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? ILW

a) $f = 500$ Hz $\quad v = 350$ m/s

$$\Delta x = \frac{\lambda}{2\pi} \Delta\phi$$

path length difference

phase difference

$$\lambda = \frac{v}{f} = \frac{350}{500} = 0.7 \text{ m}$$

$$\Delta x = \frac{0.7}{2\pi} \times \frac{\pi}{3} = 0.117 \text{ m}$$

$$= 11.7 \text{ cm}$$

b)

$$\Delta\phi = \omega \Delta t$$

$$= 2\pi f \Delta t$$

$$= 2 \times \pi \times 500 \times 1 \times 10^{-3} = \pi \text{ rad}$$

8 (2) The heaviest and lightest strings on a certain violin have linear densities of 3.0 and 0.29 g/m. What is the ratio of the diameter of the heaviest string to that of the lightest string, assuming that the strings are of the same material?

$$\mu_1 = 3 \text{ g/m}$$

$$\mu_2 = 0.29 \text{ g/m}$$

$$\mu = \frac{m}{\ell} = \frac{\rho V}{\ell} = \frac{\rho(\pi r^2 \ell)}{\ell} = \rho \pi r^2 = \rho \frac{\pi d^2}{4}$$

$$\frac{\mu_1}{\mu_2} = \frac{\rho \frac{\pi d_1^2}{4}}{\rho \frac{\pi d_2}{4}} = \left(\frac{d_1}{d_2}\right)^2$$

$$\Rightarrow \quad \frac{d_1}{d_2} = \sqrt{\frac{\mu_1}{\mu_2}} = \sqrt{\frac{3}{0.29}} = \underline{\underline{3.2}}$$

20 A sinusoidal wave is traveling on a string with speed 40 cm/s. The displacement of the particles of the string at $x =$ 10 cm is found to vary with time according to the equation $\boxed{y = (5.0 \text{ cm}) \sin[1.0 - (4.0 \text{ s}^{-1})t]}$. The linear density of the string is 4.0 g/cm. What are (a) the frequency and (b) the wavelength of the wave? If the wave equation is of the form $y(x, t) = y_m \sin(kx \pm \omega t)$, what are (c) $y_m$, (d) $k$, (e) $\omega$, and (f) the correct choice of sign in front of $\omega$? (g) What is the tension in the string?

$$y = y_m \sin(k\underset{\substack{\uparrow \\ 0.1\,m}}{x} - \omega t)$$

a) $\omega = 4 \frac{rad}{s} \Rightarrow f = \frac{\omega}{2\pi} = \underline{\underline{0.64 \text{ Hz}}}$

b) $k \times 0.1 = 1 \Rightarrow k = 10 \ /m \Rightarrow \lambda = \frac{2\pi}{k}$
$= \underline{\underline{0.63 \, m}}$

c) $y_m = 5 \text{ cm} = \underline{\underline{0.05 \, m}}$

d) $k = \underline{\underline{10 \, m^{-1}}}$

e) $\omega = \underline{\underline{4 \text{ rad/s}}}$

f) $+x$ direction

g) $\tau = \mu v^2 = 4 \times 10^{-3} \times (0.4)^2 = \underline{\underline{0.00064 \, N}}$
$\underline{6.4 \times 10^{-4} N}$

A string along which waves can travel is 2.70 m long and has a mass of 260 g. The tension in the string is 36.0 N. What must be the frequency of traveling waves of amplitude 7.70 mm for the average power to be 85.0 W?

$$\bar{P} = \frac{1}{2} \mu v \omega^2 y_m^2$$

$$\mu = \frac{m}{\ell} = \frac{0.26}{2.7} = 0.096 \text{ Kg/m}$$

$$\tau = \sqrt{\frac{v}{\mu}} \Rightarrow v = \tau^2 \mu = (36)^2 \times 0.096$$

$$v = 124.4 \text{ m/s}$$

$$\bar{P} = 85 \text{ W}$$

$$y_m = 7.7 \times 10^{-3} \text{ m}$$

$$\omega = \sqrt{\frac{2\bar{P}}{\mu v y_m^2}} = 490 \text{ rad/s} = 2\pi f$$

$$f = \underline{\underline{78 \text{ HZ}}}$$