Chapter 14 Problem 28 [†]

Given
$A = 1.2\ cm = 1.2 \times 10^{-2}\ m$
$f = 44\ Hz$
$F = 21\ N$
$m = 15\ g/m = 0.015\ kg/m$

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

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

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.

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

The maximum velocity is then

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

[†]Problem from Essential University Physics, Wolfson