

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise A, Question 8

Question:

A golfer hits a ball, from ground level on a horizontal surface. The initial velocity of the ball is 21 m s^{-1} at an angle of 60° above the horizontal. Assume that the ball is a particle and that no resistance forces act on the ball.

- (a) Find the maximum height of the ball.
- (b) Find the range of the ball.
- (c) Find the speed of the ball at its maximum height. [A]

Solution:

- (a) The equations of motion of a projectile give

$$x = 21 \cos 60^\circ t$$

$$y = 21 \sin 60^\circ t - \frac{1}{2}gt^2$$

At the maximum height, $v = u + at$ vertically, gives

$$\begin{aligned} 0 &= 21 \sin 60^\circ - gt \\ t &= \frac{21 \sin 60^\circ}{g} \\ &= 1.855 \text{ s} \end{aligned}$$

$$\begin{aligned} \text{Maximum height, } y &= 21 \sin 60^\circ \times 1.855 - \frac{1}{2}g(1.855)^2 \\ &= 16.9 \text{ m} \end{aligned}$$

- (b) For the time of flight,

$$\begin{aligned} y &= 0 \Rightarrow 21 \sin 60^\circ t - \frac{1}{2}gt^2 = 0 \\ t &= 0 \text{ (not required) or } t = \frac{21 \sin 60^\circ}{\frac{1}{2}g} \\ &= 3.7115 \text{ s} \end{aligned}$$

$$\begin{aligned} \text{Range of the ball, } x &= 21 \cos 60^\circ \times 3.7115 \\ &= 39.0 \text{ m} \end{aligned}$$

- (c) At the maximum height, the vertical speed of the ball is zero.

\therefore The speed of the ball is its horizontal speed which is $21 \cos 60^\circ$ or 10.5 m s^{-1} .