



## INTERMEDIATE

# Projectile Motion

*Hand Notes For JEE Mains, Advance, NEET UG, Class 11 & 12 etc...*

## Hand Notes

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**Note :** We also providing IIT JEE, Advance, NEET, JEE UG, GATE, IES, PSUs & Competitive Exam Materials [Handnotes, Shortnotes & Books], All Reports [Seminar Reports & PPT]

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# 'PROJECTILE MOTION'

If velocity of particle in one direction is const & Acceleration which is in  $\perp$  direction remain same w.r.t Motion of particle is called projectile & Its path is always parabolic.

## Ground - Ground projection

$$T = \frac{2u \sin \theta}{g} = \frac{2uy}{g} \leftarrow \text{Time of flight}$$

$$h_{\max} = \frac{u^2 \sin^2 \theta}{2g} = \frac{2y^2}{2g} \rightarrow \text{max height}$$

$$R = (u \cos \theta) T = \frac{2uxy}{g} = \frac{u^2 \sin \theta}{g}$$

$$\vec{v} = (u \cos \theta) \hat{i} + (u \sin \theta - gt) \hat{j}$$

$$\alpha = (u \cos \theta t) \hat{i} + (u \sin \theta t - \frac{1}{2}gt^2) \hat{j}$$

$$y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta} = x \tan \theta \left[ 1 - \frac{x}{R} \right]$$

\* velocity at time 't'

Horizontal

$$V_x = u \cos \theta \propto t^0$$

Vertical

$$V_y = (u \sin \theta) - gt$$

\* Angle of velo. from  $x$ -axis

$$\alpha = \tan^{-1} \left( \frac{v_y}{v_x} \right) = \tan^{-1} \left( \frac{u \sin \theta - gt}{u \cos \theta} \right)$$

\* Disp. at time 't'

$$|\vec{r}| = \sqrt{x^2 + y^2}$$

\* From bottom to top  $\alpha \downarrow$

\* At top position  $\alpha = 0$

\* From top to bottom  $\alpha \uparrow$

\* Horizontal Range

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

\* K.E at lowest point

$$KE = \frac{1}{2} mu^2$$

NOTE → \* Horizontal component of velocity remain same all points of its path

\* At top point path of particle is circular & Resultant velo. remain same.

## Special case for ground to ground projection

### Case-I → Max Range condition

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

$$* u = c, g = c \Rightarrow R = f(\theta)$$

max

$$(\sin 2\theta) = 1$$

$$\downarrow$$

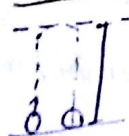
$$2\theta = 90^\circ, \pi/2$$

$$\theta = 45^\circ / \pi/4$$

$$\# R_{\max} = \frac{u^2}{g} = R_{45^\circ}$$

$$h_{45^\circ} = \frac{u^2 \sin^2 45^\circ}{2g} = \frac{u^2}{4g}$$

### # $\theta = 90^\circ$ (vertical projection)



$$R_{90} = 0$$

$$T_{\max} = \frac{2u}{g} = T_{90^\circ}$$

$$h_{90} = \frac{u^2}{2g} = \frac{R_{45^\circ}}{2} \Rightarrow R_{45^\circ} = 2h_{90}$$

$$h_{45^\circ} = \frac{R_{45}}{4} = \frac{h_{90}}{2}$$

$$R_{\max} \Rightarrow \theta \Rightarrow 45^\circ$$

$$H_{\max} \Rightarrow \theta = 90^\circ$$

$$T_{\max} \Rightarrow \theta = 90^\circ$$

1a)  $\rightarrow 0 \leq \theta \leq 45$

$\theta \uparrow, T \uparrow, h_{\max} \uparrow, R \uparrow$

1b)  $\rightarrow 45^\circ < \theta \leq 90^\circ$

$\theta \uparrow, T \uparrow, h_{\max} \uparrow, R \uparrow$