Oscillations and Waves

Tutorial: Waves

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Answer:

\[ y_m = 0.0127 \text{ m} \]
Question B

The equation of a transverse wave traveling along a very long string is \( y = 6.0 \sin(0.020 \pi x + 4.0 \pi t) \), where \( x \) and \( y \) are expressed in centimeters and \( t \) is in seconds. Determine (a) the amplitude, (b) the wavelength, (c) the frequency, (d) the speed, (e) the direction of propagation of the wave, and (f) the maximum transverse speed of a particle in the string. (g) What is the transverse displacement at \( x = 3.5 \text{ cm} \) when \( t = 0.26 \text{ s} \)?

Answer:

\[ y_m = 0.06 \text{ m}, \lambda = 1 \text{ m}, f = 2 \text{ Hz} \]
\[ v = 2 \text{ m/s}, -v_{max} = 0.75 \text{ m/s}, \]
\[ y(3.5 \text{ cm}, 0.26 \text{ s}) = -0.02 \text{ m} \]
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 varies with time according to \( y = (5.0 \text{ cm}) \sin[1.0 - (4.0 \text{ s}^{-1})t] \). 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?

**Answer:**

\[
f = 0.64 \text{ Hz}, \lambda = 0.63 \text{ m}, y_m = 0.05 \text{ m} \]

\[
k = 10/\text{m}, \omega = 4.0 \text{ rad/s}, -, \tau = 0.064 \text{ N}
\]
A sinusoidal wave moving along a string is shown twice in Fig. 16-32, as crest $A$ travels in the positive direction of an $x$ axis by distance $d = 6.0$ cm in 3.0 ms. The tick marks along the axis are separated by 10 cm; height $H = 6.00$ mm. If the wave equation is of the form $y(x, t) = y_m \sin(kx \pm \omega t)$, what are (a) $y_m$, (b) $k$, (c) $\omega$, and (d) the correct choice of sign in front of $\omega$?

**Answer:**

\[
y_m = 3.0 \text{ mm}, \quad k = 16 \text{ rad/s} \\
\omega = 3.2 \times 10^2 \text{ rad/s}
\]
Question E

A rope, under a tension of 200 N and fixed at both ends, oscillates in a second-harmonic standing wave pattern. The displacement of the rope is given by

\[ y = (0.10 \text{ m})(\sin \frac{\pi x}{2}) \sin 12 \pi t, \]

where \( x = 0 \) at one end of the rope, \( x \) is in meters, and \( t \) is in seconds. What are (a) the length of the rope, (b) the speed of the waves on the rope, and (c) the mass of the rope? (d) If the rope oscillates in a third-harmonic standing wave pattern, what will be the period of oscillation?

Answer:

\[ L = 4.0 \text{ m}, \quad v = 24 \text{ m/s}, \quad m = 1.4 \text{ kg}, \quad T = 0.11 \text{ s} \]
Question F

For a certain transverse standing wave on a long string, an antinode is at \( x = 0 \) and an adjacent node is at \( x = 0.10 \) m. The displacement \( y(t) \) of the string particle at \( x = 0 \) is shown in Fig. 16-39, where the scale of the \( y \) axis is set by \( y_s = 4.0 \) cm. When \( t = 0.50 \) s, what is the displacement of the string particle at (a) \( x = 0.20 \) m and (b) \( x = 0.30 \) m? What is the transverse velocity of the string particle at \( x = 0.20 \) m at (c) \( t = 0.50 \) s and (d) \( t = 1.0 \) s? (e) Sketch the standing wave at \( t = 0.50 \) s for the range \( x = 0 \) to \( x = 0.40 \) m.

Answer:  \[ y(0.20 \text{ m}, 0.50 \text{ s}) = 0.040 \text{ m} \]
\[ y(0.30 \text{ m}, 0.50 \text{ s}) = 0 \text{ m} \]
\[ u(0.20 \text{ m}, 0.50 \text{ s}) = 0 \text{ m/s} \]
\[ u(0.20 \text{ m}, 1 \text{ s}) = -0.13 \text{ m/s} \]
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