

PROJECTILE MOTION

1. PROJECTILE THROWN AT AN ANGLE WITH HORIZONTAL



- Consider a projectile thrown with a velocity u making an angle θ with the horizontal.
- Initial velocity u is resolved in components in a coordinate system in which horizontal direction is taken as x -axis, vertical direction as y -axis and point of projection as origin.
 $u_x = u \cos \theta$ $u_y = u \sin \theta$
- Again this projectile motion can be considered as the combination of horizontal and vertical motion. Therefore,

	Horizontal direction	Vertical direction
(a)	Initial velocity $u_x = u \cos \theta$	Initial velocity $u_y = u \sin \theta$
(b)	Acceleration $a_x = 0$	Acceleration $a_y = g$
(c)	Velocity after time t , $v_x = u \cos \theta$	Velocity after time t , $v_y = u \sin \theta - gt$

1.1 Time of flight :

The displacement along vertical direction is zero for the complete flight.
Hence, along vertical direction net displacement = 0

$$\Rightarrow (u \sin \theta) T - \frac{1}{2} gT^2 = 0 \qquad \Rightarrow \qquad T = \frac{2u \sin \theta}{g}$$

1.2 Horizontal range :

$$R = u_x \cdot T \qquad \Rightarrow \qquad R = u \cos \theta \cdot \frac{2u \sin \theta}{g}$$

$$R = \frac{u^2 \sin 2\theta}{g}$$

1.3 Maximum height :

At the highest point of its trajectory, particle moves horizontally, and hence vertical component of velocity is zero.

Using 3rd equation of motion i.e.

$$v^2 = u^2 + 2as$$

we have for vertical direction

$$0 = u^2 \sin^2 \theta - 2gH \qquad \Rightarrow \qquad H = \frac{u^2 \sin^2 \theta}{2g}$$

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Jin-Ying Zhang



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