Answer on Question #72985, Physics / Mechanics | Relativity

Question. A harmonic wave on a rope is described by $y(x,t) = (4.0\ mm)\sin[2\pi/0.82\ m\ ((10\ m/s)\ t + x)]$. i) Calculate the wavelength and time period of the wave. ii) Determine the displacement and acceleration of the element of the rope located at $x = 0.58\ m$ at time, $t = 41.0\ s$.

Given. $x = 0.58\ m; t = 41.0\ s.$

Find. $\lambda, T, y(0.58,41), a(0.58,41) - ?$

Solution.

In accordance with the equation of wave

$$\xi = A\sin(\omega t + kx),$$

where

$$k = \frac{2\pi}{\lambda} = \frac{\omega}{v}$$

we have

$$\xi = A\sin(\omega t + kx) = A\sin k\left(\frac{\omega t}{k} + x\right) = A\sin\frac{2\pi}{\lambda}(vt + x).$$

$$\xi = y(x,t) = (4.0\ mm)\sin\left[\frac{2\pi}{0.82\ m}\left(\left(10\frac{m}{s}\right)t + x\right)\right]$$

$$\lambda = 0.82\ m.$$

$$T = \frac{\lambda}{v} = \frac{0.82}{10} = 0.082\ s = 82\ ms.$$

$$y(0.58,41) = 4.0\cdot 10^{-3}\sin\left[\frac{2\pi}{0.82}(10\cdot 41 + 0.58)\right] =$$

$$= -0.00386\ m = -3.86\ mm.$$

$$a(x,t) = \frac{d^2y(x,t)}{dt^2} = -4.0\cdot 10^{-3}\left(\frac{2\pi}{0.82}\cdot 10\right)^2\sin\left[\frac{2\pi}{0.82}(10\cdot t + x)\right].$$

$$a(0.58,41) = -4.0\cdot 10^{-3}\cdot\left(\frac{2\pi}{0.82}\cdot 10\right)^2\cdot\sin\left[\frac{2\pi}{0.82}(10\cdot 41 + 0.58)\right] \approx 22.7\ \frac{m}{s^2}.$$

Answer. $\lambda = 0.82\ m; T = 82\ ms; y(0.58,41) = -3.86\ mm; a(0.58,41) = 22.7\ \frac{m}{s^2}.$