134.

Problem 17.49E (HRW)

A string fixed at both ends is 8.40 m *long and has a mass of* 0.120 kg. *It is subjected to a tension of* 96.0 N *and set oscillating. We have to find the following:*
(a) *the speed of the waves on the string;* (b) *the longest possible wavelength for a standing wave; and* (c) *the frequency of that wave.*

Solution:

(a)

We first find the mass per unit length, μ, of the string.

$$\text{Length of the string} = 8.40 \text{ m},$$

and

$$\text{mass of the string} = 0.120 \text{ kg}.$$

Therefore,

$$\mu = \frac{0.120 \text{ kg}}{8.4 \text{ m}} = 0.0143 \text{ kg m}^{-1}.$$

String is subjected to a tension, *T*, of 96.0 N. Therefore, the speed of wave motion in the string *v* is

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{96.0}{1.43\times10^{-2}}} \text{ m s}^{-1} = 81.9 \text{ m s}^{-1}.$$

(b)

The longest possible wavelength of standing waves on the string corresponds to when its ends are nodes. That is

$$\lambda = 2L = 2 \times 8.40 \text{ m} = 16.8 \text{ m}.$$

(c)

Frequency, *f*, of this wave will be

$$f = \frac{v}{\lambda} = \frac{81.9 \text{ m s}^{-1}}{16.8 \text{ m}} = 4.87 \text{ Hz}.$$