Recitation 1

•1 If a wave $y(x, t) = (6.0\text{ mm})\sin(kx + (600\text{ rad/s})t + \phi)$ travels along a string, how much time does any given point on the string take to move between displacements $y = +2.0$ mm and $y = -2.0$ mm?

$$kx + \omega t + \phi = \sin^{-1} y/y_m$$

$$\omega\Delta t = \sin^{-1}\frac{y_2}{y_m} - \sin^{-1}\frac{y_1}{y_m}$$

$$\sin^{-1}\frac{y_2}{y_m} - \sin^{-1}\frac{y_1}{y_m} = \sin^{-1}\frac{2.0}{6.0} - \sin^{-1}\frac{-2.0}{6.0} = 2\sin^{-1}\frac{1}{3.0}$$

$$\Delta t = \frac{2}{\omega}\sin^{-1}\frac{1}{3.0} = \frac{2}{600}\sin^{-1}\frac{1}{3.0} = 0.0011\text{ s} = 1.1\text{ ms}.$$

••13 ILW A sinusoidal wave of frequency 500 Hz has a speed of 350 m/s. (a) How far apart are two points that differ in phase by $\pi/3$ rad? (b) What is the phase difference between two displacements at a certain point at times 1.00 ms apart?

a)

$$\Phi_2 - \Phi_1 = \pi/3$$

$$\Phi_2 - \Phi_1 = (kx_2 - \omega t) - (kx_1 - \omega t) = k(x_2 - x_1) = k\Delta x$$

$$\Delta x = \frac{\pi/3}{k} = \frac{\pi/3}{2\pi/\lambda} = \frac{\lambda}{6} = \frac{v}{6f} = \frac{350}{6(500)} = 0.117 \text{ m} = 11.7 \text{ cm}.$$

b)

$$|\Phi_2 - \Phi_1| = |(kx - \omega t_2) - (kx - \omega t_1)| = \omega(t_2 - t_1) = \omega\Delta t$$

$$= 2\pi f \Delta t = 2\pi(500\ \text{Hz})(1.00 \times 10^{-3}\ \text{s}) = 3.14\ \text{rad.}$$

■**1.** The displacement of a string carrying a traveling sinusoidal wave is given by: $y(x,t) = y_m \sin(kx - \omega t + \varphi)$. At time $t = 0$, the point at $x = 0$ has a displacement of zero and is moving in the positive y direction. Find the value of the phase constant φ.

$$y(0,0) = y_m \sin\varphi = 0 \qquad \Longrightarrow \varphi = 0 \text{ or } \pi$$

$$u(x,t) = \frac{\partial y}{\partial t} = -y_m \omega \cos(kx - \omega t + \varphi)$$

$$u(0,0) = -y_m \omega \cos\varphi > 0 \Longrightarrow \varphi = \pi$$

■**15.** A particle of a string moves up and down as a traveling sinusoidal wave passes through it. If the time for that particle to move from maximum displacement to zero displacement is 0.2 s, what is the frequency of the wave?

$$\frac{1}{4}T = 0.2\ \text{s} = \frac{1}{4f} \qquad \Longrightarrow f = 1.25\ \text{Hz}$$

■**35.** A transverse sinusoidal wave traveling in the negative x direction has an amplitude of 10.0 cm, a wavelength of 20.0 cm, and a frequency of 8.00 Hz. Write the expression for y as a function of x (in meters) and t (in seconds) if y (0,0) = 10.0 cm.

$$\omega = 2\pi f = 2\pi(8.00\ \text{Hz}) = 50.3\ \text{rad/s}$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.200\ \text{m}} = 31.4\ \text{rad/s}$$

$$y(0,0) = y_m \sin\varphi$$

$$\varphi = \sin^{-1}\frac{y(0,0)}{y_m} = \sin^{-1} 1 = \frac{\pi}{2}$$

$$y(x,t) = (0.100\ \text{m}) \sin\left(31.4x + 50.3t + \frac{\pi}{2}\right)$$