Answer on Question #51583-Physics-Mechanics-Kinematics-Dynamics

Amplitude of vibrational of a particle in SHM with time period $T = 1\ sec$ is $S = 0.05\ m$. average speed of the particle in one period is...

1) $0.4\frac{m}{s}$. 2) $0.2\frac{m}{s}$. 3) $0.1\frac{m}{s}$. 4) $0.00\frac{m}{s}$.

Solution

An average speed of the particle in one period is always zero!

But we can prove this.

Let the displacement of a particle in SHM be

$$x = A\cos(\omega t - \varphi),$$

where A, the maximum value of the displacement, is called the amplitude of the motion. If

T is the time for one complete oscillation and φ is the phase angle, then the velocity v is

$$v = \frac{dx}{dt} = -A\omega\sin(\omega t - \varphi) = -A\omega\sqrt{1 - \frac{x^2}{A^2}}.$$

The acceleration of the particle is

$$a = \frac{dv}{dt} = -A\omega^2\cos(\omega t - \varphi) = -\omega^2 x.$$

Average speed of the particle in one period is

$$\bar{v} = \frac{1}{T}\int_{t_0}^{t_0+T} v(t)dt = \int_{t_0}^{t_0+T} (-A\omega\sin(\omega t - \varphi))dt = \frac{1}{T}\big(x(t_0 + T) - x(t_0)\big).$$

But $x(t_0 + T) = x(t_0)$ for periodic motion. Thus,

$$\bar{v} = \frac{1}{T}\cdot 0 = 0.$$

Answer: 4) $\mathbf{0.00\frac{m}{s}}$.