PROJECTILES

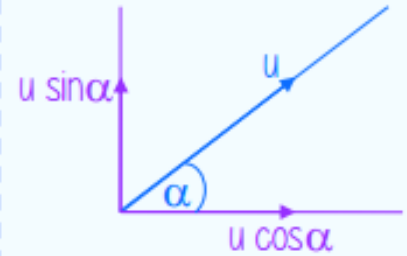
KEY WORDS & DEFINITIONS

1. **Projectile**
   A particle moving in a vertical plane under the action of gravity.
2. **Angle of Projection**
   The initial angle the projectile makes with the horizontal direction.
3. **Speed**
   The magnitude of the velocity, or the resultant velocities.
4. **Range**
   The horizontal distance that the particle travels.
5. **Time of Flight**
   The time taken for the projectile to hit the ground, or other horizontal surface, after being projected.

HORIZONTAL & VERTICAL COMPONENTS OF INITIAL VELOCITY

If a particle is projected with an initial velocity u, at an angle α above the horizontal, α is called 'The angle of projection'.

The velocity can be resolved into components that act horizontally and vertically.



The horizontal component of the initial velocity = u cos α

The vertical component of the initial velocity = u sin α

WHAT DO I NEED TO KNOW

1. The horizontal acceleration of a particle = 0
2. The horizontal velocity of a particle is constant. Therefore $s = vt$
3. The vertical acceleration a of a partical = g (constant)
4. To find the horizontal & vertical components of the initial velocity, resolve horizontally & vertically
5. When a projectile reaches its maximum height, the vertical component of velocity = 0
6. Acceleration due to gravity = $9.8 m/s^2$
   This does not depend on the mass of the object.
7. The degree of accuracy in your answers must be consistent with the values given in the question. Ie. if g = $10 m/s^2$ in the question, your answer should also be given to 1 sig. fig. Do not leave exact surd answers.
8. Many projectile problems can be solved by first using the vertical motion to find the total time taken.

POSSIBLE EQUATIONS TO DERIVE

For a particle projected with initial velocity U at angle α above horizontal and moving freely under gravity:

- Time of flight $= \frac{2U \sin \alpha}{g}$
- Time to reach greatest height $= \frac{U \sin \alpha}{g}$
- Range on horizontal plane $= \frac{U^2 \sin 2\alpha}{g}$
- Equation of trajectory:

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

where y is the vertical height of particle and x is the horizontal distance from the point of projection.