Answer on Question #37227

Physics – Mechanics | Kinematics | Dynamics

Question:

A transverse traveling wave on a taut wire has an amplitude of 0.200 mm and a frequency of 540 Hz. It travels with a speed of 196 m/s.

(a) If the wave equation is written in the form y = A sin(kx - ωt), what are the parameters A, k, and ω?

_____ m

_____ rad/m

_____ rad/s

(b) The mass per unit length of this wire is 3.90 g/m. Find the tension in the wire.

_____ N

Solution:

a) Speed, frequency and wavelength are linked by the following relation:

$$v = \lambda f$$

Thus $\lambda = v/f$ and the wave vector equals

$$k = \frac{2\pi}{\lambda} = \frac{2\pi f}{v} = \frac{2\pi \cdot 540\ Hz}{196\ m/s} = 17.3\ m^{-1}.$$

The cyclic frequency equals

$$\omega = 2\pi f = 2\pi \cdot 540\ Hz = 3390 \frac{rad}{s}.$$

Thus, the given wave has the following form:

$$y = 0.2 \sin(17.3x - 3390t).$$

b)

$$v = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu v^2 = 0.0039 \frac{g}{m} \cdot \left(196 \frac{m}{s}\right)^2 = 150\ N.$$

Answer:

a) $A = 0.2\ m$, $k = 17.3\ m^{-1}$, $\omega = 3.39 \cdot 10^3\ rad/s$.

b) 150 N.