

Chapter 14 Problem 26 †

Given

$$A = 1.2 \text{ cm} = 1.2 \times 10^{-2} \text{ m}$$

$$f = 44 \text{ Hz}$$

$$F = 21 \text{ N}$$

$$m = 15 \text{ g/m} = 0.015 \text{ kg/m}$$

Solution

a) Find the wave speed.

For a string under tension the velocity of a wave is

$$v = \sqrt{\frac{F}{\mu}}$$

Substituting in the appropriate values gives

$$v = \sqrt{\frac{21 \text{ N}}{0.015 \text{ kg/m}}} = 37.4 \text{ m/s}$$

b) Find the maximum speed of a point on the string.

The velocity of a point on the string is given by the first derivative of the displacement function.

$$u = \frac{dy}{dt} = \frac{d(A \cos(kx - \omega t))}{dt} = A\omega \sin(kx - \omega t)$$

The maximum velocity is then

$$u_{\max} = A\omega$$

The angular velocity can be found from the frequency.

$$\omega = 2\pi f = 2\pi(44 \text{ Hz}) = 276 \text{ s}^{-1}$$

The maximum velocity is then

$$u_{\max} = (1.2 \times 10^{-2} \text{ m})(276 \text{ s}^{-1}) = 3.31 \text{ m/s}$$

†Problem from Essential University Physics, Wolfson