Chapter # 04

- $\vec{V}_{avg} = \frac{\Delta d}{\Delta t} = \left(\frac{d_1+d_2+d_3}{t_1+t_2+t_3}\right)$
- $\vec{V}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta d}{\Delta t} \Rightarrow$ derivative of d w.r.t time
- $\vec{a}_{avg} = \frac{\Delta V}{\Delta t}$
- $\vec{a}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta V}{\Delta t}$

$|\vec{V}_{avg}| = \sqrt{V_x^2 + V_y^2 + V_z^2}$

$\vec{V}_{net} = \vec{V_1} + \vec{V_2} + V_3 + \ldots$

↳ sign vary

$Speed_{avg} = \frac{\vec{V}_{total}}{t_{total}}$

Equation of uniformly accelerated motions

1) $V_f = V_i + at$

2) $S = V_i t + \frac{1}{2} a t^2$

3) $2aS = V_f^2 - V_i^2$

Projectile motion → 2-D motion

↳ launched with an initial velocity V_i at an angle θ w.r.t horizontal axis

↳ horizontal axis (x-axis)

↳ vertical axis (y-axis)

↳ no air resistance

↳ g = constant = $9.8\ m/s^2$

→ horizontal motion = no acceleration

→ vertical motion = $-g$

→ initial velocity at anqngle θ
↳ always resolve into components

- $V_{ix} = V_i \cos\theta$ $\left(\because A_x = A\cos\theta \right.$
- $V_{iy} = V_i \sin\theta$ $\left. \because A_y = A\sin\theta \right)$
- Always draw triangle.
- $X = V_{ix} \cdot t$
- $Y = V_{iy} \cdot t + \frac{1}{2} g t^2$ → General Case
- $Y = V_{iy} t - \frac{1}{2} g t^2$ → against gravity یعنی نیچے سے اوپر
- $Y = \frac{1}{2} g t^2$ → if projectile is dropped from a height
- Throw horizontally ⇒ $V_y = 0$

so $Y = \frac{1}{2} g t^2$

- $a_x = 0$
- $a_y = g$ or $-g$

depends upon statement

⇒ $S = V_i t + \frac{1}{2} a t^2$

$X = V_{ix} t + \frac{1}{2} a_x t^2$

$X = V_{ix} t$

$Y = V_{iy} t + \frac{1}{2} a_y t^2$

$g = -ve$
$g = +ve$

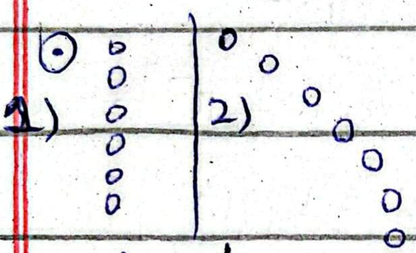
$\boxed{Y = V_{iy} t + \frac{1}{2} g t^2}$

or

$Y = V_{iy} t - \frac{1}{2} g t^2$

↓

depends upon statement.

- $Y - Y_i = V_{iy} t - \frac{1}{2} g t^2$ → if launched through some specific height.
  → also to find initial height
- similarly $X - X_i = V_{ix} t$
- Trajectory (= path of particle) in projectile motion is parabolic.
- $\vec{V_i} = V_{ix}\hat{i} + V_{iy}\hat{j}$
- In projectile motion the horizontal motion and the verticle motion are independent of each other.
- 

  ↳ Same time

  [illegible]

- At highest point $V_y = 0$
- Before the highest point (top) ⇒ $V_y > 0$
- After the highest point (top) ⇒ $V_y < 0$

V_{iy} ←
- At launch $(t=0)$ ⇒ $V_{iy} = V_i \sin\theta$
- At time t (after launch) ⇒ $V_y = V_i \sin\theta - gt$
  ↳ decreases due to gravity

V_{ix} ←
- At launch $(t=0)$ ⇒ $V_{ix} = V_i \cos\theta$
- At time t → $V_{ix} = V_i \cos\theta$

  ↳ same

  bc there is no gravity or air resistance in horizontal motion
  In short V_{ix} never changes.

- Released from a plane = its velocity as same as plane
- Shot from plane = its velocity will be something else.

⊙ angle → north of east = east سے north
کی طرف

⊙ speedometer of car measures speed (magnitude of velocity)

if θ & V_i is given

⊙ **Height of Projectile:**

$$\boxed{H = \frac{V_i^2 \sin^2\theta}{2g}}$$

$\because 2as = v_f^2 - v_i^2$

$a = -g$

$v_{f_y} = 0$

$v_{iy} = v_i \sin\theta$

$S = H$

⊙ **Time Of Flight:**

The time taken by the body to cover the distance from the place of its projection to place where it hits the ground at the same level is called TOF. or Time In Air

$$\boxed{T = \frac{2v_i \sin\theta}{g}}$$

$\because S = V_i t + \frac{1}{2} a t^2$

⊙ **Range Of Projectile:**

↳ maximum distance which a projectile covers in the horizontal direction is called range of the projectile.

$$\boxed{R = V_{ix} \cdot T}$$

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

Uniform Circular Motion (UCM)

- 2D
- obj moves around circle at const speed
- speed = uniform
- $\vec{v} \neq$ uniform b/c direction changes
- $|\vec{v}|$ = uniform.
- centrepetal acce. $\Rightarrow a = \frac{v^2}{r}$
- 1 circle circumference in time T is

$$T = \frac{2\pi r}{v}$$

T: Period for exactly once.

$$T = \frac{\theta}{\omega}$$

speed $v = \frac{2\pi r}{T}$