

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise B, Question 1

Question:

An athlete launches a shot from a height of 2 m with an initial speed of 10 m s^{-1} and at an angle of 40° above the horizontal.

- (a) Find the range of the shot.
 (b) If the throw took place in an indoor arena, find the minimum height of the roof.

Solution:

(a) The position of the shot, taking the point of launch as $(0, 0)$ are given by

$$x = 10 \cos 40^\circ t \quad [1]$$

$$y = 10 \sin 40^\circ t - \frac{1}{2}gt^2 \quad [2]$$

For the range of the shot, $y = -2$

$$\therefore \text{From equation [2], } -2 = 10 \sin 40^\circ t - \frac{1}{2}gt^2$$

$$4.9t^2 - 6.428t - 2 = 0$$

$$t = \frac{6.428 \pm \sqrt{6.428^2 + 4 \times 4.9 \times 2}}{2 \times 4.9}$$

$$= 1.5715 \text{ s (negative root not required)}$$

$$\begin{aligned} \text{From equation [1], range} &= 10 \cos 40^\circ \times 1.5715 \\ &= 12.0 \text{ m} \end{aligned}$$

(b) For maximum height of shot,

using $v^2 = u^2 + 2as$ (vertically)

$$0 = (10 \sin 40^\circ)^2 - 2gs$$

$$s = \frac{(10 \sin 40^\circ)^2}{2g} = 2.108 \text{ m}$$

The shot was launched 2 m above the ground, the minimum height of the roof is $2 + 2.108$ which is 4.11 m.