

# Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

## 7 Projectiles

### Exercise B, Question 13

#### Question:

A golfer hits a golf ball so that it moves with an initial speed of  $40 \text{ m s}^{-1}$  at an angle of  $20^\circ$  above the horizontal.

(a) State two essential assumptions that you should make if you are to estimate the horizontal distance between the point where the ball was hit and the point where it hits the ground for the first time.

(b) Find this distance to the nearest metre.

(c) The ball is actually hit on a raised area that is 5 m higher than the ground where the ball lands for the first time. By how much would this increase the answer that you obtained in (b)?

#### Solution:

(a) There is no air resistance;  
the ground is horizontal;  
there is no obstacle (e.g. a tree) in the path of the ball. [Any two of the above will be accepted].

(b) The position of the golf ball, relative to the point it is hit, is given by

$$x = 40 \cos 20^\circ t \quad [1]$$

$$y = 40 \sin 20^\circ t - \frac{1}{2}gt^2 \quad [2]$$

The ball hits the ground when  $y = 0$ ,

$$\therefore t = 0 \text{ (not required) or } t = \frac{40 \sin 20^\circ}{\frac{1}{2}g} = 2.792 \text{ s}$$

The horizontal distance,  $x$  is  $40 \cos 20^\circ \times 2.792 = 104.94$

The distance is 105 m (to the nearest metre).

(c) If the ball is hit on raised ground, the ball hits the ground when

$$y = -5$$

$$\therefore [2] \Rightarrow -5 = 40 \sin 20^\circ t - \frac{1}{2}gt^2$$

$$4.9t^2 - 13.68t - 5 = 0$$

$$t = \frac{13.68 \pm \sqrt{13.68^2 + 4 \times 4.9 \times 5}}{2 \times 4.9}$$

$$= 3.119 \text{ (positive value only required)}$$

Horizontal distance,  $x$  is  $40 \cos 20^\circ \times 3.119 = 117.238$

This is  $117.238 - 104.94$  which is 12.3 m further.

