

# Assignment # 1

## Waves I

### Chapter 15 : Mechanical Waves

#### Important Formulas:

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

$$v = \sqrt{\frac{E}{\mu}}$$

$$P_{av} = \frac{1}{2} \sqrt{\mu F} \omega^2 A^2$$

#### Question 1: (Total points 35)

A wave traveling along a string is described by;  $y(x, t) = 0.00327 \sin(72.1x - 2.72t)$ , in which the numerical constants are in SI units (0.00327 m, 72.1 rad/m, and 2.72 rad/s).

- (a) What is the amplitude of this wave? (5 points)
- (b) What are the wavelength, period, and frequency of this wave? (5 points)
- (c) What is the velocity of this wave? (10 points)
- (d) What is the displacement  $y$  of the string at  $x = 22.5$  cm and  $t = 18.9$  s? (5 points)
- (e) What is  $u$ , the transverse velocity of the element of the string at  $x = 22.5$  cm and  $t = 18.9$  s? (5 points)
- (f) After solving all of the parts in question, please draw a proper labeled diagram and show all the important parameters in that diagram. (5 points)

#### Question 2: (Total points 20)

Transverse waves on a string have wave speed 8.00 m/s, amplitude 0.0700 m, and wavelength 0.320 m. The waves travel in the  $-x$ -direction, and at  $t=0$  the  $x=0$  end of the string has its maximum upward displacement.

- (a) Find the frequency, period, and wave number of these waves. (5 points)
- (b) Write a wave function describing the wave. (5 points)
- (c) Find the transverse displacement of a particle at  $x=0.360$  m at time  $t = 0.150$  s. (5 points)
- (d) How much time must elapse from the instant in part (c) until the particle at  $x=0.360$  m next has maximum upward displacement? (5 points)

**Question 3: (Total points 15)**

One end of a horizontal rope is attached to a prong of an electrically driven tuning fork that vibrates the rope transversely at 120 Hz. The other end passes over a pulley and supports a 1.50-kg mass. The linear mass density of the rope is 0.0550 kg/m.

- (a) What is the speed of a transverse wave on the rope? (5 points)
- (b) What is the wavelength? (5 points)
- (c) How would your answers to parts (a) and (b) change if the mass were increased to 3.00 kg? (5 points)

**Question 4: (Total points 10)**

With what tension must a rope with length 2.50 m and mass 0.120 kg be stretched for transverse waves of frequency 40.0 Hz to have a wavelength of 0.750 m?

**Question 5: (Total points 20)**

A piano wire with mass 3.00 g and length 80.0 cm is stretched with a tension of 25.0 N. A wave with frequency 120.0 Hz and amplitude 1.6 mm travels along the wire.

- (a) Calculate the average power carried by the wave. (5 points)
- (b) What happens to the average power if the wave amplitude is halved? (5 points)