

# Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

## 7 Projectiles

### Exercise B, Question 2

#### Question:

A javelin is modelled as a particle. Assume that only gravity acts on the javelin after it has left the thrower's hand. The initial velocity of the javelin is  $20 \text{ m s}^{-1}$  at an angle of  $40^\circ$  above the horizontal.

(a) Find the range of the javelin on horizontal ground if the height of release is ignored.

(b) The javelin is actually released at a height of 2 metres. Find the range of the javelin in this case. [A]

#### Solution:

(a) The position of the javelin is given by

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

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

$$\text{For the range, } y = 0 \Rightarrow t = 0 \text{ (not required) or } t = \frac{20 \sin 40^\circ}{\frac{1}{2}g} = 2.6236 \text{ s}$$

$$\text{Range, } x \text{ is } 20 \cos 40^\circ \times 2.6236 = 40.2 \text{ m}$$

(b) If the initial height is 2 m,

$$\text{for the range, } y = -2$$

$$\text{Equation [2] becomes } -2 = 12.856t - 4.9t^2$$

$$4.9t^2 - 12.856t - 2 = 0$$

$$t = \frac{12.856 \pm \sqrt{12.856^2 + 4 \times 4.9 \times 2}}{2 \times 4.9}$$

$$= \frac{12.856 \pm 14.299}{9.8}$$

$$= 2.7709 \text{ s (negative root not required)}$$

$$\text{From [1]; Range, } x \text{ is } 20 \cos 40^\circ \times 2.7709 = 42.5 \text{ m .}$$