

- B4.** This question is in **two** parts. **Part 1** is about momentum, energy and power. **Part 2** is about CCDs and digital data storage.

**Part 1** Momentum, energy and power

- (a) In his *Principia Mathematica* Newton expressed his third law of motion as “to every action there is always opposed an equal reaction”. State what Newton meant by this law. [1]

.....

.....

.....

- (b) A book is released from rest and falls towards the surface of Earth. Discuss how the conservation of momentum applies to the Earth-book system. [3]

.....

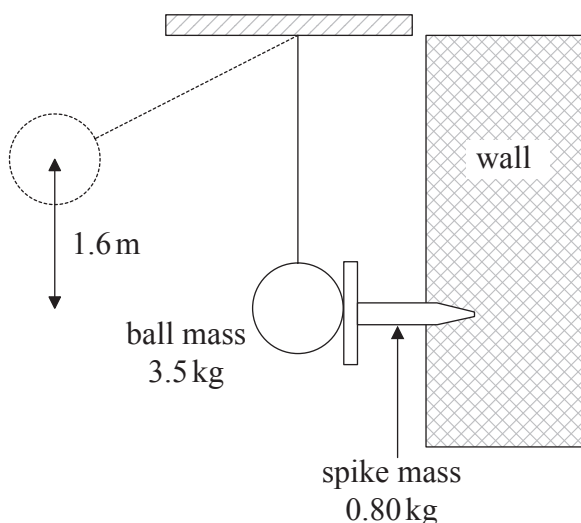
.....

.....

.....

.....

- (c) A large swinging ball is used to drive a horizontal iron spike into a vertical wall. The centre of the ball falls through a vertical height of 1.6 m before striking the spike in the position shown.



(This question continues on the following page)

*(Question B4, part 1 continued)*

The mass of the ball is 3.5 kg and the mass of the spike is 0.80 kg. Immediately after striking the spike, the ball and spike move together. Show that the

- (i) speed of the ball on striking the spike is  $5.6 \text{ m s}^{-1}$ . [1]

.....

.....

.....

- (ii) energy dissipated as a result of the collision is about 10 J. [4]

.....

.....

.....

.....

.....

.....

- (d) As a result of the ball striking the spike, the spike is driven a distance  $7.3 \times 10^{-2} \text{ m}$  into the wall. Calculate, assuming it to be constant, the friction force  $F$  between the spike and wall. [3]

.....

.....

.....

.....

.....

- (e) The machine that is used to raise the ball has a useful power output of 18 W. Calculate how long it takes for the machine to raise the ball through a height of 1.6 m. [3]

.....

.....

.....

.....

.....

*(This question continues on the following page)*