3 A ball is fired horizontally with a speed of 41.0 m s^{-1} from a stationary cannon at the top of a hill. The ball lands on horizontal ground that is a vertical distance of 57 m below the cannon, as shown in Fig. 3.1.

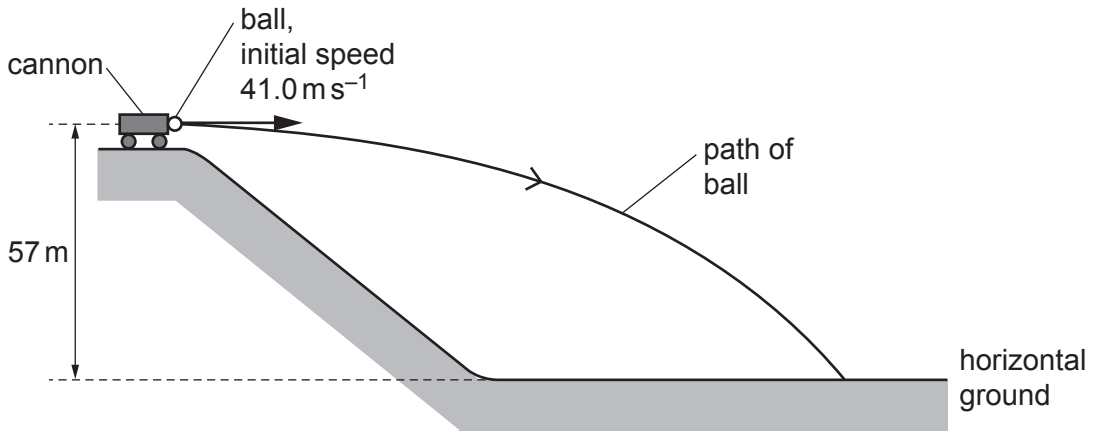

Fig. 3.1 (not to scale)

Assume air resistance is negligible.

(a) Show that the time taken for the ball to reach the ground, after being fired, is 3.4 s.

[2]

(b) Calculate the horizontal distance of the ball from the cannon at the point where the ball lands on the ground.

horizontal distance = ... m [1]

(c) Determine the magnitude of the displacement of the ball from the cannon at the point where the ball lands on the ground.

displacement = ... m [2]

(d) The ball leaves the cannon at time $t = 0$.

On Fig. 3.2, sketch a graph to show the variation of the magnitude v of the vertical component of the velocity of the ball with time t from $t = 0$ to $t = 3.4\,s$.
Numerical values are not required.

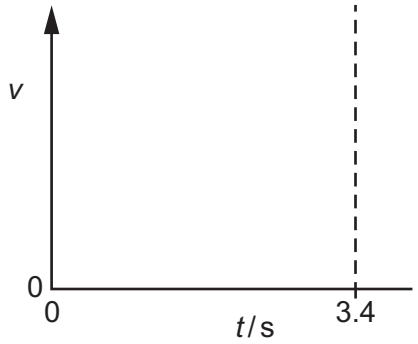

Fig. 3.2

[1]

(e) The cannon recoils horizontally with a speed of $0.340\,m\,s^{-1}$ when it fires the ball. The total mass of the ball and the cannon is 1480 kg. Assume that no external horizontal forces act on the ball-cannon system.

Determine, to three significant figures, the mass of the ball.

mass = ... kg [2]

(f) The cannon now fires a ball of smaller mass. Assume that air resistance is still negligible.

State and explain the change, if any, to the graph in Fig. 3.2 due to the decreased mass of the ball.

.....

.....

..... [2]

[Total: 10]