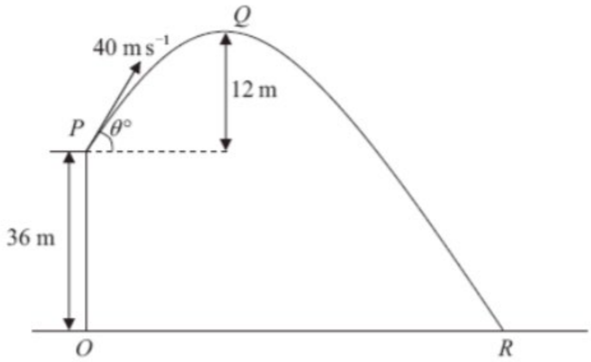
A-Level Starter Activity

Jethwa Maths

Topic: Projectiles Chapter Reference: Mechanics 2, Chapter 6	8 minutes

1.



A ball is projected with speed 40 ms^{-1} from a point *P* on a cliff above horizontal ground. The point *O* on the ground is vertically below *P* and *OP* is 36 m. The ball is projected at an angle $\theta°$ to the horizontal. The point *Q* is the highest point of the path of the ball and is 12 m above the level of *P*. The ball moves freely under gravity and hits the ground at the point *R*, as shown in the diagram above. Find

a. The value of θ **(3)**

b. The distance *OR*. **(6)**

Solutions

1a.

Use of $v^2 = u^2 + 2as$	**M1**
$(40 \sin \theta)^2 = 2 \times g \times 12$ $(\sin \theta)^2 = \frac{2 \times g \times 12}{40^2}$	**M1**
$\theta = 22.54°$	**M1**

1b.

Vertical motion of *P* using, $s = ut + \frac{1}{2}at^2$	**M1**
$-36 = 40 \sin \theta t - \frac{g}{2}t^2$ $\frac{g}{2}t^2 - 40 \sin \theta t - 36 = 0$	**M1**
$t = 4.694$	**M1**
Horizontal motion of P using, $s = dt$	**M1**
$s = 40 \cos \theta t$	**M1**
$s = 173$ m	**M1**

A-Level Starter Activity

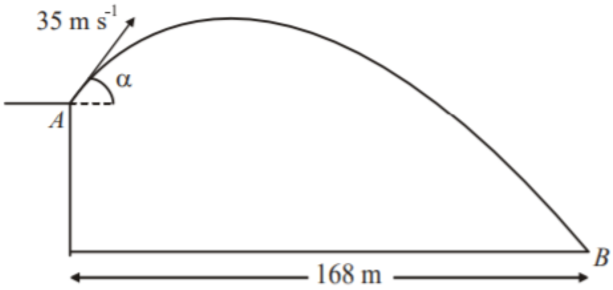
Jethwa Maths

Topic: Projectiles (Greatest Height)

Chapter Reference: Mechanics 2, Chapter 6

8 minutes

1. A golf ball *P* is projected with speed 35 ms^{-1} from a point A on a cliff above horizontal ground. The angle of projection is α to the horizontal, where tan $\alpha = \frac{3}{4}$. The ball moves freely under gravity and hits the ground at the point *B*, as shown in the diagram.



a. Find the greatest height of *P* above the level of *A*. **(3)**

The horizontal distance from *A* to *B* is 168m.

b. Find the height of *A* above the ground. **(6)**

Solutions

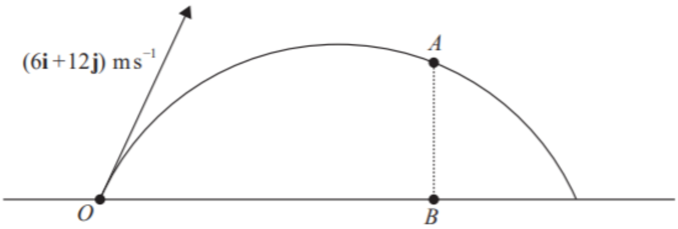
1a.

Considering vertical motion, $v = u^2 + 2as$	**M1**
$0 = (35 \sin \alpha)^2 - 2gh$	**M1**
$h = 40$ m	**M1**

1b.

Considering horizontal motion, $v = dt$	**M1**
$168 = 35 \cos \alpha \times t$	**M1**
$t = 8$ s	**M1**
Considering vertical motion, $s = ut + \frac{1}{2}at^2$	**M1**
$y = 35 \sin\alpha \times t - \frac{1}{2}gt^2$ $= 28.8 - \frac{1}{2}g8^2$ $= -89.6$ m	**M1**
Therefore, height of A = 89.6m	**M1**

1.



The point O is a fixed point on a horizontal plane. A ball is projected from O with velocity $(6\mathbf{i} + 12\mathbf{j})$ ms^{-1} and passes through the point A at time t seconds after projection. The point B is on the horizontal plane vertically below A, as shown in the figure. It is given that $OB = 2AB$.

Find the value of t. **(6)**

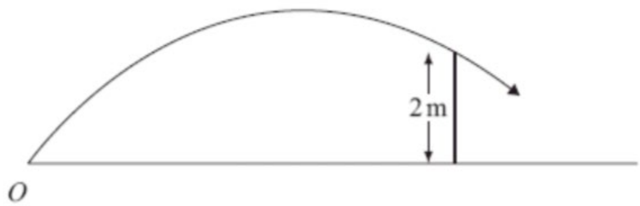
Solutions

1.

Horizontal components, $d = vt$	**M1**
$d = 6t$	**M1**
Vertical components, $s = ut + \frac{1}{2}at^2$	**M1**
Therefore at B, $2(12t - \frac{1}{2}gt^2) = 6t$	**M1**
$(24 - 6)^2 = gt^2$ $18 = gt$	**M1**
$t = \frac{18}{g} = 1.84$s.	**M1**

Jethwa Maths

1. A child playing cricket on horizontal ground hits the ball towards a fence 10 m away. The ball moves in a vertical plane which is perpendicular to the fence. The ball just passes over the top of the fence, which is 2 m above the ground, as shown in the diagram above. The ball is modelled as a particle projected with initial speed u ms^{-1} from point O on the ground at an angle α to the ground.



By writing down expression for the horizontal and vertical distance, from O of the ball t seconds after it was hit, how that,

$$2 = 10 \tan \alpha - \frac{50g}{u^2 cos^2 \alpha}$$

(7)

Solutions

1.

Horizontal motion, $s = vt$	**M1**
$x = u \cos \alpha t = 10$	**M1**
Vertical motion	**M1**
$s = ut + \frac{1}{2}at^2$	**M1**
$t = \frac{10}{u \cos \alpha}$	**M1**
$2 = u \sin \alpha$ x $\frac{10}{u cos\, \alpha}$ - $\frac{g}{2} \times \frac{100}{u^2 cos^2 \alpha}$	**M1**
$= 10 \tan \alpha$ - $\frac{50g}{u^2 cos^2 \alpha}$	**M1**