

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

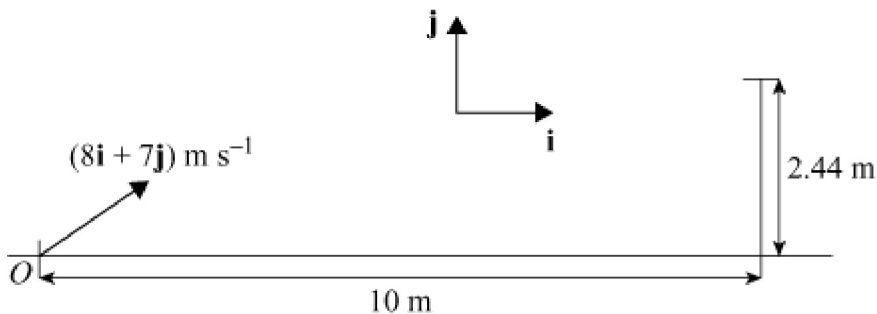
7 Projectiles

Exercise B, Question 6

Question:

During a game of football, Tom kicks the ball towards the goal. He kicks the ball with velocity $(8\mathbf{i} + 7\mathbf{j}) \text{ m s}^{-1}$, from a point O which is 10 metres from the goal. The height of the top of the goal is 2.44 metres. The unit vectors \mathbf{i} and \mathbf{j} are horizontal and vertically upwards, respectively, as shown in the diagram.

- (a) Show that the time the ball takes to reach the goal is 1.25 seconds.
- (b) Determine whether the ball passes under or over the top of the goal.
- (c) Find the speed of the ball when it reaches the goal, giving your answer to two significant figures.
[A]



Solution:

- (a) Let the position of the ball be $x\mathbf{i} + y\mathbf{j}$
The equations of motion of a projectile give

$$x = 8t$$

$$y = 7t - \frac{1}{2}gt^2$$

$$\text{When } x = 10, t = \frac{10}{8} = 1.25 \text{ s}$$

$$\begin{aligned} \text{(b) When } t = 1.25, y &= 7 \times 1.25 - \frac{1}{2} \times g \times (1.25)^2 \\ &= 1.093 \text{ m} \end{aligned}$$

\therefore The ball will pass under the top of the goal.

- (c) The horizontal component of the velocity is 8 m s^{-1} .
Using $v = u + at$ vertically,

the vertical component of the velocity is $7 - g \times 1.25$
 $= -5.25 \text{ m s}^{-1}$

\therefore The speed of the ball is $\sqrt{8^2 + 5.25^2}$
 $= 9.568$

The speed of the ball is 9.57 m s^{-1} .

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