Problem 13.28

Consider a position function $x = (0.052\ \text{m})\sin(8\pi t - 2.62)$.

a.) What is the period?

b.) What is the frequency?

c.) What is the amplitude?

d.) When will it reach x=.026 meters?

e.) What is the phase shift?

f.) Is the body moving away from or toward equilibrium at t = 0?

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Consider a position function $x = (0.052\ \text{m})\sin(8\pi t - 2.62)$.

a.) What is the period?

the angular frequency:

$$\omega = 8\pi\ \text{rad/sec}$$

the frequency:

$$\omega = 8\pi\ \text{rad/sec}$$
$$= 2\pi\nu$$
$$\Rightarrow \quad \nu = 4\ \text{rad/sec}$$

the period:

$$T = \frac{1}{\nu}$$
$$= \frac{1}{(4\ \text{rad/sec})}$$
$$\Rightarrow \quad T = .25\ \text{sec}$$

Consider a position function $x = (0.052\ \text{m})\sin(8\pi t - 2.62)$.

b.) What is the frequency?

From the function, the angular frequency is $\omega = 8\pi$, so the frequency is:

$$\omega = 2\pi\nu \Rightarrow \nu = \frac{\omega}{2\pi} = \frac{8\pi}{2\pi} = 4\ \text{cycles/sec}$$

c.) What is the amplitude?

From the function, A = 0.052 m

d.) When will it reach x=.026 meters?

$$x = (0.052\ \text{m})\sin(8\pi t - 2.62)$$

$$\Rightarrow \quad 0.026 = (0.052\ \text{m})\sin(8\pi t - 2.62)$$

$$\Rightarrow \quad \frac{0.026}{0.052\ \text{m}} = \sin(8\pi t - 2.62)$$

$$\Rightarrow \quad .5 = \sin(8\pi t - 2.62) \Rightarrow (8\pi t - 2.62) = \sin^{-1}(.5) \Rightarrow (8\pi t - 2.62) = .52$$

$$\Rightarrow \quad 8\pi t = 3.14 \Rightarrow t = \frac{3.14}{8\pi} = .125\ \text{sec}$$

Consider a position function $x = (0.052\text{ m})\sin(8\pi t - 2.62)$.

e.) What is the phase shift?

Taken right off the function, the phase shift is:

-2.62 rad

f.) Is the body moving toward equilibrium or away from equilibrium at t = 0?

The phase shift is what determines where the axis is, which in turns determines what happens just after the clock starts. A negative phase shift means the axis has been pushed leftward. For the first quarter cycle, which corresponds to a $-\pi/2$ shift (or –1.57 radian shift), the motion proceeds back toward equilibrium (look at a graph to see this). The next quarter cycle brings us to –pi radians (or –3.14 radians) for which the object will be moving away from equilibrium. As this phase shift is between those two values, we are looking at the second region and the motion will be away from equilibrium.