MOTION IN 2-D

Vector → component of vector (dirⁿ)
→ Magnitude of vector (size)

① Velocity: $\vec{v} = v_x\hat{i} + v_y\hat{j}$

$|\vec{v}| = \sqrt{v_x^2 + v_y^2}$

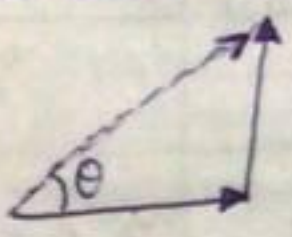
→ same for acceleration

② Displacement: $\vec{r} = \vec{r}_2 - \vec{r}_1$

$\vec{r} = [x_2 - x_1]\hat{i} + [y_2 - y_1]\hat{j}$

$\vec{r} = \Delta x\hat{i} + \Delta y\hat{j}$ is a position vector.

③ Direction of motion :-



$\tan\theta = \frac{v_y}{v_x}$

④ Equation of Motion in a plane :-
(a = constant)

$v_x = u_x + a_x t$
$v_y = u_y + a_y t$

$x = u_x t + \frac{1}{2}a_x t^2$
$y = u_y t + \frac{1}{2}a_y t^2$

⇒ x-axis and y-axis ka motion independent hota hai. Acceleration along x only change velocity of x-axis.

$v_x = \frac{dx}{dt}$ $v_y = \frac{dy}{dt}$

$a_x = \frac{dv_x}{dt}$

$a_y = \frac{dv_y}{dt}$

- Only time is same in both co-ordinate.

⑤ Equation of Trajectory

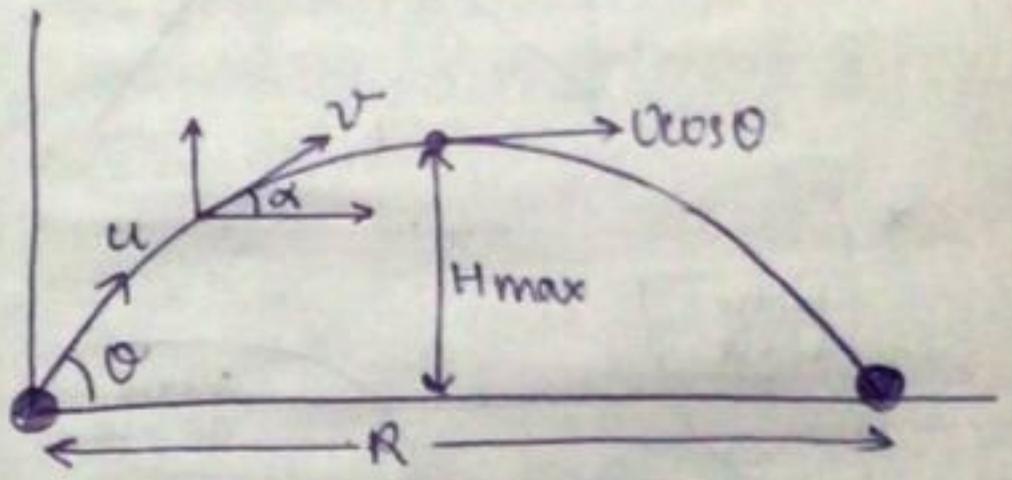
Position Vector	Equation of Trajectory
1) $\vec{r} = A\sin(\omega t)\hat{i} + A\cos(\omega t)\hat{j}$	$x^2 + y^2 = A^2$ (circle)
2) $\vec{r} = A\sin(\omega t)\hat{i} + B\cos(\omega t)\hat{j}$	$\frac{x^2}{A^2} + \frac{y^2}{B^2} = 1$ (Ellipse)
3) $\vec{r} = A\sin(\omega t)\hat{i} + B\sin(\omega t)\hat{j}$	$y = \left(\frac{B}{A}\right)x$ (straight line)
4) $\vec{r} = 2t\hat{i} + 4t^2\hat{j}$	$y = x^2$ (Parabola)

- Motion starts from rest then constant acceleration then path → straight line.
- If Angle b/w velocity and acc^n is always 90° then path → circle
- If Angle between initial velocity and acceleration is other than 0° or 180° then path → parabolic.

⑥ Projectile Motion

→ Non uniform motion with uniform acceleration.

θ = with horizontal
θ = with vertical (sab change except range) sinθ → cosθ



$\alpha = \frac{u\sin\theta - gt}{u\cos\theta}$

$v = \frac{u\cos\theta}{\cos\alpha}$

$T_f = \frac{2u\sin\theta}{g} = \frac{2v_y}{g}$

$H_{max} = \frac{u^2\sin^2\theta}{2g} = \frac{v_y^2}{2g}$

$R = v_x T_f = u\cos\theta \cdot \frac{2u\sin\theta}{g}$

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

x-axis	y-axis
At $t=0$, $\vec{v}_x = u\cos\theta\hat{i}$	$\vec{v}_y = u\sin\theta\hat{j}$
At 't', $\vec{v}_x = u\cos\theta\hat{i}$	$v_y = (u\sin\theta - gt)\hat{j}$
$\vec{a}_x = 0$	$\vec{a}_y = -g\hat{j}$
$x = v_x t = u\cos\theta t$	$y = u\sin\theta t - \frac{1}{2}gt^2$
$(v_{avg}) = u\cos\theta$	$\lvert\Delta\vec{p}\rvert = 2mu\sin\theta$

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