

PHYS 211 Quiz #7

20 points - Please write your name on the back.

1. A particle undergoes simple harmonic motion with a frequency of 10 Hz. Find the displacement x at any time t subject to the following initial condition: $t = 0$, $x = 0.25\text{m}$, $v = 0.1\text{ m/s}$

In this case the initial conditions ($v = 0.1\text{ m/s}$ at $t = 0$) suggest that both A and B will be non-zero. The linear frequency, f , is 10 Hz and the angular frequency, ω , is $20\pi\text{ rad/s}$.

$$x(t) = A \cos(\omega t) + B \sin(\omega t)$$

$$v(t) = \dot{x}(t) = -\omega A \sin(\omega t) + \omega B \cos(\omega t)$$

$$a(t) = \ddot{x}(t) = -\omega^2 A \cos(\omega t) - \omega^2 B \sin(\omega t)$$

At $t = 0$

$$0.25\text{m} = A \cos(0) + B \sin(0) \therefore A = 0.25\text{m}$$

$$0.1\text{ m/s} = -\omega(0.25\text{m})\sin(0) + \omega B \cos(0)$$

$$0.1\text{ m/s} = (20\pi\text{rad/s})B \therefore B = 0.00159\text{m}$$

so

$$x(t) = 0.25\text{m} \cos(20\pi t) + 0.00159\text{m} \sin(20\pi t)$$

2. A 1 kg body oscillates with simple harmonic motion along the x -axis. It's displacement varies with time as $x(t) = 4.0\text{m} \cos\left(\pi t + \frac{\pi}{4}\right)$, Determine the amplitude, period, angular and linear frequencies of motion and the value of k .

This may be done almost entirely by inspection as this equation has the form $x(t) = A \cos(\omega t + \alpha)$ with:

- $A = 4.0\text{m}$
- $\omega = \pi$
- $f = \frac{\omega}{2\pi} = 2\text{ Hz}$
- $T = \frac{1}{f} = 0.5\text{s}$
- $\omega^2 = \frac{k}{m} \therefore k = \omega^2 m = \pi^2(1) \therefore k = \pi^2$