Chapter 14 Problem 23 [†]

Given
$y = 1.3cos(0.69x + 31t)$
x and y are in centimeters and t is in seconds.

Solution
a) Find the amplitude of the wave.

The generic form for the displacement of a wave is

$$y = A\cos(kx + \omega t) \tag{1}$$

The A represents the amplitude. Therefore, by inspection the amplitude is 1.3 cm.

b) Find the wavelength of the wave.

In equation 1, k represents the wavenumber. The relationship between wavenumber and wavelength is

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

Solving for λ gives

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{(0.69\ cm^{-1})} = 9.11\ cm$$

The wavenumber had to have units of cm^{-1} in order to cancel out the units of x when they are multiplied together.

c) Find the period of the wave.

In equation 1, ω represents the angular frequency. The relationship between angular frequency and time period is

$$\omega = \frac{2\pi}{T}$$

Solving for ω gives

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{(31\ s^{-1})} = 0.203\ s$$

d) Find the speed of the wave.

The speed of a wave is given by the relationship

$$v = \frac{\omega}{k} = \frac{31\ s^{-1}}{0.69\ cm^{-1}} = 44.9\ cm/s$$

e) Find the direction of propagation.
Since the time dependent portion of the function is added, the wave is propagating towards the negative x direction.

[†]Problem from Essential University Physics, Wolfson