Question:

Consider the functions of kinematic motion. Which of the following statements is *false*?

a. The instantaneous position is determined from the second derivative of the acceleration function.
b. The kinematic equations are valid for uniform acceleration only.
c. The instantaneous velocity is determined from the integral of the acceleration function.
d. The instantaneous acceleration is determined from the derivative of the velocity function.

Answer:
The correct answer is *a*. The instantaneous position is determined by twice integrating the acceleration function.

Question:

Arrange the steps below in the correct order sequence for the process of finding velocity-position by integration.

a. Apply initial conditions
b. Rewrite integrated function
c. Determine integration constant
d. Substitute given numerical values to find v or x at a particular instant
e. Integrate original function

Answer:
The correct answer is: **e – a – c – b – d**

Question:

A particle moving along the *x*-axis has its motion described by the equation $v = 2t^3 - 2t$, where *v* is in meters/second and *t* is in seconds. The acceleration of the object in the *x*-direction at time *t* = 2.0 seconds is:

a. 6 m/s²
b. 12 m/s²
c. 4 m/s²
d. 22 m/s²
e. 20 m/s²

Answer:

The correct answer is *d*. The acceleration of an object can be determined from its velocity function using the relationship $a = \frac{dv}{dt}$. In this problem:

$$v = 2t^3 - 2t$$

$$a = \frac{dv}{dt} = \frac{d}{dt}(2t^3 - 2t)$$

$$a = 6t^2 - 2$$

$$a(2.0s) = 6(2s)^2 - 2 = 22m/s^2$$

Question:

A particle moving along the x-axis has its motion described by the equation $v = 2t^3 - 2t$, where v is in meters/second and t is in seconds. The displacement of the object in the x-direction between $t = 1$ second and $t = 2$ seconds is:

a. -0.5 m
b. 1 m
c. 3.5 m
d. 4.5 m
e. 4.0 m

Answer:

The correct answer is *d.* The displacement of an object can be determined from its velocity function using the relationship $x = \int v \; dt$. In this problem:

$$v = 2t^3 - 2t$$

$$x = \int v \; dt = \int (2t^3 - 2t) \; dt$$

$$x = \frac{1}{2}t^4 - t^2$$

$$\Delta x = x_2 - x_1 = \left(\frac{1}{2}2^4 - 2^2\right) - \left(\frac{1}{2}1^4 - 1^2\right)$$

$$\Delta x = 4.5m$$

Question:

A student collects position-time data for an object moving along the *x*-axis, and determines that the motion corresponds closely with a mathematical model of $x = 1.5t^2 + 2.0t - 1.0$, where *x* is in meters and *t* is in seconds. Assuming that object moves according to this model, it can be determined that

a. at time $t = 0$, the object was at the origin
b. at time $t = 0$, the object had an initial velocity of 1.0 m/s
c. at time $t = 0$, the object had an initial acceleration of 1.5 m/s^2
d. during the motion, the acceleration of the object varied according to time-squared
e. none of these

Answer:

The correct answer is *e*. We can use the position-time function for the object to identify the objects position, velocity, and acceleration in a couple of different ways.

The calculus approach is based on the fact that $v = \frac{dx}{dt}$, and $a = \frac{d^2x}{dt^2}$, or $a = \frac{dv}{dt}$. Applying these relationships to the model, we see that

$$v = \frac{d}{dt}\left(1.5t^2 + 2t - 1\right) \qquad \text{and} \qquad a = \frac{d}{dt}\left(3t + 2\right)$$

$$v = 3t + 2 \qquad\qquad a = 3$$

By using $t = 0$ in the *x(t)*, *v(t)*, and *a(t)* equations we can see that none of the statements *a-d* are true. Instead, at time $t = 0$ the object has an intial position of -1.0 m, a velocity of 2.0 m/s, and an acceleration (constant throughout its motion) of 3.0 m/s^2.

A non-calculus approach to solving this problem would consist of comparing the equation with the kinematics equation $x_f = x_i + v_i t + \frac{1}{2}at^2$. Rearrange this kinematics equation and compare it with the equation of the object's motion:

$$x_f = \frac{1}{2}at^2 + v_i t + x_i$$

$$x = 1.5t^2 + 2.0t - 1.0$$

Here we can clearly identify the same initial position, the initial velocity, and the acceleration of the object according to the terms and coefficients in the equations.

Question:
A particle moves along the x-axis with an acceleration of $a = 18t$, where a has units of m/s^2. If the particle at time $t = 0$ is at the origin with a velocity of -12 m/s, what is its position at t = 4.0s?

a. 12m
b. 72m
c. 60m
d. 144m
e. 196m

Answer:
The correct answer is *d*. The particle's displacement as a function of time can be determined by analyzing the antiderivative of the acceleration and velocity:
$v = \int a \; dt$, and $x = \int v \; dt$
To get the velocity as a function of time:
$v = \int 18t \; dt = 9t^2 + C = 9t^2 + -12$, where we've given C the value -12, which represents the velocity of the particle at time $t = 0$.
Continuing:
$x = \int 9t^2 + -12 \; dt = 3t^3 - 12t + C = 3t^3 - 12t$
In this case, $C = 0$ because the location of the particle at time $t = 0$ was the origin.
Now, solve with $t = 4.0$s:
$x = 3t^3 - 12t = 3(4)^3 - 12t = 144m$

Question:

An object moving along the x-axis has its position given by the equation $x = 2.0t^2 - 3.0t + 4$, with x in meters and t in seconds. What is the acceleration of the object at time t = 4.0s?

a. 24 m/s^2
b. 46 m/s^2
c. 13 m/s^2
d. 16 m/s^2
e. 4.0 m/s^2

Answer:

The correct answer is *e*. An object's acceleration is given by the second derivative of its position function:

$$x = 2.0t^2 - 3.0t + 4$$

$$v = \frac{dx}{dt} = \frac{d}{dt}\left(2.0t^2 - 3.0t + 4\right) = 4.0t - 3.0$$

$$a = \frac{dv}{dt} = \frac{d}{dt}(4.0t - 3.0) = 4.0$$

Question:

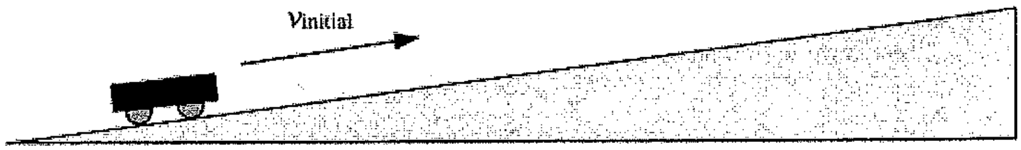
What is the first step in determining the instantaneous *velocity* and *position* functions for an object whose *acceleration* function shows a motion that is <u>not</u> uniform?

a. Apply the kinematic equations to differentiate the *acceleration* function and then use the initial conditions given to determine the *velocity* function.
b. Integrate the *acceleration* function and then apply the kinematic equations to determine the *position* function.
c. Apply the kinematic equations to differentiate the *acceleration* function and then apply the initial conditions given to determine the velocity function.
d. Differentiate the *acceleration* function and then use the initial conditions given to determine the *velocity* function.
e. Integrate the *acceleration* function and then use the initial conditions given to determine the *velocity* function.

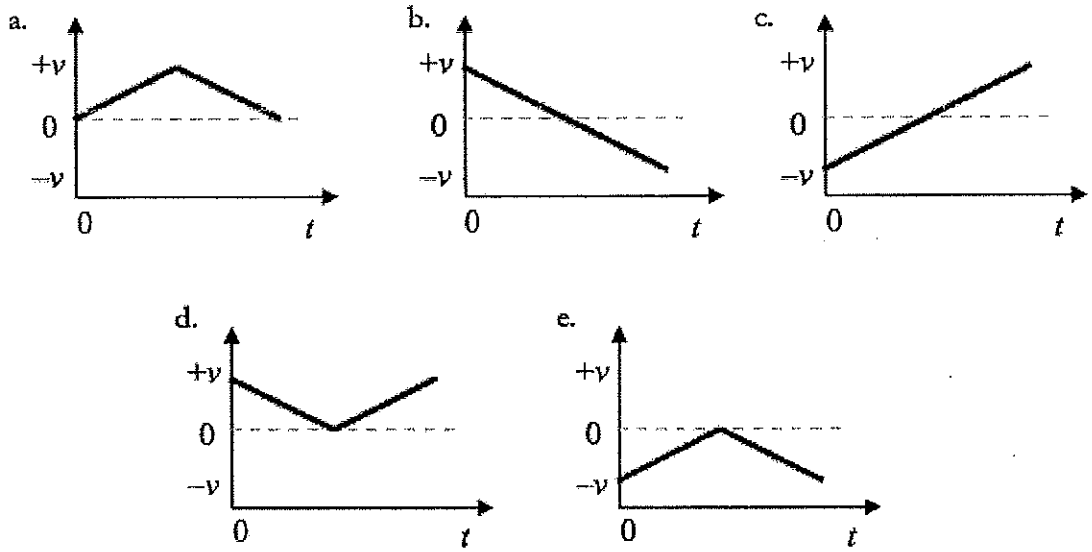
Answer:

e.

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?

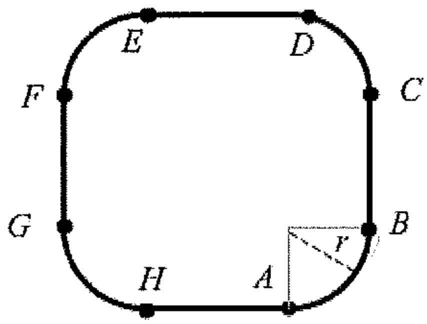


Answer:

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, $m = \frac{rise}{run} = \frac{\Delta v}{\Delta t} = a \text{ (acceleration)}$.

Question:

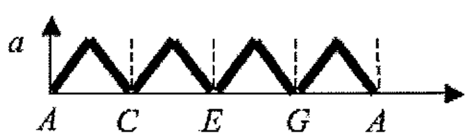


A race car drives at constant speed on a horizontal track, starting at point A and proceeding in order to points B, C, etc. until returning to point A, on the race track shown above. The race track consists of rounded, circular corners, each equal in length to the straight-line segments that connect them. Which graph best represents the magnitude of the acceleration of the car as it moves around the track?

a.

b.

c.



d.

e.

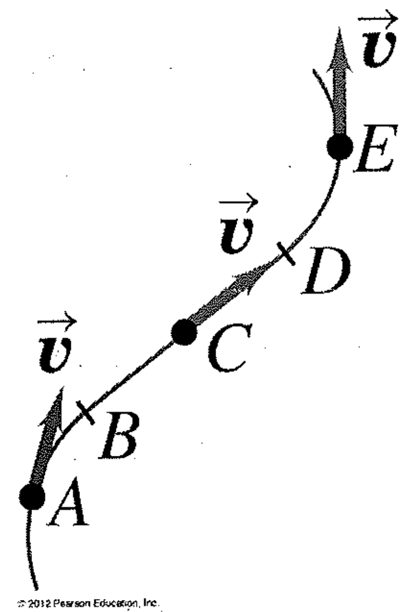
Answer:

The correct answer is *e*. The car is traveling at constant speed, so the only acceleration it will experience during its trip around the track is centripetal acceleration, when it is moving in a circular fashion at the corners. Thus, it as accelerating during line segments AB, CD, EF, and GH, but has no acceleration when it is traveling the straight-line segments that connect those circular corners.

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.

Question:

Which statement concerning kinematic rectilinear motion is correct?

I. **The magnitude of an object's average velocity is always equal to its average speed over some time interval.**
II. **The magnitude of an object's instantaneous velocity is always equal to the object's speed at that instant.**
III. **The magnitude of an object's displacement over some time interval can never be equal to its distance during that interval.**

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

Answer:

b.

Question:

An object is released from rest from a certain height above the ground. If the effects of air resistance are neglected, which of the following statements is true?

a. The object travels 9.8 m during each second
b. The object's speed changes by 9.8 m/s during each second
c. The object's acceleration changes by 9.8 m/s^2 during each second
d. The object travels 9.8 m only during the first second
e. None of the above

Answer:

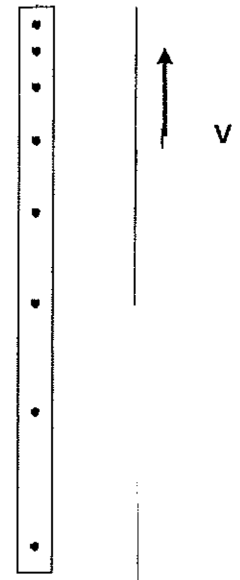
b. The acceleration *g* in free-fall is constant. This causes the speed to change by a constant amount.

Question:

Which of the following statements concerning the *SI System* are correct?

Question:

The diagram below shows the positions of an object falling upwards at equal time intervals. The velocity at the first point is ***v***.
According to the law of falling bodies, what is the velocity at the 4th point? *Neglect the effect of air.*



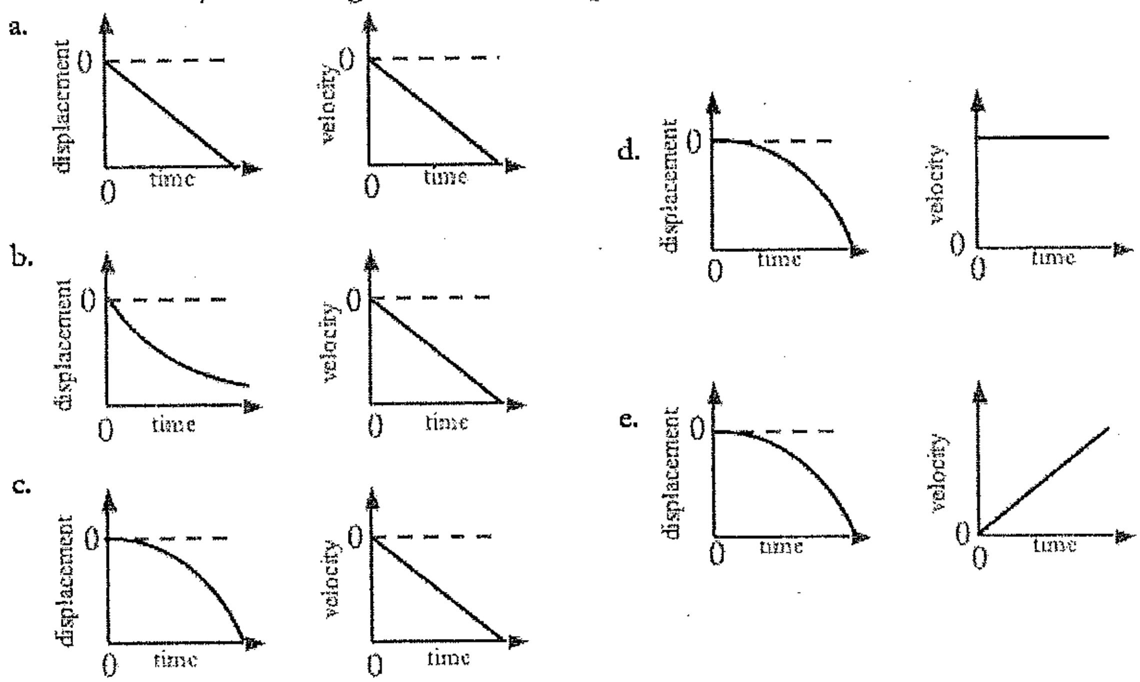
(A) $4v$
(B) $4v^2$
(C) $16v$
(D) $v/4$
(E) $v/16$

Answer:

d.

Question:

A mass is dropped from a height *h* above the ground, and freely falls under the influence of gravity. Which graphs here correctly describe the displacement and velocity of the object during the time the object is falling? Consider the "up" direction to be positive.



Answer:

The correct answer is *c*. The object begins to fall from a height *h* in the negative direction, accelerating as it falls, so it's covering a greater and greater distance per unit time. This is consistent with the displacement graphs a, c, d, and e. The object's speed increases with time, but its velocity is in the downward, or negative direction, as indicated in the velocity-time graph for answer *c*.

Question:

Which of the following statements concerning *free-fall* motion are correct?

- **I. The rate of change of *position* is constant during free-fall.**
- **II. The rate of change of *velocity* is constant during free-fall.**
- **III. The rate of change of *acceleration* is zero during free-fall.**

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

Answer:

e.

Question:

A baseball is tossed straight up into the air in the $+y$ direction. Which of the following statements is true at the point where the baseball reaches its greatest height?

a. The velocity of the ball is 0 and the acceleration of the ball is negative.
b. The velocity of the ball is 0 and the acceleration is 0.
c. The velocity of the ball is positive and the acceleration of the ball is negative
d. The velocity of the ball is positive and the acceleration of the ball is 0.
e. The velocity of the ball is negative and the acceleration of the ball is negative.

Answer:

The correct answer is *a*. Although the ball's instantaneous velocity at this point in its path is 0, its acceleration remains a constant 9.80 m/s^2 in the downward (negative) direction.

Question:

Which statement regarding *free-fall* motion is correct?

Neglect the effect of air.

I. **When objects fall upward, they accelerate downward.**
II. **The rate of change of position for falling objects is constant.**
III. **The acceleration of an object falling vertically downward is zero.**

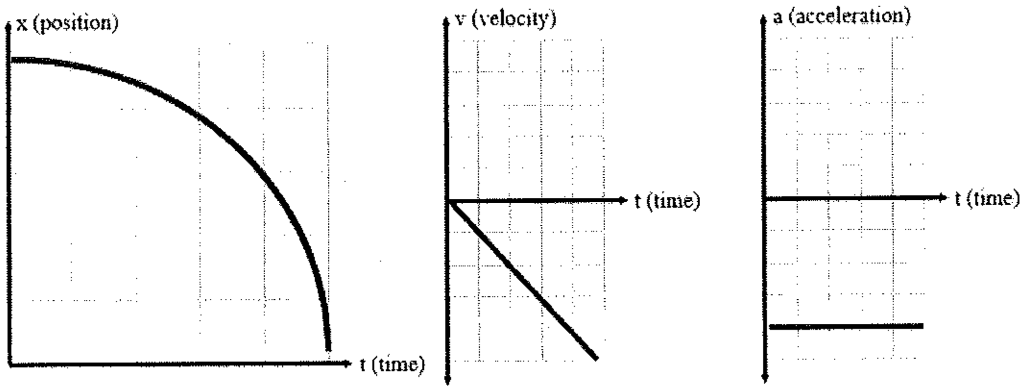
a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

Answer:

a.

Question:

The graphs below could correspond to which motion?



I. **An object falling upward.**
II. **An object falling downward.**
III. **An object with uniform acceleration moving along a horizontal path with increasing speed.**

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

Answer:

d.

Question:

Which statement regarding uniformly accelerated motion is correct?

I. Free-fall motion is not an example of uniformly accelerated motion, if the effect of air resistance is neglected.
II. The rate of change of velocity in any uniformly accelerated motion is constant if the effect of air resistance is neglected.
III. The rate of change of an object's total displacement when accelerating uniformly is never constant and changes with time according to the law of odd numbers.

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

Answer

b.

Question:

A student gives a steel ball an initial velocity to roll it up an inclined plane. In terms of the distance ***x*** traveled during the first interval of time, how far does it travel during the fourth interval of time?

a. $4x$
b. $7x$
c. $16x$
d. $1/4^2\ x$
e. $1/7\ x$

Answer:

e.