Description: A series of multiple-choice questions about the variables that appear in the standard formulae of one-dimensional kinematics (limited to the case of constant, non-zero acceleration).

Constants | Periodic Table

Learning Goal:

To understand the meaning of the variables that appear in the equations for one-dimensional kinematics with constant acceleration.

Motion with a constant, nonzero acceleration is not uncommon in the world around us. Falling (or thrown) objects and cars starting and stopping approximate this type of motion. It is also the type of motion most frequently involved in introductory kinematics problems.

The kinematic equations for such motion can be written as

$$x(t) = x_{\rm i} + v_{\rm i} t + \frac{1}{2} a t^2,$$

$$v(t) = v_{\rm i} + a t,$$

where the symbols are defined as follows:

- $x(t)$ is the position of the particle;
- $x_{\rm i}$ is the *initial* position of the particle;
- $v(t)$ is the velocity of the particle;
- $v_{\rm i}$ is the *initial* velocity of the particle;
- a is the acceleration of the particle.

In anwering the following questions, assume that the acceleration is constant and nonzero: $a \neq 0$.

Part A

The quantity represented by x is a function of time (i.e., is not constant).

ANSWER:

- (•) true
- ( ) false

Part B

The quantity represented by $x_{\rm i}$ is a function of time (i.e., is not constant).

ANSWER:

- ○ true
- ◉ false

Recall that x_i represents an initial value, not a variable. It refers to the position of an object at some initial moment.

Part C

The quantity represented by v_i is a function of time (i.e., is not constant).

ANSWER:

- ○ true
- ◉ false

Part D

The quantity represented by v is a function of time (i.e., is not constant).

ANSWER:

- ◉ true
- ○ false

The velocity v always varies with time when the linear acceleration is nonzero.

Part E

Which of the given equations is not an explicit function of t and is therefore useful when you don't know or don't need the time?

ANSWER:

- ○ $x = x_i + v_i t + \frac{1}{2} a t^2$
- ○ $v = v_i + at$
- ◉ $v^2 = v_i^2 + 2a(x - x_i)$

Part F

A particle moves with constant acceleration a. The expression $v_i + at$ represents the particle's velocity at what instant in time?

ANSWER:

- ○ only at time $t = 0$
- ○ only at the "initial" time
- ◉ when a time t has passed since the particle's velocity was v_i

More generally, the equations of motion can be written as

$$x(t) = x_i + v_i \, \Delta t + \frac{1}{2} a \, (\Delta t)^2$$

and

$$v(t) = v_i + a \, \Delta t.$$

Here Δt is the time that has elapsed since the beginning of the particle's motion, that is, $\Delta t = t - t_i$, where t is the current time and t_i is the time at which we start measuring the particle's motion. The terms x_i and v_i are, respectively, the position and velocity at $t = t_i$. As you can now see, the equations given at the beginning of this problem correspond to the case $t_i = 0$, which is a convenient choice if there is only one particle of interest.

To illustrate the use of these more general equations, consider the motion of two particles, A and B. The position of particle A depends on time as $x_A(t) = x_i + v_i t + (1/2)at^2$. That is, particle A starts moving at time $t = t_{iA} = 0$ with velocity $v_{iA} = v_i$, from $x_{iA} = x_i$. At time $t = t_1$, particle B has twice the acceleration, half the velocity, and the same position that particle A had at time $t = 0$.

Part G

What is the equation describing the position of particle B?

▸ **View Available Hint(s)** (1)

ANSWER:

- ○ $x_B(t) = x_i + 2v_i t + \frac{1}{4}at^2$
- ○ $x_B(t) = x_i + 0.5v_i t + at^2$
- ○ $x_B(t) = x_i + 2v_i(t + t_1) + \frac{1}{4}a(t + t_1)^2$
- ○ $x_B(t) = x_i + 0.5v_i(t + t_1) + a(t + t_1)^2$
- ○ $x_B(t) = x_i + 2v_i(t - t_1) + \frac{1}{4}a(t - t_1)^2$
- ◉ $x_B(t) = x_i + 0.5v_i(t - t_1) + a(t - t_1)^2$

Part H

At what time does the velocity of particle B equal that of particle A?

▸ **View Available Hint(s)** (2)

ANSWER:

- ○ $t = t_1 + \frac{v_i}{4a}$
- ◉ $t = 2t_1 + \frac{v_i}{2a}$
- ○ $t = 3t_1 + \frac{v_i}{2a}$
- ○ The two particles never have the same velocity.