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

NAME: Key ID# SECTION# 37

When a wave travels through a medium, individual particles execute a periodic motion given by the equation: $y = 4.0 \sin\{\pi/4(2t+x/8)\}$ where x and y and are in meters and t is in seconds. Calculate

(a) The displacement of the particles at x = 1.0 m and t = 3.0 s.

$$y(x,t) = 4 \sin\left(\frac{\pi}{32}x + \frac{\pi}{2}t\right)$$

$$y(1,3) = 4 \sin\left(\frac{\pi}{32}\times 1 + \frac{\pi}{2}\times 3\right) = \boxed{-3.98\text{m}} \simeq -4\text{ m}$$

(b) The transverse velocity at x = 1.0 m and t = 3.0 s.

$$u(x,t) = 4 \times \frac{\pi}{2} \cos\left(\frac{\pi}{32}x + \frac{\pi}{2}t\right)$$

$$u(1,3) = 2\pi \cos\left(\frac{\pi}{32}\times 1 + \frac{\pi}{2}\times 3\right)$$

$$= \boxed{0.62\text{ m/s}}$$

(c) The transverse acceleration at x = 1.0 m and t = 3.0 s.

$$a(x,t) = -4 \times \left(\frac{\pi}{2}\right)^2 \sin\left(\frac{\pi}{32}x + \frac{\pi}{2}t\right)$$

$$a(1,3) = -4 \times \left(\frac{\pi}{2}\right)^2 \sin\left(\frac{\pi}{32} + \frac{\pi}{2}\times 3\right)$$

$$= \boxed{-9.8\text{ m/s}^2}$$

or $a(1,3) = \omega^2 y(1,3) = \left(\frac{\pi}{2}\right)^2 \times (-3.98)$

$$= \boxed{-9.8\text{ m/s}^2}$$

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A string, fixed at its ends, vibrates according to the equation: $y = 0.5 \sin(1.5\pi x) \cos(40\pi t)$ where x and are in meters and t is in seconds.

(a) What is the speed of one of the two combining waves?

$$v = \frac{\omega}{k} = \frac{40\pi}{1.5\pi} = \boxed{26.7 \text{ m/s}}$$

(b) What the transverse velocity of a particle at x = 1.0 m and t = 2.0 s?

$$u = -0.5 \times 40\pi \sin(1.5\pi x) \sin(40\pi t)$$

$$u = -0.5 \times 40\pi \sin(1.5\pi \times 1) \sin(40\pi \times 2)$$

$$= \boxed{0}$$

(c) What are the positions of the first antinode and the second node?

first antinode $x = \frac{\lambda}{4} = \frac{2\pi}{4k} = \frac{2\pi}{4 \times 1.5\pi} = \boxed{0.33 \text{ m}}$

Second node $x = \frac{\lambda}{2} = \boxed{0.67 \text{ m}}$

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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.

(a) What is the angular wavenumber of this wave?

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.2} = 10\pi \text{ rad/m}$$

(b) What is the angular frequency of this wave?

$$\omega = 2\pi f = 16\pi \text{ rad/s}$$

(c) Write the expression for y(x,t) as a function of x and t if y(0,0) = 10.0 cm.

$$y(x,t) = y_m \sin(kx + \omega t + \phi)$$

$$y(0,0) = 10 \text{ cm} = y_m = y_m \sin\phi$$

$$\Rightarrow \quad \sin\phi = 1 \Rightarrow \phi = \frac{\pi}{2}$$

$$\Rightarrow \boxed{y(x,t) = (10\text{ cm}) \sin\left(10\pi x + 16\pi t + \frac{\pi}{2}\right)}$$