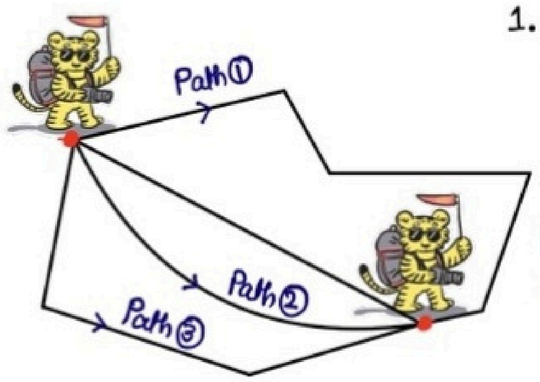
MIRACLE ACADEMY

Kinematics - 1D



1. Distance and Displacement:-

Distance:
- Actual path length
- → Multiple possible paths
- → can not be negative

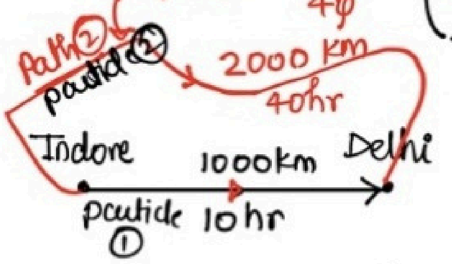
Displacement:
- → shortest possible path (straight) from i to f.
- "vector quantity"
- → unique value
- → can be negative, positive or zero

→ If the particle changes location, both distance and displacement can not be zero.

→ For a round trip displacement will be zero but distance will not.

→ | Displacement | ≤ Distance.

$$\text{speed} = \frac{2000}{40} = \left(50 \frac{km}{hr}\right)$$



2. Speed and Velocity

Speed:
- · rate of change of dist.
- · Scaler quantity
- · only magnitude.

Velocity:
- → Rate of change of displacement.
- → vector quantity
- magnitude as well as Direction ⇓ equal to speed

3. Avg Speed and Avg velocity:-

$$V_{avg} = U_{speed} = \frac{1000}{10} = (100)$$

$$V_{avg} = \frac{1000}{40} = 25\ km/hr$$

Avg Speed $= \frac{\text{total distance}}{\text{total time}}$; Avg velocity $= \frac{\text{total displacement}}{\text{total time}}$

\# NOTE that:- | Avg velocity | may or may not be equal to avg speed.

\# If particle moves with velocity v_1, v_2 and v_3

a) for time t_1, t_2 and t_3 ; if $t_1 = t_2 = t_3 = t$

$$V_{avg} = \frac{v_1t_1 + v_2t_2 + v_3t_3}{t_1 + t_2 + t_3} \qquad V_{avg} = \frac{v_1 + v_2 + v_3}{3}$$

b) for distances s_1, s_2 and s_3 ; if $s_1 = s_2 = s_3 = s$.

$$V_{avg} = \frac{s_1 + s_2 + s_3}{\frac{s_1}{v_1} + \frac{s_2}{v_2} + \frac{s_3}{v_3}} \qquad \frac{3}{V_{avg}} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$$

4. Acceleration:- Rate of change of velocity

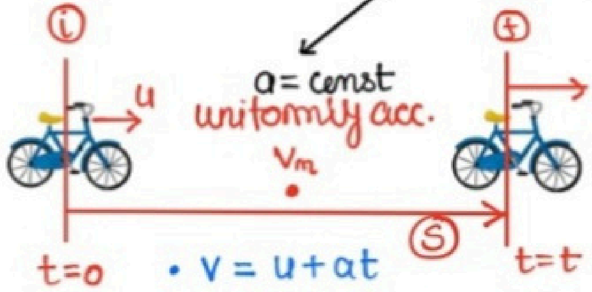
$$a = \frac{d\bar{v}}{dt}$$

$$a_{avg} = \frac{\Delta \bar{v}}{\Delta t} = \frac{\bar{v}_f - \bar{v}_i}{\Delta t}$$

→ by change in magnitude
- $\bar{a} \parallel \bar{v}$: $|\bar{v}|$ ↑ ; accelerat[ion]
- $\bar{a}$ anti $\parallel \bar{v}$: $|\bar{v}|$ ↓ ; Deaccelera[tion]

→ by change in direction ; $\bar{a} \perp \bar{v}$ "Circular Motion"

- $a \neq 0$
  - $a = \text{const}$ — uniformly acc.
  - $a \neq \text{const}$ (Do not use equation)
- $a = 0$
  - $\bar{v} = \text{const}$
  - "uniform motion"



- $v = u + at$
- $s = ut + \frac{1}{2}at^2 \rightarrow$ s in time 't'.
- $v^2 = u^2 + 2as$
- $S_n = u + \frac{a}{2}(2n-1)$ ← S_n in time t^{th}
- $V_m = \sqrt{\frac{u^2+v^2}{2}}$ PYQ
- $V_{avg} = \frac{u+v}{2}$ & $s = \left(\frac{u+v}{2}\right)t$
- if $u=0$; $s = \frac{1}{2}at^2$; $s \propto t^2$
- Distance moved by particle in equal time interval will be in the ratio of 1:3:5 and so on

$a \neq$ const:

⊗ Power of t ↑ by ① — area under v-t graph: Displacement ← $\int v\,dt$ — velocity

⊗ Power of t ↑ by ① — area under a-t graph: velocity ← $\int a\,dt$ — Acceleration

Displacement → velocity: $x \propto t^4$, $\frac{dx}{dt}$ — ⊗ Power of t ↓ by ①

velocity → Acceleration: $v \propto t^3$, $\frac{dv}{dt}$ — $a \propto t^2$ — ⊗ Power of t ↓ by ①

 # stopping dist.

u →, ← a, V=0

$$s = \frac{u^2}{2a}$$

$\because S \propto u^2$

5. Motion under Gravity:-

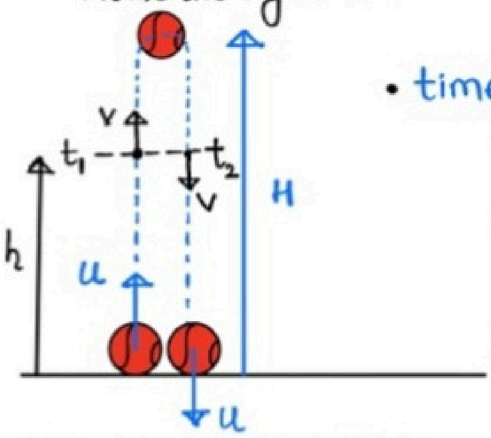
- Motion under constant $a = g\downarrow$, always directed downward. (−ve always)
- $v = u + at$
- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as$
- $S_n = u + \frac{a}{2}(2n-1)$

→ replace a with g, and use equations with proper sign convention,

velocity ↑ (+ve), ↓ (−ve)

Displacement ↑ (+) and ↓ (−).

$v_y = 0$; but $a = g\downarrow$
momentarily at rest



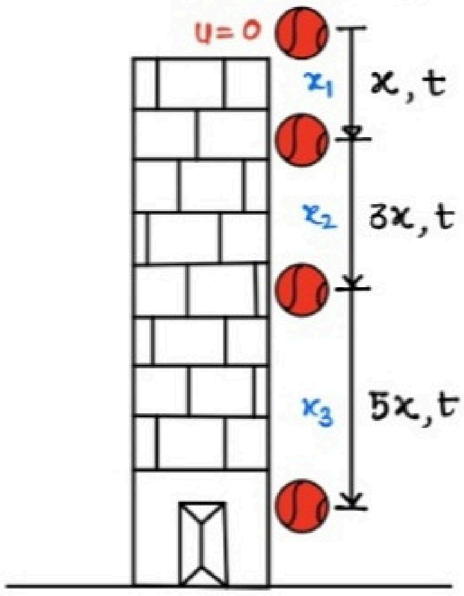
- time of ascent = time of descent $= \frac{u}{g}$
  ∵ provided that air resistance is zero.
- Time of flight $(T) = \frac{2u}{g}$
- Maximum Height $(H) = \frac{u^2}{2g}$
- Particle will be at same height for two time t_1 (while going up) and t_2 (while going ↓) then;

$$h = \frac{1}{2}g t_1 t_2 \quad \text{and} \quad u = \frac{1}{2}g(t_1 + t_2)$$

- if air resistance $\neq 0$
  ↓
  always act opposite to direction of motion

$$t_a' = \frac{u}{g+a} \quad \text{and} \quad t_d' = \frac{u}{g-a}$$

6. Motion under gravity [object droped from 'H' with u=0]



distances moved by object in equal time interval is "Galileo trick"

$= 1 : 3 : 5 : 7 \ldots\ldots$

- if $t = 1\,sec$; then $x = 5\,m$. $g = 10\,m/s^2$, $t = 1\,sec$

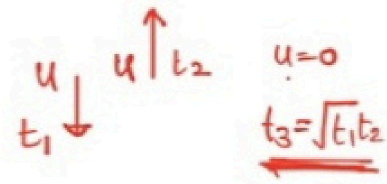
so

$x_1 = 5\,m$

$x_2 = 15\,m$

$x_3 = 25\,m$ and so on.

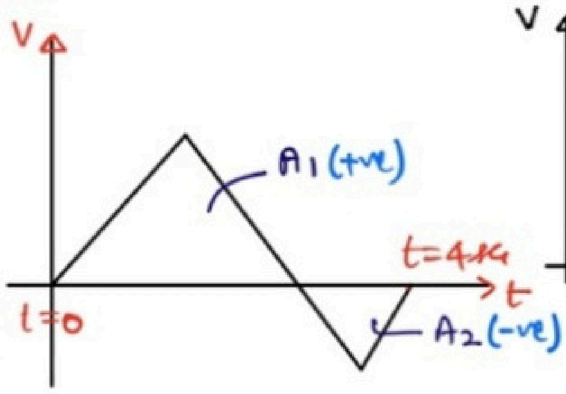
- Time of fall $= T = \sqrt{\frac{2H}{g}}$
- velocity at any time 't' ; $v_y = gt \downarrow$

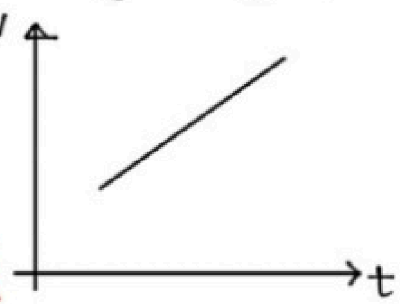


8. Displacement time graph :-

- $V_{avg} = \frac{x_f - x_i}{t_2 - t_1}$
- slope = velocity.

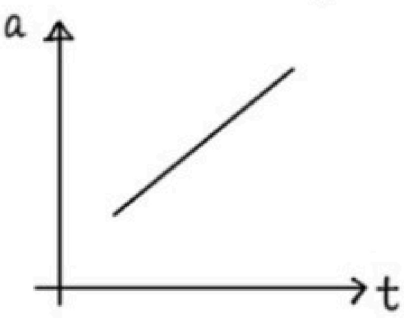
9. velocity time graph :-





- $a_{avg} = \frac{v_f - v_i}{t_2 - t_1}$ → total time taken.
- $a = \frac{dv}{dt}$ = slope
- $\int v.dt$ = area under curve
  - distance ⇒ all areas add up. $= A_1 + |-A_2|$
  - Displacement $\boxed{A_1 - A_2}$ ⇒ area above time axis +ve otherwise −ve.

10. Acceleration time graph :-



- $\int a.dt = \Delta v$ = area under curve
  ⇓
  change in velocity
- slope $= \tan\theta = \frac{da}{dt}$ = jerk.