

**1.4** A wave traveling along a string is given by

$$y(x,t) = 2 \sin(4\pi t + 10\pi x) \quad (\text{cm}),$$

where  $x$  is the distance along the string in meters and  $y$  is the vertical displacement. Determine: (a) the direction of wave travel, (b) the reference phase  $\phi_0$ , (c) the frequency, (d) the wavelength, and (e) the phase velocity.

**Solution:**

(a) We start by converting the given expression into a cosine function of the form given by (1.17):

$$y(x,t) = 2 \cos\left(4\pi t + 10\pi x - \frac{\pi}{2}\right) \quad (\text{cm}).$$

Since the coefficients of  $t$  and  $x$  both have the same sign, the wave is traveling in the negative  $x$ -direction.

(b) From the cosine expression,  $\phi_0 = -\pi/2$ .

(c)  $\omega = 2\pi f = 4\pi$ ,

$$f = 4\pi/2\pi = 2 \text{ Hz}.$$

(d)  $2\pi/\lambda = 10\pi$ ,

$$\lambda = 2\pi/10\pi = 0.2 \text{ m}.$$

(e)  $u_p = f\lambda = 2 \times 0.2 = 0.4 \text{ (m/s)}$ .

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