Chapter 14 Problem 48 †

Given
Figure 14-35

Solution
Write out the mathematical description of the wave.

The generic form of the displacement of the wave is

$$y = A\cos(kx + \omega t)$$

The amplitude, A, is the maximum displacement from equilibrium. From Figure 14-36 the amplitude is 1.5 cm.
The wavelength, λ, is the distance between crests of the wave. From Figure 14-36 the wavelength is 8 cm.
Wavenumber, k, can now be calculated from the wavelength.

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{(8.0\ cm)} = 0.785\ cm^{-1}$$

In 2.6 *seconds* the wave shifted 2 cm toward the positive x direction. The velocity of the wave is then

$$v = \frac{\Delta x}{\Delta t} = \frac{2.0\ cm}{2.6\ s} = 0.769\ cm/s$$

The relationship between velocity and angular frequency is given by

$$v = \frac{\omega}{k}$$

Therefore, the angular frequency is

$$\omega = kv = (0.785\ cm^{-1})(0.769\ cm/s) = 0.604\ s^{-1}$$

Since the wave is propagating in the positive x direction, the time dependent portion must be subtracted from the x dependent portion. Combining all this information gives a wave function of

$$y = (1.5\ cm)\cos((0.785\ cm^{-1})x - (0.604\ s^{-1})\ t)$$

†Problem from Essential University Physics, Wolfson