

Chapter 7 Problem 44 †

Given

$$m = 200 \text{ g} = 0.200 \text{ kg}$$

$$k_l = 130 \text{ N/m}$$

$$x_l = 16 \text{ cm} = 0.16 \text{ m}$$

$$k_r = 280 \text{ N/m}$$

Solution

a) Find the compression of the spring on the right-hand side.

The energy stored in the left-hand spring at the beginning of the problem is

$$\Delta U = -W = - \int_0^{x_l} -k_l x dx = \frac{k_l x_l^2}{2}$$

This is assuming that the potential energy in the spring is zero when $x = 0 \text{ m}$. When the spring is released, the potential energy in the spring is converted to kinetic energy. When the mass reaches the right-hand spring, the kinetic energy is converted into potential energy in the right-hand spring. The potential energy in this spring is

$$\Delta U = -W = - \int_0^{x_r} -k_r x dx = \frac{k_r x_r^2}{2}$$

Assuming there is no loss due to friction, these two potential energies must be equal.

$$\frac{k_l x_l^2}{2} = \frac{k_r x_r^2}{2}$$

Solving for x_r gives

$$x_r = \sqrt{\frac{k_l x_l^2}{k_r}} = \sqrt{\frac{(130 \text{ N/m})(0.16 \text{ m})^2}{(280 \text{ N/m})}} = 0.109 \text{ m}$$

$$x_r = 10.9 \text{ cm}$$

b) Find the velocity travelling between the blocks.

The potential energy stored in the left-hand block is converted to kinetic energy, which is given by the expression

$$K = \frac{1}{2} m v^2$$

Assuming no loss of energy due to friction, this kinetic energy must be equal to the potential energy stored in the left-hand spring.

$$\frac{k_l x_l^2}{2} = \frac{m v^2}{2}$$

Solving for velocity gives

$$v = \sqrt{\frac{k_l x_l^2}{m}} = \sqrt{\frac{(130 \text{ N/m})(0.16 \text{ m})^2}{0.200 \text{ kg}}} = 4.08 \text{ m/s}$$

†Problem from Essential University Physics, Wolfson