Name KEY SP436 Quiz 1

A simple oscillator whose natural frequency is 5 rad/sec is displaced a distance 0.030 m from its equilibrium position and released with an initial push that gives it a speed of .10 m/s at t = 0 sec. What is the amplitude of the resulting motion?

$$x = A\cos(\omega t + \phi)$$

$$x(t=0) = .03\,m = A\cos\phi$$

$$u(t=0) = .10\,m/s = -A\omega\sin(\omega t + \phi) = -A\omega\sin\phi$$

$$A = \frac{.03m}{\cos\phi}$$

$$.10\,m/s = -\frac{(.03m)}{\cos\phi}(5\,rad/s)\sin\phi$$

$$\tan\phi = -.667 \Rightarrow \phi = -.588\,rad \quad (-33.7°)$$

$$A = \frac{.03m}{\cos(-.588\,rad)} = \boxed{0.036\,m}$$

OR

$$x = A_1\cos\omega t + A_2\sin\omega t$$

$$x(t=0) = .03 = A_1$$

$$u(t=0) = -A_1\omega\sin\omega t + A_2\omega\cos\omega t = .10\,m/s$$

$$A_2 = \frac{.10\,m/s}{5\,rad/s} = .02\,m$$

$$A = \sqrt{A_1^2 + A_2^2} = \sqrt{.03m^2 + .02m^2}$$

$$= \boxed{.036\,m}$$

$$\phi = \tan^{-1}\left(\frac{.02m}{.03m}\right) = .588\,rad \quad (33.7°)$$