

3 The lower end of a vertical spring is fixed to a horizontal surface, as shown in Fig. 3.1.

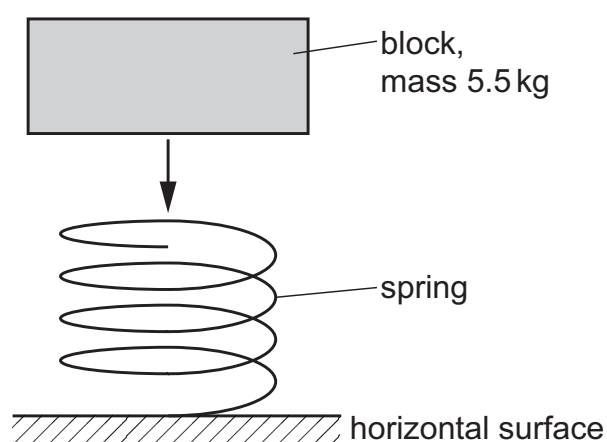


Fig. 3.1

The mass of the spring is negligible. A block of mass 5.5 kg drops vertically onto the spring and is brought to rest as the spring is compressed.

(a) The block has kinetic energy 110 J as it makes contact with the spring.

Calculate the speed of the block as it makes contact with the spring.

speed = ms^{-1} [2]

(b) The gravitational potential energy of the block decreases by 20 J as the spring is compressed to its maximum compression x_0 .

Show that x_0 is 0.37 m.

[2]

(c) Assume that, as the spring compresses, all of the energy lost by the block is converted into the elastic potential energy of the spring.

Use the data from (a) and (b) to determine the maximum elastic potential energy of the spring.

Show your working.

maximum elastic potential energy = J [1]

(d) The variation of the force F acting on the spring with the compression x of the spring is shown in Fig. 3.2.

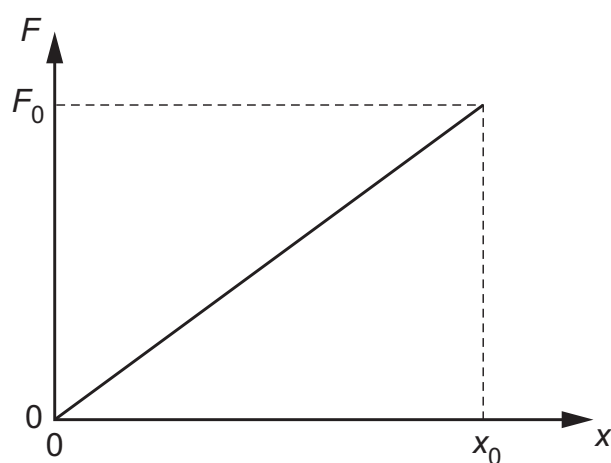


Fig. 3.2

Use the information in (b) and your answer in (c) to show that the maximum force F_0 exerted on the spring by the block is 700 N.

[2]

(e) Use the information in (d) to determine, for the instant that the block is first brought to rest by the spring, the magnitude of:

(i) the resultant force acting on the block

resultant force = N [2]

(ii) the acceleration of the block.

acceleration = ms^{-2} [2]

[Total: 11]