreases to zero as the cart reaches its high point. As the cart begins to roll back down the ramp, its velocity is negative, and increases in the negative direction as it speeds up down the ramp.

If asked, we could identify the acceleration of the cart by examining the slope of this *velocity-time* graph, where the slope is the "rise over the run" of the graph. With velocity on the *y*-axis and time on the *x*-axis, $m = \frac{rise}{run} = \frac{\Delta v}{\Delta t} = a$ (acceleration).

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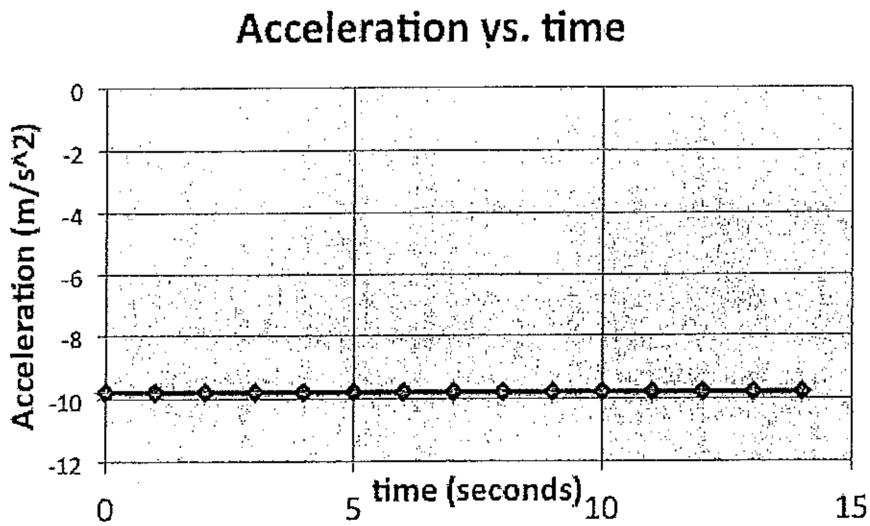


The motion of an object has been graphed above, with *positive* values on the *y*-axis indicating an *upward* direction. Which of the following statements is true about this object in motion?

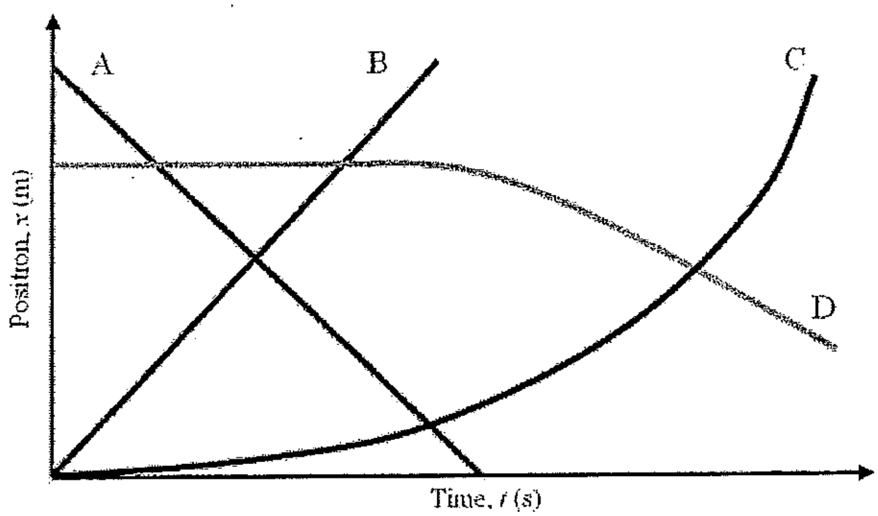
a. The graph is flat, indicating that the object is not moving.
b. The graph is flat, indicating that the object has a constant velocity in the negative direction.
c. The graph is flat, indicating that the object is not accelerating.
d. The graph is flat, and indicates a constant downward acceleration.
e. None of the statements above are true.

Answer:
The correct answer is *d*. The graph indicates a constant acceleration of 9.8 m/s^2 in the negative, or *downward* direction.

This is the acceleration for any object that is experiencing freefall, where the effect of air friction is negligible. Note that the acceleration for an object that has been thrown into the air with a positive velocity is also -9.8 m/s^2. The object traveling upwards slows down due to the negative acceleration, and after it reaches its maximum height, it speeds up as it falls, due to this save negative acceleration. Just looking at the graph above, however, there's no way to know whether the object is traveling upwards or downwards. All we can say is that it has a negative acceleration.

Question:

Which statement concerning the *position-time* graph below is correct?



I. **Curve A corresponds to an object slowing down.**

II. **Curve D describes and an object first at rest, then accelerating with negative velocity and increasing speed.**

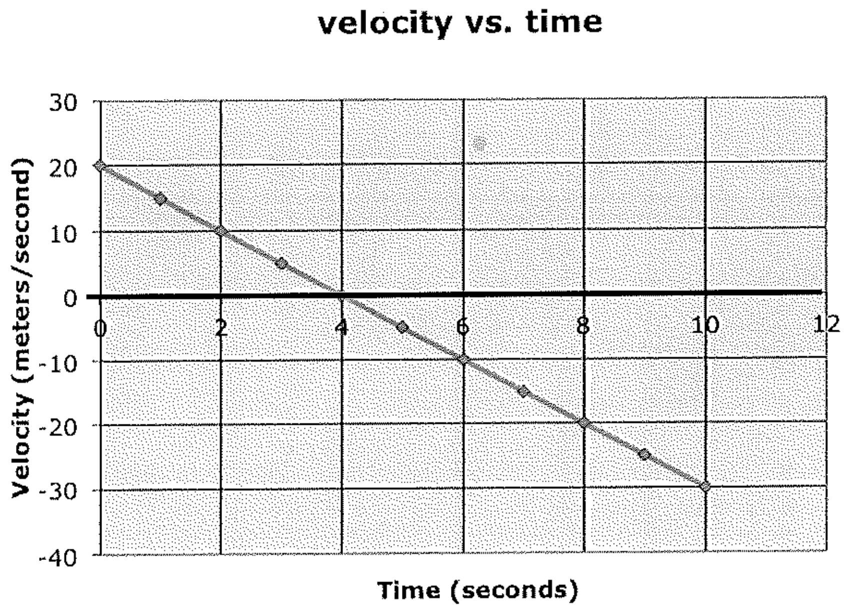
III. **Curve C represents an object that has a positive, increasing velocity and a positive acceleration.**

a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

Answer:

d.

Question:



The motion of an object traveling horizontally has been graphed as shown above, with *positive* velocity values indicating a *forward* direction. Which of the following statements is true about this object in motion?

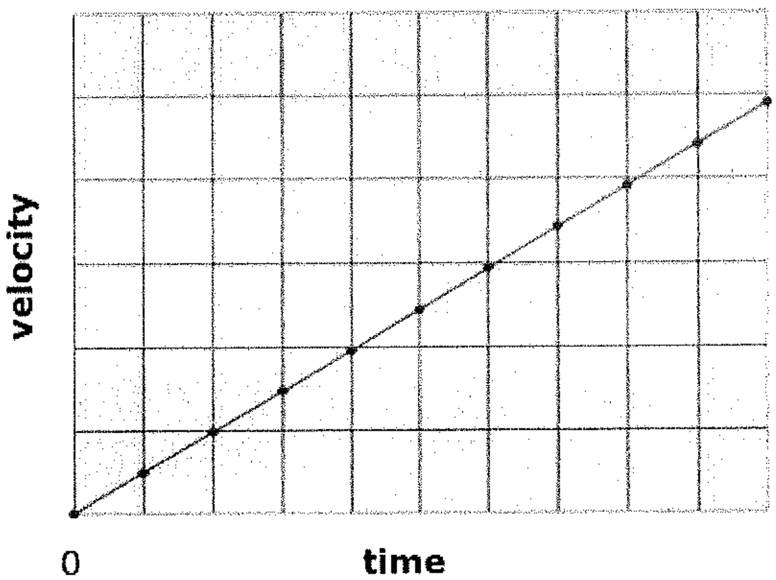
a. The slope of the graph is constant, indicating a constant velocity for the object.
b. The slope of the graph is negative, indicating an object that is traveling *backwards*.
c. At time $t = 0$, the object is not moving.
d. This object has an acceleration of -10 m/s^2 .
e. This object moves *forwards* and *backwards* during the course of its motion.

Answer:
The correct answer is *e*. The initial velocity of the object is +20 m/s, and the slope of its velocity-time graph is calculated using its rise-over-run:

$$m = \frac{\Delta y}{\Delta x} = \frac{0 - 20m/s}{4m/s - 0} = -5m/s^2$$

This suggests that the object, initially moving forward, is slowing down over time, until it reaches an instantaneous velocity of 0 at time $t = 4$ s. After that point, the object begins moving faster and faster in the negative direction, going backwards. The only answer consistent with this analysis is choice *e*.

Question:



The velocity-time graph above describes the motion of a truck traveling in a straight line. What does the *slope* of the line indicate for the time period indicated?

a. the speed of the truck
b. the distance the truck has traveled
c. the velocity of the truck
d. the time that the truck has traveled for
e. the acceleration of the truck

Answer:
The correct answer is *e*. The slope of a graph *m* is determined by looking at the "rise over the run":

$$m = \frac{rise}{run} = \frac{\Delta y}{\Delta x}$$

In this case, the value changing on the *y*-axis is the velocity, and the value changing on the *x*-axis is time. Therefore,

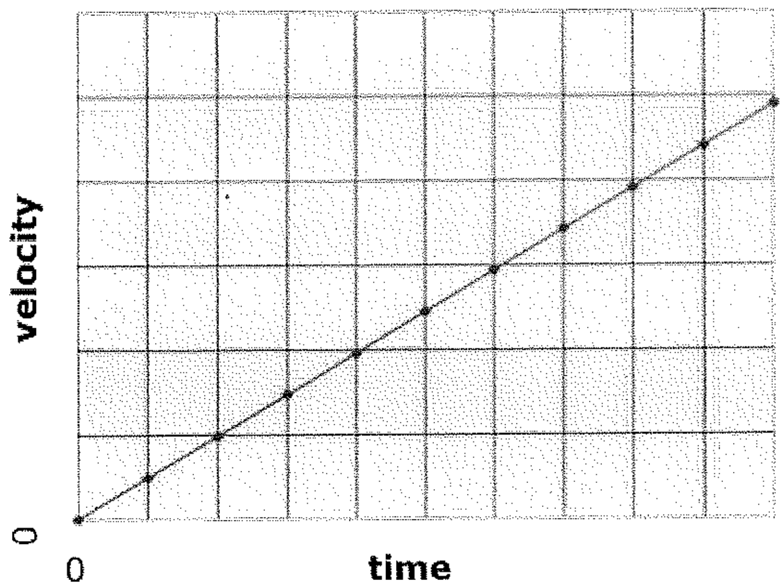
$$m = \frac{\Delta y}{\Delta x} = \frac{\Delta velocity}{time}$$

We recognize the formula for acceleration, where $a = \frac{\Delta v}{t}$.

We might also think about the units for velocity and time, and look at the unit that results when we do a division. Those units, m/s^2, are the units for acceleration:

$$a = \frac{\Delta velocity}{time} = \frac{meters / second}{second} = \frac{m}{s^2}$$

Question:

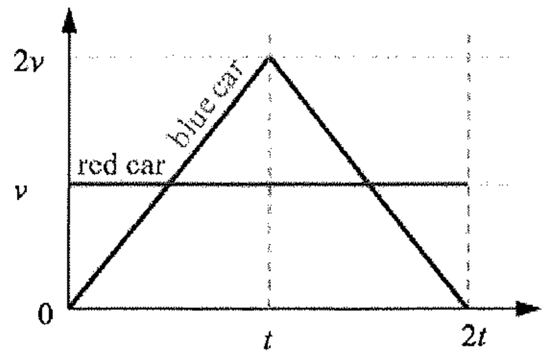


A car moves in a straight line with a motion described by the velocity-time graph shown here. Based on the graph, we can tell that the car

a. is traveling at a constant speed.
b. is traveling at a constant velocity.
c. is speeding up as it moves.
d. is slowing down as it moves.
a. none of the above.

Answer:
The correct answer is *c*. As time passes, the velocity of the car on the *y*-axis is getting higher and higher. For a car traveling in a straight line, this means that the car is speeding up.

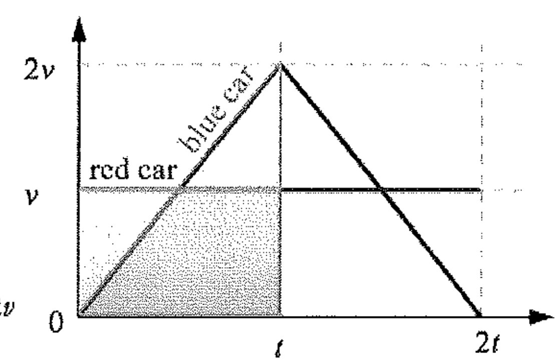
Question:



At time $t = 0$, a red car and a blue car are both located at $x = 0$, with the red car travelling at a constant speed v along the positive x-axis and the blue car at rest and just beginning to accelerate along a path parallel to the red car. The velocity of both cars from time 0 to $2t$ is graphed above. At time t:

a. the blue car has traveled farther, and both cars have the same velocity
b. both cars have traveled the same distance, and the blue car has a greater velocity
c. the red car has traveled farther, and both cars have the same velocity
d. both cars have traveled the same distance, and both cars have the same velocity
e. the blue car has traveled farther, and the blue car has a greater velocity

Answer:
The correct answer is *b*. The displacement of the cars can be determined by looking at the area under the curve of the velocity-time graph. The area under curve for the red car at time t is vt, while the area under the curve for the blue car is $\frac{1}{2}(2v)(t) = vt$, so both cars have the same displacement.
At time t, the blue car has the greater velocity—$2v$ compared with the red car's v.



Question:

A race car, starting from rest, accelerates at 30 feet/s^2 for 7 seconds. How far does the car travel during this time?

a. 735 feet
b. 105 feet
c. 6300 feet
d. 1470 feet
e. 210 feet

Answer:

The correct answer is *a*. One can arrive at this answer in a number of ways.

One solution involves carefully considering various aspects of the car's motion. It started at rest, and accelerated at 30 feet/s^2 for 7 seconds, so its final velocity must be 210 feet/s. Knowing this, we can determine that its average velocity is half that value, or 105 feet/s. And finally, knowing that the car traveled at that average velocity for 7 seconds:

$$d = v_{avg}t$$
$$d = (105 ft/s)(7s) = 735 ft$$

Another solution simply requires using a formula that is built upon this same thought process:

$$d = \frac{1}{2}at^2$$
$$d = \frac{1}{2}(30 ft/s^2)(7s)^2 = 735 ft$$

While using the formula is more convenient and probably a faster way to get the answer, make sure that your understanding of physics goes beyond simply plugging numbers into an equation!

Note that some Conceptual Physics courses use a more complete version of the distance-acceleration formula. This version takes into account the initial velocity of the object, if it's moving: $d = v_i t + \frac{1}{2}at^2$

Question:

A car at one moment in time is traveling at 30 kilometers per hour. Five seconds later, the car is traveling at 40 kilometers per hour. The car's acceleration is

a. 10 km/hr
b. 5 km/hr
c. 2 km/hr
d. 10 km/hr/s
e. 2 km/hr/s

Answer:

The correct answer is *e*. The car sped up 10 km/hr over the course of 5 seconds, so it must have been speeding up at 2 km/hr each second, or 2 km/hr/s.

That may make some intuitive sense, and in study of conceptual physics, we'll try to emphasize the logical nature these kinds of things. As you continue your study of physics, however, you'll also want to be able to use a formula to help determine the answer to problems that may not have nice round numbers given to you. The formula that helps us calculate the acceleration here is

$$acceleration = \frac{change\ in\ velocity}{time\ period}$$

$$a = \frac{v_{final} - v_{initial}}{t}$$

$$a = \frac{40km/hr - (30km/hr)}{5s}$$

$$a = \frac{10km/hr}{5s} = \frac{2km/hr}{s} = 2km/hr/s$$

Question:

A marble rolling across a carpet in the $-x$ direction (to the left), slows from an initial speed of 55 cm/s to a final speed of 11 cm/s, 4.0 seconds later? What is the acceleration of the marble during this time period?

a. 11 cm/s to the left
b. 11 cm/s to the right
c. 11 cm/s^2 to the left
d. 11 cm/s^2 to the right
e. none of these

Answer:

The correct answer is ***d***. We can see that in the 4.0 second time period in this problem, the marble slows down from 55 cm/s to 44, then 33, then 22, then 11 cm/s. In other words, it is slowing down by 11 cm/s, ***per second***, or 11 cm/s^2.

The direction of an acceleration is in the same direction as the motion if the object is speeding up, and in the opposite direction of the motion if the object is slowing down. Here, the marble is traveling in the negative-x direction (to the left) and is slowing down, so its acceleration must be in the opposite direction, to the right.

This is all neatly determined by using the acceleration equation:

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{(-11cm/s) - (-55cm/s)}{4.0s} = +11cm/s^2$$

Question:

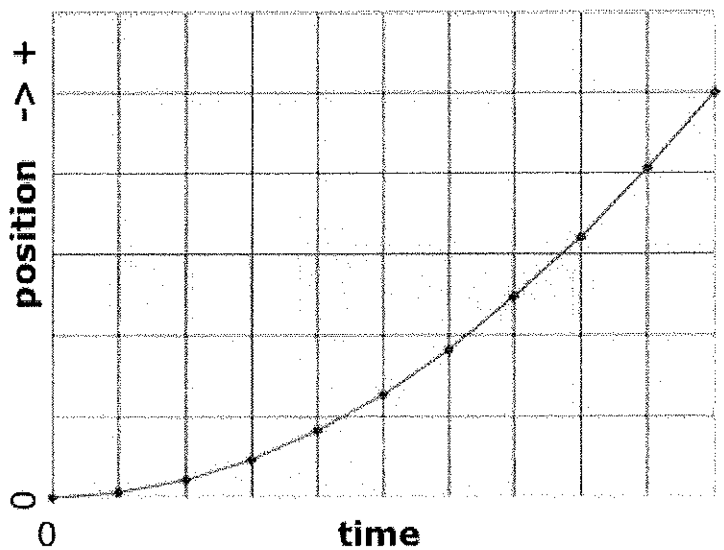
Displacement is a vector that indicates change in position. *Velocity* is a vector that indicates how quickly the change in position occurs. An object has *acceleration* if

a. its direction of motion is changing.
b. its speed is changing.
c. its velocity is changing.
d. its speed *and* direction are changing.
e. all of the above.

Answer:

The correct answer is *e*. Acceleration is, by definition, a vector quantity that indicates how quickly an object's velocity is changing. Because the velocity vector includes both direction of travel and speed, a changing velocity occurs in each situation *a* – *d* listed above.

Question:



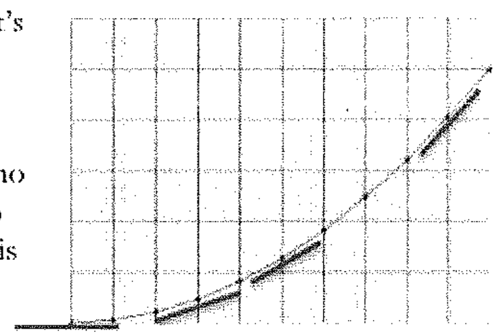
A student walks along a straight line according to the displacement-time graph shown here. Based on the graph, we can tell that the student

a. began at rest, then began to move faster and faster with acceleration in the positive direction
b. began at rest, then began to move in the positive direction with a negative acceleration
c. began with a positive velocity that increased over time
d. began with a positive velocity that decreased over time
e. moved with a constant positive speed the entire time

Answer:

The correct answer is *a*. We can determine the student's velocity at any point in time by looking at the slope of the graph at that point in time.

At the beginning, the slope of the line is 0, indicating no velocity. As time passes. the slope of the line begins to increase, revealing an increasing velocity. The student is covering greater and greater distances as each second passes. This is the very definition of acceleration, with an increasing velocity in the direction of motion.



Green lines indicate increasing slope with time.

Question:

A car travels at an average speed of 50 kilometers per hour for 2 hours. What distance did it travel during this time?

a. 25 km
b. 100 km
c. 2500 km
d. 200 km
e. 0.40 km

Answer:

The correct answer is *b*. The car travels 50 kilometers during the first hour, and another 50 kilometers during the second hour, for a total of 100 km for the two hours.

We can analyze this more quantitatively using the speed formula– $speed = \frac{distance}{time}$ –and rearranging it to solve for distance.

$$s = \frac{d}{t}$$

Rearrange to get :

$$d = st$$

$$d = \left(50\frac{km}{hr}\right)(2hr) = 100km$$

Notice that it's useful to include units in our calculations, so that we can see them cancel and ensure that we've set up our calculation correctly.

Question:

Acceleration is defined as...

a. how quickly a moving object's speed changes.
b. how quickly a moving object's velocity changes.
c. the change in an object's position over time.
d. the change in an object's displacement over time.
e. a scalar quantity.

Answer:

The correct answer is *b*. By definition, an object's acceleration is determine by the rate at which its velocity changes. You may see this formula written in several different ways:

$$acceleration = \frac{change\ \ in\ \ velocity}{time\ \ period}$$

$$a = \frac{\Delta v}{\Delta t}$$

$$a = \frac{v_{final} - v_{initial}}{t_{final} - t_{initial}}$$

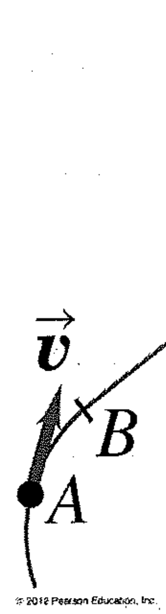
$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{v - v_0}{t}$$

Question:

The motion diagram below shows an object moving along a curved path at constant speed. At which of the points *A, C,* and *E* does the object have *zero* acceleration?

a. Point *A* only
b. Point *C* only
c. Point *E* only
d. Points *A* and *C* only
e. Points *A, C,* and *E*



Answer:

b.