Lesson 7

A-Level Applied Mathematics : Mechanics : Year 2

Projectiles (Kinematics III)

7.1 Revision

Any solution based entirely on graphical
or numerical methods is not acceptable

Marks Available : 50

Question 1

A particle is projected with velocity $(13\mathbf{i} + 19\mathbf{j})$ m s^{-1} over level ground.

(i) What is the speed of the projection ?

[2 marks]

(ii) With what angle of elevation is the particle projected ?

[2 marks]

(iii) What is the greatest height reached by the particle ?

[4 marks]

(iv) What is the horizontal range of the particle ?

[4 marks]

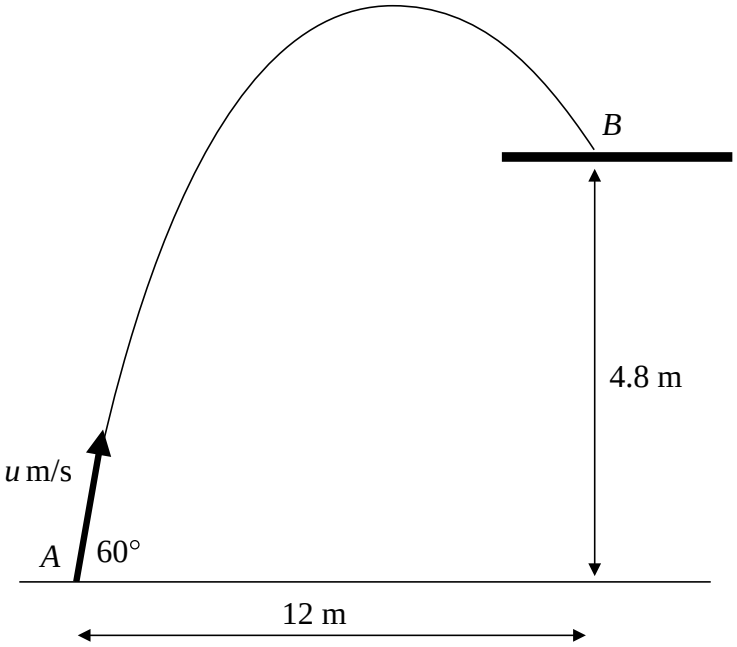
Question 2

A particle is projected from a point O with speed 43 m s^{-1} at an angle of elevation of 21°. The particle moves freely under gravity.

Find the length of time for which the particle is 12 metres or more above O.

[8 marks]

Question 3



A ball is thrown at an angle of elevation of 60° with unknown speed, u, m s^{-1} from A. It lands on a flat roof at B which is 4.8 metres above the point of projection. The horizontal distance travelled by the ball between A and B is 12 metres. With what speed, u, was the ball projected ?

[8 marks]

Question 4

A vertical mast is 50 metres high. Two balls, *P* and *Q*, are projected simultaneously. Ball *P* is projected horizontally from the top of the mast with speed 16 m s^{-1}. Ball *Q* is projected from the bottom of the mast with speed 34 m s^{-1} at an angle θ above the horizontal. The balls move freely under gravity in the same vertical plane and collide in mid-air.

(a) By considering the horizontal motion of each ball prove that,

$$\cos\theta = \frac{8}{17}$$

[4 marks]

(b) Find the time which elapses between the instant when the balls are projected and the instant when they collide.

[4 marks]

Question 5

A projectile is launched from a point on a horizontal plane with initial speed u m s^{-1} at an angle of elevation θ.

The particle moves freely under gravity until it strikes the plane.

The range of the projectile is R metres.

The acceleration due to gravity is g.

(a) Show that the time of flight of the particle, T, is

$$T = \frac{2u \sin \theta}{g} \text{ seconds}$$

[4 marks]

(b) Show that,

$$R = \frac{u^2 \sin 2\theta}{g}$$

[4 marks]

(c) Deduce that, for a fixed u, the greatest possible range is when $\theta = 45°$

[2 marks]

(d) Given that

$$R = \frac{2u^2}{5g}$$

find the two possible values of the angle of elevation at which the projection could have been launched.

[4 marks]