PHY 110 Spring 2018 Quiz 12 Solution

Consider a particle that undergoes simple harmonic motion in the *x*-direction according to the following expression (*x* is in meters, *t* is in seconds):

$$x = 0.8\sin\left(5\pi t - 0.7\right)$$

1. What is the maximum acceleration the particle experiences?

a) 34 m/s^2 b) 75 m/s^2 c) 119 m/s^2 d) 146 m/s^2 **e) 197 m/s^2**

$$a_{\max} = \omega^2 A = \left(5\pi\right)^2\left(0.8\right) = 197\frac{m}{s^2}$$

2. What is the first time $t > 0$ when the particle is at the equilibrium position ($x = 0$)?

a) 0.045 s b) 0.083 s c) 0.092 s d) 0.126 s e) 0.155 s

Note that at t = 0, the particle is at x = 0.8 sin(–0.7) = –0.515 m. Note that as t increases, the argument of the sine function (the "phase" of the motion) increases (becomes more positive). The sine function becomes zero when the argument is zero or any multiple of π, whether positive or negative. Since the argument at t = 0 is already more positive than –π, the next "zero" of the sine occurs when the argument reaches 0. Set 5πt – 0.7 = 0 and you'll get the answer.

3. Which direction is the particle moving at the instant described in question 2?

a) Towards positive *x* b) Towards negative *x* c) Its velocity is zero

Follow what the sine function is doing in the previous explanation.

4. When the velocity of the particle is maximum and positive, its acceleration is

a) zero b) maximum and negative c) maximum and positive

The particle's velocity is maximum when it passes through the spring's equilibrium point, therefore the force (and the acceleration) is zero.

5. When the acceleration of the particle is maximum and positive, its position is

a) zero **b) maximum and negative** c) maximum and positive

You get maximum positive (to the right) force when you're at the spring's maximum location to the left (negative).

$$\omega = 2\pi f \qquad f = \frac{1}{T} \qquad x(t) = A\cos\left[\omega t + \phi\right]$$