3   A ball is thrown vertically upwards towards a ceiling and then rebounds, as illustrated in Fig. 3.1.
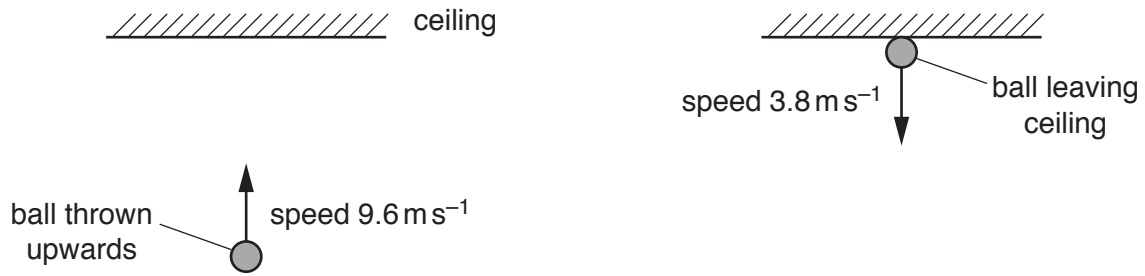
/////////////////// ceiling

//////////////////

speed 3.8 m s⁻¹ | ball leaving ceiling

ball thrown upwards — speed 9.6 m s⁻¹

Fig. 3.1

The ball is thrown with speed 9.6 m s⁻¹ and takes a time of 0.37 s to reach the ceiling. The ball is then in contact with the ceiling for a further time of 0.085 s until leaving it with a speed of 3.8 m s⁻¹. The mass of the ball is 0.056 kg. Assume that air resistance is negligible.

(a) Show that the ball reaches the ceiling with a speed of 6.0 m s⁻¹.

[1]

(b) Calculate the height of the ceiling above the point from which the ball was thrown.

height = ... m [2]

(c) Calculate

   (i) the increase in gravitational potential energy of the ball for its movement from its initial position to the ceiling,

increase in gravitational potential energy = ... J [2]

(ii) the decrease in kinetic energy of the ball while it is in contact with the ceiling.

decrease in kinetic energy = ... J [2]

(d) State how Newton's third law applies to the collision between the ball and the ceiling.

....

....

....

....[2]

(e) Calculate the change in momentum of the ball during the collision.

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

(f) Determine the magnitude of the average force exerted by the ceiling on the ball during the collision.

average force = ... N [2]

[Total: 13]