Motion of a Projectile 1

Q1.

A particle is projected with speed $15\,\text{m s}^{-1}$ at an angle of $\theta°$ above the horizontal. At the instant 4 s after projection the speed of the particle is $30\,\text{m s}^{-1}$.

(i) Find θ. [4]

(ii) Show that at the instant 4 s after projection the particle is 33.75 m below the level of the point of projection and find the direction of motion at this instant. [4]

Q2.

A particle is projected from a point on horizontal ground with speed $15\,\text{m s}^{-1}$ at an angle of $\theta°$ above the horizontal. The particle strikes the ground 2 s after projection.

(i) Find θ. [2]

(ii) Calculate the time after projection at which the direction of motion of the particle is 20° below the horizontal. [4]

Q3.

A small ball B is projected with speed $30\,\text{m s}^{-1}$ at an angle of 60° above the horizontal from a point O. At time t s after projection the horizontal and vertically upwards displacements of B from O are x m and y m respectively.

(i) Express x and y in terms of t and hence find the equation of the trajectory of the ball. [4]

(ii) Find the value of x for which OB makes an angle of 45° above the horizontal. [3]

Q4.

A small ball is projected from a point O on horizontal ground at an angle of 30° above the horizontal. At time t s after projection the horizontal and vertically upwards displacements of the ball from O are x m and y m respectively. It is given that $x = 40t$.

(i) Calculate the initial speed of the ball, and express y in terms of t. [3]

(ii) Hence find the equation of the trajectory of the ball. [2]

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Q5.

A particle is projected from a point O on horizontal ground with speed $V\,\text{m s}^{-1}$ at an angle of 60° above the horizontal. At the instant 3 s after projection the direction of motion of the particle is 30° below the horizontal.

(i) Find V. [3]

(ii) Calculate the distance of the particle from O at the instant 3 s after projection. [3]

Q6.

A particle P is projected with speed u at an angle of 30° above the horizontal from a point O on a horizontal plane and moves freely under gravity. The particle reaches its greatest height at time T after projection.

Find, in terms of u, the speed of P at time $\frac{2}{3}T$ after projection. [5]

Q7.

A particle P is projected with speed u at an angle θ above the horizontal from a point O on a horizontal plane and moves freely under gravity. The direction of motion of P makes an angle α above the horizontal when P first reaches three-quarters of its greatest height.

(a) Show that $\tan\alpha = \frac{1}{2}\tan\theta$. [6]

(b) Given that $\tan\theta = \frac{4}{3}$, find the horizontal distance travelled by P when it first reaches three-quarters of its greatest height. Give your answer in terms of u and g. [4]

Q8.

A particle P is projected with speed u at an angle α above the horizontal from a point O on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of P from O at a subsequent time t are denoted by x and y respectively.

(a) Derive the equation of the trajectory of P in the form

$$y = x\tan\alpha - \frac{gx^2}{2u^2}\sec^2\alpha.$$ [3]

The point Q is the highest point on the trajectory of P in the case where $\alpha = 45°$.

(b) Show that the x-coordinate of Q is $\frac{u^2}{2g}$. [3]

(c) Find the other value of α for which P would pass through the point Q. [4]
