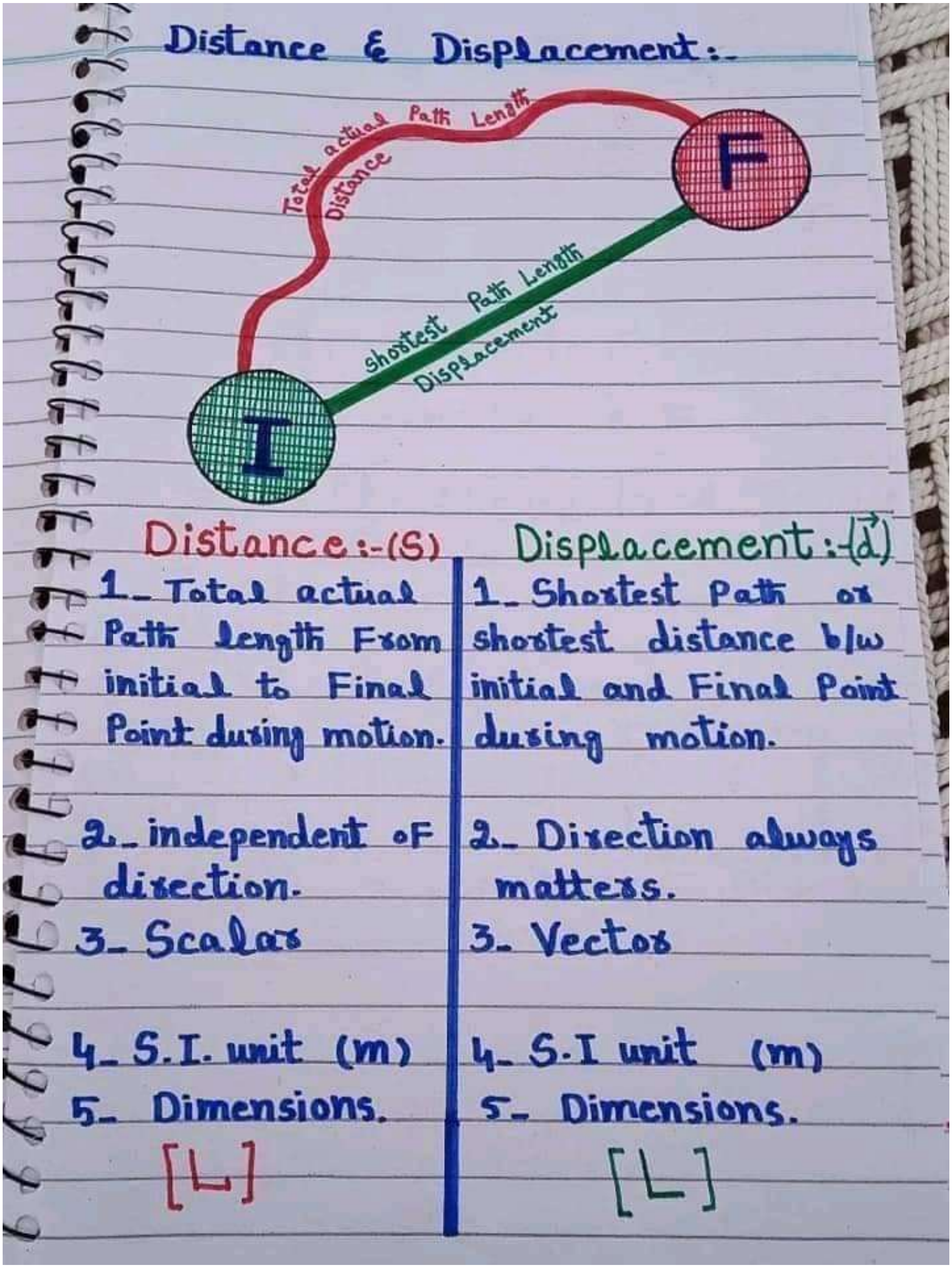
Distance and displacement notes



Distance & Displacement :-

Total actual Path Length
Distance

Shortest Path Length
Displacement

F

I

Distance :- (S)	Displacement :- ($\vec{d}$)
1- Total actual Path length From initial to Final Point during motion.	1- Shortest Path or shortest distance b/w initial and Final Point during motion.
2- independent oF direction.	2- Direction always matters.
3- Scalar	3- Vector
4- S.I. unit (m)	4- S.I unit (m)
5- Dimensions. [L]	5- Dimensions. [L]

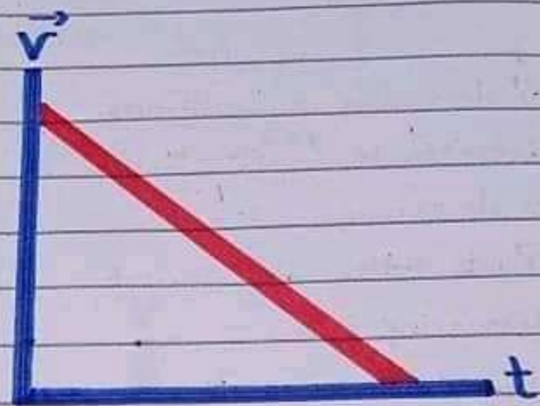
Distance and displacement notes

When $\vec{v}$ is decreasing UniFormly:-

$\vec{v}$ is decreasing uniFormly.

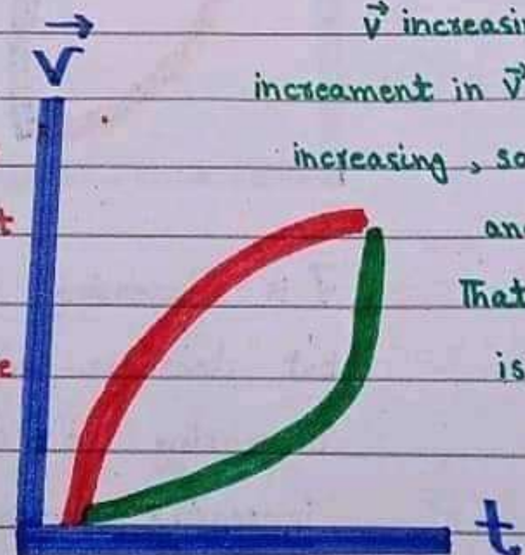
$\vec{a}$ is -ive constant or uniForm

-ive $\vec{a}$ = Retardation



When $\vec{v}$ is increasing non-uniFormly:-

$\vec{v}$ increasing non-uniFormly. But increament in $\vec{v}$ w.r.t time decreasing, so $\vec{a}$ is +ive but decrease That's why slope is decreasing



$\vec{v}$ increasing non-uniFormly increament in $\vec{v}$ with time increasing, so $\vec{a}$ is +ive and increasing That's why slope is increasing.

Distance and displacement notes

Speed:-

1- Time rate of change of distanc

$\boxed{Speed = \Delta S/t}$

2- Scalar

3- ms^{-1}

$[LT^{-1}]$

4- $V_{av} = \frac{Total\ S}{Time}$

5- When Body moves-

S can never be zero

$S \neq 0$

So,

average speed can not be zero

$V_{av} \neq 0$

Velocity:-

1- Time rate of change of displacement.

$\boxed{Velocity = \Delta \vec{d}/t}$

2- Vector

3- ms^{-1}

$[LT^{-1}]$

4- $\vec{V}_{av} = \frac{Total\ \vec{d}}{total\ time}$

5- When Body moves-

i- if closed Path-

$d = 0 \longrightarrow \Delta d = 0$

So,

average velocity is zero

$\vec{V}_{av} = 0$

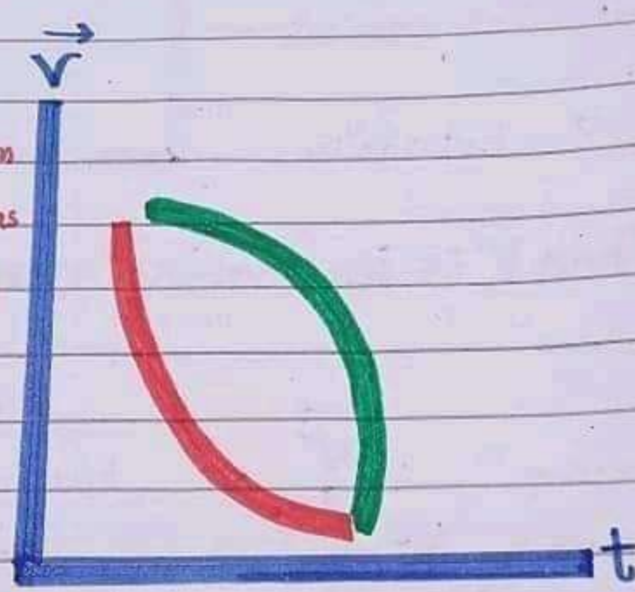
ii- if open Path-

$\vec{V}_{av} \neq 0$

Distance and displacement notes

When $\vec{v}$ is decreasing non-UniFormly:-

$\vec{v}$ decreasing non-uniFormly.
decrease in $\vec{v}$ with time
is decreasing, so
$\vec{a}$ is (-ive) but
decreasing i.e.
non-uniForm retardation
slope is decreasing as
-ive $\vec{a}$ is decreasing



$\vec{v}$ is decreasing non-uniFormly
But decrease in $\vec{v}$ with time
increasing so $\vec{a}$ is (-ive) but
increasing [increasing retardation]
that's why slope is increasing.

Distance and displacement notes

Acceleration:-

Time rate of change of velocity.

$$\boxed{a_{av} = \frac{\Delta \vec{v}}{\Delta t}}$$

Type:- Vector , Unit:- ms^{-2} $[LT^{-2}]$

$\vec{a}$ is Uniform:- if $\vec{v}$ changes by equal amount in equal intervals of time.

$\vec{a}$ is Variable:- if $\vec{v}$ changes are unequal in equal intervals of time.

$$\boxed{\vec{a}_{uniform} \Rightarrow \vec{a}_{av} = \vec{a}_{ins}}$$

1- $\vec{v}$ is increasing in a Straight Line:-

$\vec{a}$ is +ive , $\vec{a}$ in The direction of $\vec{v}$

θ b/w $\vec{a}$ & $\vec{v}$ is $0°$ [Parallel]

2- $\vec{v}$ is decreasing in a Straight Line:-

$\vec{a}$ is -ive , opposite direction of $\vec{v}$

θ b/w $\vec{a}$ & $\vec{v}$ is $180°$ [Antiparallel]

Negative $\vec{a}$ $\longrightarrow$ Retardation

$\vec{v}$ is Uniform $\longrightarrow$ $\vec{a}$ is constant

$\vec{v}$ is Constant $\longrightarrow$ $\Delta V = 0$ $\longrightarrow$ $\vec{a} = 0$

Calculation:

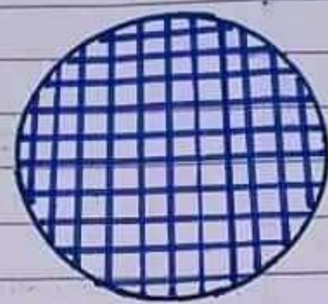
$\vec{a}_{av}$ From variable $\vec{a}$

$\vec{a}_{ins}$ From Uniform $\vec{a}$

Distance and displacement notes

Complete Circle:- (100%)

$S = 2\pi r$

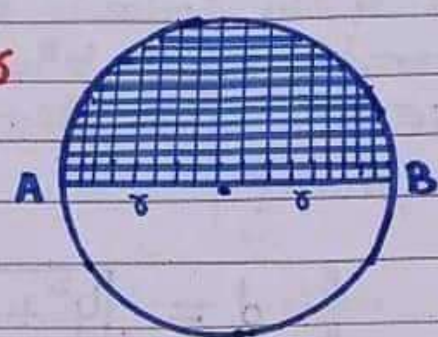


$d = 0$

Semi / or Half Circle:- (50%)

$S = \pi r$

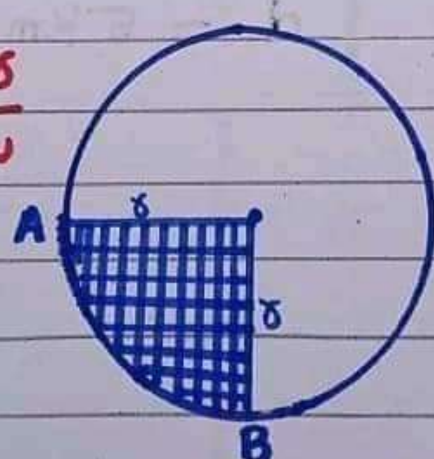
$d = 2r$



Quarter / 1/4 of Circle:- (25%)

$S = \frac{\pi r}{2}$

$d = \sqrt{2}.r$

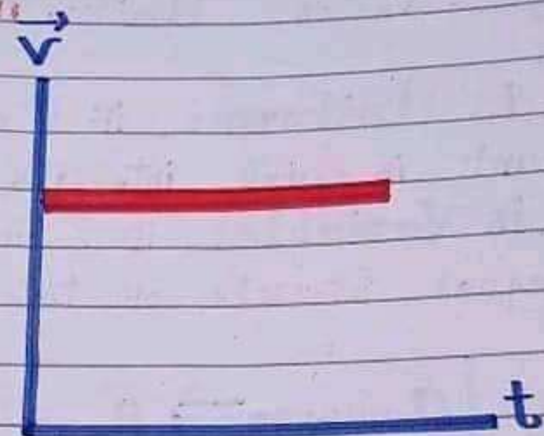


Distance and displacement notes

$\vec{v}-t$ Graph:-

Slope of $\vec{v}-t$ graph $\longrightarrow$ Acceleration
Area of $\vec{v}-t$ graph $\longrightarrow$ Distance

When $\vec{V}$ is Constant:-



$\vec{v}$ = constant

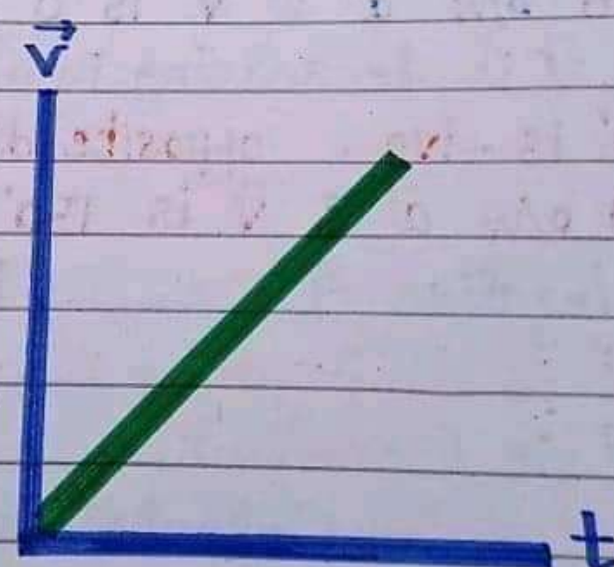
$\Delta v = 0$

$\vec{a} = 0$

Slope = 0

Graph is straight Line Parallel to x-axis or time-axis

When $\vec{V}$ is increasing Uniformly:-

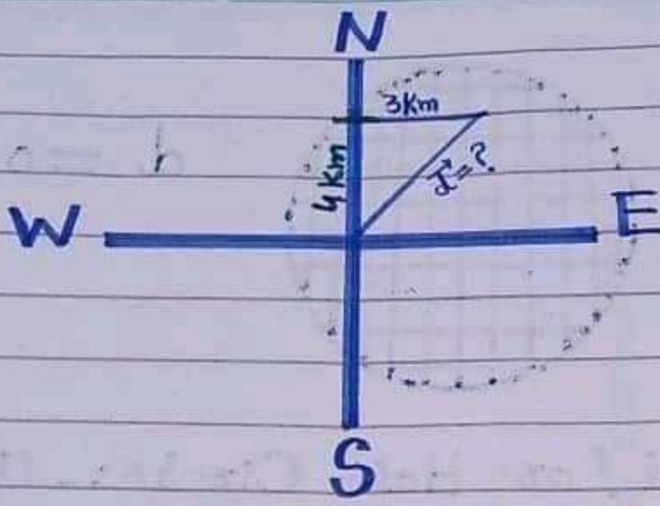


$\vec{v}$ is increasing uniformly.

$\vec{a}$ is +ive constant or uniform

Slope = $\vec{a}$ = $\tan\theta$

Distance and displacement notes



A man walks 4 Km towards north then 3Km towards east. What is The total distance and displacement covered by man?

$S = 4 + 3$

$S = 7\ km$

$$d = \sqrt{4^2 + 3^2}$$
$$= \sqrt{16 + 9}$$
$$= \sqrt{25}$$
$$d = 5\ Km$$

Distance and displacement notes

Displacement - time Graph:-

Slope of $\vec{d}$-t graph gives Velocity:-

When Body at Rest:-

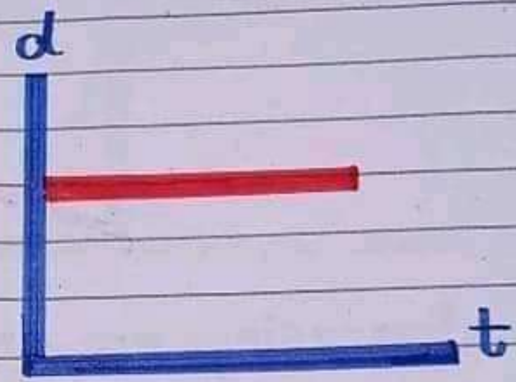
$\vec{d}$ = constant

$\Delta\vec{d}$ = 0

$\vec{v}$ = 0

Slope = 0

Graph is straight Line parallel to x/t axis.



When $\vec{d}$ is increasing uniFormly:-
decreasing

$\vec{d}$ increasing uniFormly

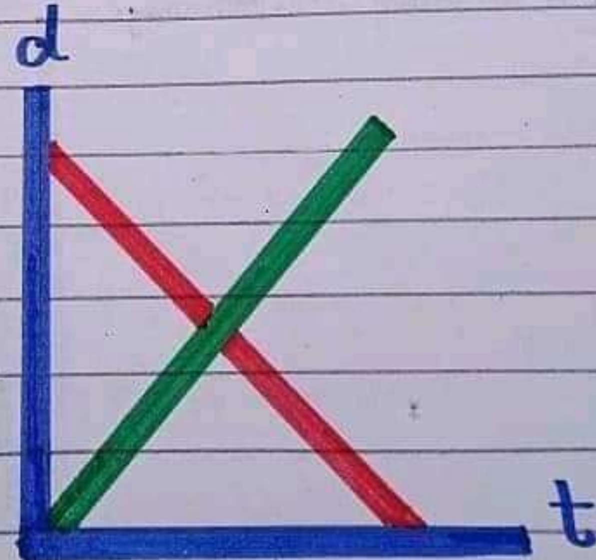
$\vec{v}$ is constant (uniForm)

$\vec{v}$ = Slope = tan θ

$\vec{d}$ decreasing uniFormly

$\vec{v}$ is constant (uniForm)

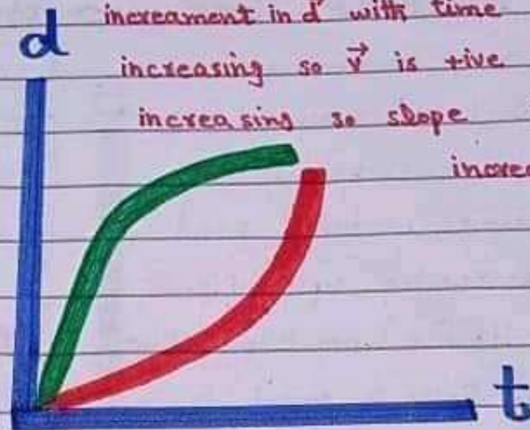
$\vec{v}$ = Slope



Distance and displacement notes

$\vec{d}$ is increasing non-UniFormly:-

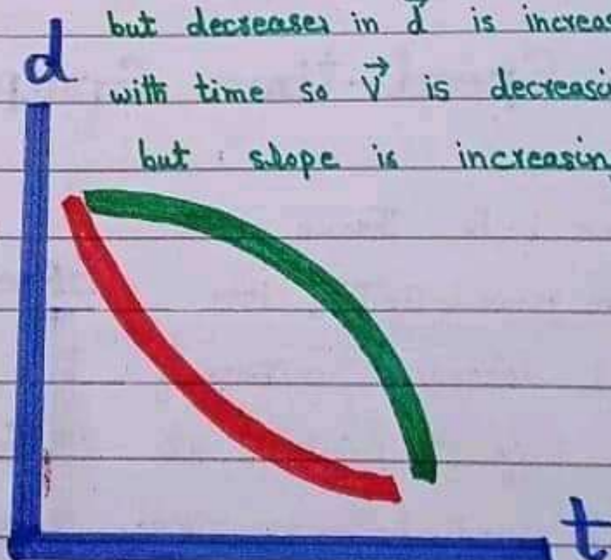
$\vec{d}$ increase non-uniFormly but increament in $\vec{d}$ with time decreasing so $\vec{v}$ is +ive but decreasing That's why slope is decreasing



$\vec{d}$ increase non-uniFormly increament in $\vec{d}$ with time is increasing so $\vec{v}$ is +ive and increasing so slope is increasing

$\vec{d}$ is decreasing non-uniFormly:-

$\vec{d}$ is decreasing non-uniFormly but decreases in $\vec{d}$ is increasing with time so $\vec{v}$ is decreasing but slope is increasing



$\vec{d}$ is decreasing non-uniFormly. But decrease in $\vec{d}$ with time is decreasing That's why slope also decreasing

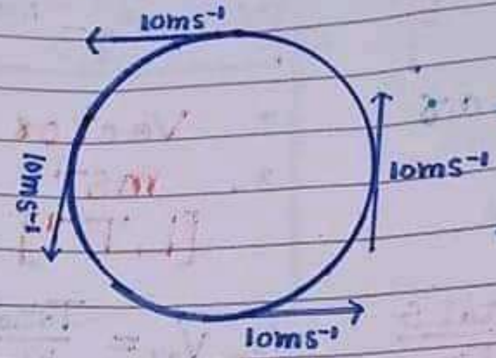
Distance and displacement notes

Special Case:-

i. Speed is uniform.

ii. Velocity is variable.

A body is moving with constant velocity of $10ms^{-1}$ in a circle:-



Reason:-

At every Point magnitude of velocity remains same which is called speed i-e- $10ms^{-1}$ but at every Point direction changes so velocity changes.

Speed:-

1- $S_1 \neq S_2,\ t_1 = t_2 \longrightarrow V_{av} = \frac{V_1 + V_2}{2}$

2- $S_1 = S_2,\ t_1 \neq t_2 \longrightarrow V_{av} = \frac{2V_1V_2}{V_1 + V_2}$

3. $S_1 = S_2,\ t_1 = t_2 \longrightarrow V_{av} = V_{ins}$

4- $S_1 \neq S_2,\ t_1 \neq t_2 \longrightarrow V_{av} = \frac{S_1 + S_2 + \cdots}{t_1 + t_2 + \cdots}$

Uniform Velocity:- $d_1 = d_2 \rightarrow t_1 = t_2 \rightarrow \vec{V}_{av} = \vec{V}_{ins}$

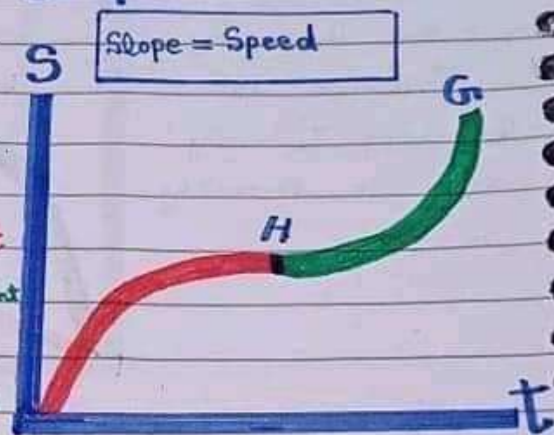
Variable Velocity:- $d_1 \neq d_2 \rightarrow t_1 = t_2$

Distance and displacement notes

A Body is Thrown upward Then it Falls Back to Ground:

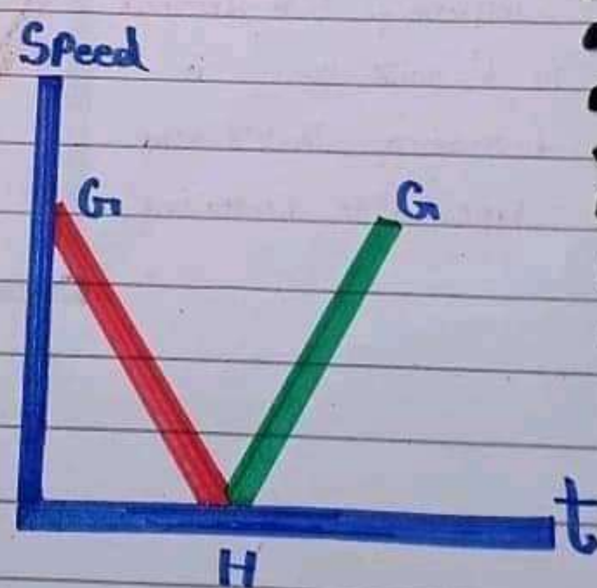
1- Distance-time Graph:-

When body Thrown upward Then S is increasing with time but slope is decreasing because speed is decreasing upto heighest Point H. Then From Heighest Point H body Falls to ground so distance again increasing and slope also increasing because speed is increasing as body Falls back to ground.

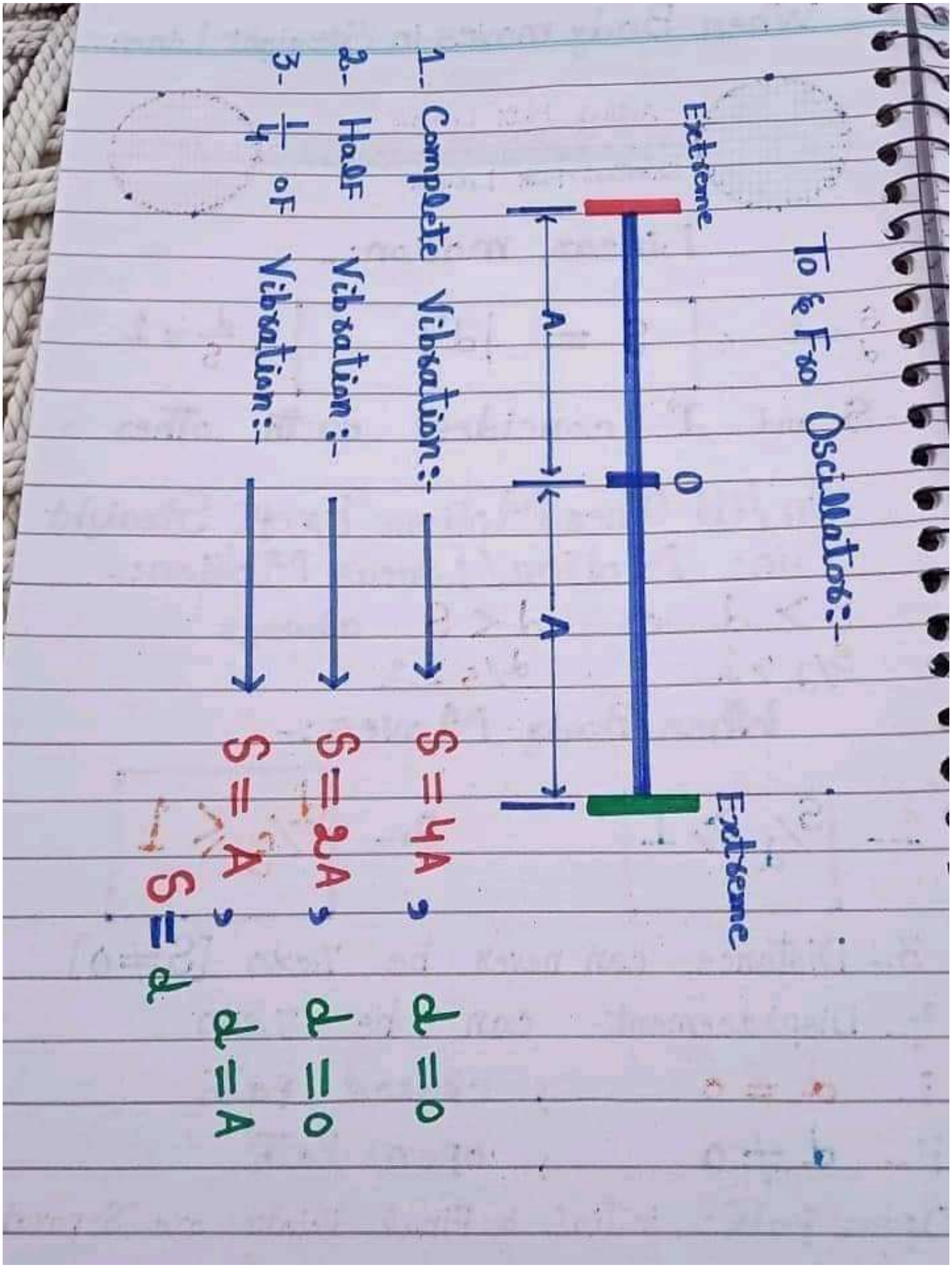


2- Speed-time Graph:-

When body Thrown upward From ground G Then it's speed decreases uniFormly upto heighest point 'H' at which speed becomes zero. Then From heighest point 'H' body Falls back and it speed increases uniFormly till body strikes the Ground.



Distance and displacement notes


To & Fro Oscillator:-

Extreme — 0 — Extreme

A | A

1- Complete Vibration:- → $S = 4A$, $d = 0$

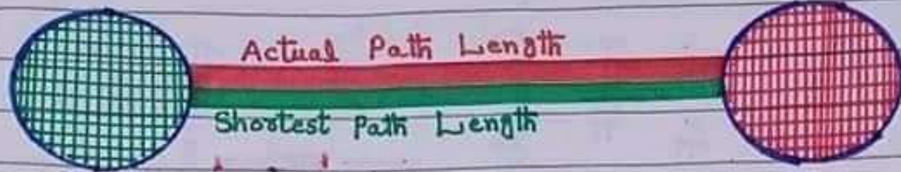
2- Half Vibration:- → $S = 2A$, $d = 0$

3- $\frac{1}{4}$ of Vibration:- → $S = A$, $d = A$

$S = d$

Distance and displacement notes

When Body moves in Straight Line:-



Linear motion:-

$\frac{S}{d} = 1 \leftarrow \boxed{S = |\vec{d}|} \rightarrow \frac{d}{S} = 1$

S and $\vec{d}$ concides each other

In All Other Motions Exept Straight Line Motion/ Linear Motion:-

$S > d$ or $d < S$ always

$S/d > 1$ $\quad$ $d/S < 1$

When Body Moves:-

1. $\boxed{S/d \geq 1}$ $\quad$ 2. $\boxed{d/S \leq 1}$

3. Distance can never be zero $[S \neq 0]$

4. Displacement can be zero

i. $d = 0 \longrightarrow$ closed path

ii. $d \neq 0 \longrightarrow$ open Path

Open Path:- initial & Final Points are Separate.

Closed Path:- initial & Final Points is same i.e. body stops from where it starts.