

6A Horizontal Projections

1. A ball is thrown horizontally, with speed 20ms^{-1} , from the top of a building of height 30m.
Find:
 - a) The time the ball takes to reach the ground

- b) The horizontal distance travelled in that time

2. A particle is projected horizontally with a velocity of 15ms^{-1} . Find:
- a) The horizontal and vertical components of the displacement of the particle from the point of projection after 3 seconds

- b) Find the distance of the particle from its starting point after 3 seconds

3. A particle is projected horizontally with a speed of $U \text{ ms}^{-1}$ from a point 122.5m above a horizontal plane. The particle hits the plane at a point which is at a horizontal distance of 90m away from the starting point.

Find the initial speed of the particle.

6B Breaking Down Angled Projections

1. A ball is thrown horizontally, with speed 20ms^{-1} , from the top of a building of height 30m.
Find:
 - a) The time the ball takes to reach the ground

b) Write the initial velocity in vector form

c) A particle is projected with velocity $\mathbf{U} = (3\mathbf{i} + 5\mathbf{j}) \text{ ms}^{-1}$, where \mathbf{i} and \mathbf{j} are the unit vectors in the horizontal and vertical directions respectively.

Find the initial speed of the particle and its angle of projection.

6C Angled Projections

1. A particle P is projected from a point O on a horizontal plane with speed 28ms^{-1} , and with angle of elevation 30° . After projection, the particle moves freely under gravity until it strikes the plane at a point A.

Find:

- a) The greatest height above the plane reached by P

- b) The time of flight of P

- c) The distance OA

2. A particle is projected from a point O with speed $V\text{ms}^{-1}$ at an angle of elevation θ , where $\tan\theta = \frac{4}{3}$. The point O is 42.5m above the horizontal plane. The particle strikes the plane 5 seconds after it is projected.

a) Show that $V = 20\text{ms}^{-1}$

b) Find the distance between O and A

3. A particle is projected from a point O with speed 35ms^{-1} at an angle of elevation of 30° . The particle moves freely under gravity.

Find the length of time for which the particle is 15m or more above O

4. A ball is struck by a racket at a point A which is 2m above horizontal ground. Immediately after being struck, the ball has velocity $(5\mathbf{i} + 8\mathbf{j}) \text{ ms}^{-1}$, where \mathbf{i} and \mathbf{j} are unit vectors horizontally and vertically respectively.

After being struck, the ball travels freely under gravity until it strikes the ground at a point B, as shown. Find:

- a) The greatest height above ground reached by the ball

- b) The speed of the ball as it reaches B

- c) The angle the velocity of the ball makes with the ground as the ball reaches B

6D Deriving Formulae

1. A particle is projected from a point on a horizontal plane with an initial velocity U at an angle θ above the horizontal, and moves freely under gravity until it hits the plane at point B. Given that the acceleration due to gravity is g , find expressions for:

a) The time of flight, T

b) The range, R , on the horizontal plane

2. A particle is projected from a point with speed u and an angle of elevation θ , and moves freely under gravity. When the particle has moved a horizontal distance x , its height above the point of projection is y .

Show that:

$$y = x \tan \theta - \frac{gx^2}{2u^2} (1 + \tan^2 \theta)$$

3. A particle is projected from a point A on a horizontal plane, with initial speed 28ms^{-1} and an angle of elevation θ . The particle passes through a point B, which is 8m above the plane and a horizontal distance of 32m from A

Find the two possible values of θ , giving your answers to the nearest degree.

(Use the formula we have just calculated)