QUIZ#1- CHAPTER 16
DATE: 30/01/20

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1. Two identical sinusoidal transverse waves travel in the same direction along a stretched string. Each wave has an amplitude $y_m = 2.0$ cm and wavelength λ. The phase difference between the two waves is $0.20\,\lambda$.

(a) What is the phase difference in radian?

$$\phi = (0.2\lambda)\left(\frac{2\pi \text{ rad}}{1\ \lambda}\right) = \boxed{1.257 \text{ rad}}$$

(b) What is the amplitude of the resultant?

$$y'_m = 2 y_m \cos\frac{\phi}{2} = \boxed{3.24 \text{ cm}}$$

2. A standing wave, having three nodes, is set up on a string fixed at both ends. If the frequency of the wave is doubled, how many antinodes will there be?

f_2  2nd harmonic

double the freq $\Rightarrow$ f_4  4th harmonic

5 nodes

4 antinodes

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A wave on a stretched string is described by the displacement wave:

$$y(x,t) = 0.400 \sin(300t - 15.0x)$$

where x and y are in meters and t is in seconds.

(a) What is the speed of the wave?

$k = 15$ rad/m $\quad \omega = 300$ rad/s $\quad v = \frac{\omega}{k} = \frac{300}{15} = \boxed{20\ m/s}$

(b) What is the maximum transverse velocity?

$$u_{max} = \omega y_m = (300)(0.4) = \boxed{120\ m/s}$$

(c) What is the tension in the string if the linear mass density is 60 g/m?

$$v = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu v^2 = (60\times10^{-3})(20)^2 = \boxed{24N}$$

(d) What is the phase difference between two points on the string 21.0 cm apart?

$$x = \frac{\lambda}{2\pi}\phi \Rightarrow \phi = \frac{2\pi}{\lambda}x = \frac{2\pi}{0.42} \times 0.21 = \boxed{\pi\ rad}$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{15} = 0.42m$$

(e) What is the average power transmitted by this wave?

$$P = \frac{1}{2}\mu v \omega^2 y_m^2 = \frac{1}{2}(60\times10^{-3}) \times 20 \times (300)^2 \times (0.4)^2$$

$$\boxed{P = 8640\ W}$$

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1. Two sinusoidal waves travel simultaneously through the same medium. The first wave is described by $y_1(x,t) = y_m \cos(kx-\omega t)$ and the second wave by $y_2(x,t) = y_m \cos(kx-\omega t + \varphi)$. If the amplitude of the resulting superposition is $y_m/2$, what is the value of φ in wavelength?

$$y'_m = 2y_m \cos\frac{\phi}{2} = \frac{y_m}{2}$$

$$\cos\frac{\phi}{2} = \frac{1}{4} \Rightarrow \frac{\phi}{2} = \cos^{-1}\left(\frac{1}{4}\right)$$

$$\phi = 2\cos^{-1}\left(\frac{1}{4}\right) = 151^\circ = 2.63 \text{ rad}$$

$$= 2.63 \text{ rad}\left(\frac{1\lambda}{2\pi \text{ rad}}\right) = \boxed{0.42\lambda}$$

2. A string, fixed at both ends, has a fundamental frequency $f_a = 248$ Hz. The tension τ in the same string is changed so that the new fundamental frequency is $f_b = 496$ Hz. What is the value of the ratio τ_b/τ_a?

$$f_a = \frac{v_a}{2L} \qquad f_b = \frac{v_b}{2L}$$

$$\frac{f_b}{f_a} = \frac{\frac{v_b}{2L}}{\frac{v_a}{2L}} = \frac{v_b}{v_a} = \frac{\sqrt{\frac{\tau_b}{\mu}}}{\sqrt{\frac{\tau_a}{\mu}}} = \sqrt{\frac{\tau_b}{\tau_a}}$$

$$\frac{\tau_b}{\tau_a} = \left(\frac{f_b}{f_a}\right)^2 = \left(\frac{496}{248}\right)^2 = (2)^2 = \boxed{4}$$