KING FAHD UNIVERSITY OF PERTOLEUM & MINERALS
PHYSICS DEPARTMENT
QUIZ #1- CHAPTER 16

NAME: Key ID# SECTION#

When a wave travels through a medium, individual particles execute a periodic motion given by the equation: $y = 0.5 \cos\{2\pi(t+x/8)\}$ where x and y and are in meters and t is in seconds.

(a) Calculate the wavelength

$\lambda = \frac{2\pi}{k}$ $\quad k = \frac{2\pi}{8} = \frac{\pi}{4} m^{-1} \Rightarrow \lambda = \frac{2\pi}{\frac{\pi}{4}} =$ **8 m**

(b) Calculate the frequency

$f = \frac{\omega}{2\pi}$ $\quad \omega = 2\pi \Rightarrow f = \frac{2\pi}{2\pi} =$ **1 Hz**

(c) Calculate the speed of the wave

$v = \frac{\omega}{k} = \frac{2\pi}{\frac{\pi}{4}} =$ **8 m/s**

(d) Calculate the maximum transverse velocity.

$u_{max} = y_m \omega = 0.5 \times 2\pi =$ **π m/s**

(e) Calculate the phase difference in radian at any given instant between two particles that are 12 m apart.

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

$x = 12m \Rightarrow \phi = \frac{2\pi}{8} \times 12 =$ **3π rad**

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A string, fixed at both ends, vibrates according to the equation: $y = 1.2 \sin(3.0\pi x) \cos(10\pi t)$ where x is meters and t is in seconds.

(a) Calculate the wavelength.

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{3\pi} = \boxed{0.67\ m}$$

(b) What are the positions of the first two antinodes?

$$x_1 = \frac{\lambda}{4} = \boxed{0.167\ m}$$

$$x_2 = \frac{3\lambda}{4} = \boxed{0.5\ m}$$

(c) What are the positions of the first two nodes?

$$x_1 = 0$$

$$x_2 = \frac{\lambda}{2} = \boxed{0.335\ m}$$

(d) What is the tension in the string if its mass per unit length is 30 g/m?

$$v = \frac{\omega}{k} = \frac{10\pi}{3\pi} = 3.33\ m/s$$

$$v = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu v^2 = 0.03 \times (3.33)^2 = \boxed{0.33\ N}$$

(e) What is the frequency of the 3th harmonic if the length of the string is 5.0 m?

$$f_3 = 3\frac{v}{2L} = 3 \times \frac{3.33}{2 \times 5} = \boxed{1.0\ HZ}$$

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Two identical waves, moving in the same positive direction along a stretched string, interfere with each other. The amplitude, wavelength and frequency of each wave are 5.0 mm, 15 cm, and 200 Hz, respectively. The phase difference between them is 1.2 radians.

(a) Write the wave equations of the two interfering waves.

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.15} = 13.3\pi \ m^{-1}$ $\quad y_m = 5 \text{ mm}$

$\omega = 2\pi f = 2\pi(200) = 400\pi \text{ rad/s}$ $\quad \phi = 1.2 \text{ rad}$

$$y_1 = (5 \text{ mm}) \sin(13.3\pi x - 400\pi t)$$

$$y_2 = (5 \text{ mm}) \sin(13.3\pi x - 400\pi t + 1.2)$$

(b) Write the wave equation of the resultant wave.

$$y' = 2y_m \cos\frac{\phi}{2} \sin(kx - \omega t + \frac{\phi}{2})$$

$$= 10 \text{ mm} \cos(0.6) \sin(13.3\pi x - 400\pi t + 0.6)$$

$$y' = (8.25 \text{ mm}) \sin(13.3\pi x - 400\pi t + 0.6)$$

(c) What is maximum transverse speed of the particles in the medium?

$$u'_{max} = (8.25 \text{ mm})(400\pi)$$

$$= 8.25 \times 10^{-3} \times 400\pi = 10.4 \text{ m/s}$$