

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise Test yourself, Question 3

Question:

A ball is thrown from a height of 1.5 m at a speed of 12 m s^{-1} and at an angle of 20° above the horizontal. It hits the ground for the first time T seconds after it was thrown.

- (a) Find T .
- (b) Find the horizontal distance travelled by the ball.
- (c) Find the speed of the ball when it hits the ground.

Solution:

(a) Position of the ball relative to the point of throwing is given by

$$x = 12 \cos 20^\circ t$$

$$y = 12 \sin 20^\circ t - \frac{1}{2}gt^2$$

Ball hits the ground when $y = -1.5$,

$$-1.5 = 12 \sin 20^\circ t - \frac{1}{2}gt^2$$

$$4.9t^2 - 4.104t - 1.5 = 0$$

$$t = \frac{4.104 \pm \sqrt{4.104^2 + 4 \times 4.9 \times 1.5}}{2 \times 4.9}$$

$$= 1.112 \text{ s (negative value not required)}$$

$$\therefore T = 1.11 \text{ s}$$

(b) Horizontal distance, $x = 12 \cos 20^\circ \times 1.112$
 $= 12.54 \text{ m}$

\therefore Horizontal distance is 12.5 m

Horizontal speed is $12 \cos 20^\circ = 11.276$

For the vertical speed, using $v = u + at$ gives

(c) $v = 12 \sin 20^\circ - g \times 1.112$
 $= -6.793$

\therefore speed of ball is $\sqrt{11.276^2 + (-6.793)^2}$
 $= 13.16$

\therefore Speed is 13.2 m s^{-1} .