Today's goal

→ JEE Revision

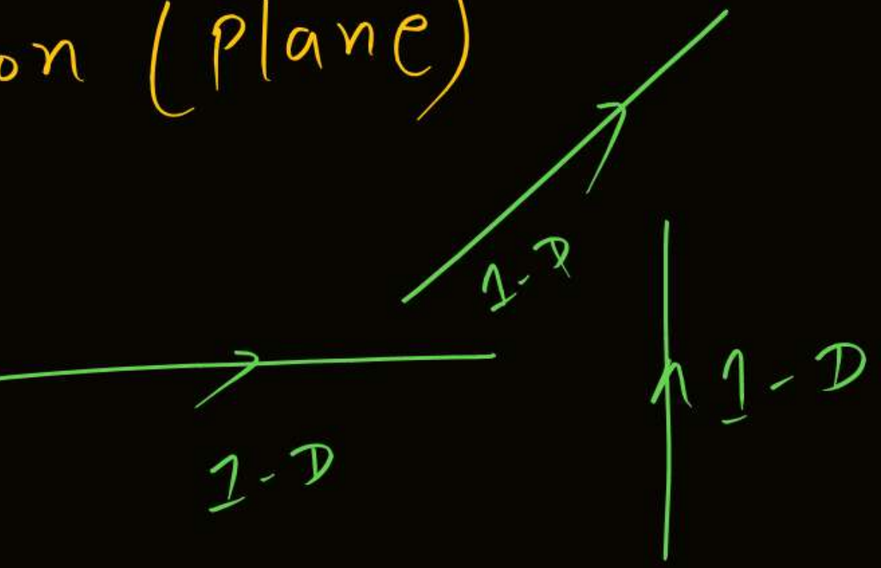
Complete 1-D

With MOKSHA

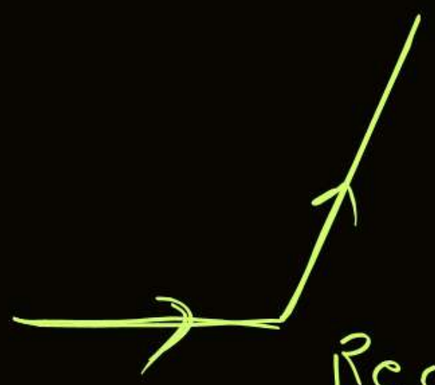
Kinematics

→ 2-D motion (plane)

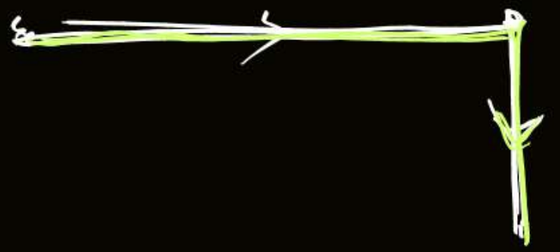
Motion in a straight line (1-D)



Rectanlinr motion



Rectili



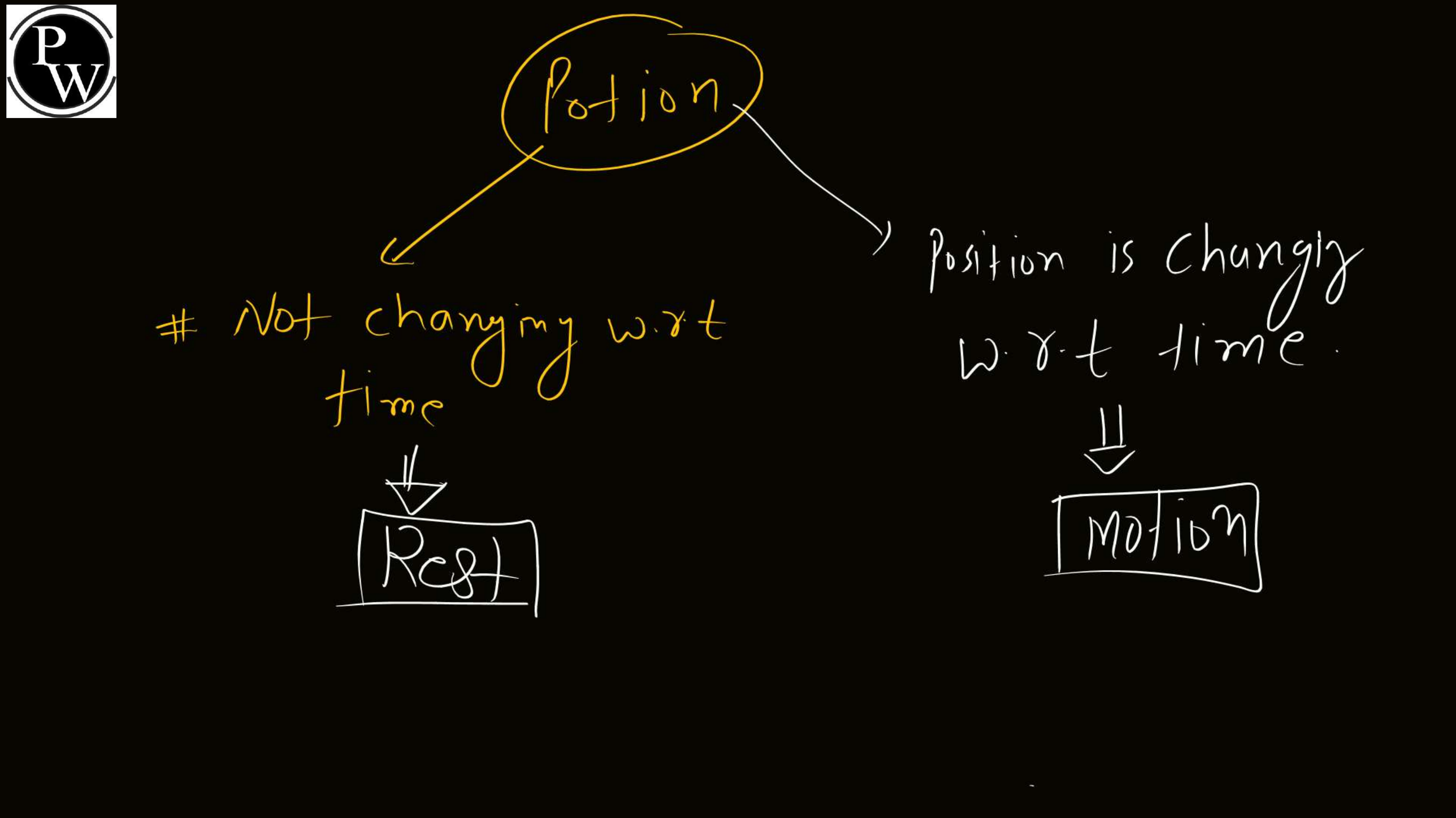
Position

Location of object w.r.t frame of ref

↳ A place from where we take observation.

Observer → Who take obsebation.

↳ always assume himself at a rest


Potion
Not changing w.r.t time
Rest
Position is changing w.r.t time.
Motion

Distance

- Total Path length
  - Scale (magnitued)
- It depends upon Path taken
- It can't decrease with time
- distance can't be (-ve)

Displacement

- Displ^{m} always a straight line
- shortest length b/w initial & final Position
  - $\Delta \vec{x} = \vec{x}_f - \vec{x}_i$
- It does not depend on Path taken.
- It can be +ve, -ve or zero

open dire.

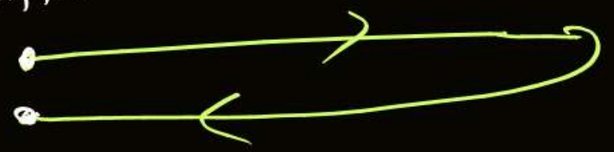
disp^m.

Sucessive = 0

then Σ must be zero

distance

Initial Position



⇒ dist^n ≠ 0

⇒ disp^m = 0

Sucess = संघर्ष

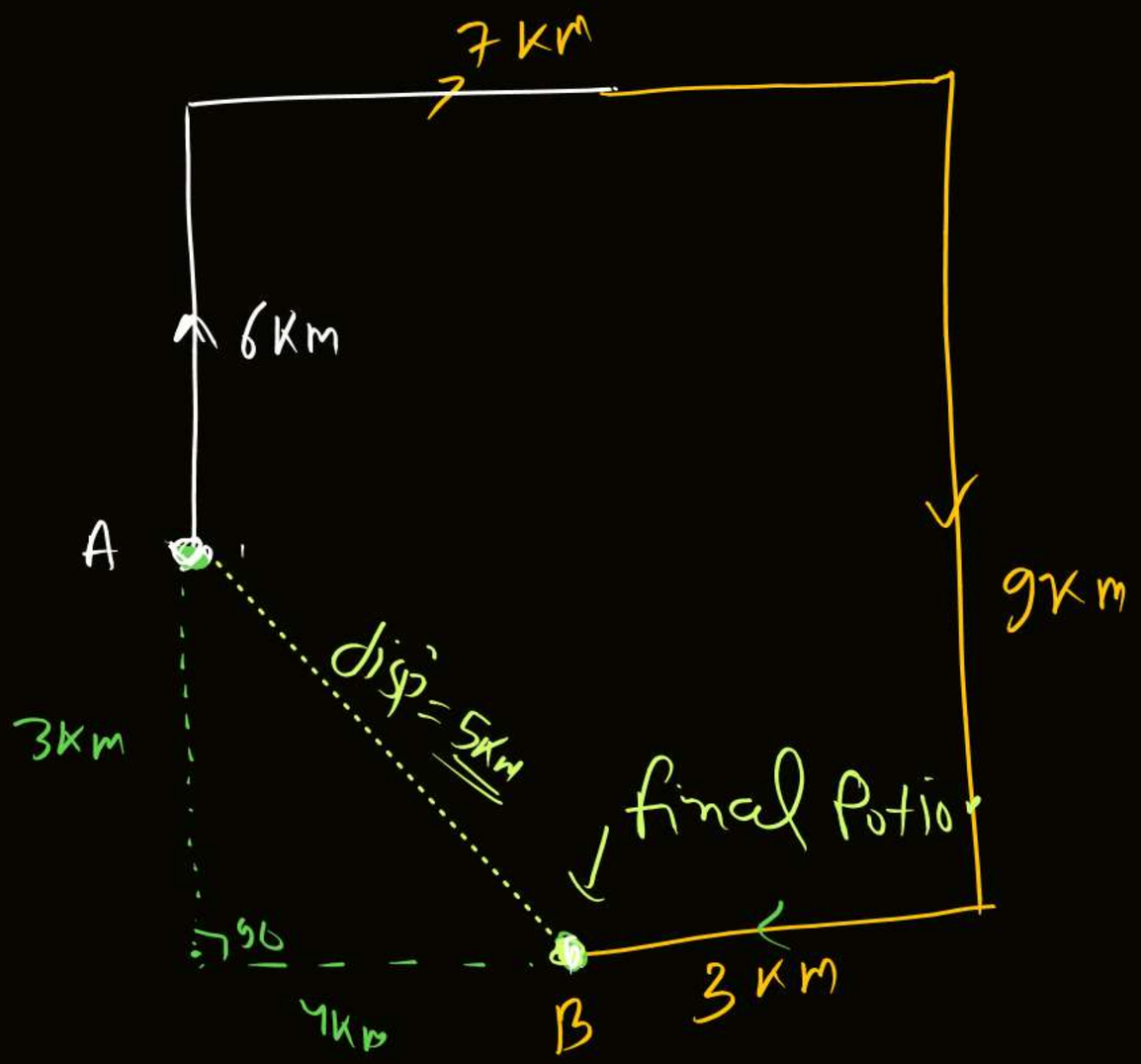
|disp^{m}| = distance

→ When object is moving without change in direction.

If distance is zero then disp^{m} must be zero ⇒ True

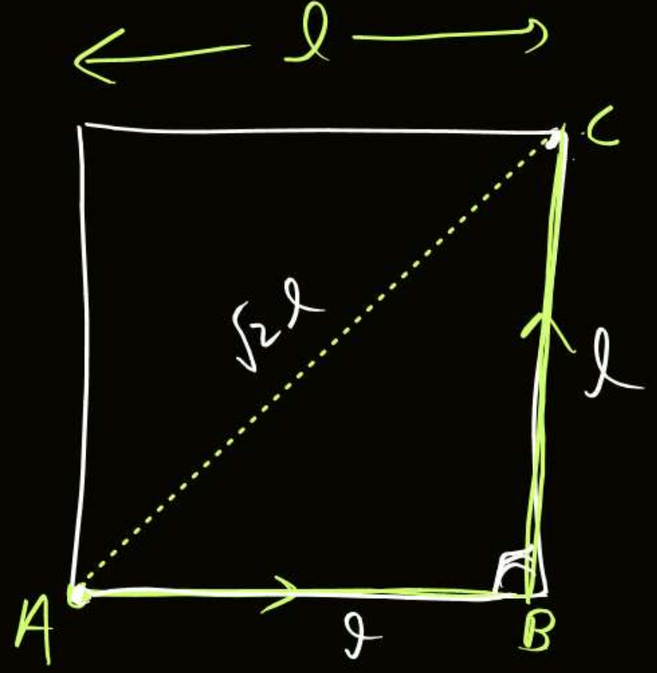
(संघर्ष)

If displacement is not equal to zero then distance must be nonzero → True.



distance = 25 km

$|\text{disp}^{m}|$ =



$$\text{distance} = 2l$$

$$|\text{disp}^n| = \sqrt{2}\,l$$

Which of the following relⁿ is correct for 1-D motion

(a) $\frac{|\text{disp}^{m}|}{\text{dist}^{n}} = 1$

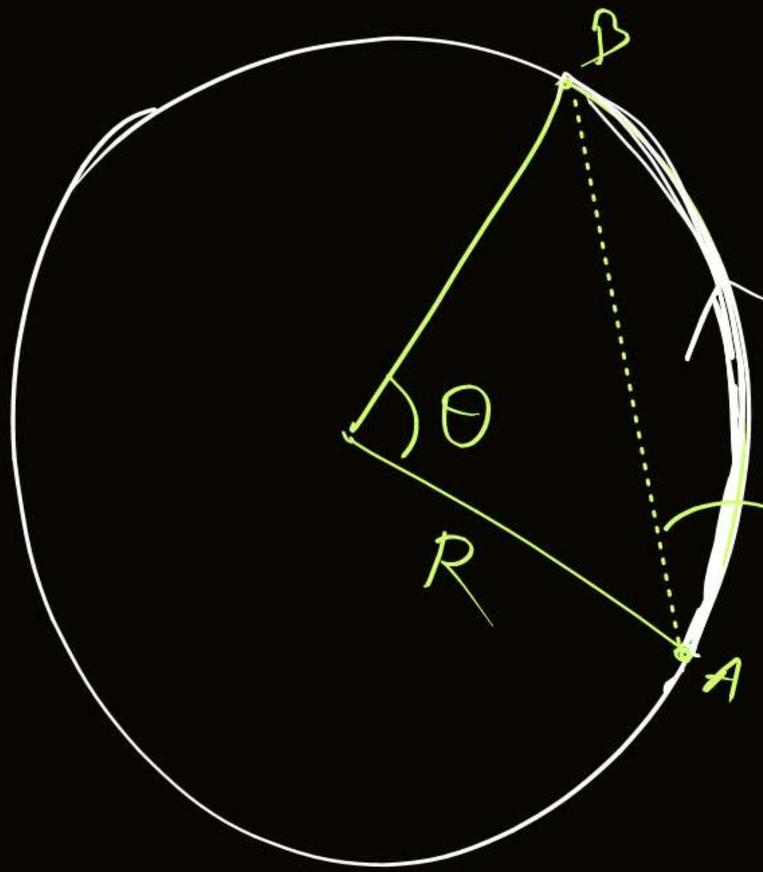
(b) $\frac{|\text{disp}^{n}|}{\text{dist}^{n}} < 1$

(c) $\frac{|\text{disp}^{n}|}{\text{dist}} > 1$

(d) $\frac{\text{disp}^{n}}{\text{distan}} \leq 1$

always wrong option ⇒ (c)

Object is moving on circular Path

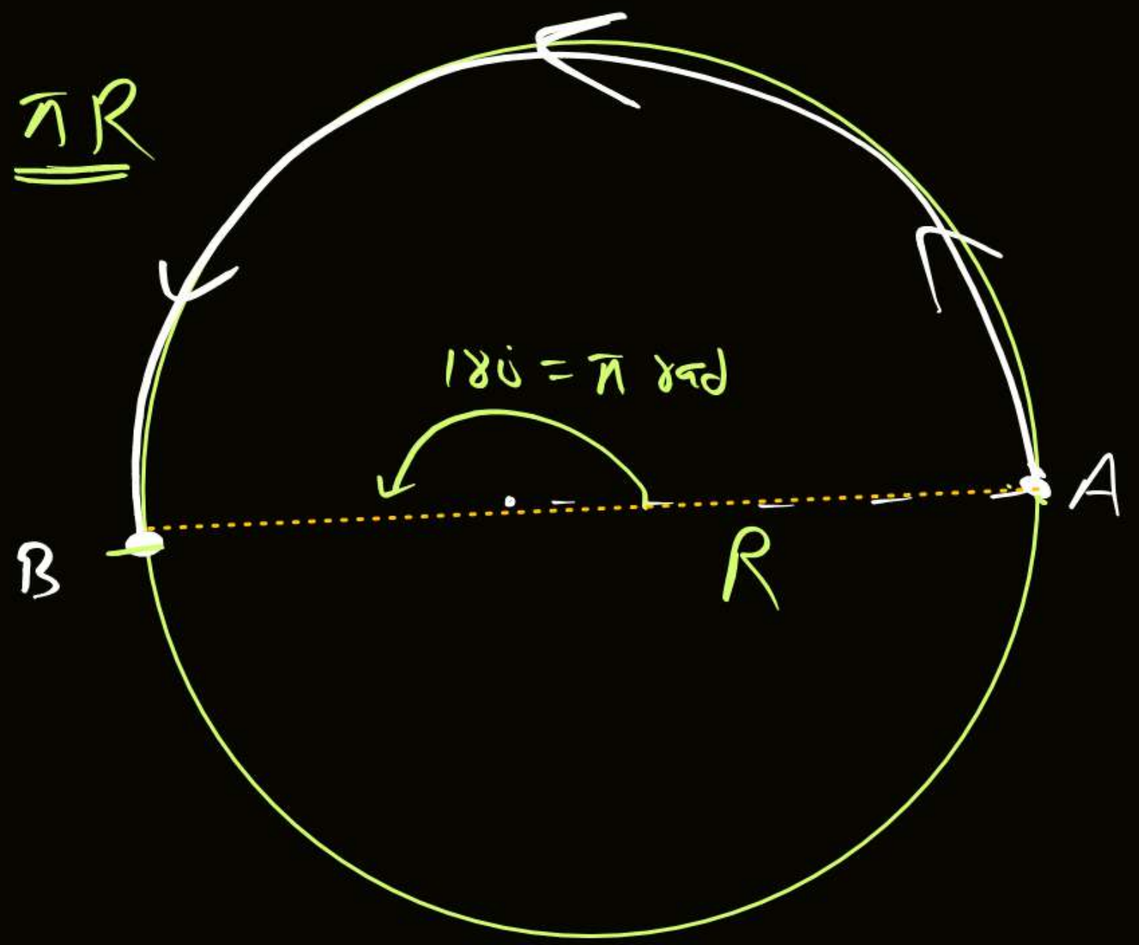


Arc = dist^{n}
$= R\theta$

dist^{n} $= 2R\sin(\theta/2)$

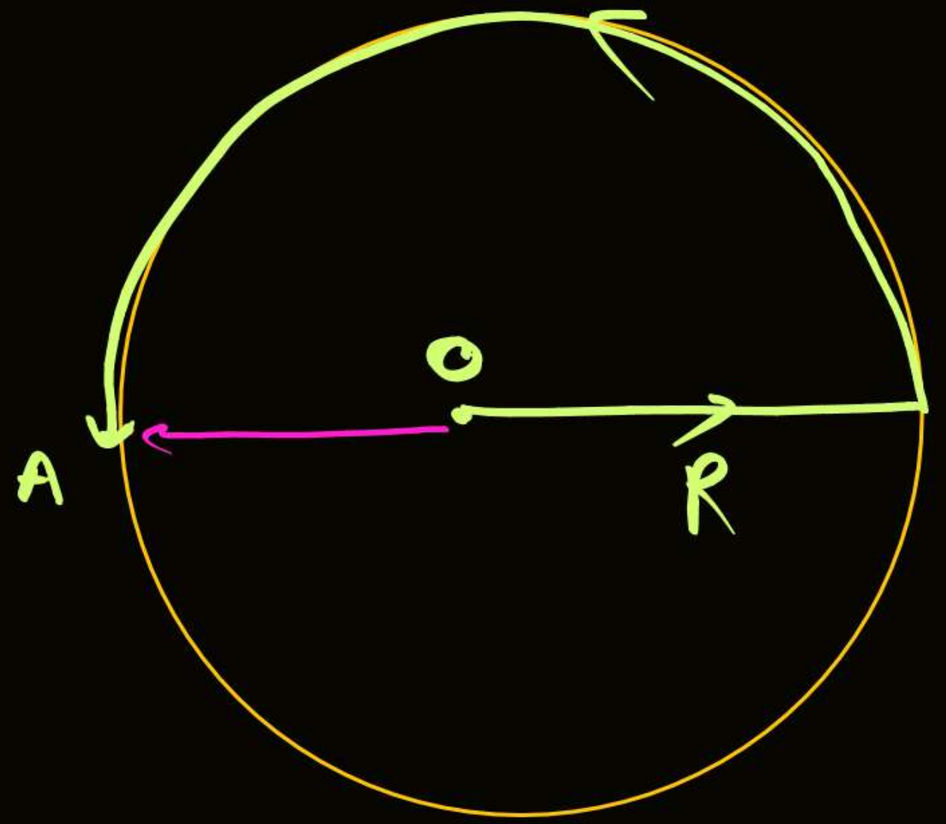
distance $= R\theta = \pi R$

$disp^m = 2R$



$$(\text{distance})_{OA} = [R + \pi R]\ m$$

$$|\text{displ}^n|_{OA} = R.$$



Speed → How fast (No direction) → Scalar

In time Interval

$$\text{Avg speed} = \frac{\text{total distⁿ}}{\text{total time}}$$

$$S_{Avg} = \frac{\text{total distⁿ}}{\text{total time}}$$

$$\# \quad S_{Av} = \frac{\int S_{inst}\, dt}{\int dt} \checkmark$$

At time 't'

$$S_{inst} = \left(\frac{dx}{dt}\right)$$

= Rate of chge in distance with respect to time

Instantaneous = How fast

velocity

direction (vector)

direction of velocity always along motion.

In time (t)
Intraval (t)

At time

Avg velocity = $\frac{\text{total disp}^n}{\text{total time}}$.

$v_{inst} = \frac{d\vec{x}}{dt}$ ($\vec{x}$ → Position)

= The rate of change in Position w.r.t time

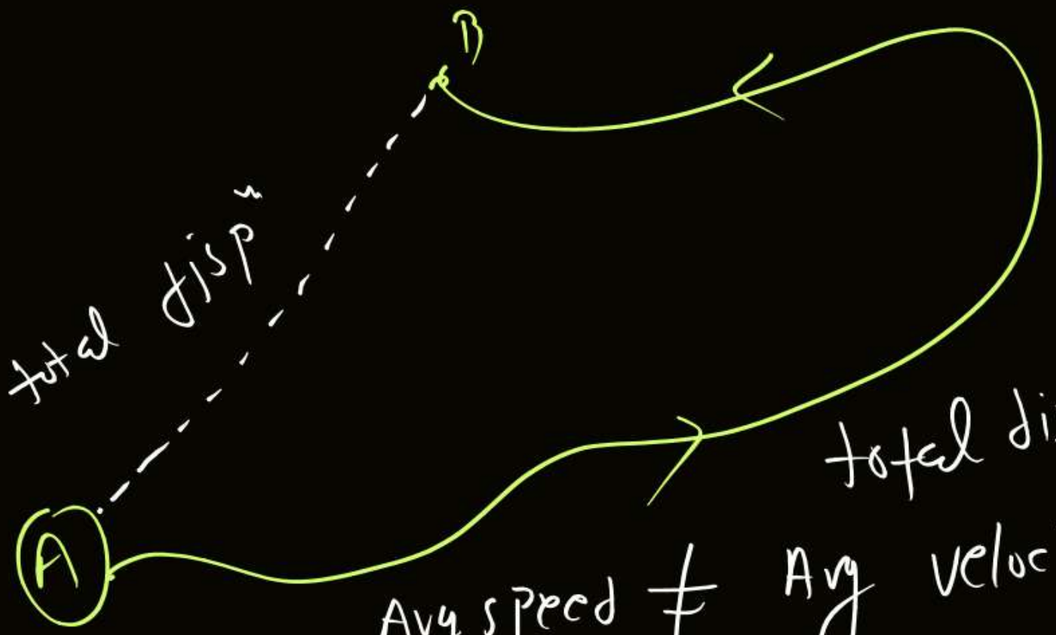
$$\text{Avg Speed} = |\text{Avg velocity}|$$

→ as may or may not be

total disp^{m} = total dist.

When object is moving without change in direction

Avg velocity = Avg speed



Avg speed ≠ Avg velocity

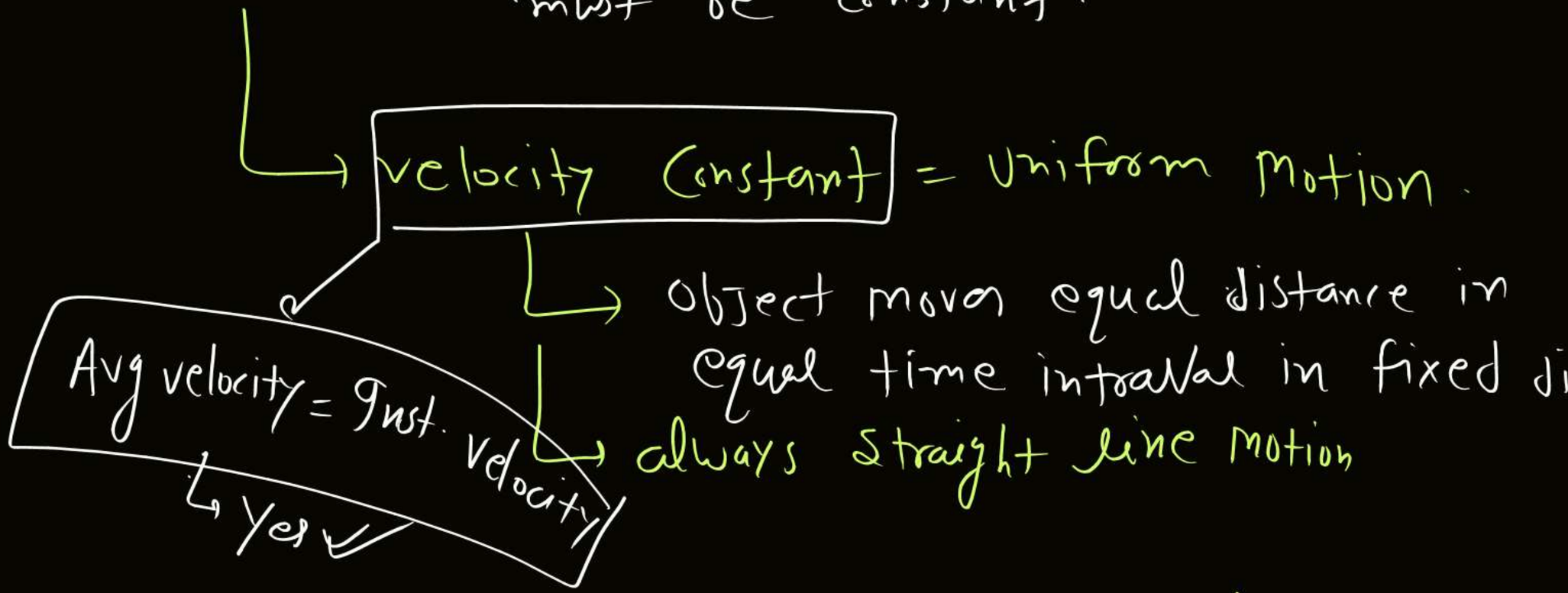
$|\text{inst. velocity}| = \text{inst speed}$ → always valid

in very small time interval
distance always equal to disp^{m}

Velocity = How fast / where
= Speed

Velocity = How fast / where

If velocity is Constant then speed must be Constant.



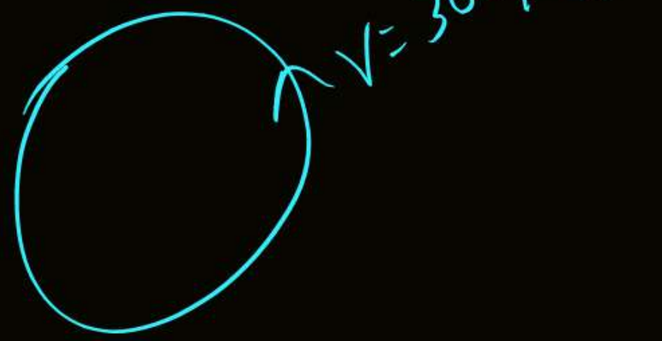
$$\vec{V}_{Avg} = \frac{\int v_{gnst}\, dt}{\int dt}$$

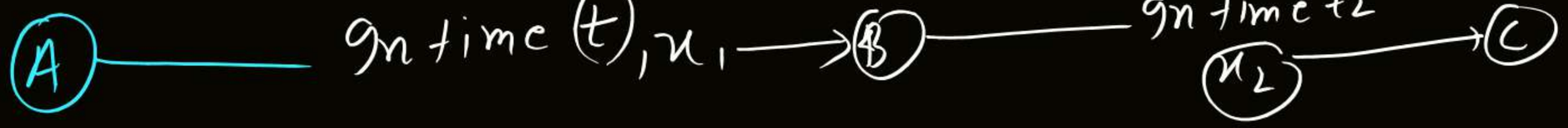
If velocity is Cost^n.

$$\vec{V}_{Avg} = \frac{v_{gnst} \int dt}{\int dt} = v_{gnst}$$

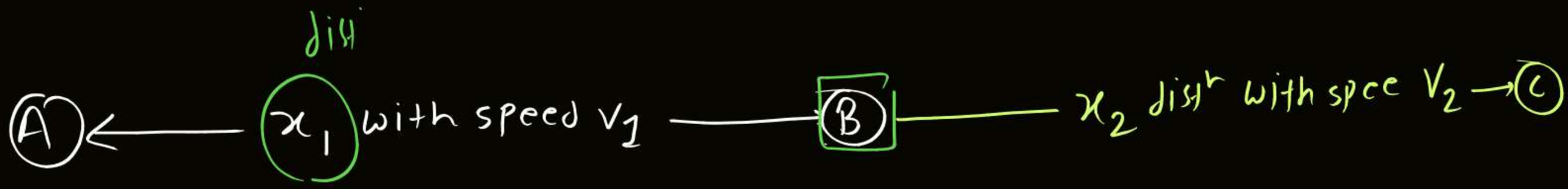
If speed is Const^{n} then what about velocity

↳ Ans velocity may or may not be Const.





$$\text{Avg speed} = \left[\frac{x_1 + x_2}{t_1 + t_2}\right]$$



$$\text{Avg speed} = \frac{x_1 + x_2}{t_1 + t_2} = \boxed{\frac{x_1 + x_2}{\left(\frac{x_1}{v_1}\right) + \left(\frac{x_2}{v_2}\right)}}$$

If dist^n Interval is Same $(x_1 = x_2 = x)$

$$\text{Speed} = \frac{\text{dist}^n}{\text{time}}$$

$$\text{Avg speed} = \frac{2x}{x\left(\frac{1}{v_1} + \frac{1}{v_2}\right)} = \frac{2}{\frac{v_1 + v_2}{v_1 v_2}} = \boxed{\frac{2 v_1 v_2}{v_1 + v_2}}$$

$$\text{Avg speed} = \frac{\text{total distance}}{\text{total time}} = \frac{x_1 + x_2}{t_1 + t_2}$$

$$\boxed{\text{Avg speed} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}}$$

$$\boxed{\text{dist}^n = \text{speed} \times \text{time}}$$

* If equal time interval $t_1 = t_2 = t$

$$\text{Avg speed} = \frac{(v_1 + v_2)t}{2t} = \boxed{\frac{v_1 + v_2}{2}}$$

Q. Object moves with speed 50 m/s for time 5 min & then with speed 50 m/s for 20 min then find Avg. speed.

उत्तर बनाया ; वाहीत मजा आया

Ans — 50 m/s

Sol^n

(a) $Avg = \frac{v_1 + v_2}{2}$

(b) $Avg\ SR = \frac{2v_1v_2}{v_1+v_2}$

(c) $Avg\ SR = \frac{\text{total dist}^n}{\text{total time}}$

If Avg speed for compt journy is 100 m/s of object moves with speed 60 m/s for half of the compt dist^n then find speed for other half dist^n.

Sol^n equal dist^n Intaval.

$$\text{Avg speed} = \frac{2v_1v_2}{v_1+v_2}$$

$$100 = \frac{2\times 60\times v_2}{60+v_2}$$

$$300 + 5v_2 = 6v_2$$

$$v_2 = 300\ \text{m/s}$$

$$\text{Avg speed} = \frac{\text{total dist}^n}{\text{total time}}$$

equal time interval

(a) object moves with 50m/s for 10 mint & then with speed 30m/s for next 10 mint then Avg speed

$$v_{Av} = \frac{v_1 + v_2}{2} = \frac{80}{2} = 40 \text{ m/s}$$

equal distance Intn

(a) Ramlal move with speed 60m/s from home to School & find School is closed then he return back with triple speed then Avg speed for compt Journey

dop

$$\text{Av sp} = \frac{2 \times 60 \times 180}{(60+180)}$$

$$\text{Avg SP} = \frac{2 \times 60 \times 180}{240}$$

$$= \frac{360}{4} = 90 \text{ m/s}$$

acceleration → vector

↳ acc^n along the change in velocity

On time interval 't'

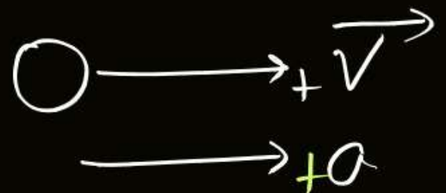
$$\text{Avg acc}^n = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

$$\text{Avg acc}^n = \vec{a}_{Avg} = \frac{\int a\,dt}{\int dt}$$

At time t

$a_{ins} = \left[\frac{dv}{dt}\right]$ = The rate of change in velocity

$$\vec{a}_{ins} = \frac{d^2\vec{x}}{dt^2} = \left(\frac{dv}{dt}\right) = v\left(\frac{dv}{dx}\right)$$

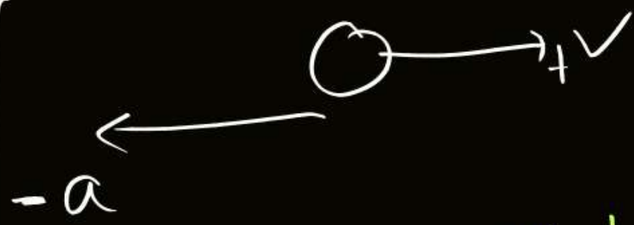


Speed ↑

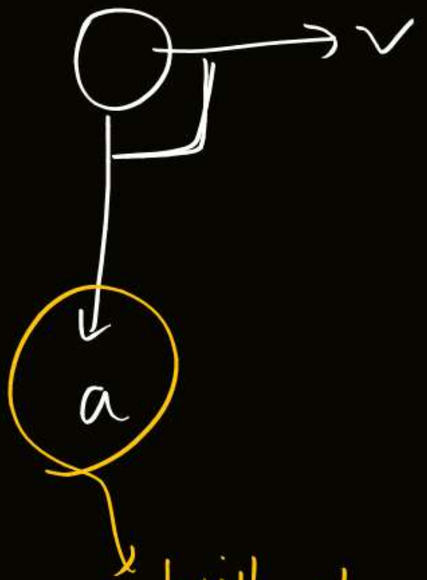
there is no chaye in dirn

$\vec{F} = m\vec{a}$

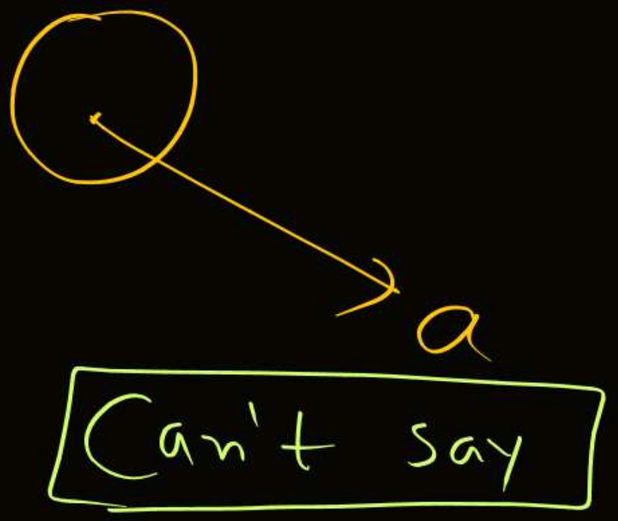
acc^n is always ||^y to velocity

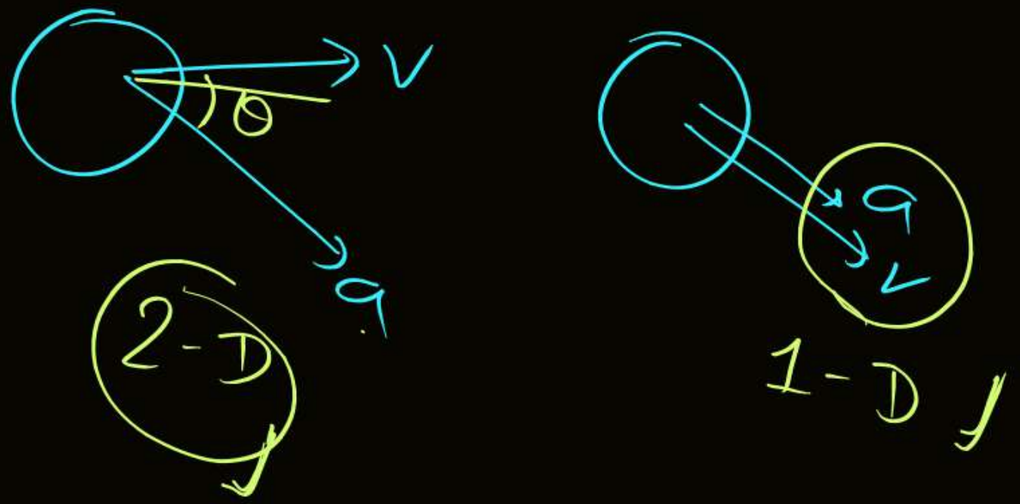


Speed will ↓ and object comes to at rest then will move in backward.



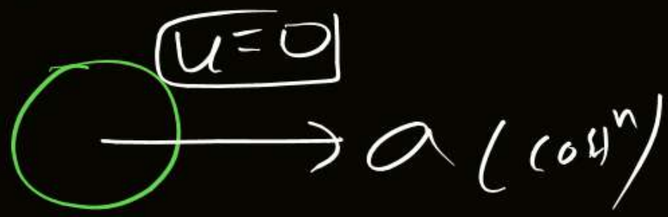
Will chaye direct





Path of object will decide by Angle b/w velocity & accn

$u = 0$, Cost^n acc^n



Path must be straight line

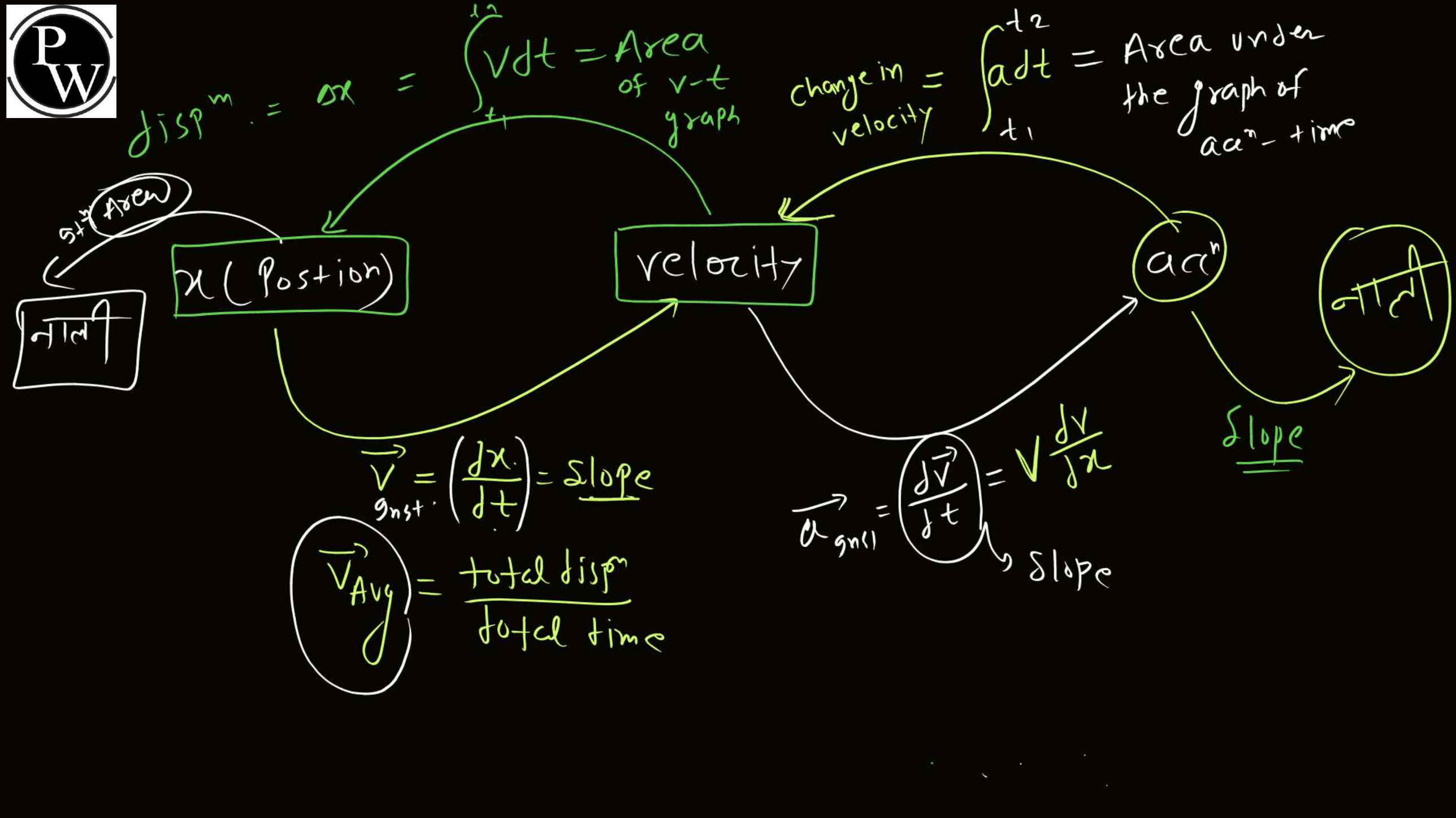
(Q) If velocity is cost^n then acc^n may be

(a) $a = \text{cost}$

(b) $a \uparrow$

(c) $a \downarrow$

(d) $a = 0$


disp^m = Δx = ∫ v dt = Area of v-t graph
change in velocity = ∫ a dt = Area under the graph of acⁿ - time
s.t. Area
x (Postion)
velocity
acⁿ
नाली
नाली
slope
$\vec{v}_{Inst.} = \left(\frac{dx}{dt}\right)$ = slope
$\vec{a}_{Inst.} = \left(\frac{d\vec{v}}{dt}\right) = v\frac{dv}{dx}$
slope
$\vec{v}_{Avg} = \frac{\text{total disp}^m}{\text{total time}}$

If $x = 2t^2 + 5t + 6$ then find acⁿ.

$$\frac{dx}{dt} = v = 2(2t) + 5 + 0$$

$$v = 4t + 5$$

$$a = \frac{dv}{dt} = 4$$

$x \propto t^2$

↳ acⁿ cosy

$v \propto t$

acⁿ = 0

⑦ If $x = 4\sin(t^2)$ then nature of acc^n

↳ Sol^n $v = \frac{dx}{dt} = 4\cos(t^2) \times 2t$

↳ a = variable

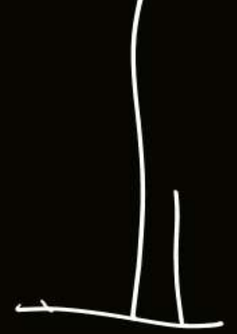
---

⑧ If Velocity of object $v = e^t$ then nature of acc^n.

$v \propto t^1$

$v = e^t \Rightarrow a = e^t$ → variable acc^n

If velocity $V = \sqrt{x}$ then nature of acc^n.



Sol^n $V = \sqrt{x}$

$$a = v\frac{dv}{dx} = \sqrt{x}\frac{d\sqrt{x}}{dx} = \sqrt{x} \times \left(\frac{1}{2}x^{\frac{1}{2}-1}\right)$$

$$= \sqrt{x}\frac{1}{2}\frac{1}{\sqrt{x}} = \frac{1}{2}\ m/s^2$$

IIT

Q. If $v \propto \sqrt{x}$ then Which is correct

(a) $x \propto \sqrt{t}$

(b) $x \propto t^3$

(c) $x \propto t$

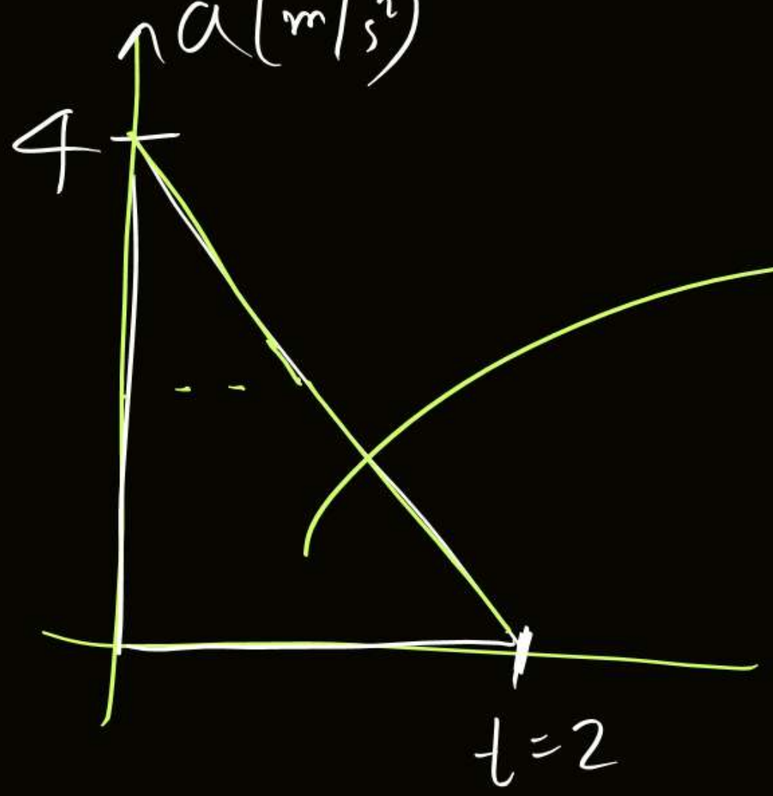
(d) $x \propto t^2$

$$v = \sqrt{5 - 4x}$$

Why aa^n is $(as)^n$ = ??

$$a = v\frac{dv}{dx}$$

$$a = (as)$$



Find Velocity at $t=2$ sec if initial velocity is 10 m/s

Soln

Area = $v-u$

$\frac{1}{2} \times 2 \times 4 = v-u$

$v = 4+u$

$= 4+10$

$v_f = 14\ m/s^2$

Babu Jaldi

$v = u+at$

↳ Ans नहीं आ रहा ?? (acc^n Variable)

Motion with Constant acc^{n}.

↳ Calculus

$$\# \quad \boxed{a = \frac{dv}{dt}}$$

$$\int_{t_1=0}^{t} a\,dt = \int_{u}^{v} dv$$

$$\boxed{a = (0,1)^{r}}$$

$$a\int_{0}^{t} dt = \int_{u}^{v} dv$$

$$a(t)_{0}^{t} = (v)_{u}^{v}$$

$$at = v - u$$

$$\boxed{v = u + at}$$

$$v = \frac{dx}{dt} = u + at$$

$$\int_{x_i}^{x_f} dx = \int_0^t u\,dt + \int_0^t at\,dt$$

$$[x]_{x_i}^{x_f} = ut + a\int t\,dt$$

$$\Delta x = s = ut + \frac{1}{2}at^2$$

$$\int dt = t$$

$$\int t\,dt = \frac{t^2}{2}$$

(e) If $u=0$ & acc^n $a=kx^{3/2}$ then find velocity after x_0 disp^n.

→ Solution

$v^2=u^2+2ax$ ⟶ ✗ Not apply

$a=kx^{3/2}$

$v\frac{dv}{dx}=kx^{3/2}$

$$\vec{v} = \vec{u} + \vec{a}t$$

$$\vec{s} = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

always valid for an Intraval of 1-sec

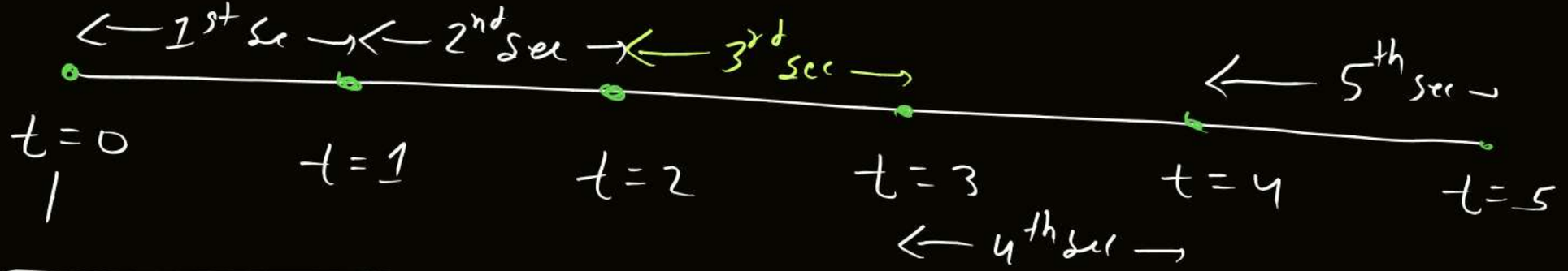
acc^n Const.

$$V_{Avg} = \frac{\vec{u}+\vec{v}}{2}$$

$$V_{mid} = \sqrt{\frac{u^2+v^2}{2}}$$

Motion starts from rest and $a = a_{cc}^{n}$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} = 1 : 3 : 5 : 7 : 9 \quad (\text{Odd no ration})$$



$$S_{5\,sec} : S_{next\ 5\,sec} = x : 3x$$

$$S_{1\,osec} : S_{next\ 1\,ose} = x : 3x$$

$$S_{5\,sec} : S_{next\ 1\,osec} = x : 3x$$ ✗

$u = 0$; acc^n is cost^n

$S_{1\,sec} : S_{2\,sec} : S_{3\,sec} : S_{4\,sec} : S_{5\,sec} = 1 : 4 : 9 : 16 : 25$

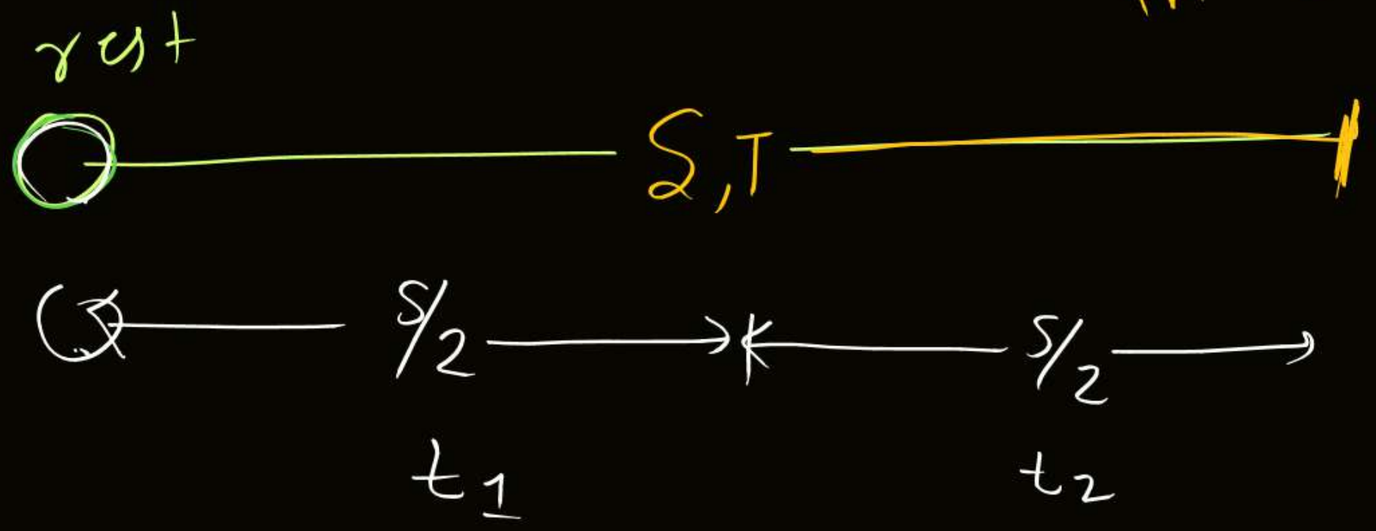
$= x : (2)^2 x : (3)^2 x : (4)^2 x : (5)^2 x$

$S_t : S_{2t} = x : 4x$

$S_{5\,sec} : S_{10\,sec} = x : 4x$

$u = 0$: a = constt

T = total time in Compt Journey



Compt Journey

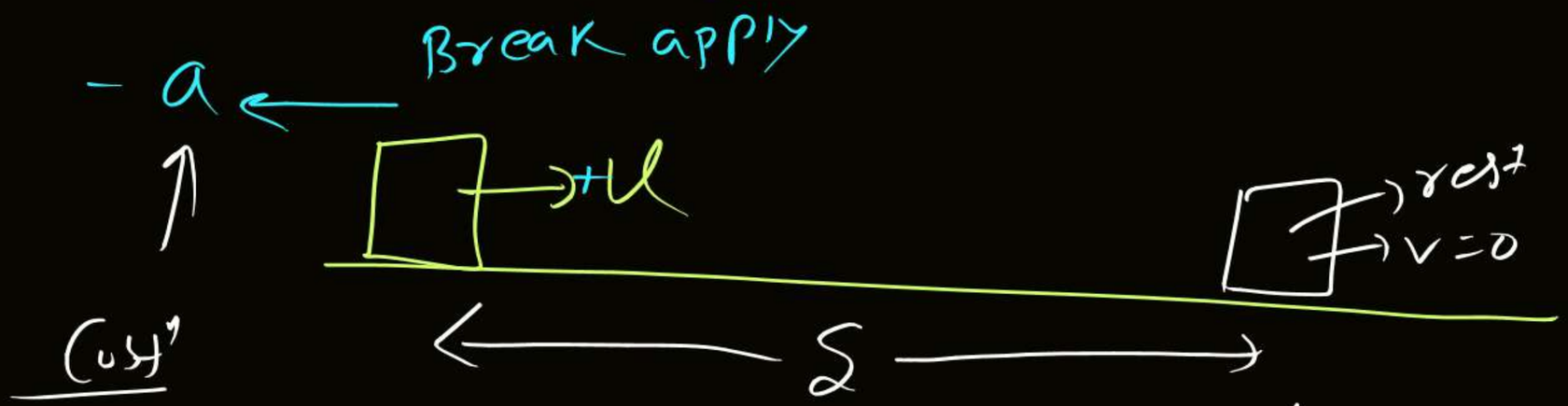
$$S = \frac{1}{2} a T^2$$

$$\frac{S}{2} = \frac{1}{2} a t_1^2$$

$$\Rightarrow t_1 = \sqrt{\frac{T^2}{2}} = \frac{T}{\sqrt{2}}$$

$$t_2 = T - \frac{T}{\sqrt{2}}$$

Stopping distance



$$v^2 - u^2 = 2as$$

$$-u^2 = 2(+a)s$$

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

$$S = \frac{u^2}{2a} \quad \#$$

$$S \propto (u^2)$$

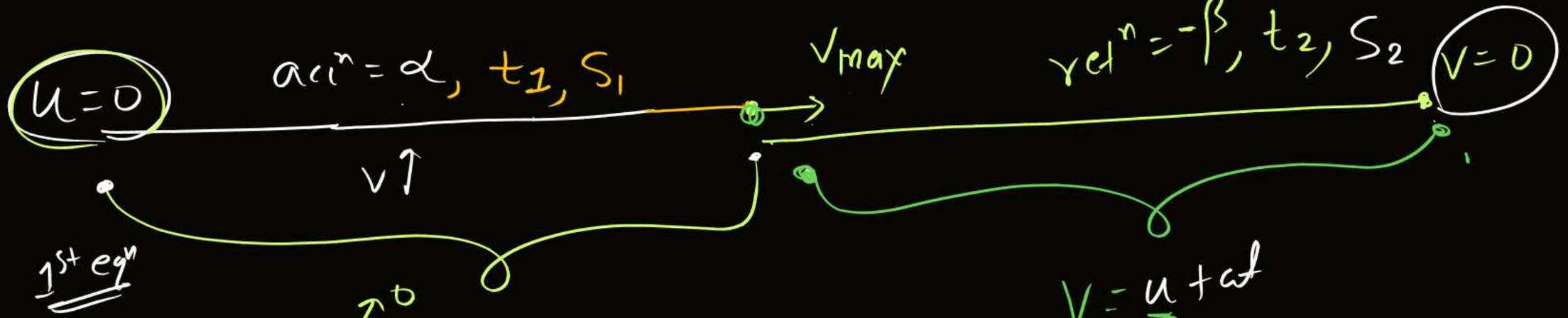
$u = 50\,m/s \Rightarrow S = 200\,m$

$u = 200\,m/s \Rightarrow S' = 3200\,m$

$m R^*$

u_{max} ??

Rest to Rest



$V = u + at$

$V = \cancel{u}^{0} + at$

$V_{max} = \alpha t_1$

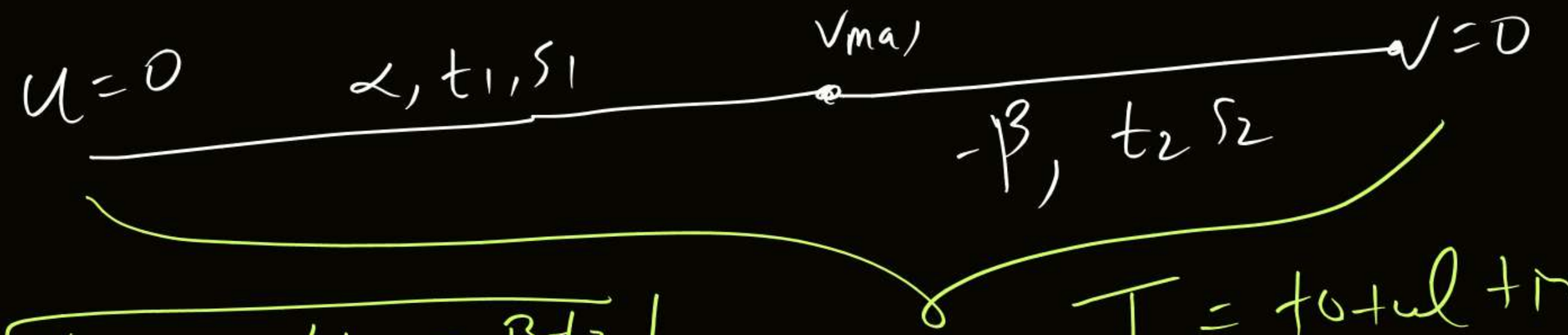
$V = u + at$

$0 = V_{max} - \beta t_2$

$V_{max} = \beta t_2$

$\Rightarrow \alpha t_1 = \beta t_2$

$S_1 \alpha = \beta S_2$



$$T = t_0 + t_1 + t_2$$

$$v_{max} = \alpha t_1 = \beta t_2$$

$$v_{max} = a_{eff}\, t$$

$$v_{max} = \left(\frac{\alpha\beta}{\alpha+\beta}\right) T$$

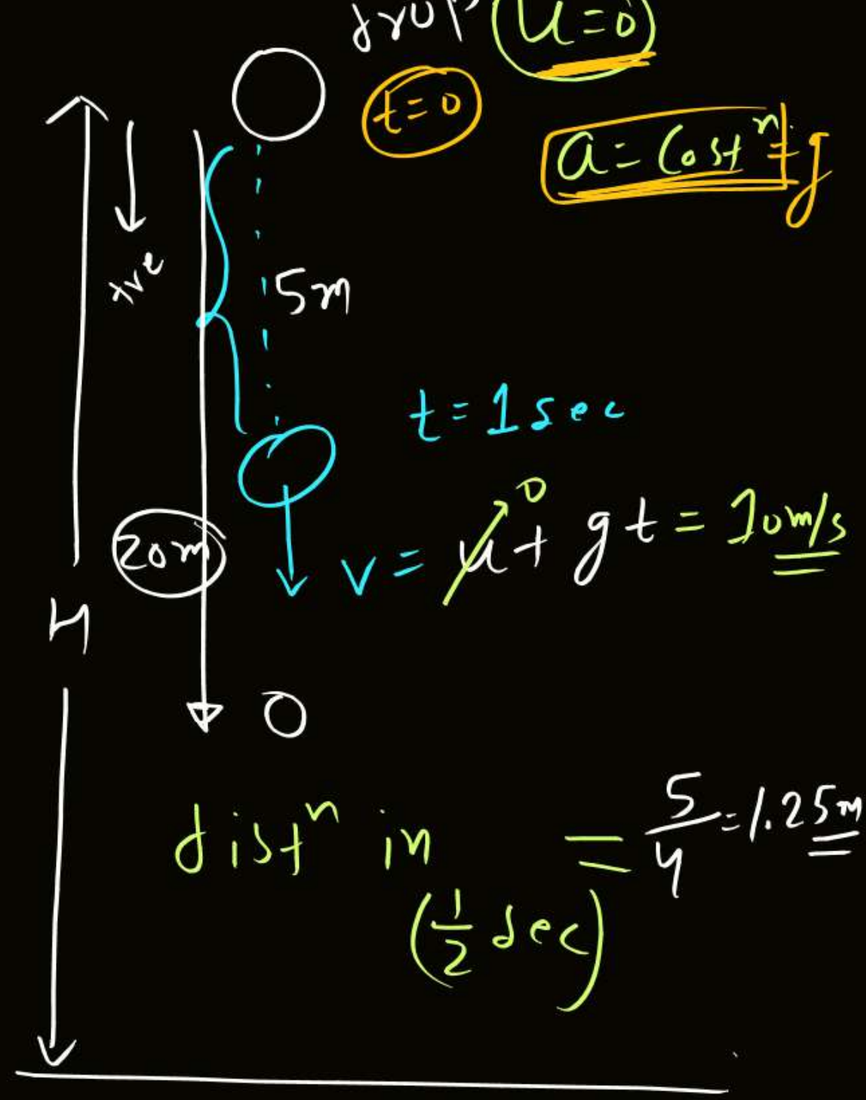
$$S = \frac{1}{2}\left(\frac{\alpha\beta}{\alpha+\beta}\right) T^2$$

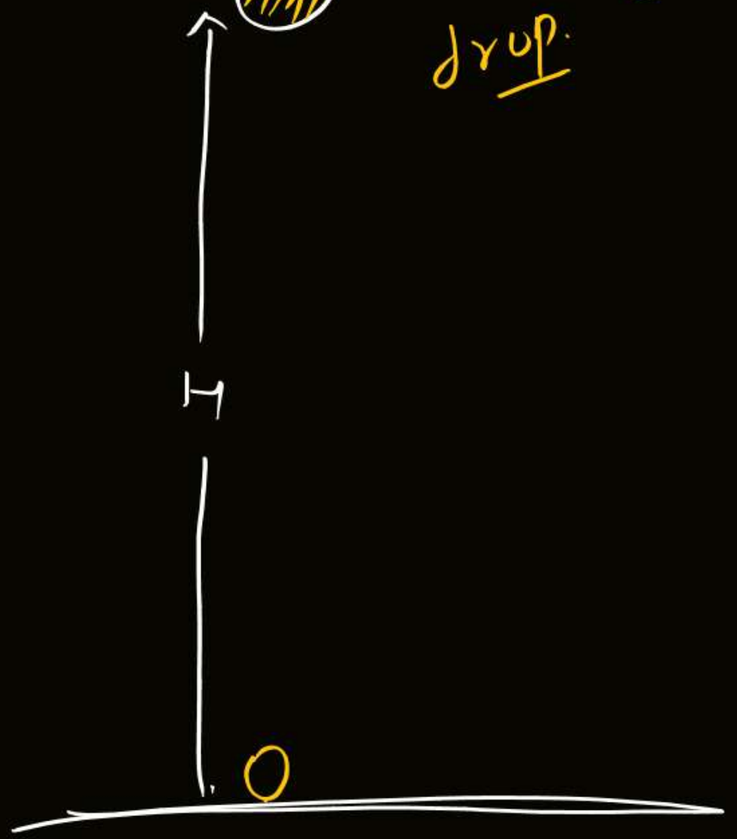
Motⁿ Under gravity

→ Motion Under gravity is a motion with Constⁿ acⁿ & (non-uniform)

→ $a = g = 9.8\ m/s^2 = 10\ m/s^2$

→ air friction



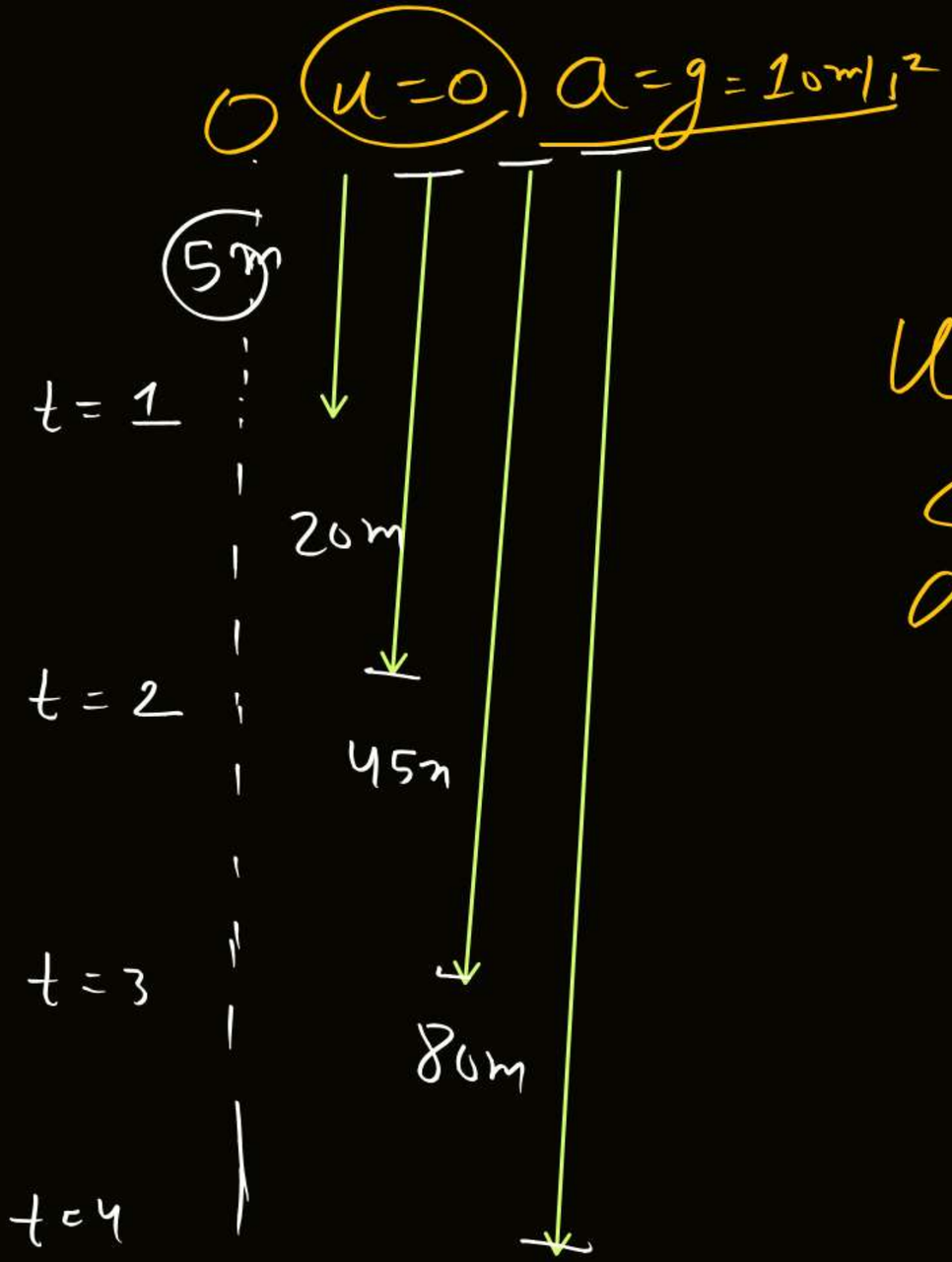


$$S = \cancel{ut}^{0} + \frac{1}{2}at^2$$

$$H = \frac{1}{2}gt^2$$

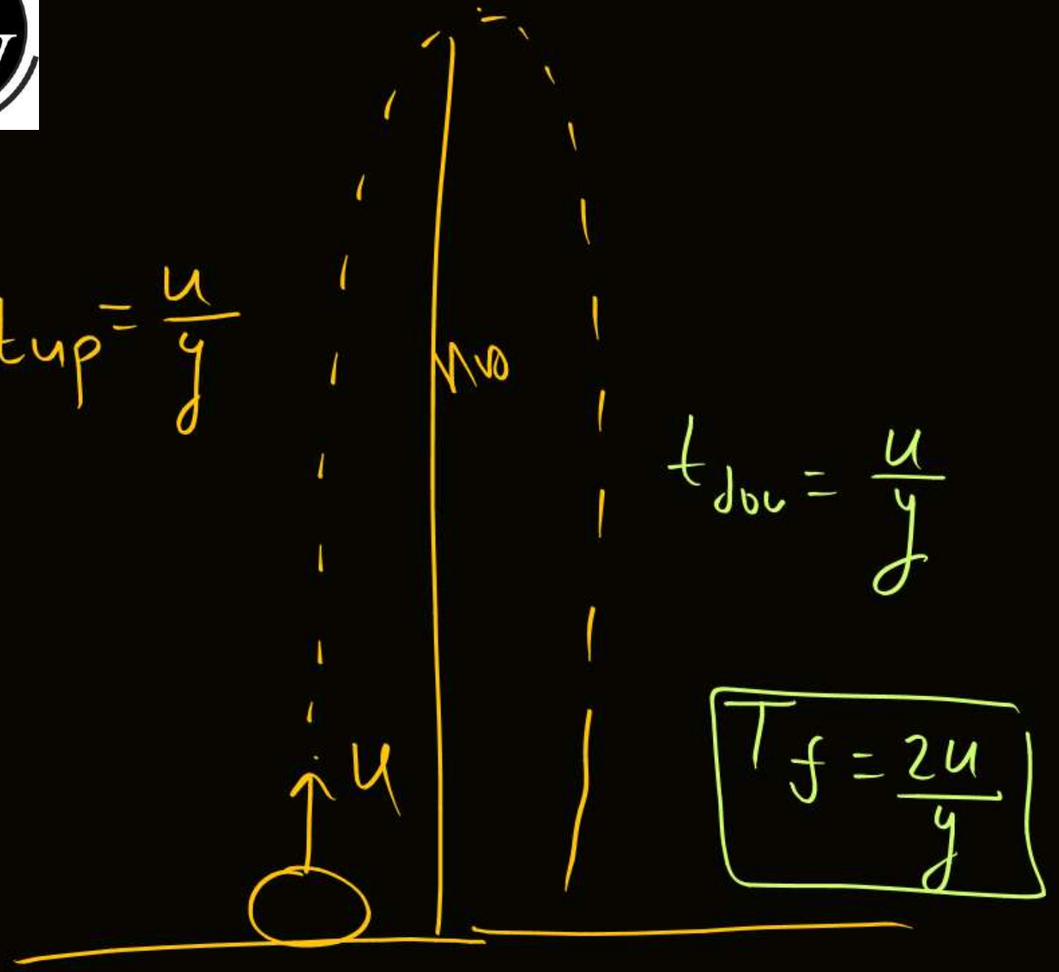
$$\frac{2H}{g} = T_f^2$$

$$T_f = \sqrt{\frac{2H}{g}}$$



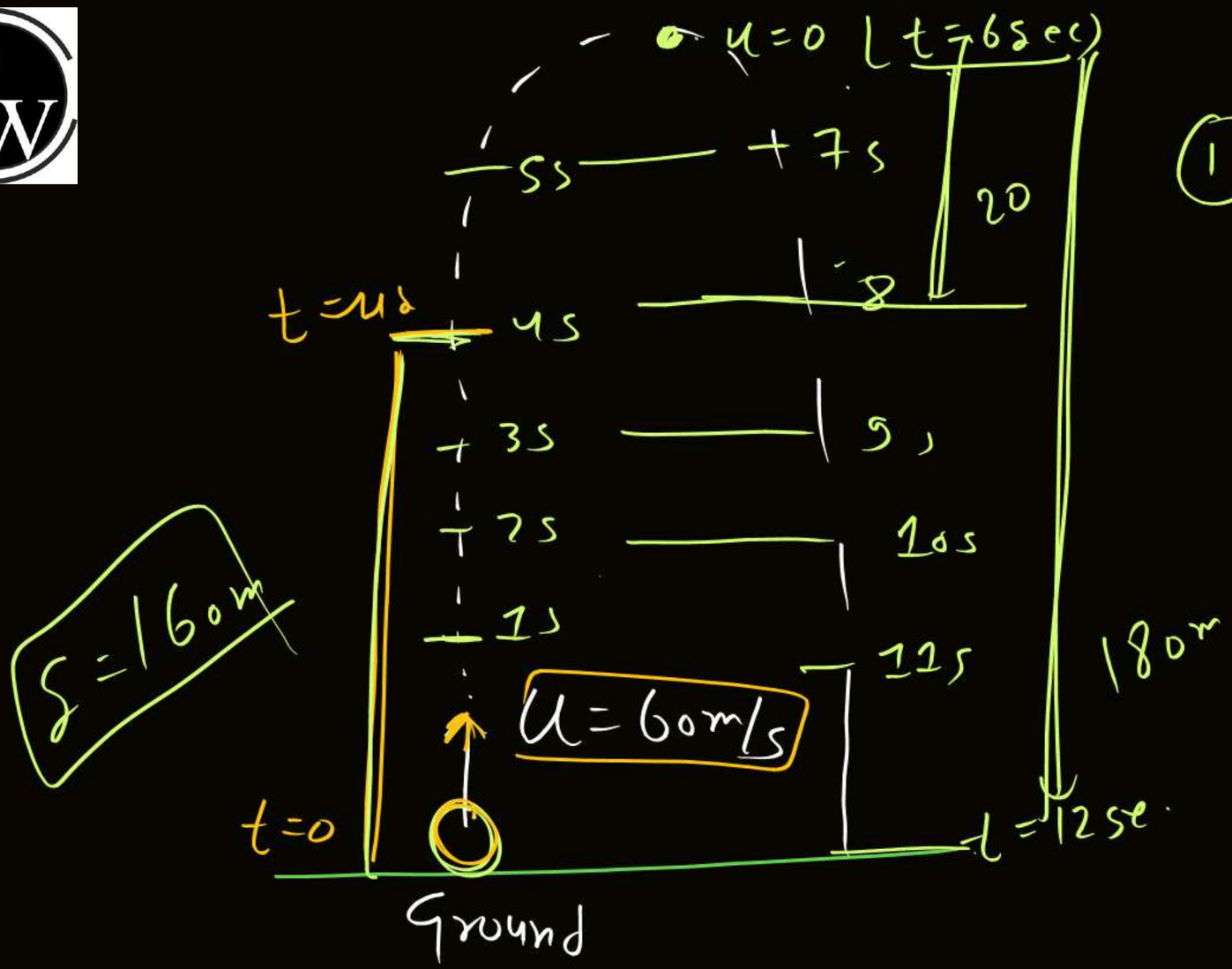
$u=0 \quad a=a$

$S_{1s} : S_{2s} : S_{3s} : S_{4} = 5 : 20 : 45 : 80 : 125 : 180$



$$H_m = \frac{u^2}{2g}$$

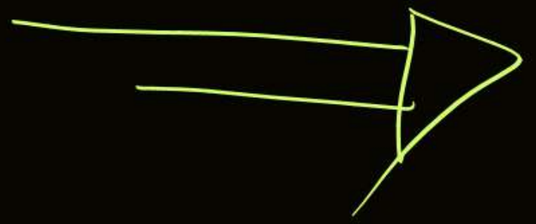
$$T_f = \frac{2u}{g}$$



① find disp^n in 4-sec

$u = 0$ drop.

find disp^m in y^{th} sec.



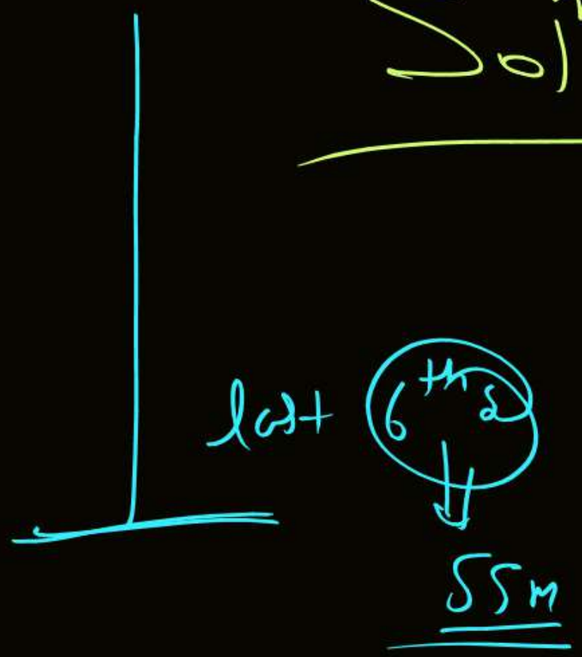
35m

@ If disp^{m} in 1st 5-sec is equal to the last 1-sec of Journey then total time of flight will be.

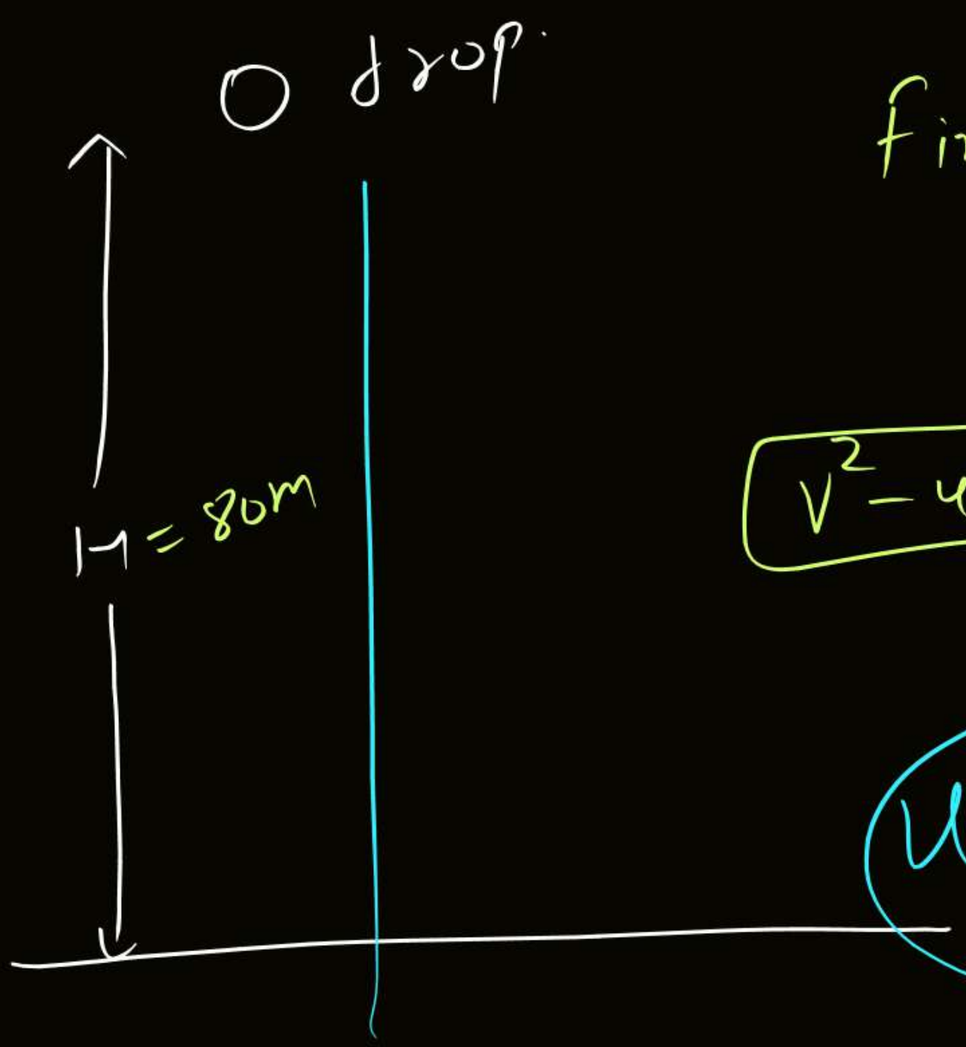
Sol^{n}

$S_{5\text{-sec}} = 125\,m$

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$



ch. v.



find velocity of object at ground.

$v^2 - u^2 = 2as$

$u = \sqrt{2gH}$