Nishant Jindal

Avg accleration and Instantanious accleration

Avg accleration:- $\dfrac{\text{Change in Velocity}}{\text{Time taken for the Change}}$.

$$\boxed{\vec{a}_{avg} = \frac{\Delta\vec{V}}{\Delta t}}$$

$$\boxed{\vec{a}_{avg} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}}$$

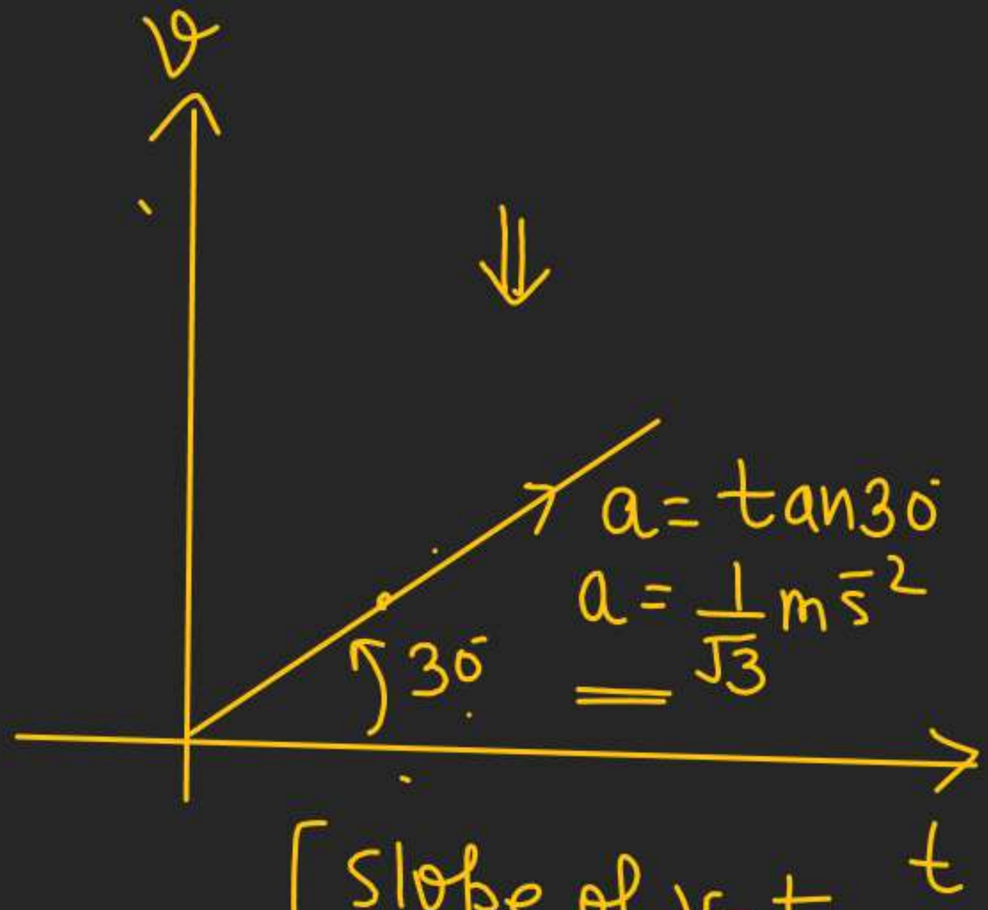
$\vec{a}_{inst} = \left(\dfrac{d\vec{V}}{dt}\right)$.

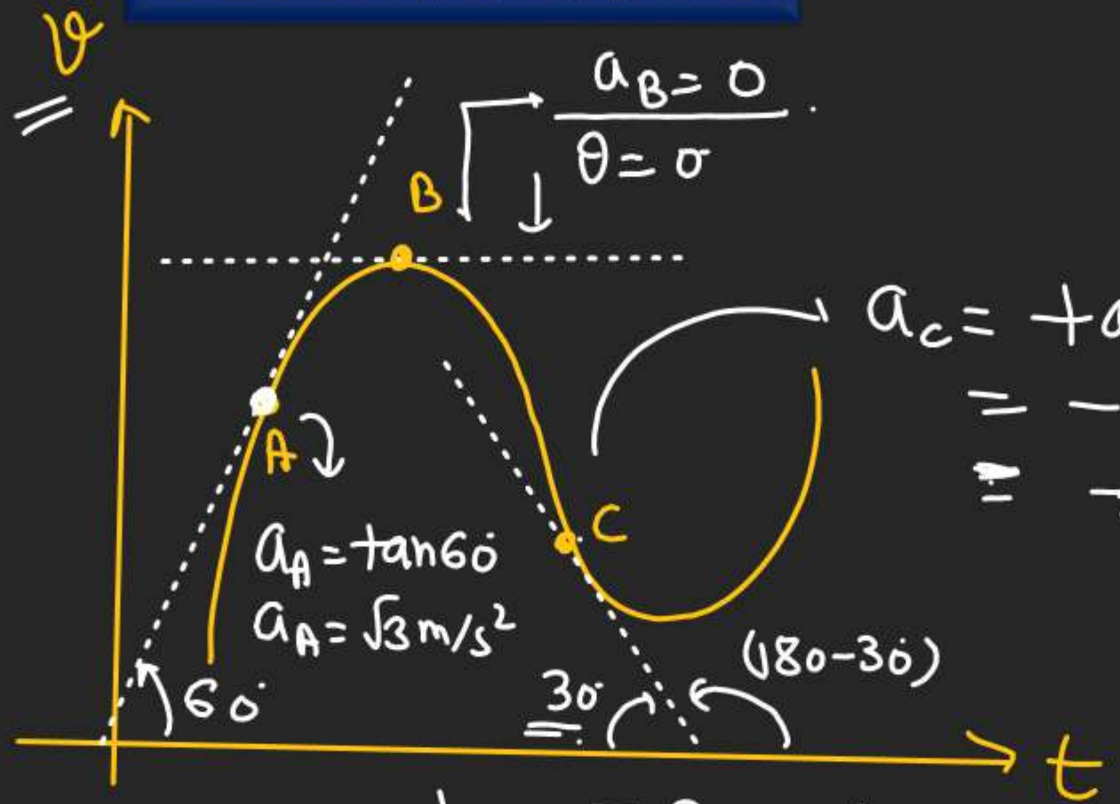
$a_{inst} = \dfrac{dv}{dt}$

→ Rate of Change of. Velocity w.r.t time.

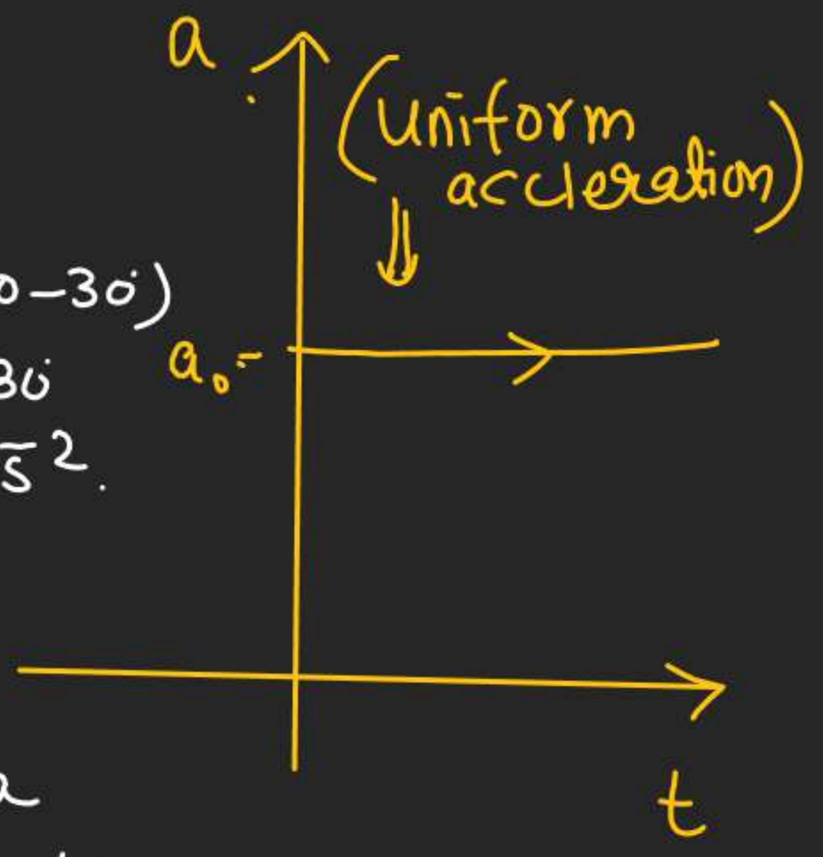
① Slope of V–t graph gives accleration at any point.

KINEMATICS





$a_C = \tan(180-30°)$
$= -\tan 30°$
$= -\frac{1}{\sqrt{3}} m s^{-2}$



[Slope of v-t graph gives accleration

If v-t graph is a st. line ⇒ Uniform accleration

If v-t graph is a curve ⇒ Represent Non-Uniform accleration

Case of Uniform accleration :→

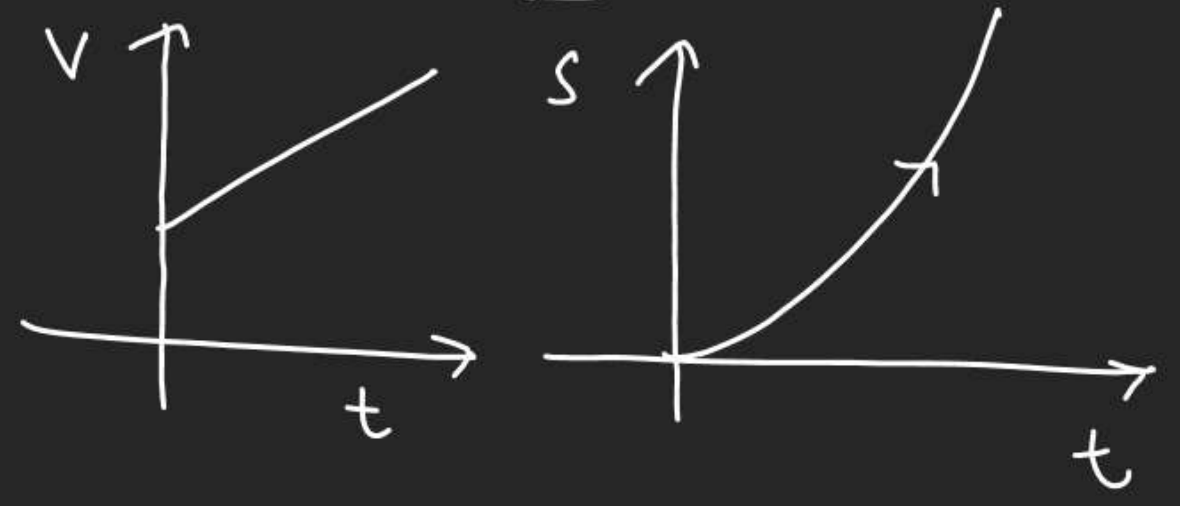
↳ 3-Kinematics Equation

[Valid for uniform accleration]

① $v = u + at \Rightarrow v \to f(t)$

② $S = ut + \frac{1}{2}at^2 \Rightarrow S \to f(t)$

③ $v^2 = u^2 + 2as \to v \to f(s)$



v = (Velocity at any time $t = t$)

u = Initial velocity

a = accleration ⇒ (uniform)

S = Displacement

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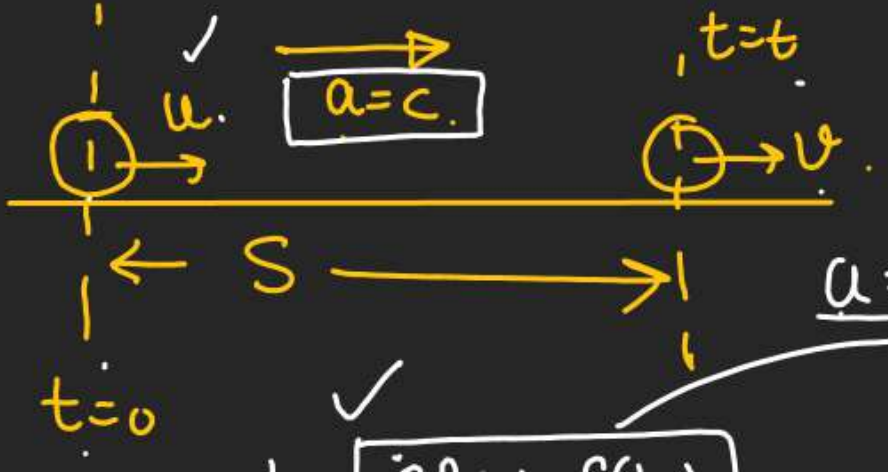
KINEMATICS

Derviation :-

↳ Particle moving in a St. line

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



$$a = \left(\frac{dv}{dt}\right)$$

$$\int_u^v dv = \int_0^t a\,dt$$

$$[v]_u^v = a[t]_0^t$$

$$(**)\quad v - u = a[t - 0]$$

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

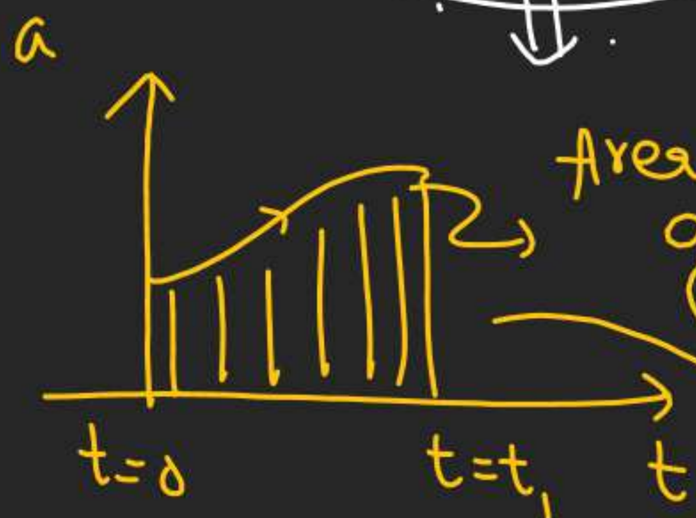
Slope of $(v-t)$ gives accleration.

$$a = (dv/dt)$$

$$\boxed{v \to f(t)} \quad \boxed{a \to f(t)}$$

$$\int a \cdot dt$$

$\Downarrow$



Area under a-t graph gives = (Change in velocity)

$$\int_{t_1}^{t_2} a\,dt = \int_u^v dv = V_f - V_i$$

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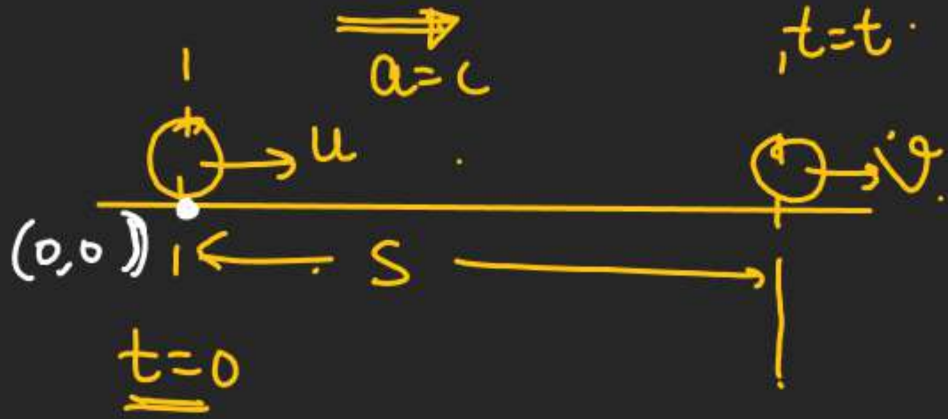
KINEMATICS

2nd Formula.

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

$$v = \left(\frac{ds}{dt}\right)$$

$$\int ds = \int v\,dt$$



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

$$\int_0^S ds = \int_0^t (u+at)\,dt \Rightarrow [S]_0^S = \int_0^t u\,dt + \int_0^t a\,t\cdot dt$$

** $S = u[t]_0^t + a\left[\frac{t^2}{2}\right]_0^t$

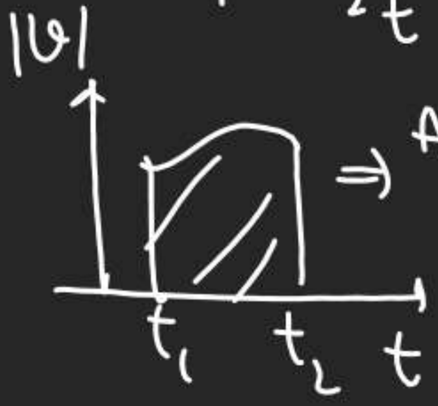
$$\boxed{S = ut + \frac{1}{2}at^2}$$

Slope of S vs t gives v. $\Leftarrow \left(ds/dt\right)$

$\boxed{S \to f(t)}$ $\boxed{v \to f(t)}$

$\int_{t_1}^{t_2} v.dt$

$\rightarrow$ Area under v-t graph gives displacement.



$\Rightarrow$ Area under |v| vs t graph gives distance.

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(*)

$$\boxed{v^2 = u^2 + 2as}$$

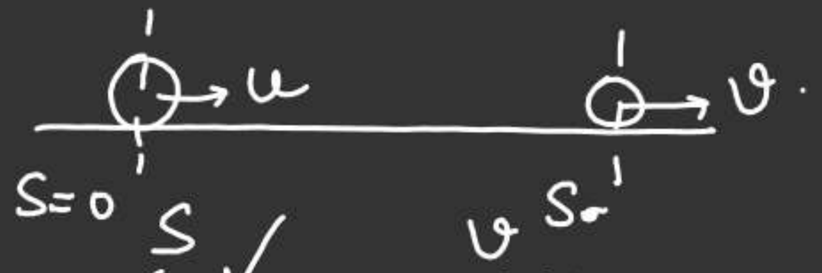
$\hookrightarrow v = f(s)$

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

$$a = \left(\frac{dv}{ds}\right) \times \left(\frac{ds}{dt}\right)$$

$$\frac{ds}{dt} = v$$

$$\boxed{a = v\frac{dv}{ds}}$$



$$\int_0^s a\,ds = \int_u^v v\,dv$$

$$a\left[s\right]_0^s = \left[\frac{v^2}{2}\right]_u^v$$

$$as = \frac{\left[v^2 - u^2\right]}{2}$$

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

$$\boxed{v^2 = u^2 + 2as}$$

$$a = \left(v\frac{dv}{ds}\right)$$

$\boxed{v \to f(s)}$ $\boxed{a = f(s)}$

$$\int_{s_i}^{s_f} a\,ds$$

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KINEMATICS

Q. A cyclist travels from centre O of a circular park of radius 1 km and reaches point P. After cycling 1/4th of the circumference along PQ, he returns to the centre of the park QO. If the total time taken is 10 minute, calculate

(i) net displacement Fig. → 0 [Initial position is Same as final position so displacement is zero.

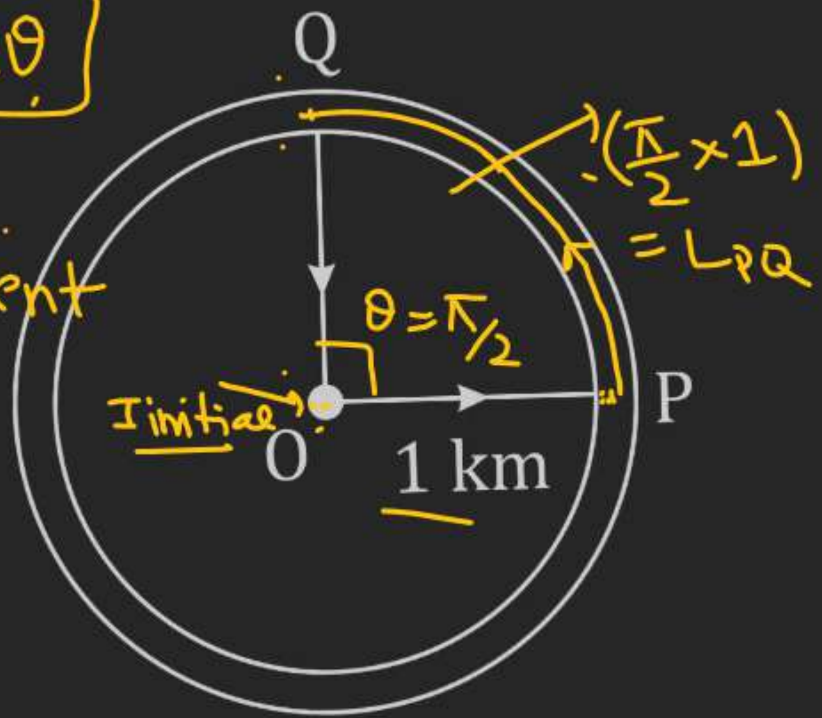
(ii) average velocity and → 0

(iii) average speed of the cyclist. → Total distance

$= OP + PQ + QO$

$= \left(2 + \frac{\pi}{2}\right)$ Km.

$L = R\theta$



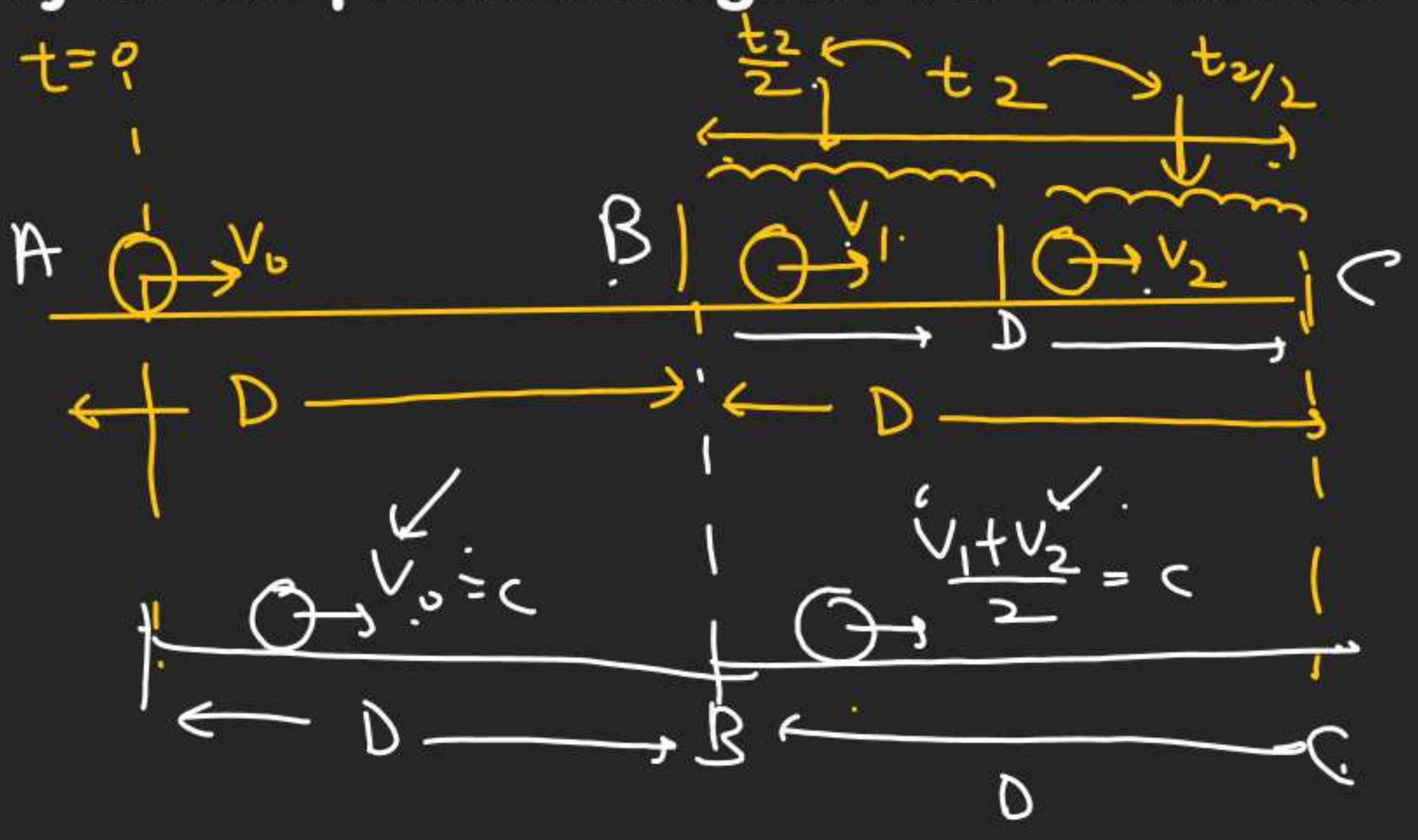
$$|V_{avg}| = \frac{(2 + \pi/2)}{\left(\frac{10}{60}\right) hr} = \frac{6}{2}(4+\pi) = 3(\pi+4)\ Km/h$$

KINEMATICS

Q. A point traversed half the distance with a velocity v_0. The remaining part of the distance was covered with velocity v_1 for half the time, and with velocity v_2 for the other half of the time. Find the mean velocity of the point averaged over the whole time of motion.

$$V_{avg} = \frac{\cancel{2}(V_0)\left(\frac{V_1+V_2}{\cancel{2}}\right)}{V_0 + \left(\frac{V_1+V_2}{2}\right)}$$

$$V_{avg} = \frac{2V_0(V_1+V_2)}{(2V_0+V_1+V_2)}$$



KINEMATICS

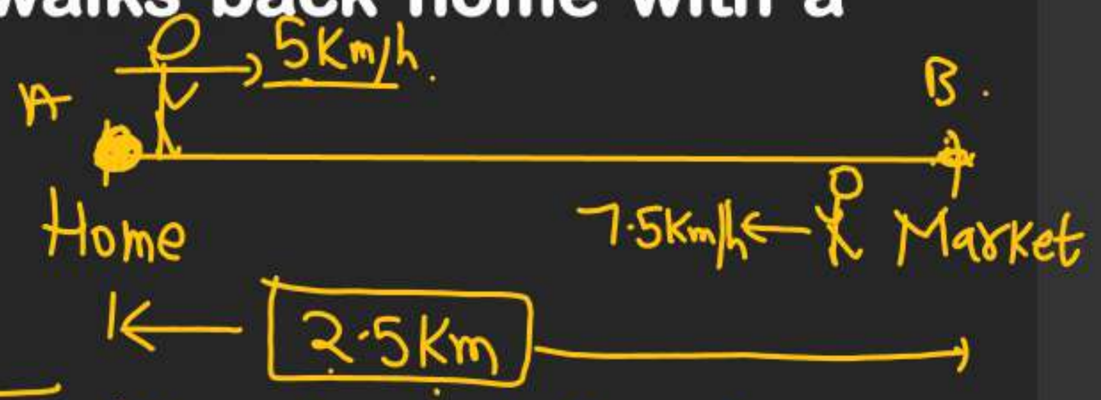
Q. A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 km/h. Finding market closed, he instantly turns and walks back home with a speed of 7.5 km/h. What is the

(a) magnitude of average velocity,

(b) average speed of the man over the interval of time

(i) 0 to 30 min., (ii) 0 to 50 min., (iii) 0 to 40 min. ?

$\left(\frac{1}{2}\text{hr.}\right)$ $\frac{50}{60} = \frac{5}{6}\text{hr}$ $\frac{40}{60} = \frac{2}{3}\text{hr}$



Home to market → t_1

$t_1 = \frac{2.5}{5} = 0.5 = \frac{1}{2}$ hrs.

(i) 0 to 30 min

Avg speed = Avg velocity $= \left(\frac{2.5}{1/2}\right)$

$= 5$ km/h

t_2 → Market to home

$t_1 + t_2 = \frac{1}{2} + \frac{1}{3}$

$t_2 = \frac{2.5}{7.5} = \left(\frac{1}{3}\text{hr}\right) \Rightarrow$ Avg velocity $= 0$

Avg Speed $= \left(\frac{2.5 \times 2}{5/6}\right) = \frac{5}{5} \times 6 = 6$ Km/h

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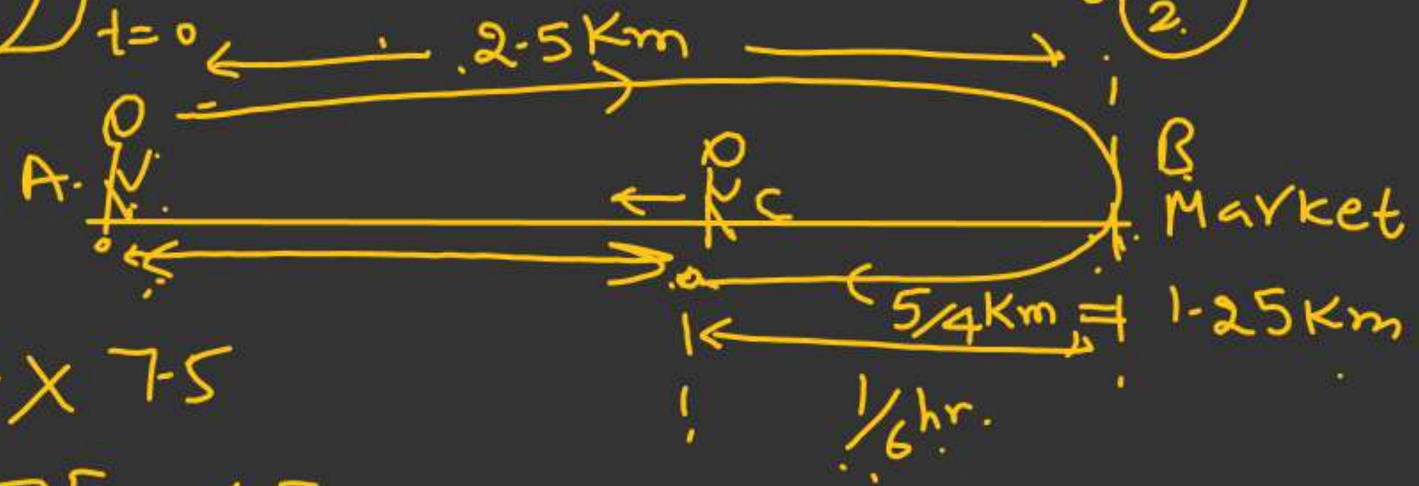
$$\boxed{t = \frac{4}{6} = \frac{2}{3}\text{ hrs}}$$

$$\frac{2}{3} - \frac{1}{2} = \frac{4-3}{6} = \frac{1}{6}$$



$$BC = \frac{1}{6} \times 7.5$$

$$= \frac{75}{60} = \left(\frac{5}{4}\right)\text{Km}$$

$$AC = \underline{\text{Displacement}} = 2.5 - \frac{5}{4}$$

$$= \frac{10-5}{4} = \left(\frac{5}{4}\right) = 1.25\text{ Km}$$

$$\text{Avg velocity} = \frac{1.25 \times 3}{2}$$

$$= \boxed{1.5 \times 1.25}$$

$$\text{Avg Speed} = \left(\frac{3.75 \times 3}{2}\right) = (3.75 \times 1.5) = \text{—}$$