Teacher notes
Topic A

Applying conservation of energy

This is a good example of the application of conservation of energy.

A block of mass 4.0 kg falling vertically will impact a vertical spring of spring constant 2500 N m^{-1}. At the position shown the speed of the block is 2.0 m s^{-1}.
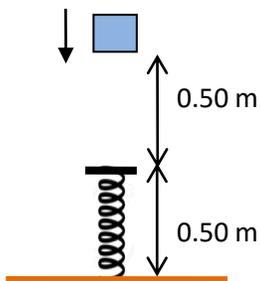
(a) What is the maximum compression of the spring?

(b) What is the maximum height the block will rebound to after leaving the spring?

(a) The initial total mechanical energy of the system is

$E = \dfrac{1}{2}mv^2 + mgh = \dfrac{1}{2} \times 4.0 \times 2.0^2 + 4.0 \times 10 \times 1.0 = 48\,\text{J}$. When fully compressed by an amount x the total

mechanical energy of the system is $E = \dfrac{1}{2}kx^2 + mgh' = \dfrac{1}{2} \times 2500 \times x^2 + 4.0 \times 10 \times (0.50 - x)$. Hence

$\dfrac{1}{2} \times 2500 \times x^2 + 4.0 \times 10 \times (0.50 - x) = 48$

$1250x^2 - 40x - 28 = 0$

The calculator solves this as x = 0.17 m.

(b) Here we can forget the spring completely:

$$\frac{1}{2}mv^2 + mgh_i = mgh_f$$

$$2.0^2 + 2 \times 10 \times 1.0 = 2 \times 10 h_f$$

$$h_f = 1.2 \text{ m}$$