Chapter 14 Problem 47 [†]

Given
$v_1 = 18\ m/s$
$F_1 = 14\ N$
$F_2 = 40\ N$

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

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

[†]Problem from Essential University Physics, Wolfson