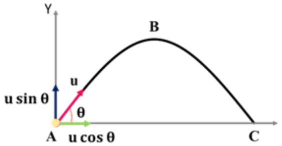
MIND MAP

Kinematics 2D

Projectile motion



$$T = \frac{2u\sin\theta}{g} = \frac{2u_y}{g}$$

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

Range is maximum when θ is 45°

For complimentary angles of projection θ and 90 - θ $\quad R = \frac{u^2\sin 2\theta}{g}$

$$\frac{T_1}{T_2} = \tan\theta, \quad \frac{H_1}{H_2} = \tan 2\theta, \quad \frac{R_1}{R_2} = 1,$$

Relation between horizontal range and maximum height

$$H = \frac{R}{4}\tan\theta$$

Equation of trajectory

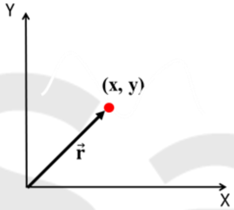
$$\boxed{y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta} = x\tan\theta\left(1 - \frac{x}{R}\right)}$$

If a person can throw a ball to a maximum distance x then the maximum height to which he can throw the ball will be $\frac{x}{2}$

Path of particle having constant acceleration

Initial Velocity (u)	Path
u = 0	Straight Line
u ≠ 0, u and a collinear	Straight Line
u ≠ 0, u and a non-collinear	Parabolic

If two particles are projected in gravitational field then during the time at flight of both particles, trajectory of one particle w.r.t. other particle will be a straight line.

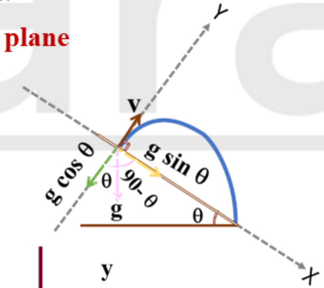


$$\vec{r} = x\hat{i} + y\hat{j}$$

$$\vec{v} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$$

$$\vec{a} = \frac{d^2x}{dt^2}\hat{i} + \frac{d^2y}{dt^2}\hat{j}$$

Projectile on inclined plane



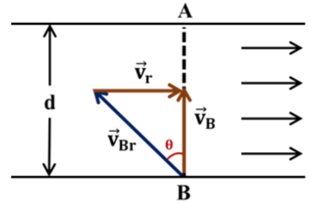
x	y
$u_x = 0$	$u_y = 0$
$a_x = g\sin\theta$	$a_x = -g\cos\theta$
	$s_y = 0$
$t = \frac{2v}{g\cos\theta}$	$0 = ut + \frac{1}{2}(g\cos\theta)t^2$
$s_x = \frac{1}{2}g\sin\theta\left(\frac{2v}{g\cos\theta}\right)^2$	$t = \frac{2v}{g\cos\theta}$

River and Boat:

For Shortest Path:

To reach at B, $V_{Br}\sin\theta = V_r$

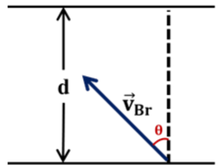
$$\sin\theta = \frac{V_r}{V_{Br}}$$



Time of Crossing:

If $V_r > V_{Br}$ then for minimum drifting

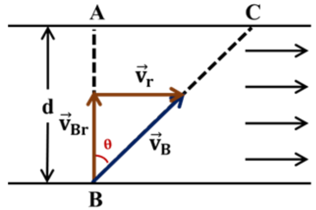
$$\sin\theta = \frac{V_{Br}}{V_r}$$



$$t = \frac{d}{V_{Br}\cos\theta}$$

For Minimum Time

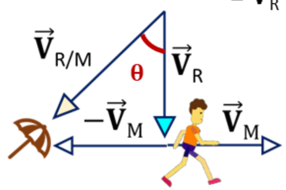
$$t_{min} = \frac{d}{V_{Br}}$$



Rain Man situation:

1 Man observes rain in direction of velocity of rain w.r.t. man ($\vec{V}_{R/M}$).

2. Umbrella is held in direction opposite to the velocity of rain w.r.t. man ($-\vec{V}_{R/M}$). $\quad = \vec{V}_R - \vec{V}_M$



$$\tan\theta = \frac{V_M}{V_R}$$