

Chapter 14 Problem 47 †

Given

$$v_1 = 18 \text{ m/s}$$

$$F_1 = 14 \text{ N}$$

$$F_2 = 40 \text{ N}$$

Solution

Find the new wave speed.

The relationship between tension in a string and the velocity of the wave is

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

Using algebra on this equation, the mass per length is

$$\mu = \frac{F}{v^2}$$

In this problem the only thing that does not change is the mass per length. Therefore, the ratio of Force to velocity squared should be constant.

$$\mu = \frac{F_1}{v_1^2} = \frac{F_2}{v_2^2}$$

Solving for v_2 gives

$$v_2^2 = \frac{v_1^2 F_2}{F_1}$$

$$v_2 = \sqrt{\frac{v_1^2 F_2}{F_1}} = v_1 \sqrt{\frac{F_2}{F_1}}$$

Substituting in the known values gives a new velocity of

$$v_2 = (18 \text{ m/s}) \sqrt{\frac{40 \text{ N}}{14 \text{ N}}} = 30.4 \text{ m/s}$$

†Problem from Essential University Physics, Wolfson