Chapter 7 Problem 43 †

Given
$m = 200\ g = 0.200\ kg$
$k_l = 130\ N/m$
$x_l = 16\ cm = 0.16\ m$
$k_r = 280\ N/m$

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 $x = 0\ m$. When the spring is released, the potential energy in the spring is convert 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

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

$$x_r = 10.9\ cm$$

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

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

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

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

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†Problem from Essential University Physics, Wolfson