

Applied 2 - Projectiles Exam Questions

Q1.

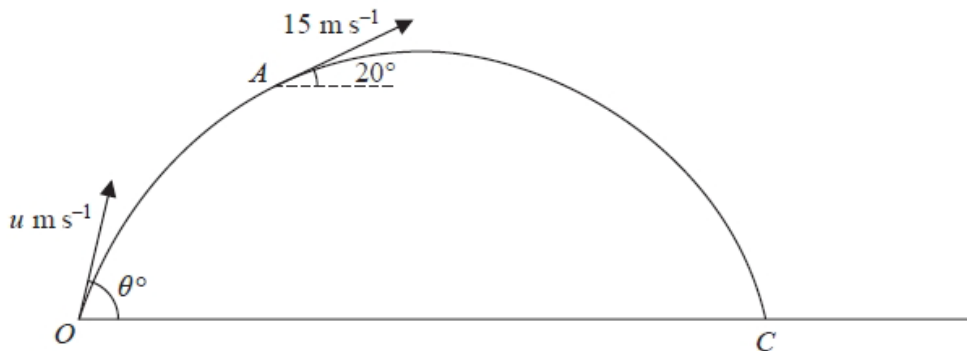


Figure 3

At time $t = 0$, a particle is projected from a fixed point O on horizontal ground with speed $u \text{ m s}^{-1}$ at an angle θ° to the horizontal. The particle moves freely under gravity and passes through the point A when $t = 4 \text{ s}$. As it passes through A , the particle is moving upwards at 20° to the horizontal with speed 15 m s^{-1} , as shown in Figure 3.

(a) Find the value of u and the value of θ .

(7)

At the point B on its path the particle is moving downwards at 20° to the horizontal with speed 15 m s^{-1} .

(b) Find the time taken for the particle to move from A to B .

(2)

The particle reaches the ground at the point C .

(c) Find the distance OC .

(3)

(Total for question = 12 marks)

Q2.

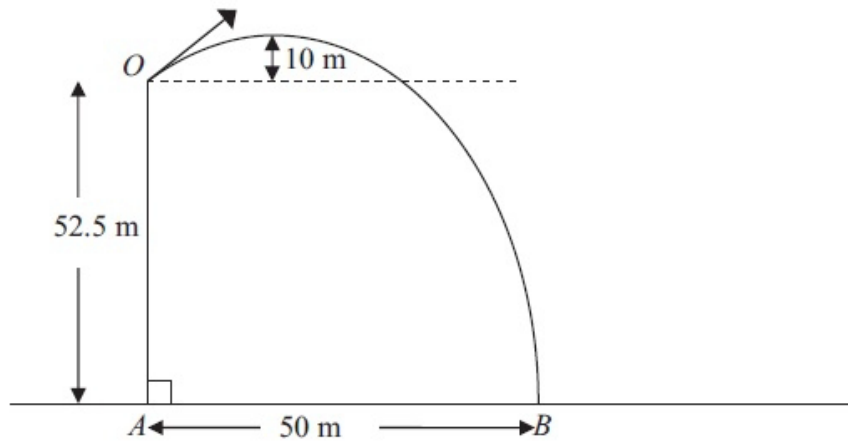


Figure 4

A small stone is projected from a point O at the top of a vertical cliff OA . The point O is 52.5 m above the sea. The stone rises to a maximum height of 10 m above the level of O before hitting the sea at the point B , where $AB = 50$ m, as shown in Figure 4. The stone is modelled as a particle moving freely under gravity.

(a) Show that the vertical component of the velocity of projection of the stone is 14 m s^{-1} .

(3)

(b) Find the speed of projection.

(9)

(c) Find the time after projection when the stone is moving parallel to OB .

(5)

(Total 17 marks)

Q3.

[In this question, the unit vectors $\mathbf{i}$ and $\mathbf{j}$ are horizontal and vertical respectively.]

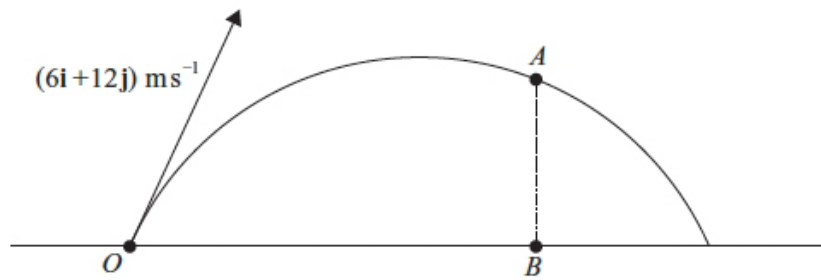


Figure 3

The point O is a fixed point on a horizontal plane. A ball is projected from O with velocity $(6\mathbf{i} + 12\mathbf{j}) \text{ m s}^{-1}$, 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 Figure 3. It is given that $OB = 2AB$.

Find

(a) the value of t ,

(7)

(b) the speed, $V \text{ m s}^{-1}$, of the ball at the instant when it passes through A .

(5)

At another point C on the path the speed of the ball is also $V \text{ m s}^{-1}$.

(c) Find the time taken for the ball to travel from O to C .

(3)

(Total 15 marks)

Q4.

[In this question, the unit vectors $\mathbf{i}$ and $\mathbf{j}$ are in a vertical plane, $\mathbf{i}$ being horizontal and $\mathbf{j}$ being vertically upwards.]

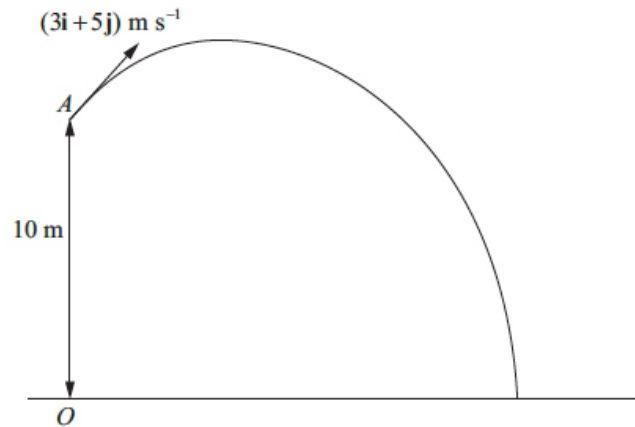


Figure 1

At time $t = 0$, a particle P is projected from the point A which has position vector $10\mathbf{j}$ metres with respect to a fixed origin O at ground level. The ground is horizontal. The velocity of projection of P is $(3\mathbf{i} + 5\mathbf{j}) \text{ m s}^{-1}$, as shown in Figure 1. The particle moves freely under gravity and reaches the ground after T seconds.

- (a) For $0 \leq t \leq T$, show that, with respect to O , the position vector, $\mathbf{r}$ metres, of P at time t seconds is given by

$$\mathbf{r} = 3t\mathbf{i} + (10 + 5t - 4.9t^2)\mathbf{j} \quad (3)$$

- (b) Find the value of T .

(3)

- (c) Find the velocity of P at time t seconds ($0 \leq t \leq T$).

(2)

When P is at the point B , the direction of motion of P is 45° below the horizontal.

- (d) Find the time taken for P to move from A to B .

(2)

- (e) Find the speed of P as it passes through B .

(2)

(Total 12 marks)

Q5.

Unless otherwise stated, whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

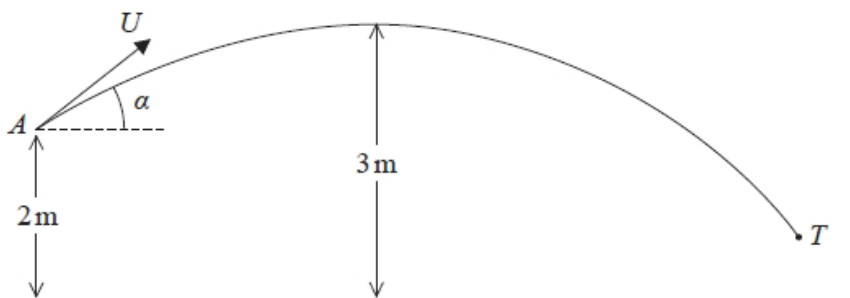


Figure 4

A boy throws a ball at a target. At the instant when the ball leaves the boy's hand at the point A , the ball is 2 m above horizontal ground and is moving with speed U at an angle α above the horizontal.

In the subsequent motion, the highest point reached by the ball is 3 m above the ground.

The target is modelled as being the point T , as shown in Figure 4.

The ball is modelled as a particle moving freely under gravity.

Using the model,

$$U^2 = \frac{2g}{\sin^2 \alpha}.$$

(a) show that

(2)

The point T is at a horizontal distance of 20 m from A and is at a height of 0.75 m above the ground. The ball reaches T without hitting the ground.

(b) Find the size of the angle α

(9)

(c) State one limitation of the model that could affect your answer to part (b).

(1)

(d) Find the time taken for the ball to travel from A to T .

(3)

(Total for question = 15 marks)

