

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise A, Question 10

Question:

A particle P is projected at time $t = 0$ in a vertical plane from a point O with speed u at an angle α above the horizontal. Write down expressions for the horizontal and vertical components of:

- (a) the velocity of P at time t ,
- (b) the displacement, at time t , of P from O .
- (c) Given that the particle strikes the horizontal plane through O at time T show that

$$T = \frac{2u \sin \alpha}{g}.$$

Find, in terms of g and T , the maximum height that P rises above the horizontal plane through O . [A]

Solution:

$$\begin{aligned} (a) \quad v_x &= u \cos \alpha \\ v_y &= u \sin \alpha - gt \end{aligned}$$

$$x = u \cos \alpha t$$

$$(b) \quad y = u \sin \alpha t - \frac{1}{2}gt^2$$

- (c) The particle strikes the horizontal plane through O when

$$y = 0 \quad \Rightarrow \quad 0 = u \sin \alpha t - \frac{1}{2}gt^2$$

$$\therefore t = 0 \text{ (not required) or } t = \frac{u \sin \alpha}{\frac{1}{2}g}$$

$$\therefore T = \frac{2u \sin \alpha}{g}$$

For the maximum height,

$$v = u + at \text{ vertically} \quad \Rightarrow \quad 0 = u \sin \alpha - gt$$

$$t = \frac{u \sin \alpha}{g}$$

$$\begin{aligned} \text{The vertical height, } y &= u \sin \alpha \cdot \frac{u \sin \alpha}{g} - \frac{1}{2}g \left(\frac{u \sin \alpha}{g} \right)^2 \\ &= \frac{u^2 \sin^2 \alpha}{2g} \end{aligned}$$