Position, Velocity, and Acceleration Solutions

PHYS 2425

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1. Position, Velocity, and Acceleration

A. This is mainly becuase we don't know the starting position. Knowing how position has changed without knowing where it actually started doesn't help us know the new position.

B. Their graphs will have the same slope but will have different y intercepts.

C. Yes- an object could start with a negative velocity and be accelerating in the positive direction, meaning eventually the velocity will reach 0 with a constant acceleration. Imagine throwing an object up- eventually, it has to turn around to fall down, so at the peak (turn around point) it will have zero velocity.

D. Yes, just because an object isn't acceleration (speeding up) doesn't mean it's not moving.

E. The velocity must have a positive slope (must be speeding up.) However, if position started in the negative than it could be moving towards the origin.

F.

$$\vec{v}(t) = 5, \qquad \vec{a}(t) = 0$$
$$\vec{v}(t) = 2t, \qquad \vec{a}(t) = 2$$
$$\vec{v}(t) = cos(t), \qquad \vec{a}(t) = -sin(t)$$

G.

$$\vec{x}(t) = t^2 + 3t + 3 \quad \frac{m}{s}$$

2. Circular Motion

A. Define uniform circular motion. What is constant and what is changing? Uniform circular motion means the particle moves around a circle at constant speed. The magnitude of velocity is constant, but the direction changes. Therefore, acceleration is nonzero and points toward the center of the circle.

B. A particle moves in a circle of radius r with (instantaneous) speed v. Write expressions for:

1. Angular speed: $\omega = \frac{v}{r}$.
2. Period and frequency: $T = \frac{2\pi}{\omega}, \quad f = \frac{1}{T} = \frac{\omega}{2\pi}$.
3. Radial acceleration: $a_{\mathrm{r}} = \frac{v^2}{r} = r\omega^2$.

C. For uniform circular motion, explain qualitatively why the acceleration vector is nonzero even though the speed is constant. The speed $|\mathbf{v}|$ does not change, but the *direction* i of $\mathbf{v}$ does. Acceleration is the derivative of velocity, so a changing direction implies $\mathbf{a} \neq 0$. The acceleration points inward toward the center, perpendicular to the velocity.