**6A Horizontal Projections**

1. A ball is thrown horizontally, with speed 20ms-1, from the top of a building of height 30m.

Find:

1. The time the ball takes to reach the ground
2. The horizontal distance travelled in that time
3. A particle is projected horizontally with a velocity of 15ms-1. Find:
4. The horizontal and vertical components of the displacement of the particle from the point of projection after 3 seconds
5. Find the distance of the particle from its starting point after 3 seconds
6. A particle is projected horizontally with a speed of $U ms^{-1}$ 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:

1. The time the ball takes to reach the ground
2. Write the initial velocity in vector form
3. A particle is projected with velocity $U=\left(3i+5j\right) ms^{-1}$, where $i$ and $j$ 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:

1. The greatest height above the plane reached by P
2. The time of flight of P
3. The distance OA
4. A particle is projected from a point O with speed Vms-1 at an angle of elevation θ, where tanθ = 4/3. The point O is 42.5m above the horizontal plane. The particle strikes the plane 5 seconds after it is projected.
5. Show that V = 20ms-1
6. Find the distance between O and A
7. 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

1. 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**i** + 8**j**) ms-1, where **i** and **j** are unit vectors horizontally and vertically respectively.

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

1. The greatest height above ground reached by the ball
2. The speed of the ball as it reaches B
3. 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:
2. The time of flight, $T$
3. The range, $R$, on the horizontal plane
4. 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:

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

1. 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)