4 A horizontal spring is fixed at one end. A block is pushed against the other end of the spring so that the spring is compressed, as shown in Fig. 4.1.

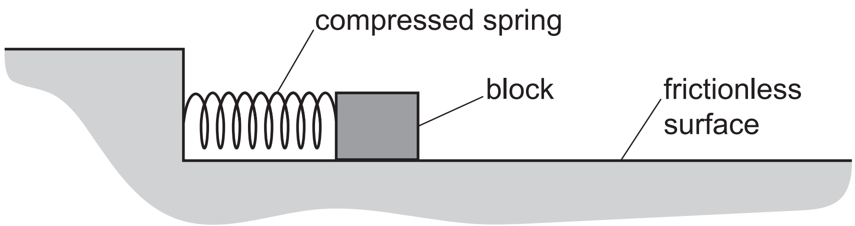

Fig. 4.1

The block is released and accelerates along a horizontal frictionless surface as the spring returns to its original length. The block leaves the end of the spring with a speed of $2.3\,\text{m}\,\text{s}^{-1}$, as shown in Fig. 4.2.

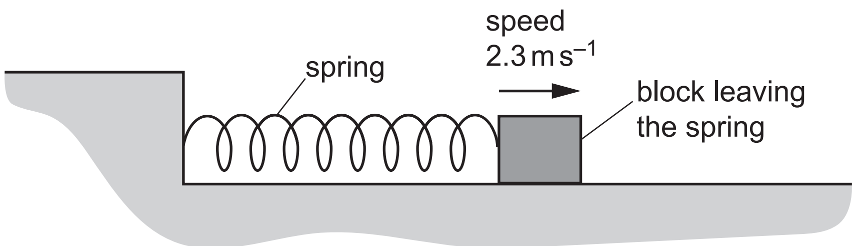

Fig. 4.2

The block has a mass of 250 g and the spring has a spring constant of $420\,\text{N}\,\text{m}^{-1}$.

Assume that the spring always obeys Hooke's law and that all the elastic potential energy of the spring is transferred to the kinetic energy of the block.

(a) Calculate the kinetic energy of the block as it leaves the spring.

kinetic energy = ... J [2]

(b) Calculate the compression of the spring immediately before the block is released.

compression = ... m [2]

(c) After leaving the spring, the block moves along the surface until it hits a barrier at a speed of $2.3\,\mathrm{m\,s^{-1}}$. The block then rebounds at a speed of $1.5\,\mathrm{m\,s^{-1}}$ and moves back along its original path. The block is in contact with the barrier for a time of 0.086 s.

Calculate:

(i) the change in momentum of the block during the collision

change in momentum = ... N s [2]

(ii) the average resultant force exerted on the block during the collision.

average resultant force = ... N [1]

(d) The maximum compression x of the spring is now varied in order to vary the kinetic energy E_K of the block as it leaves the spring. Assume that all the elastic potential energy in the spring is always transferred to the kinetic energy of the block.

On Fig. 4.3, sketch a graph to show the variation with x of E_K.

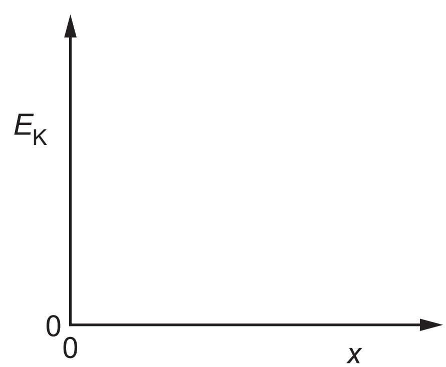

Fig. 4.3

[1]

[Total: 8]