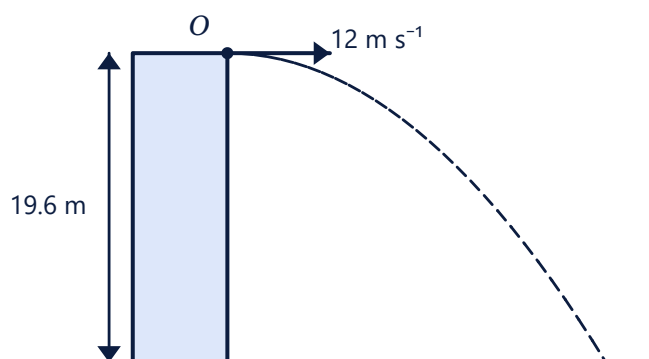




Name: _____ **Date:** _____ **Score:** _____ / 91

- 1** A ball is thrown horizontally with speed 12 m s^{-1} from a point O at the top of a vertical wall. The point O is 19.6 m above horizontal ground. The ball is modelled as a particle moving freely under gravity.
- Find the time taken for the ball to reach the ground.
 - Find the horizontal distance from the foot of the wall to the point where the ball lands.
 - Find the speed of the ball just before it hits the ground.



(5 marks)

Answer _____

2

A particle is projected from a point O on horizontal ground with speed 20 m s^{-1} at an angle of 30° above the horizontal. The particle moves freely under gravity.

Find

- the greatest height of the particle above the ground,
- the time of flight,
- the horizontal distance from O to the point where the particle lands.

(6 marks)

Answer _____

3

A small stone is projected from a point on horizontal ground with speed 25 m s^{-1} at an angle α above the horizontal, where $\tan \alpha = \frac{3}{4}$

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

- Find the speed of the stone 2 seconds after it is projected.
- Find the direction of motion of the stone at this time.

(6 marks)

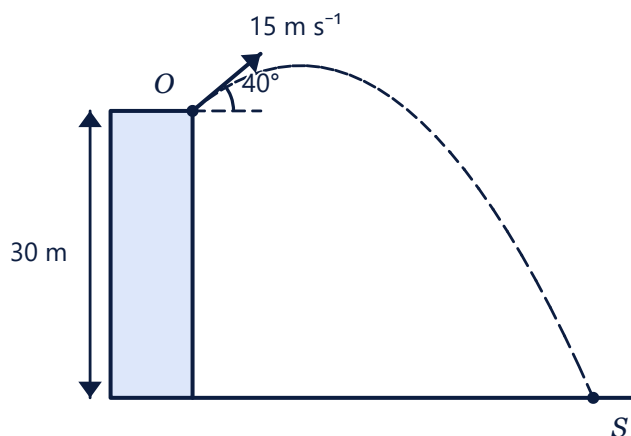
Answer _____

4

A stone is thrown from a point O at the top of a vertical cliff. The point O is 30 m above the sea. The stone is thrown with speed 15 m s^{-1} at an angle of 40° above the horizontal, as shown in the diagram. The stone hits the sea at the point S .

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

- Find the time taken for the stone to travel from O to S .
- Find the distance from the foot of the cliff to S .



(6 marks)

Answer _____

5

A golf ball is hit from a point A on horizontal ground. It leaves the ground with speed U m s⁻¹ at an angle of 35° above the horizontal and first lands at the point B on the ground, where $AB = 80$ m.

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

- Show that $U^2 \sin 35^\circ \cos 35^\circ = 392$
- Find the value of U .
- Find the time the ball takes to travel from A to B .

(7 marks)

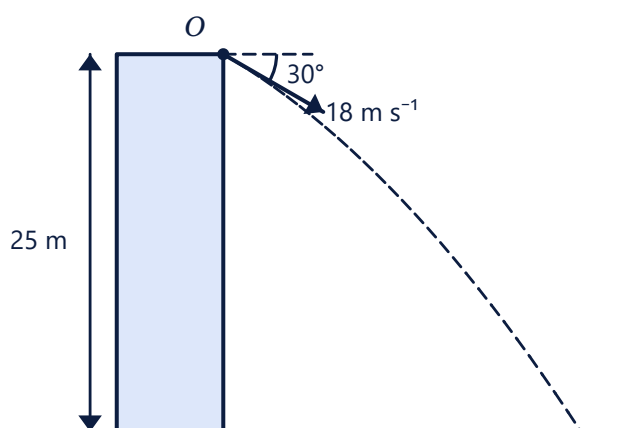
Answer

6

A ball is thrown from a point O on a balcony, 25 m above horizontal ground. The ball is thrown with speed 18 m s^{-1} at an angle of 30° **below** the horizontal, as shown in the diagram.

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

- the vertical component of the velocity of the ball just before it hits the ground,
- the time taken for the ball to reach the ground,
- the speed and direction of motion of the ball just before it hits the ground.



(8 marks)

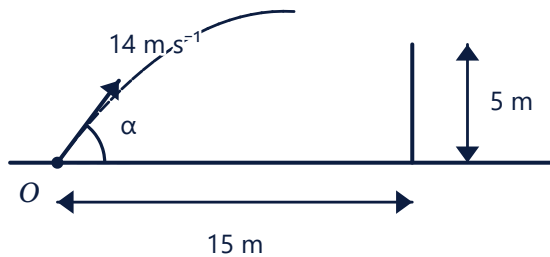
Answer _____

7

A particle is projected from a point O on horizontal ground with speed 14 m s^{-1} at an angle α above the horizontal, where $\tan \alpha = \frac{4}{3}$

At time t seconds the particle is x metres horizontally and y metres vertically from O . The particle moves freely under gravity.

- Show that $y = \frac{4}{3}x - \frac{5}{72}x^2$
- Use your answer to part (a) to find the horizontal distance from O to the point where the particle lands.
- A vertical wall of height 5 m stands 15 m horizontally from O , in the plane of the motion. Determine whether the particle passes over the wall.



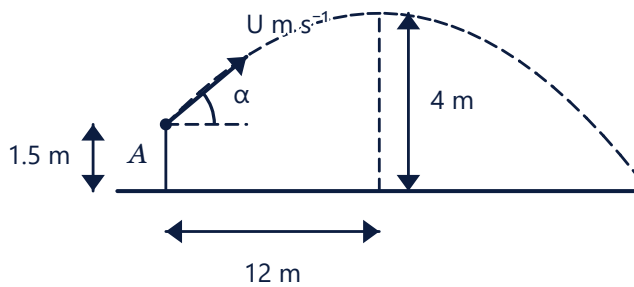
(9 marks)

Answer _____

8

A girl throws a ball from a point A , 1.5 m above horizontal ground. The ball leaves A with speed $U \text{ m s}^{-1}$ at an angle α above the horizontal. The highest point reached by the ball is 4 m above the ground, and at this moment the ball has travelled 12 m horizontally from A . The ball is modelled as a particle moving freely under gravity.

- Show that $U \sin \alpha = 7$
- Find the value of U and the size of the angle α .



(8 marks)

Answer _____

9

A firework is launched from a point on horizontal ground with speed 24.5 m s^{-1} at an angle of 60° above the horizontal. The firework is modelled as a particle moving freely under gravity.

- a. Find the length of time for which the firework is at least 15 m above the ground.
- b. Write down the least speed of the firework during its flight.
- c. Find the speed of the firework when it is 15 m above the ground.

(8 marks)

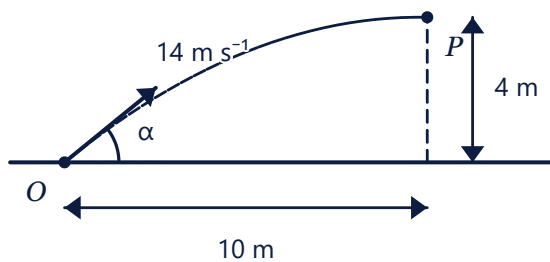
Answer

10

A ball is projected from a point O on horizontal ground with speed 14 m s^{-1} at an angle α above the horizontal. The ball passes through the point P , which is 10 m horizontally and 4 m vertically from O , as shown in the diagram.

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

- Show that the time taken to reach P is $\frac{5}{7 \cos \alpha}$ seconds.
- Show that $5 \tan^2 \alpha - 20 \tan \alpha + 13 = 0$
- Find the two possible values of α .
- For the smaller value of α , find the time taken for the ball to reach P .



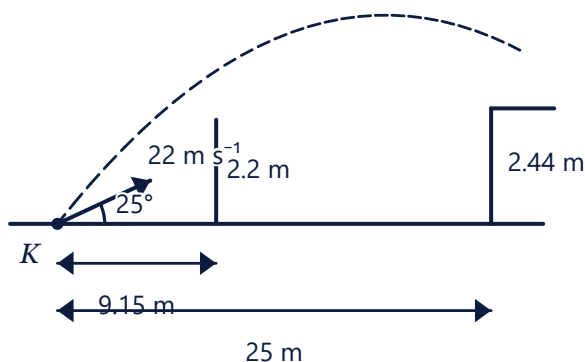
(10 marks)

Answer _____

11

A footballer takes a free kick from a point K on horizontal ground, 25 m from the goal line. The ball leaves the ground with speed 22 m s^{-1} at an angle of 25° above the horizontal, in a vertical plane perpendicular to the goal line. A line of defenders stands 9.15 m from K ; they jump to a height of 2.2 m. The crossbar of the goal is 2.44 m above the ground. The ball is modelled as a particle moving freely under gravity.

- Show that the ball passes over the defenders.
- Determine whether the ball passes under or over the crossbar, and by how much.
- State one limitation of the model that could affect your answer to part (b).



(8 marks)

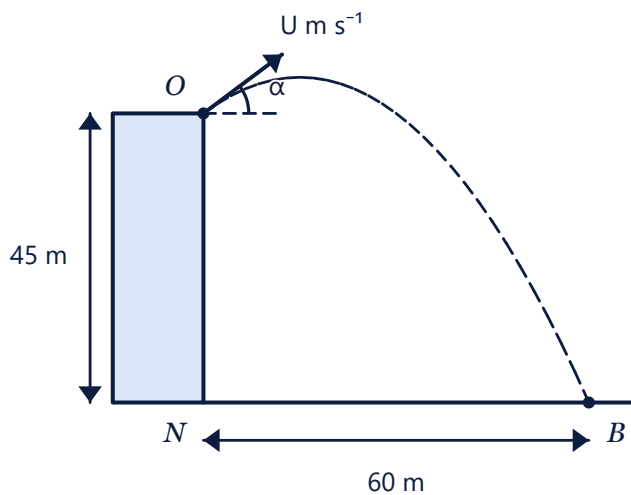
Answer

12

A small stone is projected from a point O at the top of a vertical cliff. The point O is 45 m vertically above the point N on horizontal ground. The stone is projected with speed U m s⁻¹ at an angle α above the horizontal, where $\tan \alpha = \frac{3}{4}$. The stone hits the ground at the point B , where $NB = 60$ m, as shown in the diagram.

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

- Show that $U = 17.5$
- Find the length of time for which the stone is higher than O .
- Find the speed of the stone just before it hits the ground.



(10 marks)

Answer _____

End of questions | Total 91 marks