Topics *to be covered*

1. Distance , Displacement, speed , velocity
2. Acceleration
3. Kinematics equation
4. Motion under gravity

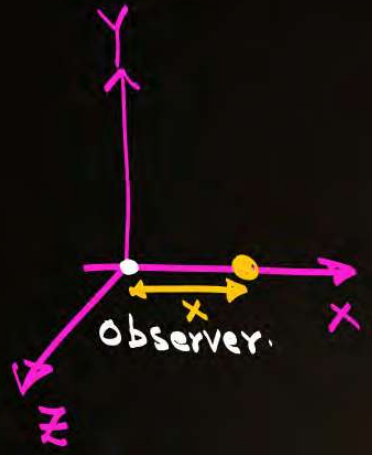
Plane
Vectors → add/Sub.
Projectile
Relative → 1D & 2D.

FOR NOTES & DPP CHECK DESCRIPTION

Duration. 5-6 hrs.

Relative.

Rest & Motion



Position doesn't Vary wrt time wrt observer.

Position vary wrt time wrt observer.

Position = x = Constant	$x = f(t)$

Ex $x = 3$, $x = -10$

Ex $x = 3t^2 + t + 4$

$x = 5\sin t$

$t \rightarrow$ vary

$x \rightarrow$ vary

$\Rightarrow$ Motion.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

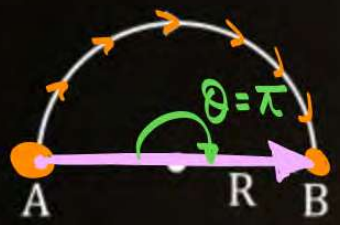
Distance and Displacement

	Distance	Displacement
Definition	Total Path Covered.	Shortest path from Initial to Final. ⇒ Change in Position.
Scalar / Vector	Scalar	Vector.
Unit / Dimension	m [L]	m [L]
Positive/Negative	Zero, (+)	(-ve), 0, (+ve) → (-) Represent dir.
Decrease/ Increase	either Constant or Increase.	0, Incr, decr.

Jab chale hi nahi.

Question 1

Final distance and displacement



distance = $R\theta = \pi R$

displacement = $2R\sin\left(\frac{\theta}{2}\right)$

$= 2R\sin\left(\frac{\pi}{2}\right)$

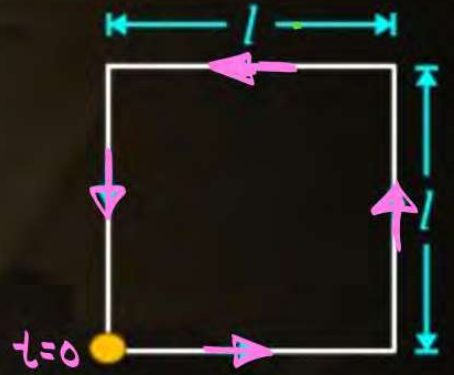
$= 2R$.

distance = πR

displacement = $2R$

Question 2 (CHCV)

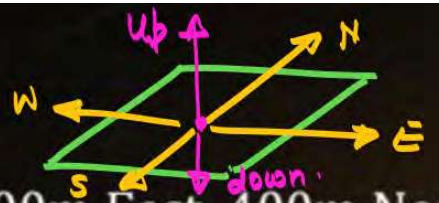
Find distance and displacement after two round.



Distance = $8L$

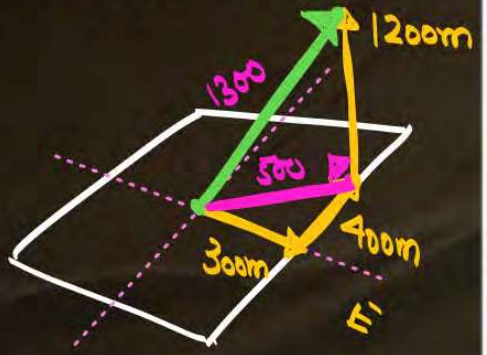
Displacement = 0

Question 3



Person moves 300m East, 400m North, 1200m vertically up. Find distance and displacement.

This is not North.



Distance = 300 + 400 + 1200

= 1900 m

Displacement. = 1300m.

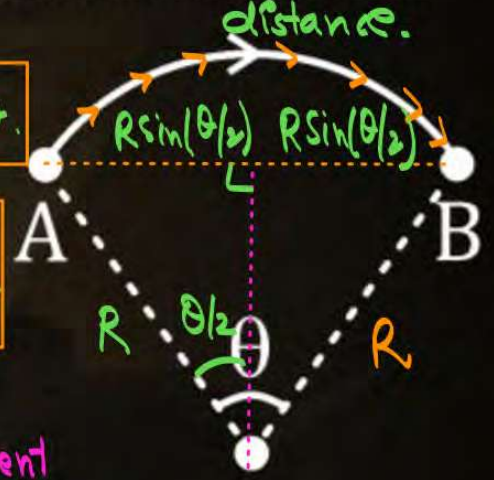
Question 4

Standard Result: $\theta = \frac{\text{Arc length}}{R}$ (Radians)

Find distance and displacement from A to B.

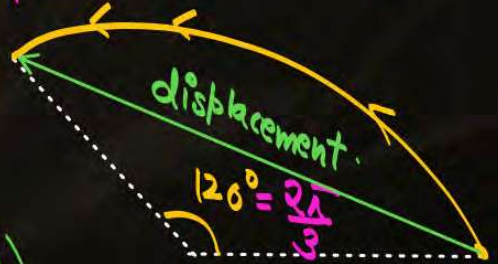
distance = Arc length = $R\theta$.

displacement = $2R\sin\left(\frac{\theta}{2}\right)$



Ex: distance & displacement

distance = $R\theta = \frac{2\pi R}{3}$

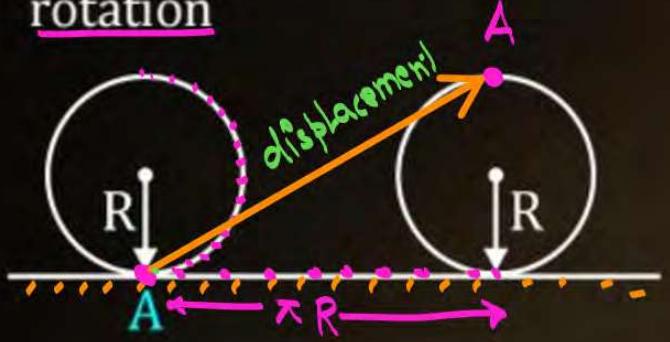


displacement = $2R\sin\left(\frac{120}{2}\right)$

$= 2R\sin 60 = R\sqrt{3}$.

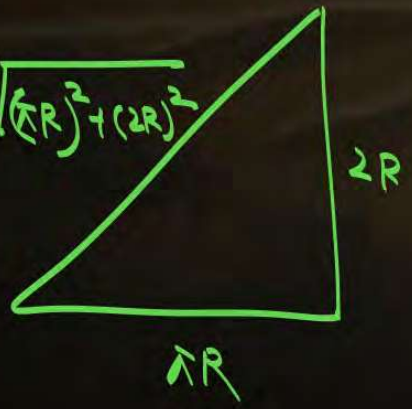
Question 5

Find displacement of A after half rotation



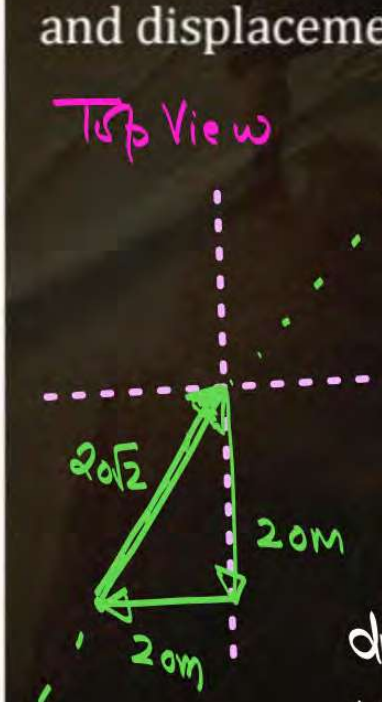
displacement = $\sqrt{(\pi R)^2 + (2R)^2}$

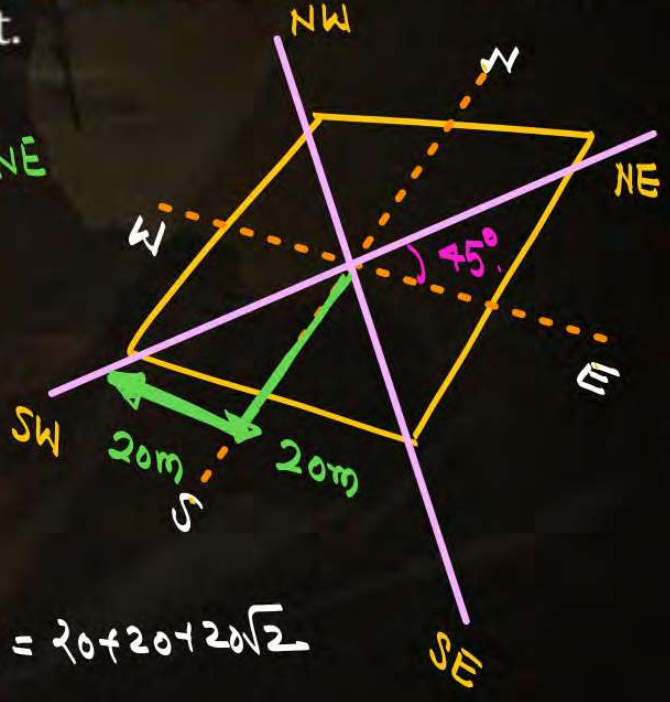
$R\sqrt{4+\pi^2}$



Question 6

A person moves 20m South 20m West and $20\sqrt{2}$m towards North East. Find distance and displacement.



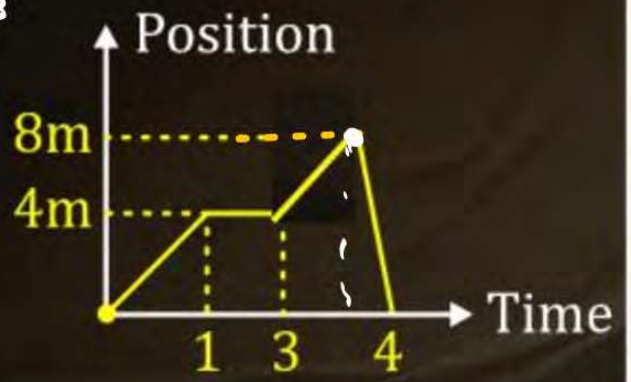


dist = 20 + 20 + $20\sqrt{2}$

disp = 0.

Question 7

Distance and displacement in 3s and 4 sec

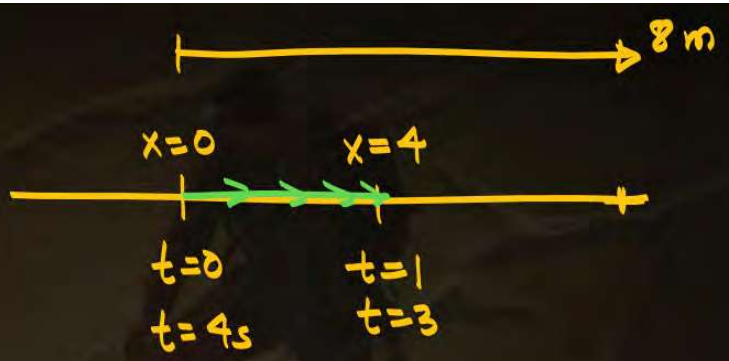


3Sec

distance = 4m displacement = 4m

4Sec

distance = 16m displacement = 0.



#

Position = $x = f(t)$

Ex: $x = 3t^2$ (Time ke saath uski position)

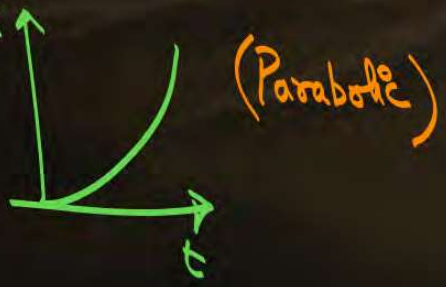
$t = 0$	$x = 0$
$t = 1$	$x = 3m$
$t = 2$	$x = 12m$
t	x
⋮	⋮

Rasta pucho.

$y = f(x)$

Equation of trajectory.

- Rest / Motion ✓
- Particle is on Parabolic path (T/F) ✓
  (Particle in 1D)
- x/t graph.



(Parabolic)

Velocity = Rate of change of position wrt time.

differentiation

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

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Speed and Velocity

	Speed	Velocity
Definition	Rate of change of distance wrt time.	Rate of change of disp wrt time.
Formula	Speed = distance/Time	Velocity = displacement/time.
Unit / Dimension	m/s $[LT^{-1}]$	m/s $[LT^{-1}]$
Positive/Negative	(+) or Zero	(+), (−), (0).
Decrease/ Increase	Avg speed = Constant or ↑, Inst Speed = ↑ or ↓.	Avg velocity (↑ or ↓) Inst velocity (↑ or ↓)

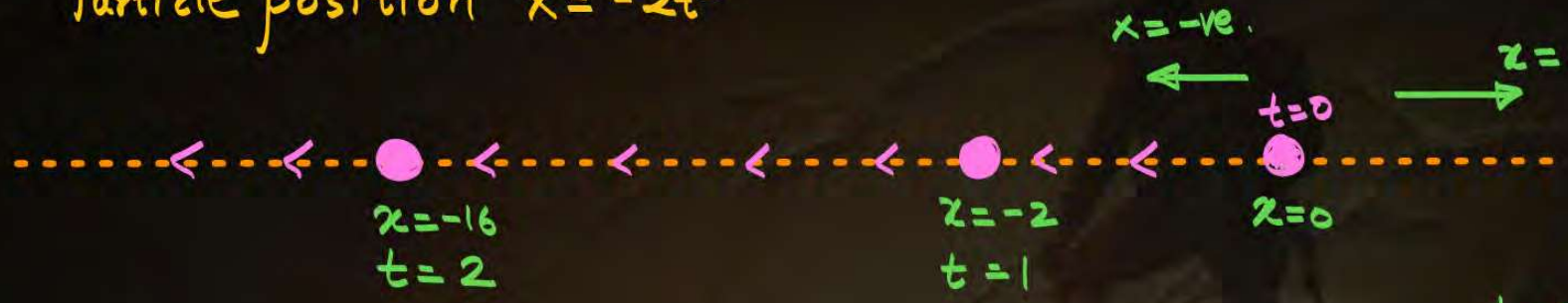
Average speed = $\frac{\text{Total Distance}}{\text{Total time}}$

Average Velocity = $\frac{\text{Total disp}}{\text{Total time}}$.

Instantaneous speed = Mag of inst vel.

Instantaneous Velocity = $\left.\frac{dx}{dt}\right|_{t=t_1}$

Que Particle position $x = -2t^3$



Position

$t = 0 \quad x = 0$

$t = 1 \quad x = -2$

$t = 2 \quad x = -2 \cdot 2^3 = -16$

v = Rate of change of x wrt time

$$v = \frac{dx}{dt} = \frac{d}{dt}(-2t^3)$$

$$v = -6t^2$$

Inst velocity.

$t = 0$	$t = 1$	$t = 2$
$v = 0$	$v = -6\ m/s$ (direction)	$v = -24\ m/s$ (direction)

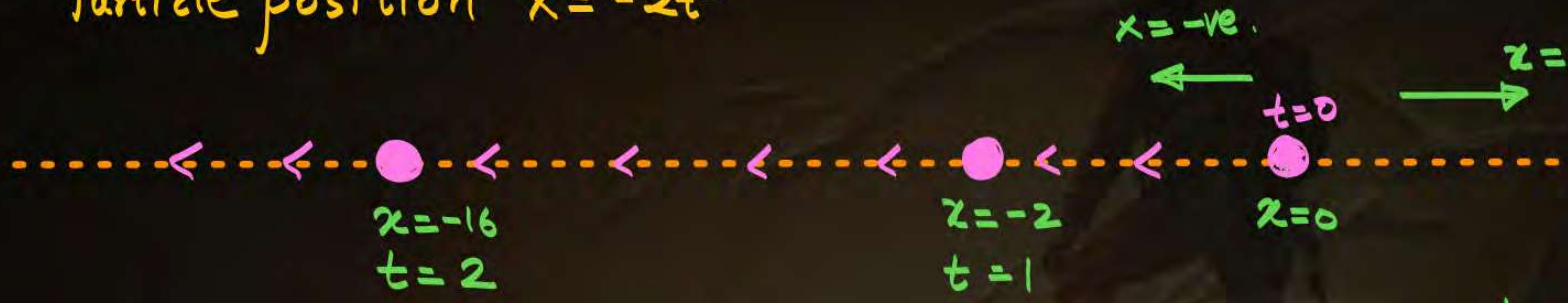
Speed at $t = 0$ — Speed = 0

$t = 1$ — Speed = 6 m/s

$t = 2$ — Speed = 24 m/s.

Instantaneous Speed = | Instantaneous velocity |.

Que Particle position $x = -2t^3$



Position	
$t = 0$	$x = 0$
$t = 1$	$x = -2$
$t = 2$	$x = -2 \cdot 2^3 = -16$

distance in 2 sec = 16m

displacement in 2 sec = −16m (−ve dir mein 16 m).

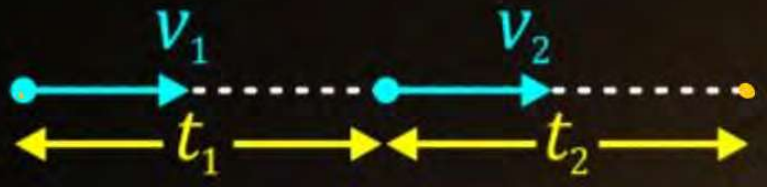
Average speed = $\frac{\text{Total distance}}{\text{Total time}}$

$= \frac{16\text{m}}{2} = 8\text{m/s}$

Average velocity = $\frac{\text{Total disp}}{\text{Total time}} = -\frac{16}{2} = -8\text{m/s}$.

Question 8

$S = \frac{D}{t}$ $\quad D = S \times t$ $\quad t = \frac{D}{S}$



$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time}}$$

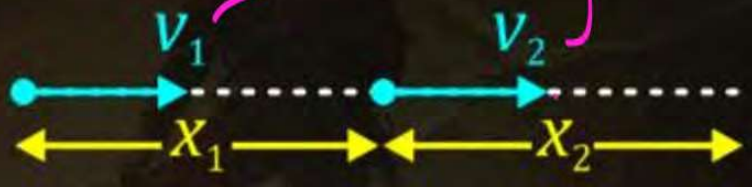
$$= \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$$

If $t_1 = t_2$

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

Question 9

$t = \frac{x_1}{v_1}$ $\quad t_2 = \frac{x_2}{v_2}$



$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time}}$$

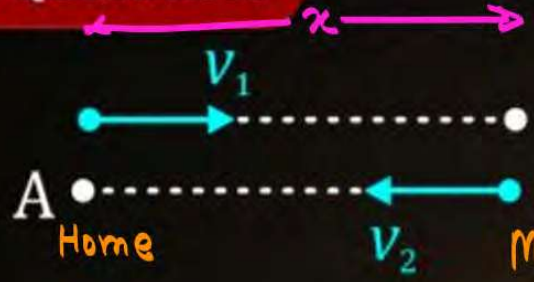
$$= \frac{x_1 + x_2}{\frac{x_1}{v_1} + \frac{x_2}{v_2}}$$

If $x_1 = x_2$

$$\text{avg Speed} = \frac{2 v_1 v_2}{v_1 + v_2}$$

$$\text{avg Speed} = \frac{v_1 v_2 (x_1 + x_2)}{x_1 v_2 + x_2 v_1}$$

Question 10



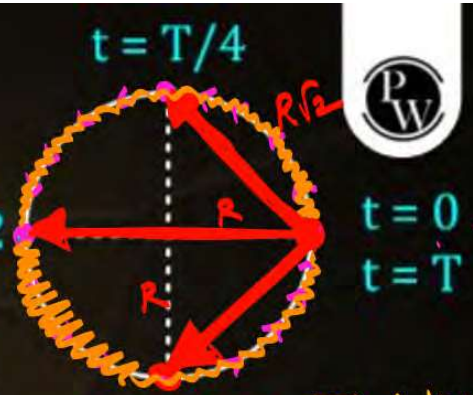
Average Speed = $\frac{\text{Total distance}}{\text{Total time}} = \frac{2x}{\frac{x}{v_1}+\frac{x}{v_2}} = \frac{2v_1v_2}{v_1+v_2}$

Average velocity = $\frac{\text{Total disp.}}{\text{Total time}} = 0$

Question 11

dist = $R\theta$

disp = $2R\sin(\theta/2)$



$\frac{\text{Total distance}}{\text{Total time}}$ $\frac{\text{Total disp}}{\text{Total time}}$

	Avg. Speed	Avg. Velocity
$0 \to T/4$	$\left(\frac{\pi R}{2}\right)/T/4$	$\frac{R\sqrt{2}}{T/4}$
$0 \to T/2$	$\pi R/T/2$	$2R/(T/2)$
$0 \to 3T/4$	$\left(\frac{3\pi R}{2}\right)/(3T/4)$	$R\sqrt{2}/(3T/4)$
$0 \to T$	$2\pi R/T$	0

JEE

Question 12

For equal distance average speed

$$\text{Avg speed} = \frac{\text{Total dist}}{\text{Total time}}$$

$$= \frac{3x}{\frac{x}{u} + \frac{x}{v} + \frac{x}{w}}$$

$$\text{avg speed} = \frac{3uvw}{vw + uw + uv}$$

JEE Mains

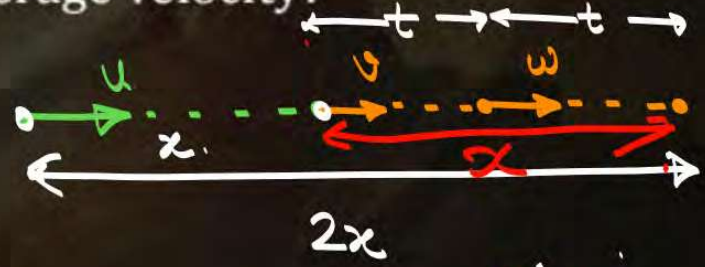
Question 13

Person travel with u for half the distance. Then for remaining half distance he travels with v for half the time and w for next half time.

Average velocity?

$$vt + wt = x$$

$$t = \frac{x}{v+w}$$

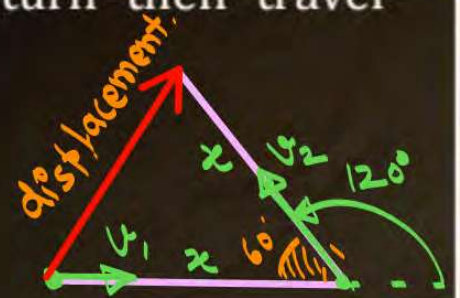


$$\text{Avg velocity} = \frac{\text{Total disp}}{\text{Total time}} = \frac{2x}{\frac{x}{u} + 2t} = \frac{2x}{\frac{x}{u} + \frac{2x}{v+w}}$$

$$= \frac{2}{\frac{1}{u} + \frac{2}{v+w}}$$

Question 14

Particle move with v_1 for x distance and then take 120° turn then travel another x with v_2



Average speed = $\frac{\text{Total dist}}{\text{total time}} = \frac{2x}{\frac{x}{v_1}+\frac{x}{v_2}} = \frac{2v_1v_2}{v_1+v_2}$

Average velocity = $\frac{\text{Total disp}}{\text{Total time}} = \frac{x}{\frac{x}{v_1}+\frac{x}{v_2}} = \frac{v_1v_2}{v_1+v_2}$

Question 15

JEE

$x = 6t^2 - t^3$

Time when velocity is zero.

Position = $f(t)$ Particle → Motion.

$v = \frac{dx}{dt} = \frac{d}{dt}(6t^2 - t^3)$

$= 6(2t) - 3t^2$

$\boxed{v = 12t - 3t^2}$

When $v = 0 = 12t - 3t^2$

$0 = 3t(4-t)$

$t = 0$

$t = 4$

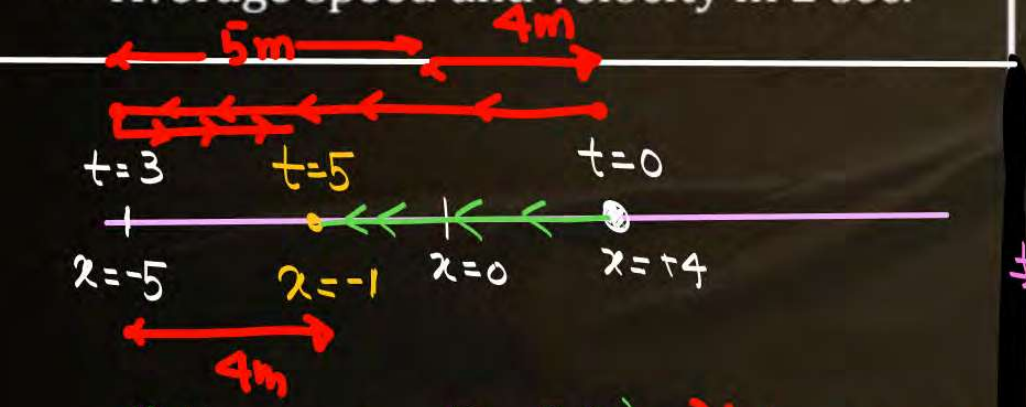
Question 16

(Done already)

$x = -2t^3$

Find

- Distance in $t = 3$
- Velocity and speed at $t = 3$
- Average speed and velocity in 2 sec.



displacement = 5m (−x) , Distance = 13m.

= −5m

Avg speed = $\frac{13}{5}$ Avg velocity = $-\frac{5}{5}$

Question 17

If $x = t^2 - 6t + 4$

Find distance and displacement in 5 sec.

(N)

$t=0 \quad x = 0^2 - 6(0) + 4 = 4$

$t=5 \quad x = 5^2 - 6\times5 + 4$

$= 25 - 30 + 4$

$= -1$

$v = \frac{dx}{dt} = 2t - 6$

$0 = 2t - 6$

$\boxed{t=3}$

x at t=3

$x = 3^2 - 6\times3 + 4$

$= 9 + 4 - 18$

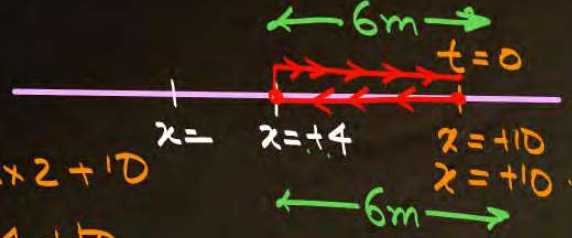
$= 13 - 18$

$= -5$

Question 18

Position $x = 6t^2 - 12t + 10$ (Motion)
Find distance in 2 sec.

$t = 0 \quad x = +10$



$t = 2 \quad x = 6\times4 - 12\times2 + 10$
$= 24 - 24 + 10$
$= 10$

Displacement = 0.

$x = 6 - 12 + 10$
$= 4m$.

$v = \frac{dx}{dt} = 12t - 12$

$t = 1$

Dist = 12

Question 19

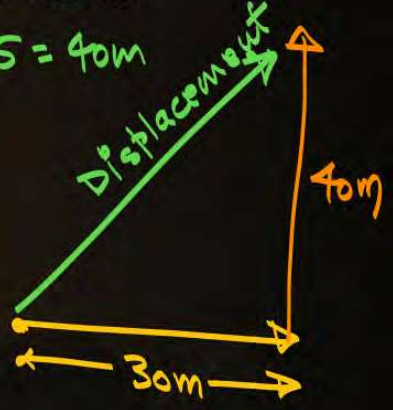
$D = S\times t$
$= 15\times2 = 30m$.

Particle move with 15 m/s for 2 sec in East then 5 m/s for 8 sec in North.
Average speed.

$D = 8\times5 = 40m$

Total distance / Total time $= \frac{30+40}{10}$

$= 7m/s$



Arg velocity $= \frac{50}{10} = 5m/s$.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Acceleration

Acceleration: Rate of change of velocity wrt time.

$v = f(t)$

$acc = \frac{dv}{dt}$ m/s^2, $[LT^{-2}]$, Vector Qty.

Particle speed up or slow down.

Average acceleration $\vec{a}_{avg\ acc} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

Instantaneous acceleration $a = \left.\frac{dv}{dt}\right|_{t=t}$

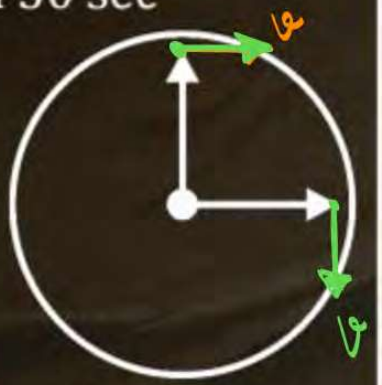
Question 20

Speed of tip is v.

For second hand of clock.

- Average acceleration in 15 sec
- Average acceleration in 30 sec

$$\text{Avg acc} = \frac{|\Delta \vec{v}|}{\Delta t} = \frac{v\sqrt{2}}{15}$$



"for tip"

Change in speed = 0.

$\vec{v_1} = v\hat{i}$

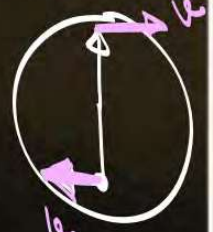
$\vec{v_2} = -v\hat{j}$

$\Delta \vec{v} = \vec{v_2} - \vec{v_1} = -v\hat{j} - v\hat{i}$

$|\Delta v| = \sqrt{v^2 + v^2} = v\sqrt{2}$.

avg acc in 30 Sec.

$$\text{acc}_{avg} = \frac{|\Delta v|}{T} = \frac{2v}{30}$$



Question 21

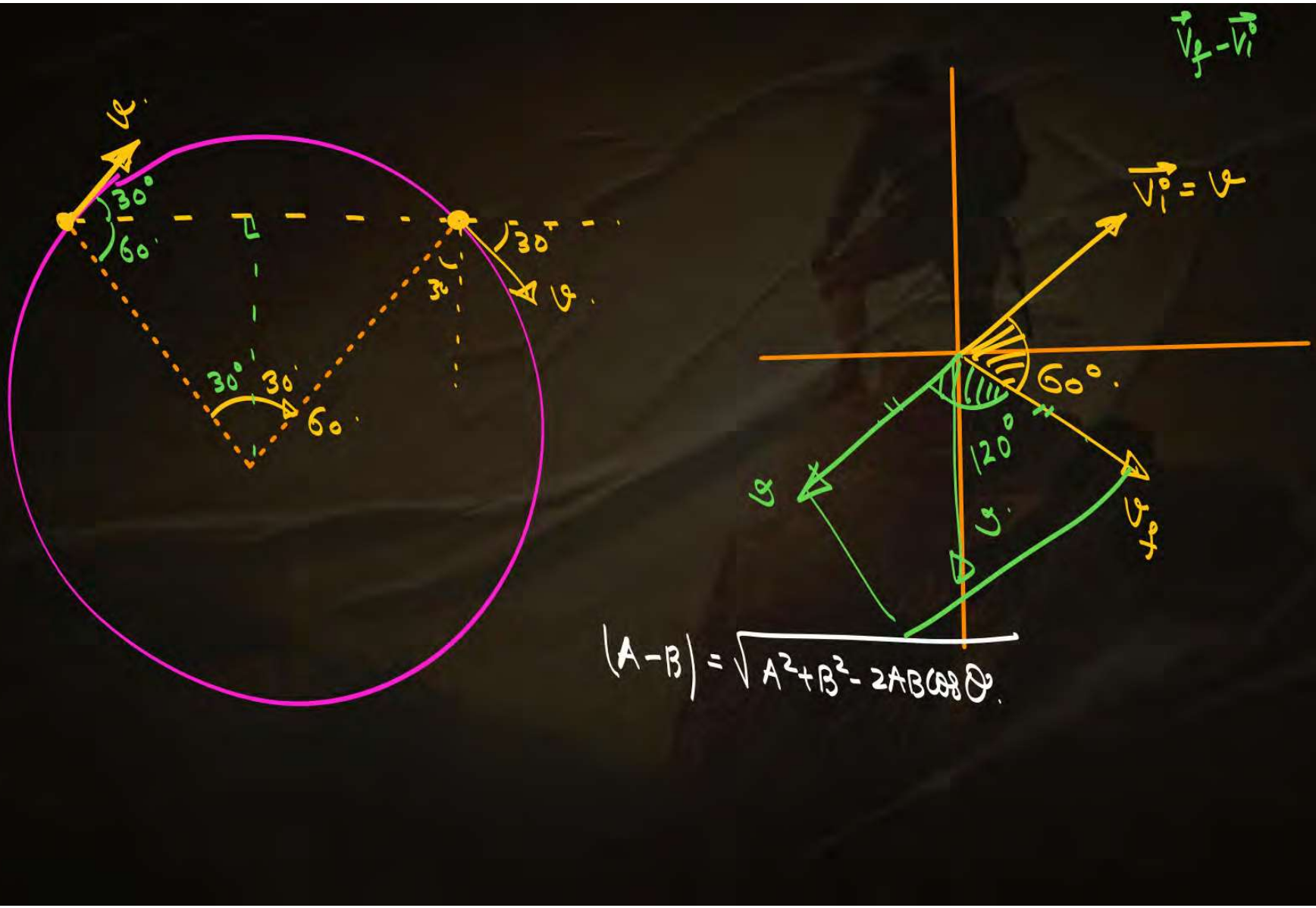
- |Average velocity|

$$\frac{\text{Total disp}}{\text{Total time}} = \frac{2R\sin 30}{T}$$

- Average speed $= \frac{R(\pi/3)}{T}$

$$\frac{v_f - v_i}{T}$$

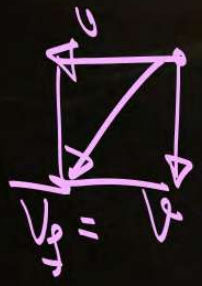
- |Average acceleration| $= \frac{v}{T}$.


v
30°
60°
30°
v
30°
30°
60°
$\vec{v}_f - \vec{v}_i$
$\vec{v}_i = v$
60°
120°
v
v
$|A-B| = \sqrt{A^2+B^2-2AB\cos\theta}$

$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

(Addition with opp sign)

$\longrightarrow v = \vec{v}_i$



JEE

Question 22

$x = at^2 - bt^3$

Acceleration is zero at what time. $t = ?$ $a = 0$

$v = \frac{dx}{dt} = 2at - 3bt^2$

$a = \frac{dv}{dt} = 2a - 6bt$

$t = ?$ $\quad 0 = 2a - 6bt$

$a = 0$ $\quad \frac{2a}{6b} = t$

$\frac{a}{3b} = t$

JEE

Question 23

$x = 2 - 5t + 6t^2$

Find acceleration when velocity is zero

$v = \frac{dx}{dt} = 0 - 5 + 12t = 12t - 5$

when $v = 0$

$v = 0 = 12t - 5$

$t = \frac{5}{12}$

$a = \frac{dv}{dt} = 0 + 12$

acc is Independent of time.

Question 24

Concept $v_{max/min} \Rightarrow a = 0$

$x_{max/min} \Rightarrow v = 0$

Velocity $v = 2t(3 - t)$ time at which velocity is maximum.

$t = ?$ Jab v_{max}

$v = 6t - 2t^2$

$\frac{dv}{dt} = 6 - 4t$

$0 = 6 - 4t$

$\frac{6}{4} = t = 3/2$

$\frac{d^2v}{dt^2} = -4 < 0$ Maxima

Question 25

JEE Mains

Velocity $= v_0 + gt + Ft^2$ if position $x = 0$ at $t = 0$ displacement in 1 sec.

$t = 0$
$x = 0$.

$v = v_0 + gt + Ft^2$.
given

$\frac{dx}{dt} = v_0 + gt + Ft^2$

$\int dx = \int (v_0 + gt + Ft^2)\,dt$

$x_f - x_i = v_0[t]_0^1 + g\left[\frac{t^2}{2}\right]_0^1 + F\left[\frac{t^3}{3}\right]_0^1$

$\text{Disp} = v_0 + \frac{g}{2} + F/3$

Question 26

$v_x = \frac{dx}{dt} = 3t^2$

$v_y = \frac{dy}{dt} = 2t$

$x = t^3$
$y = t^2$
} Position (x, y) (2D).

Acceleration at $t = 1$ sec.

$\vec{r} = r_x \hat{i} + r_y \hat{j}$

$\vec{r} = t^3 \hat{i} + t^2 \hat{j}$

$\vec{v} = \frac{d\vec{r}}{dt} = 3t^2 \hat{i} + 2t \hat{j}$

$\vec{a} = \frac{d\vec{v}}{dt} = 6t \hat{i} + 2 \hat{j}$

at $t = 1$

$\vec{a} = 6\hat{i} + 2\hat{j}$

$|a| = \sqrt{6^2 + 2^2}$

Question 27

$a = 8t + 5$ (given)

Velocity at $t = 2$ if starts from rest.

$t = 0 \quad v = 0$

$\frac{dv}{dt} = 8t + 5$

$\int_0^v dv = \int_{t=0}^{t=2} (8t + 5)\, dt$

$v = 8\left[\frac{t^2}{2}\right]_0^2 + 5[t]_0^2$

$v = 4[2^2 - 0^2] + 5(2 - 0)$.

Question 28

JEE

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

$v = \beta x^{-2n}$, where β and n are constants acceleration a function of x.

$v = \beta x^{-2n} \Rightarrow \frac{dv}{dx} = \beta(-2n)(x^{-2n-1})$

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

$= \beta x^{-2n}\left(-2n\beta x^{-2n-1}\right)$

$\boxed{a = -2n\beta^2 x^{-4n-1}}$

Question 29

(JEE) x2

$v = (150 - 10x)^{1/2}$

Find acceleration of body.

$v = \sqrt{(150-10x)}$

$v^2 = 150 - 10x$

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

diff wrt x

$2v\left(\frac{dv}{dx}\right) = 0 - 10$

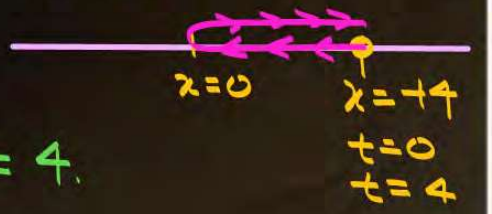
acc

$2a = -10$

$\boxed{a = -5}$ Ans.

Question 30

Position $x = (t-2)^2$ distance in first 4 sec.



$t=0 \quad x=4$

$t=4 \quad x=(4-2)^2=4.$

Displacement = 0

$v=\frac{dx}{dt}=2(t-2)$

distance = 4+4

= 8m.

$v=0=2(t-2)$

$t=2$

at $t=2$ $x=0$

Question 31

JEE

$\sqrt{x} = 3t+5$ graph of v as a function of time.

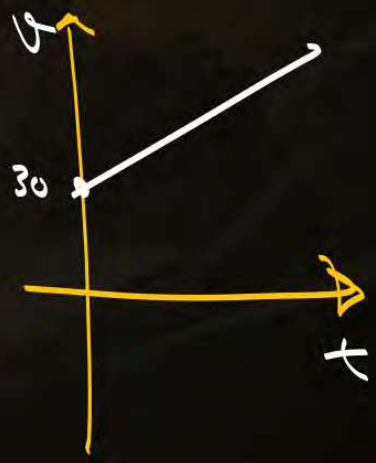
$x=(3t+5)^2$

$v=\frac{dx}{dt}=2(3t+5)\cdot 3$

$v=6(3t+5)$

Linear graph

$v=18t+30$



Question 32

JEE

$t = \alpha x^2 + \beta x$

Where α, β are constant. Find acceleration as function of v.

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

diff wrt t

$1 = 2\alpha x\left(\frac{dx}{dt}\right) + \beta\left(\frac{dx}{dt}\right)$

$1 = (2\alpha x + \beta)v$

$v = \frac{1}{2\alpha x + \beta} = (2\alpha x + \beta)^{-1}$

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

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

$= v\left(\frac{-2\alpha}{(2\alpha x + \beta)^2}\right)$

$a = -2\alpha v v^2$

$\boxed{acc = -2\alpha v^3}$

Question 33

JEE

$x^2 = 2 + t$

Acceleration as function of x.

diff wrt t

$2x\left(\frac{dx}{dt}\right) = 0 + 1$

$2xv = 1$

$\boxed{v = \frac{1}{2x}}$

$v = \frac{1}{2}x^{-1}$

$\frac{dv}{dx} = \frac{1}{2}(-1x^{-2})$

$= \frac{-1}{2x^2}$

diff wrt x.

$2x = 0 + \frac{dt}{dx}$

$2x = \frac{1}{v}$

$\boxed{v = \frac{1}{2x}}$

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

$= \frac{1}{2x}\left(\frac{-1}{2x^2}\right) = \frac{-1}{4x^3}$

$\boxed{acc = -\frac{1}{4x^3}}$

$$v = (2\alpha x + \beta)^{-1}$$

$$\frac{dv}{dx} = -\frac{1}{(2\alpha x+\beta)^2} \cdot (2\alpha)$$

$t = \alpha x^2 + \beta x$

diff wrt x

$\frac{dt}{dx} = 2\alpha x + \beta$

$\frac{1}{v} = 2\alpha x + \beta$

$v = \frac{1}{2\alpha x + \beta}$.

diff wrt t

$\frac{d(t)}{dt} = 1$

$\frac{d(t)}{dt} = \frac{d}{dt}(\alpha x^2) + \frac{d}{dt}(\beta x)$

$1 = \alpha\, 2x \frac{dx}{dt} + \beta \frac{dx}{dt}$

Question 34

$t=0$
$x=0$
$u=0$

Particle starts from origin such that $v = 4t^3 - 2t$. Acceleration when $x = 2$.

$a = \frac{dv}{dt} = 12t^2 - 2$

Lets find time when $x = 2$.

$\frac{dx}{dt} = 4t^3 - 2t$

$dx = 4t^3\,dt - 2t\,dt$

$\int_0^2 dx = \int_0^t 4t^3\,dt - \int_0^t 2t\,dt$

$x = [t^4]_0^t - t^2$

$t^4 - t^2 = 2$

$t =$ —

Question 35

JEE

$v = f(t)$ milja yaa toh maga

$\dot{v} = b\sqrt{x}$

Find speed when $t = \tau$ When starts from origin

$t=0$
$u=0$
$x=0$

$\frac{dx}{dt} = b\sqrt{x}$

$\int_0^x \frac{dx}{\sqrt{x}} = \int_0^t b\,dt$

$2\sqrt{x} = bt$

$\sqrt{x} = \frac{bt}{2}$

$x = \frac{b^2t^2}{4}$

diff wrt time

$\frac{dx}{dt} = v = \frac{b^2}{4} \cdot 2t = \frac{b^2}{2}t$

$v = \frac{b^2}{2}t$

at $t = 2$

$v = \frac{b^2}{2}2$

Question 36

$\dot{x} = a\cos(\omega t)$
$\dot{y} = a\sin(\omega t)$
$\dot{z} = a\omega t^2$

} 3D.

Acceleration of particle at t=0

$\vec{r} = a\cos(\omega t)\hat{i} + a\sin(\omega t)\hat{j} + a\omega t^2\hat{k}$

$v = \frac{dr}{dt} = -a\omega\sin\omega t\,\hat{j} + a\omega\cos(\omega t)\hat{j} + 2a\omega t\,\hat{k}$

$a = \frac{dv}{dt} = -a\omega^2\cos(\omega t)\hat{i} - a\omega^2\sin(\omega t)\hat{j} + 2a\omega\,\hat{k}$.

at $t = 0$

$a_{rr} = -a\omega^2\hat{i} + 2a\omega\hat{k}$

Question 37

HW

$t = mx^2 + nx$ acceleration as a function of v.

diff wrt t.

$v = f(x)$

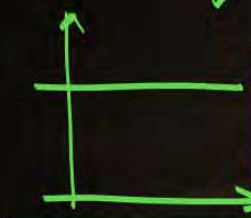
$a = v\frac{dv}{dx}$.

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

Graphs and analysis

Slope analysis:

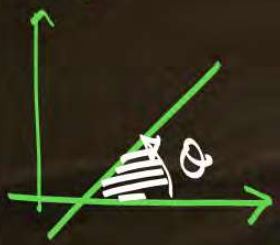
$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1} = \tan\theta$$



Slope = 0

$\tan\theta = 0°$

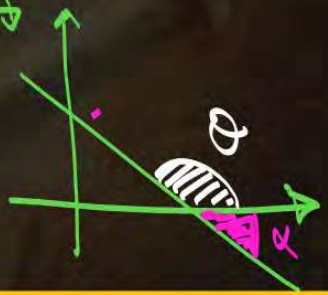
Parallel to x axis.



$m = \text{Slope} = +ve = +\tan\theta$.

"θ = acute"

More is θ more is slope ↑



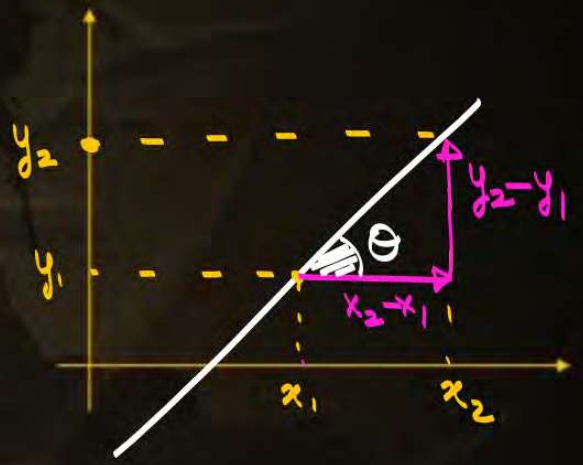
Slope = $\tan\theta$ or $-\tan\alpha$

↓

obtuse

= (-ve)

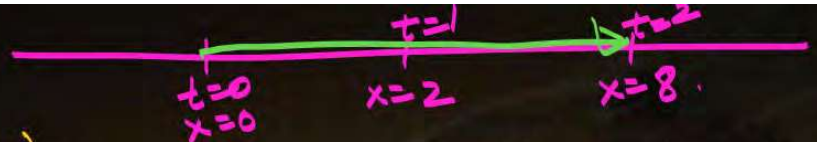
More is the α More is the slope.



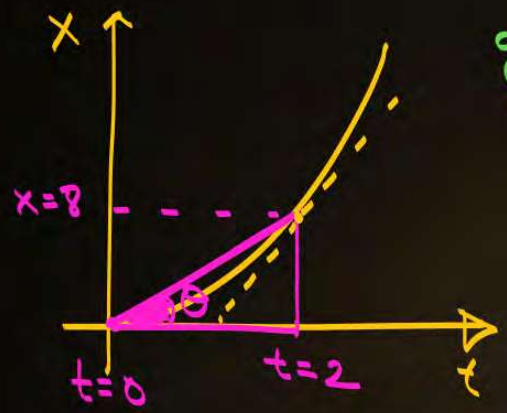
$x = f(t)$

$x = 2t^2$

(1D Motion)



avg velocity in 2 Sec. $= \frac{x_f - x_i}{\Delta t} = \frac{8-0}{2} = 4\ m/s$



graph parabola bana.

Inst velocity of $t=2$. $= \frac{dx}{dt} = 4t$

At $t=2$

$v = 8\ m/s$

Note: Ye content bilkul sufficient hai (MAINS/ Advanced) For class 11,12,13

- **Slope of position vs time:**
- **Slope of velocity vs time**
- **Area of acceleration vs time graph**
- **Area of velocity vs time graph**

differentiation → slope.
Integration → area

differentiation →

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

$v_{avg} = \frac{x_f - x_i}{\Delta T}$

Slope of x/t → v

differentiation

$a = \frac{dv}{dt}$ or $a = \frac{dv}{dt} \cdot \frac{dx}{dx} = \frac{v\,dv}{dx}$

$a_{avg} = \frac{\Delta \vec{v}}{\Delta t}$, Slope of v/t

Position = x ⇄ Velocity = v ⇄ acceleration "a"

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

$\int dx = \int v\,dt$

area of v/t graph = change in Position.

$x_f - x_i = \int v\,dt$

Change in position or displacement.

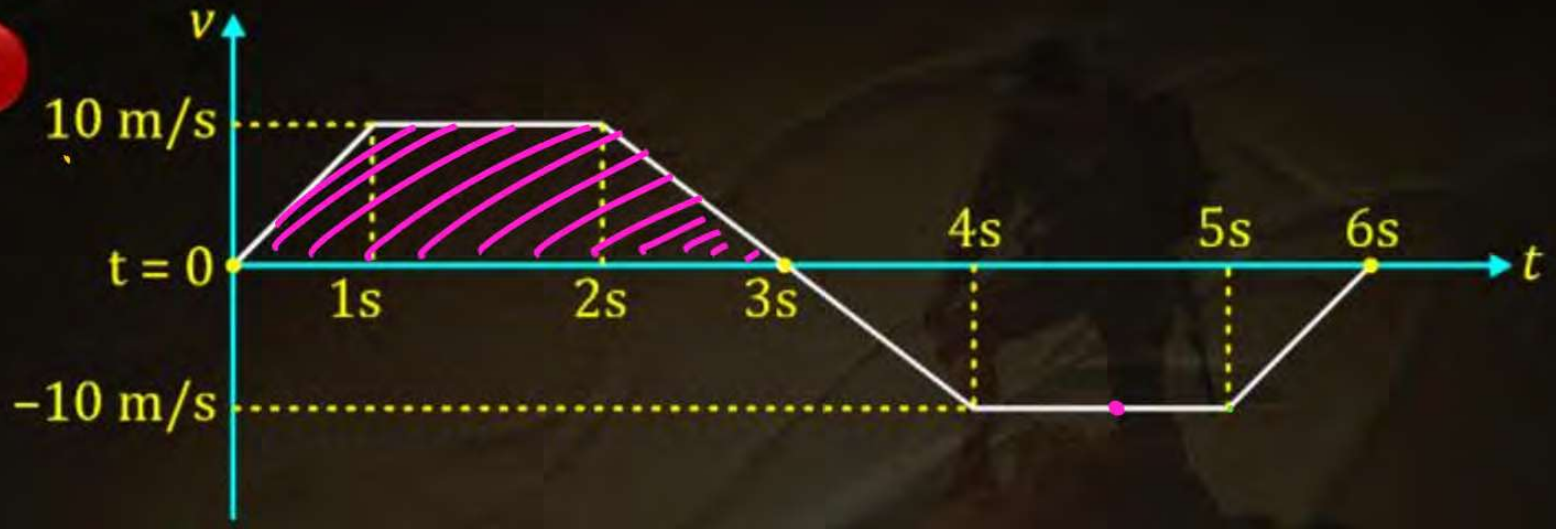
$a = \frac{dv}{dt}$

$\int dv = \int a\,dt$

$v_f - v_i = \int a\,dt$ = area of a/t = Change in Velocity

Change in velocity =

Question 38



Find:

(a) Velocity at $t = 1.5s, 3.5s, 4.5s, 6s$

"Read the graph".

10m/s −5 −10m/s 0

(b) Acceleration at $t = 0.5s, 1.5s, 3s, 5.5s$

"Slope of v/t".

$+10 m/s^2$ Slope = 0, a = 0

acc = +tanθ = $+10 m/s^2$.

Slope = −tanα = $-10 m/s^2$.

(c) Distance in $t = 3$ sec, $t = 6$ sec

"Area of v/t"

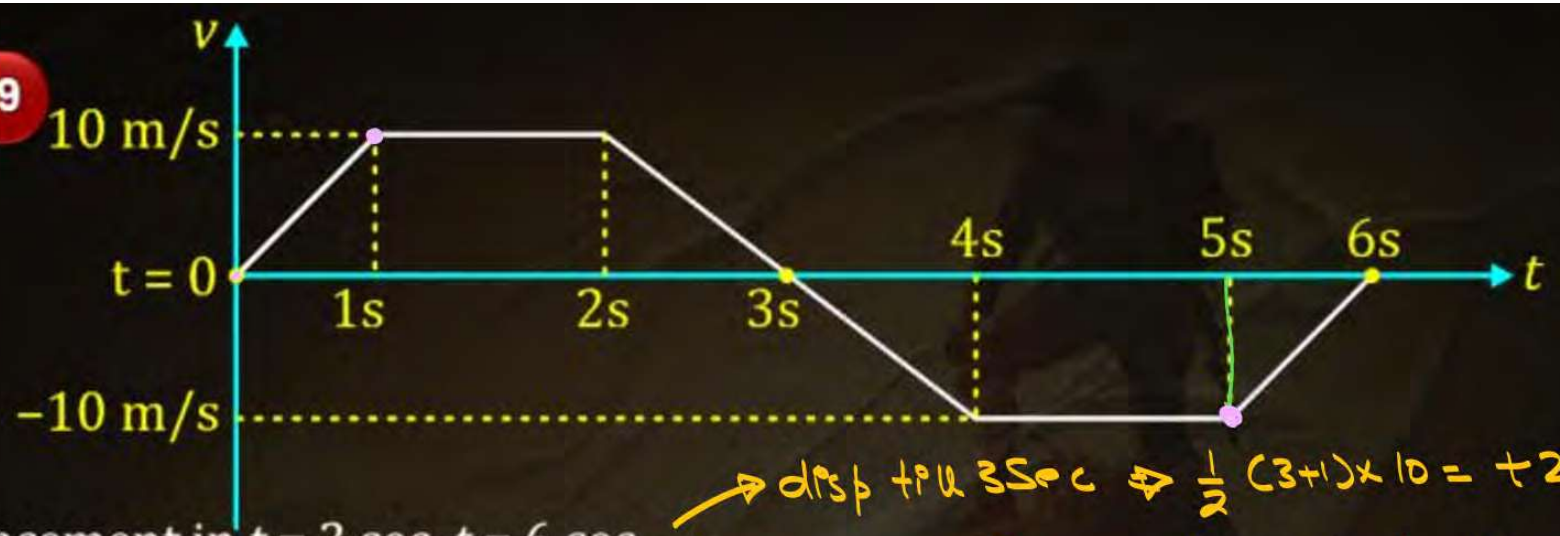
Upper & Lower area = +ve.

$\frac{1}{2} \times (3+1) \times 10 = 20m$.

Distance till 6 sec = |Upper Area| + |Lower Area|

$20 + 20 = 40m$.

Question 39



(d) Displacement in $t = 3$ sec, $t = 6$ sec

Area of v/t graph = |upper Area| − |Lower Area|.

→ disp till 3sec ⇒ $\frac{1}{2}(3+1)\times 10 = +20$m.

→ " " 6sec ⇒ |upper Area| − |Lower Area|

$= 20 - 20 = 0$m.

(e) Average speed in $t = 2s$ and $t = 5$ sec

$\frac{\text{Total distance}}{\text{Total time}}$.

→ till 2sec = $v_{avg} = \frac{\frac{1}{2}(2+1)\times 10}{2} = 7.5$m/s

→ till 5sec $v_{avg} = \frac{20+15}{5} = \frac{35}{5} = 7$m/s.

(f) Average velocity in $t = 2$ sec and $t = 4$ sec

$\frac{\text{Total disp}}{\text{Total time}} = \frac{15}{2} = +7.5$m/s.

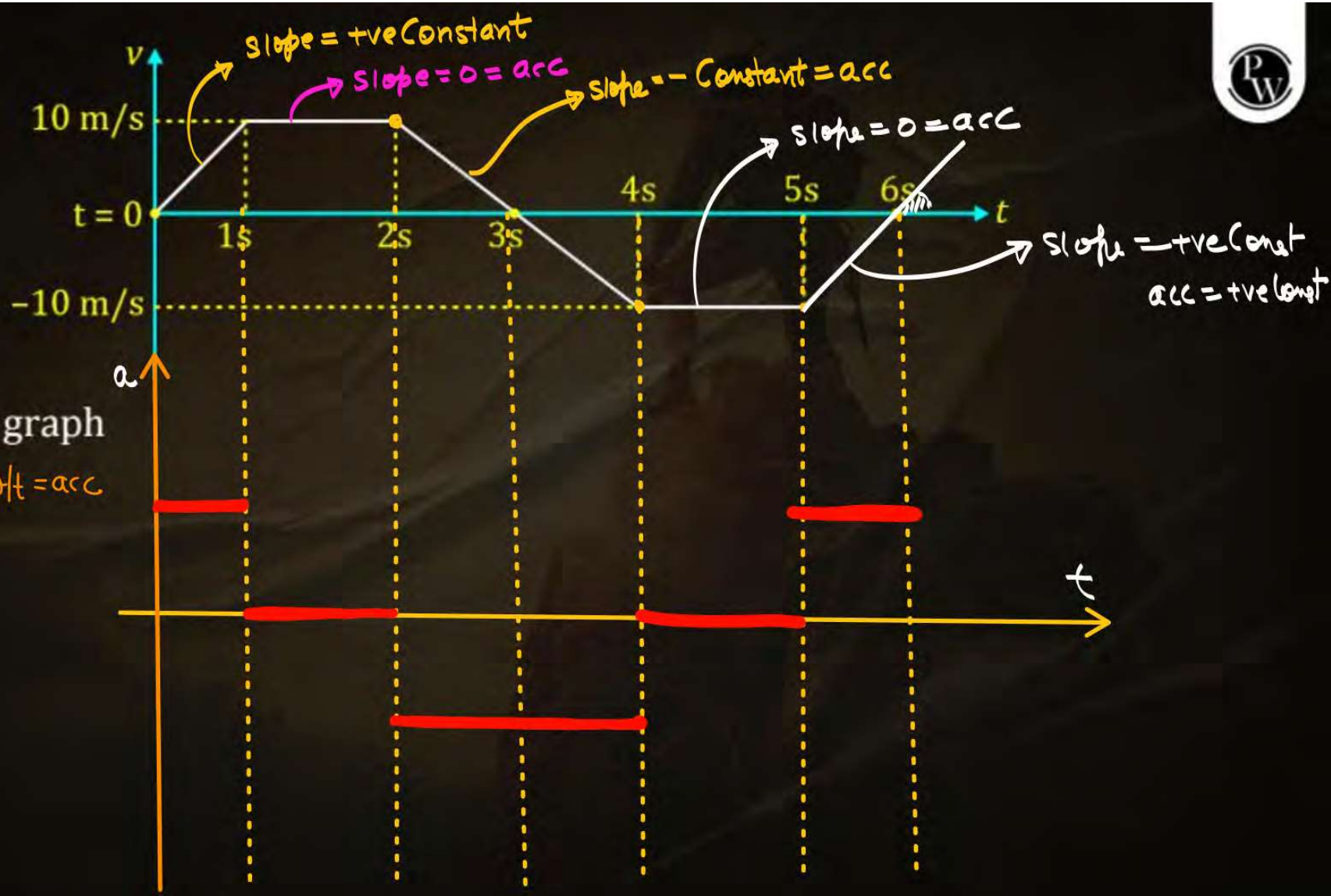
→ $\frac{20 - \frac{1}{2}\times 1\times 10}{4} = \frac{15}{4} = 3.75$.

(g) Average acceleration in $t = 1s$, $t = 5$ sec

avg acc = $\frac{\Delta V}{\Delta t}$. $a = \frac{10-0}{1} = 10$m/s².

→ avg acc = $\frac{\Delta V}{\Delta T} = \frac{-10-0}{5} = -2$m/s².

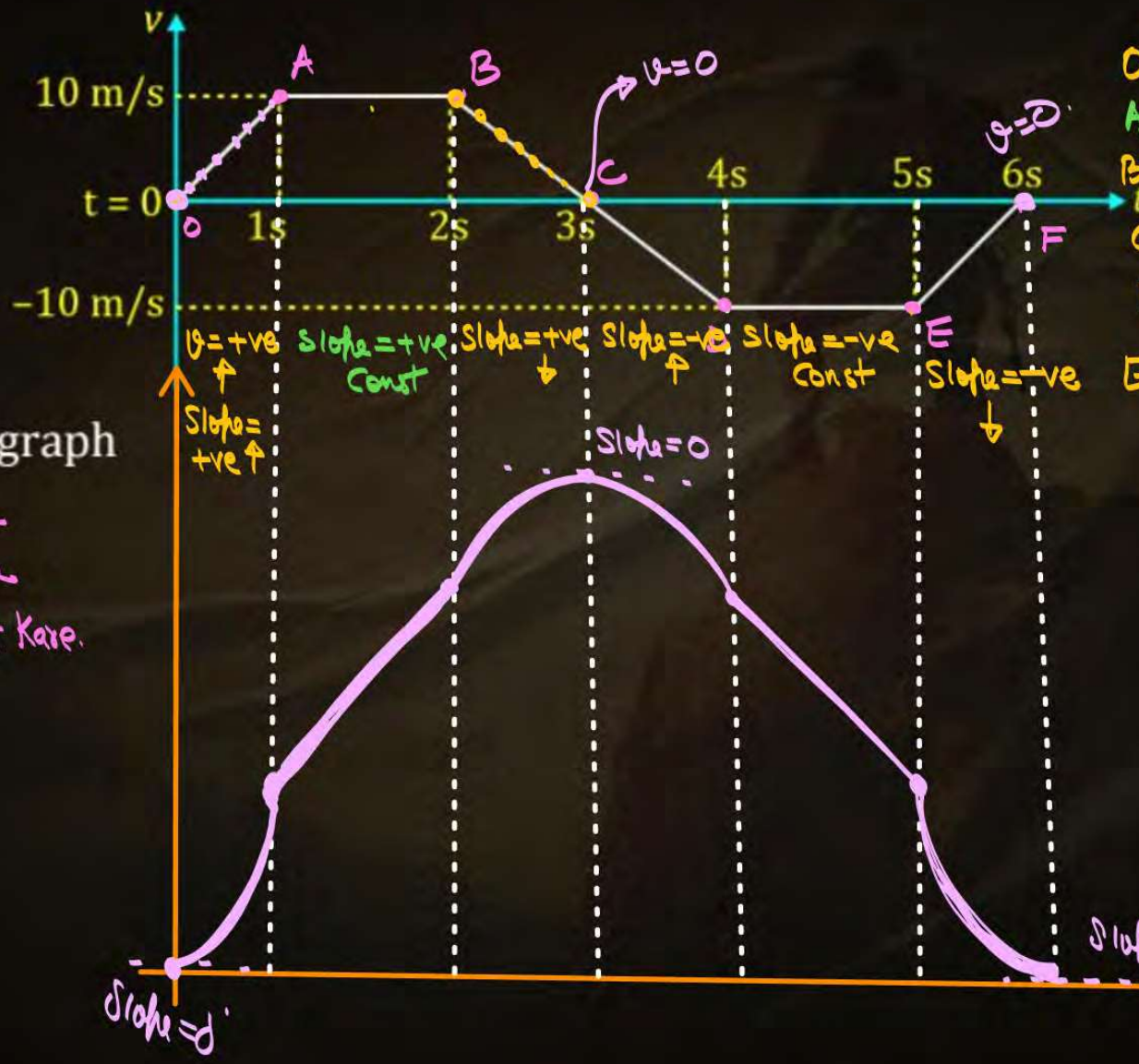
Question 40



(h) Draw a/t graph

Concept = Slope of v/t = acc

Question41



(i) Draw x/t graph

x/t Ka graph aisa banao Ki usKi slope velocity Ko re present Kare.

velocity

OA → v = +ve ↑

AB → v = + Const

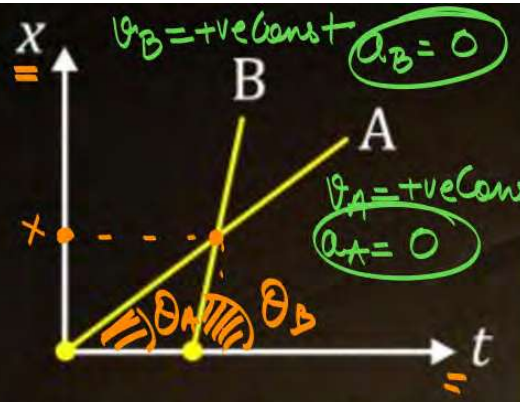
B → C → v = +ve ↓

C → D → v = −ve ↑

D → E → v = −ve Const.

E → F → v = −ve ↓

Question 42



Velocity = slope.

$\theta_B > \theta_A$

Slope$_B$ > Slope$_A$

v_B = +ve Const. $a_B = 0$

v_A = +ve Const. $a_A = 0$

- Which has more velocity. $v_B > v_A$ (B)
- Which has more acceleration.

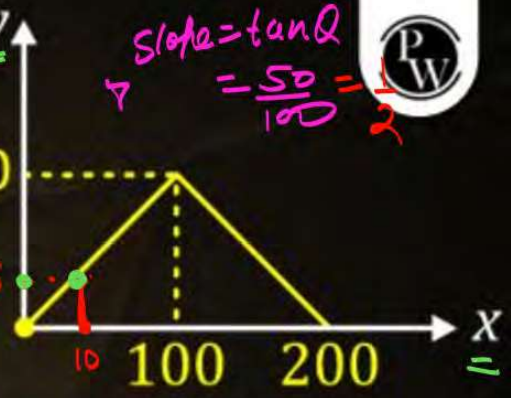
  Both acc = 0.
- Does they meet?

  Yes they meet once.

  (Position Same at Same time).

Question 43

Acceleration at $x = 10$ and $x = 150$m.



Slope = tanθ $= \frac{50}{100} = \frac{1}{2}$

$v = f(x)$

$a = v\left(\frac{dv}{dx}\right)$ or $y = mx + c = 0$

$v = \frac{1}{2}x$

$\frac{dv}{dx} = \frac{1}{2}$

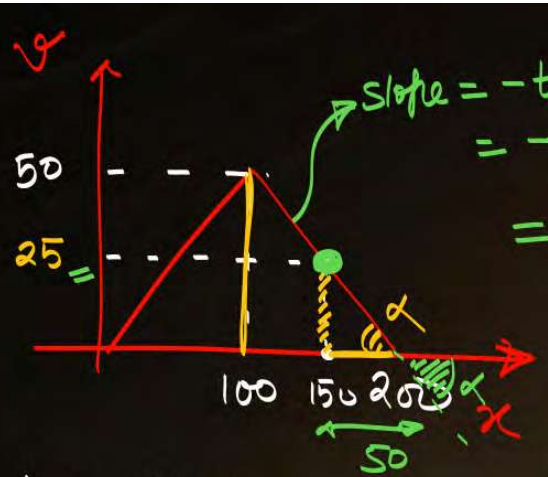
$v = \frac{10}{2} = 5$

acc at $x = 10$

$acc = 5\left(\frac{dv}{dx}\right)$

$= 5/2$.

acc = (velocity at that x)(Slope at that $\frac{1}{2}$)



slope $= -\tan\alpha$

$= -\frac{50}{100}$

$= -\frac{1}{2}$

$a = v\left(\frac{dv}{dx}\right) = 25\left(\frac{-1}{2}\right) = -12.5$

acc at $x = 150$ m.

$\tan\alpha = \frac{P}{50} = \frac{50}{100}$

$\frac{100}{2}$

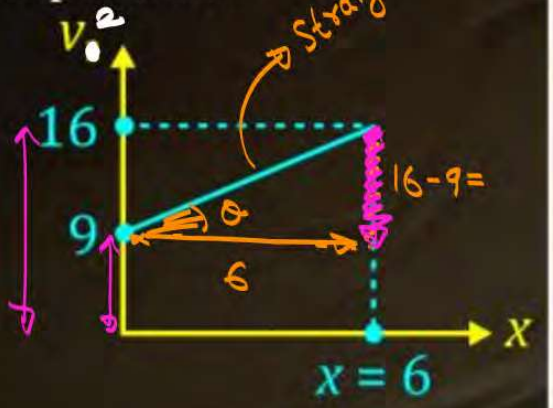
$P = 25$

Question44

Find acceleration of particle.

$y = mx + c$

$v^2 = \frac{7}{6}x + 9$



$\tan\theta = \frac{16-9}{6} = \frac{7}{6}$

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

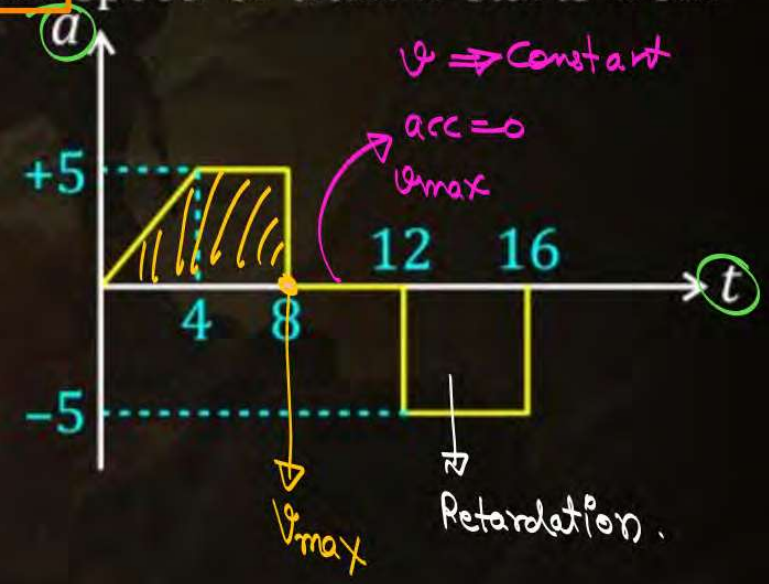
diff wrt x

$acc. \quad v\frac{dv}{dx} = \frac{7}{6}$

$acc = \frac{7}{12}$ Ans

Question 45

Find maximum speed of train if starts from rest?



$t = 0$

Rest

$a = +ve$

Speed ↑

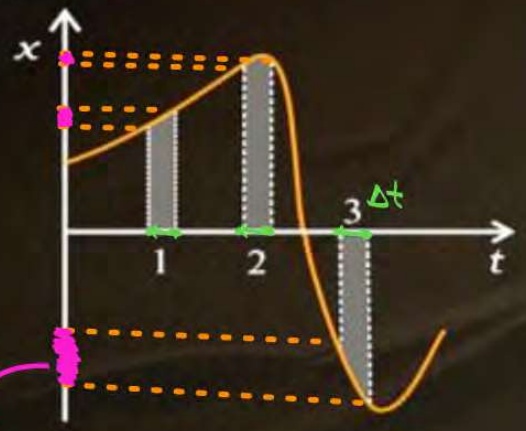
$v_2 - v_1 =$ area of a/t.

$v_{max} - 0 = \frac{1}{2}(8+4)\times 5$

Question 46

(NCERT)

If time interval is same. Which has greatest average speed.



Total distance / Total time

distance Max

③ is v_{max} avg speed.

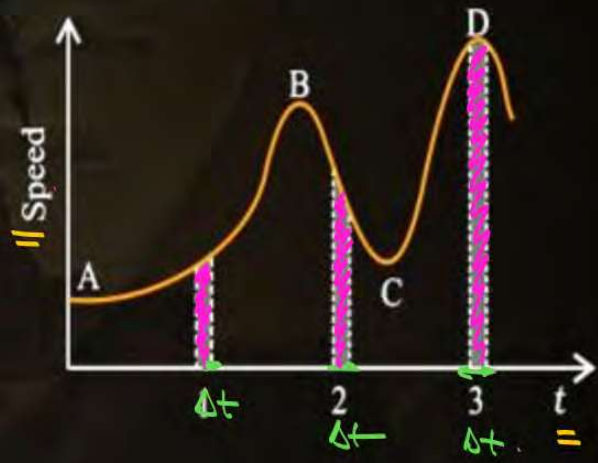
Question 47

(NCERT)

Area of speed x time ⇒ distance

Which has highest average speed?

Total distance / Total time



Area of 3 → Max

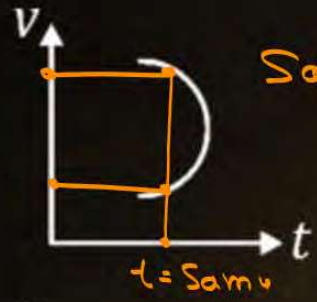
distance$_3$ → Max

Avg speed → Max.

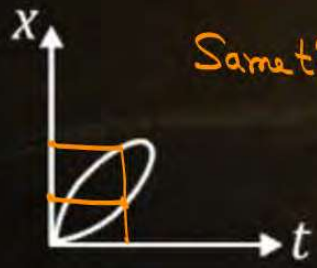
Question 48

Jo nahi banaye Ja Sakte.

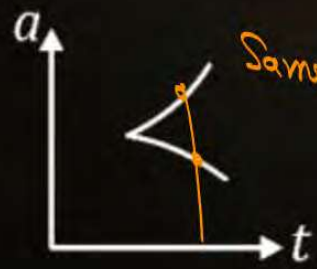
What are the reason for prohibited curves?

(a) 

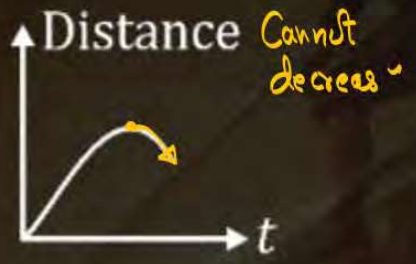
Same t → 2 velocity

(b) 

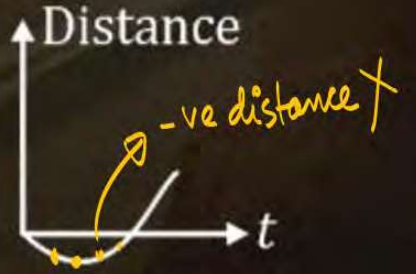
Same time → 2 positions ✗

(c) 

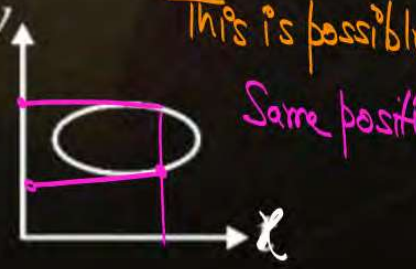
Same time 2 acc ✗

(d) 

Cannot decrease

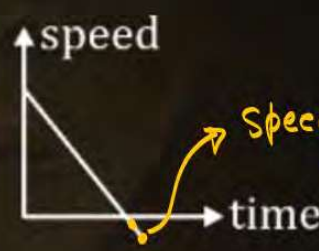
(e) 

-ve distance ✗

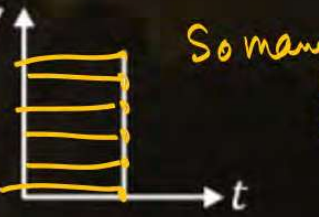
(f) 

This is possible.

Same position par 2 Vel ✓

(g) 

Speed = -ve
distance = -ve ✗

(h) 

So many velocity at same time.

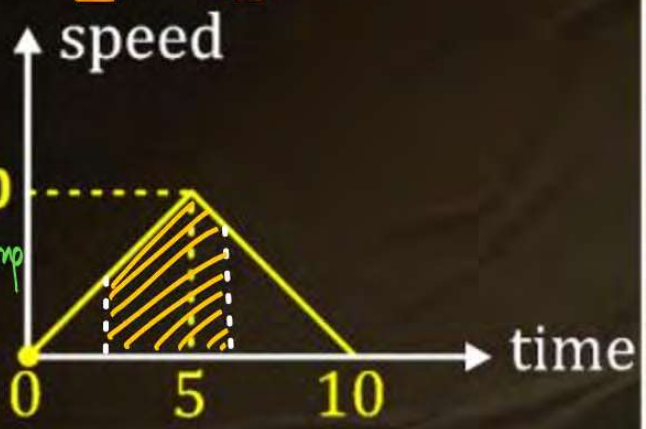
Question 49

Distance from $t = 2$ to $t = 6$.

Concept :=

Area of Speed/time

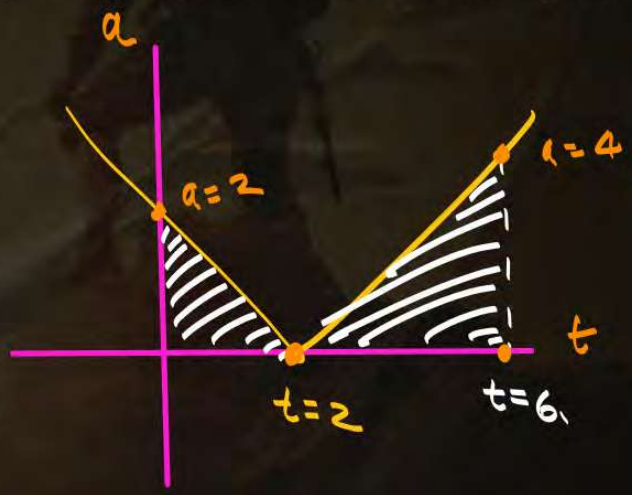
distance.



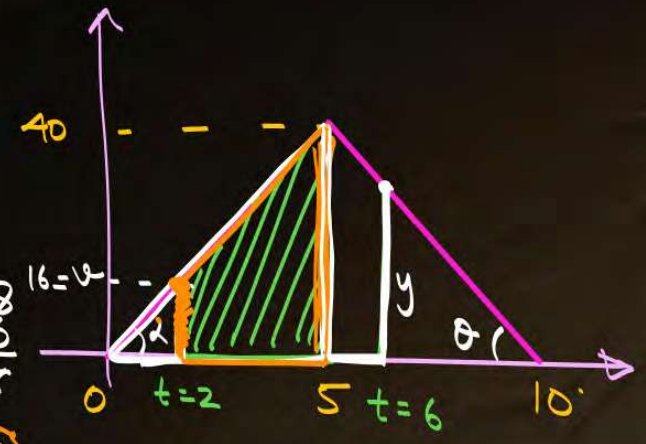
Question 50

$t=0$ $u=0$

If $a = |t - 2|$ m/s^2. Find velocity after 6 sec.



$v_f = \frac{1}{2} \times 2 \times 2 + \frac{1}{2} \times 4 \times 4 =$ ____



$\tan\alpha = \frac{P}{B} = \frac{v}{2} = \frac{40}{8}$

$= v = 16$

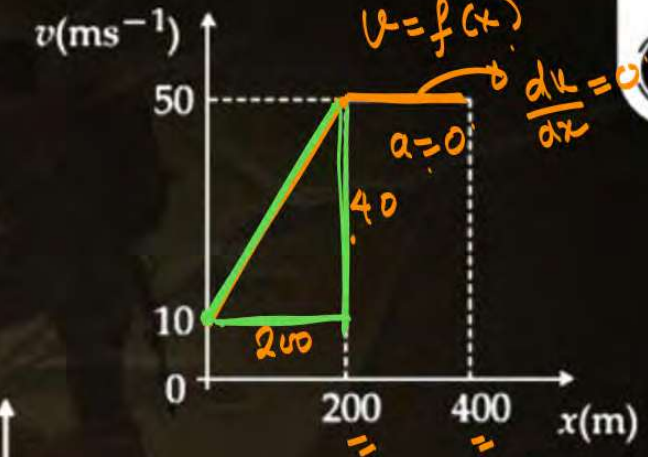
$\tan\theta = \frac{P}{B} = \frac{y}{4} = 8$

$y = 32$

distance $= \frac{1}{2} \times (16+40) \times 3 + \frac{1}{2}(40+32) \times 1 =$ Ans

Question 51

The velocity-displacement graph describing the motion of bicycle is shown in the figure. The acceleration-displacement graph of the bicycle's motion is best described by: **[JEE Main 2021]**



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

$= \left(\frac{x}{5}+10\right)\frac{1}{5}$

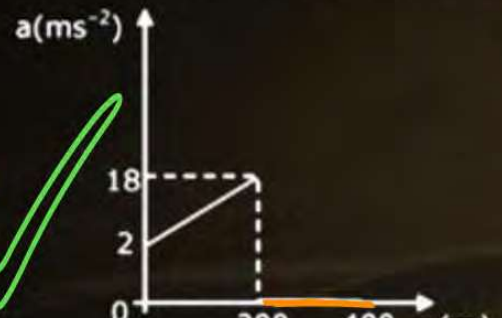
$a = \frac{x}{25} + 2$

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

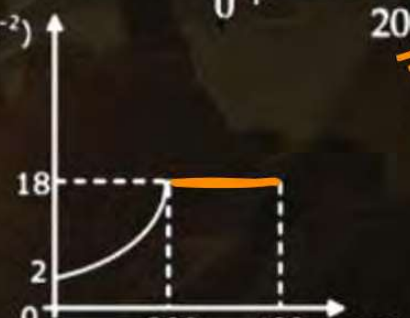
$y = mx + c$

$v = \frac{1}{5}x + 10$

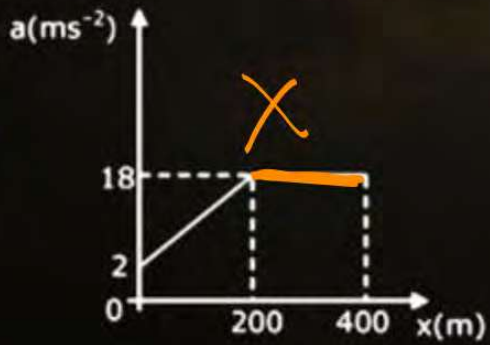
A ✓



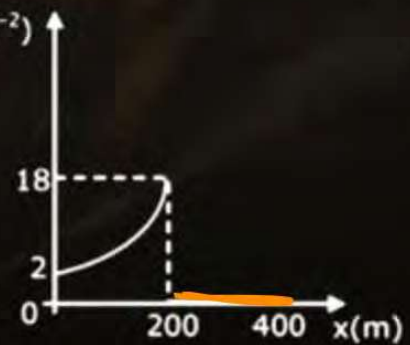
B ✗



C

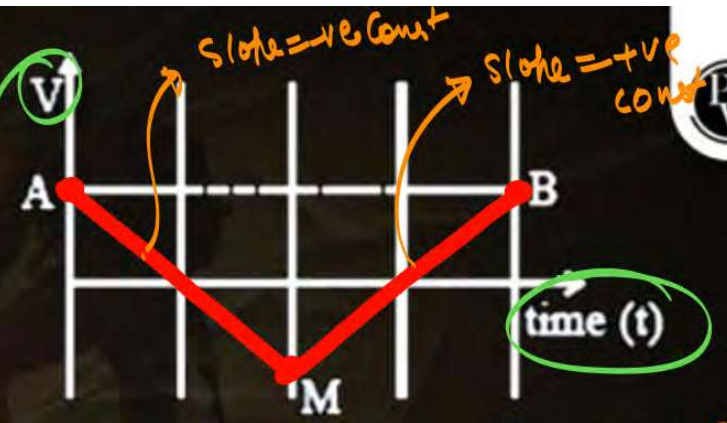


D



Question 52

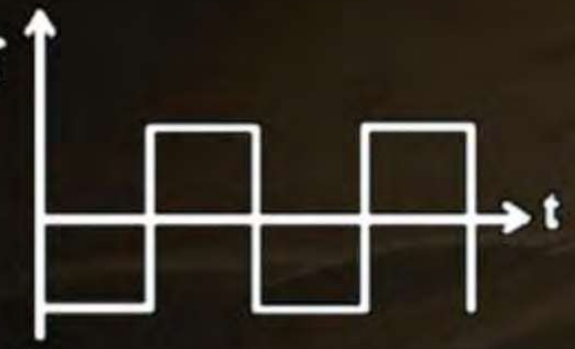
If the velocity-time graph has the shape has the shape AMB, what would be the shape of the corresponding acceleration-time graph? **[JEE Main 2021]**



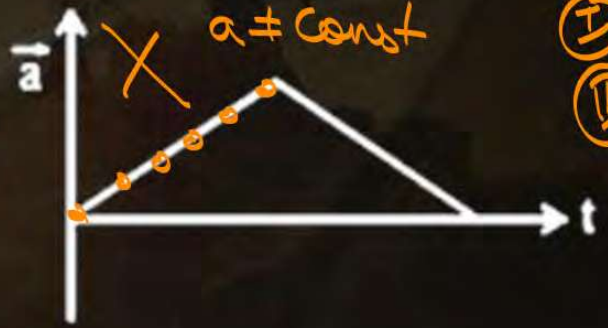
(I) a = -ve Const

(II) a = +ve Const

A

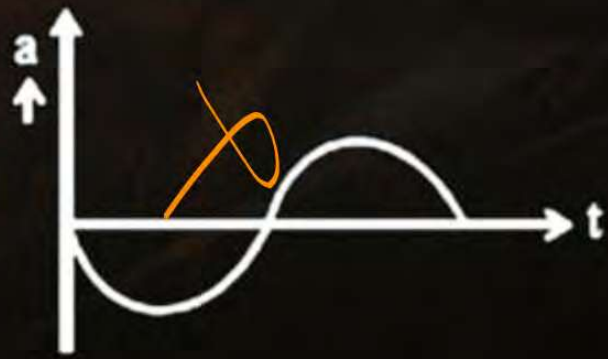


B



C

D

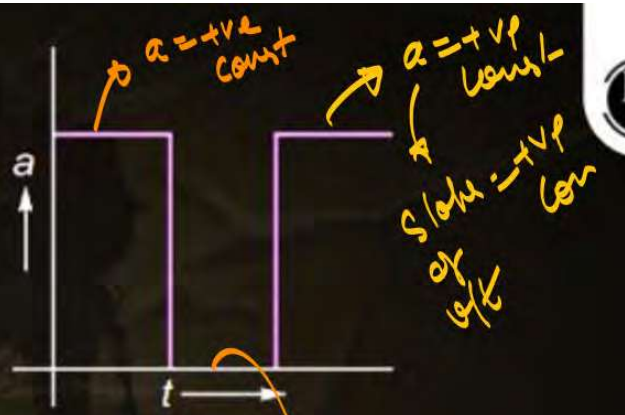


Question 53

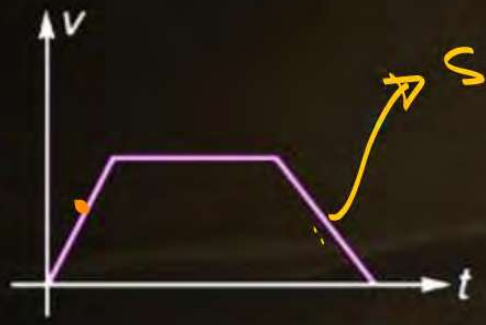
For the motion of a particle acceleration-time graph is shown in figure. The velocity time curve for the duration of 0-4 seconds is:

Question 54

Figure shows the acceleration-time graphs of a particle. Which of the following represents the corresponding velocity-time graphs

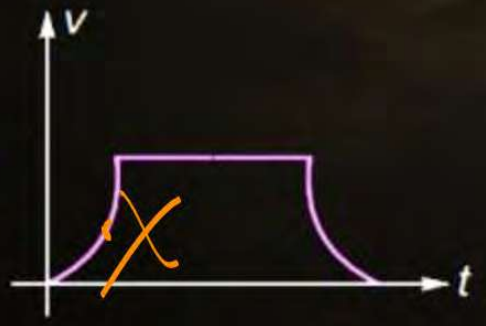


(A)

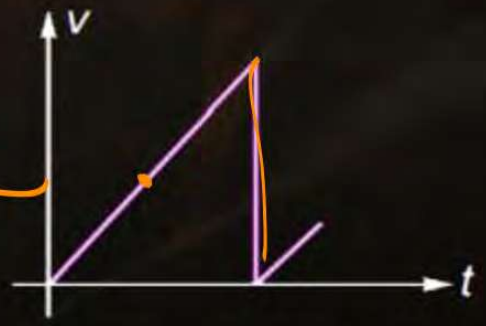


(B)

(C)



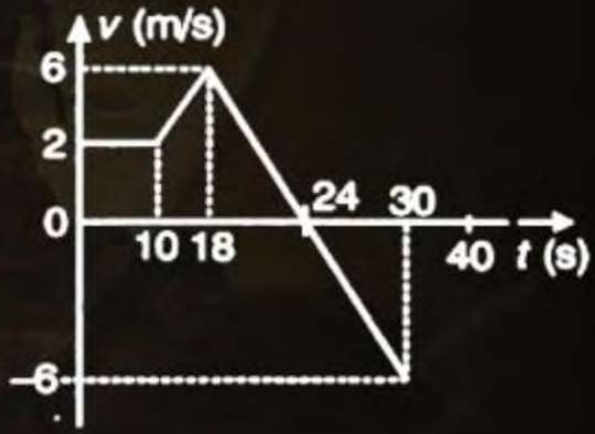
(D)



QUESTION 55 (Multiple)

HW

A particle moves in a straight line with the velocity as shown in figure. At $t = 0$, $x = -16$ m



A The maximum value of the position coordinate of the particle is 54 m

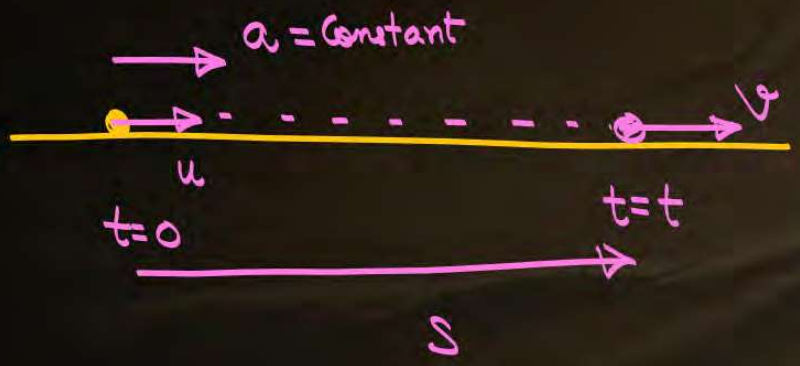
B The maximum value of the position coordinate of the particle is 36 m

C The particle is at the position of 36 m at $t = 18$ s

D The particle is at the position 36 m at $t = 30$ s

Kinematics Equation

If acceleration = Constant (+ve Const, -ve Const) (± direction of acceleration).



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

$$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$$

s → displacement

$v^2 - u^2 = 2as$ ⟹ Scalar Equation

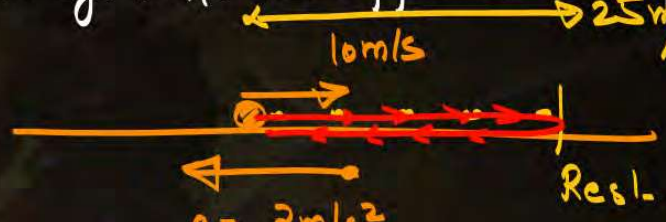
$$\vec{v}\cdot\vec{v} - \vec{u}\cdot\vec{u} = 2\vec{a}\cdot\vec{s}$$

displacement in n^{th} Second → dimensionally correct.

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

$$S_{n^{th}} = u(1s) + \frac{a}{2}(2n1s - 1s^2)$$

Ex A particle is moving with 10m/s in +x. If acc of $2m/s^2$ is applied in -ve direction for 10 sec.



① velocity at 10 sec, $v = u + at$

$v = 10 - 2\times10 = -10 m/s$ (-ve dir).

② Speed at 10 sec = |Just velocity| = 10m/s.

③ distance in 10 Sec. $S = ut + \frac{1}{2}at^2$

$= 10\times10 - \frac{1}{2}\times2\times10^2$

displacement = 0

Distance = 50m.

$V = u + at$

$0 = 10 - 2\times t$

$t = 5$

$S = ut + \frac{1}{2}at^2$ for 5 sec.

$= 10\times5 - \frac{1}{2}\times2\times25$

$= 25m$.

A particle moving with 10m/s (−x) is retarding with $2m/s^2$ find velocity after 2 sec.

Slow down.

Sol

$\vec{u} = -10\ m/s$

Retarding

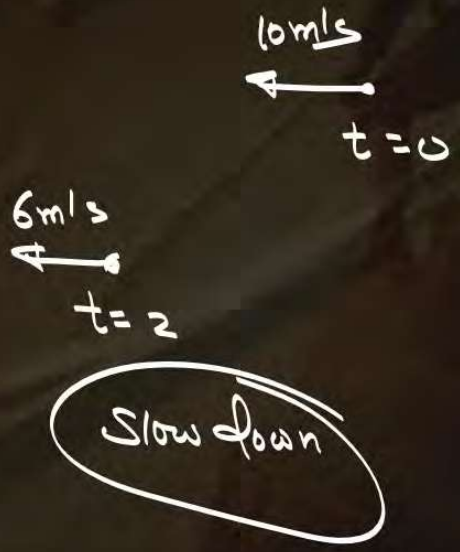
$a = +2\ m/s^2$

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

$\vec{v} = -10 + 2 \times 2$

$= -10 + 4$

$= -6$



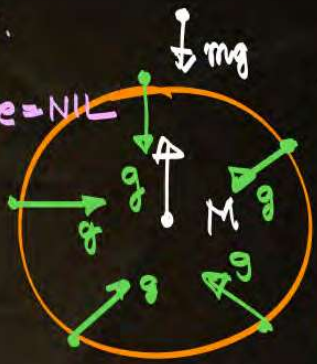
Retardation = a & v are anti parallel.

acceleration = a & v are ||ly.

Motion under gravity

→ Motion in Constant acceleration

assumptions = g = Constant.
air Resistance = NIL



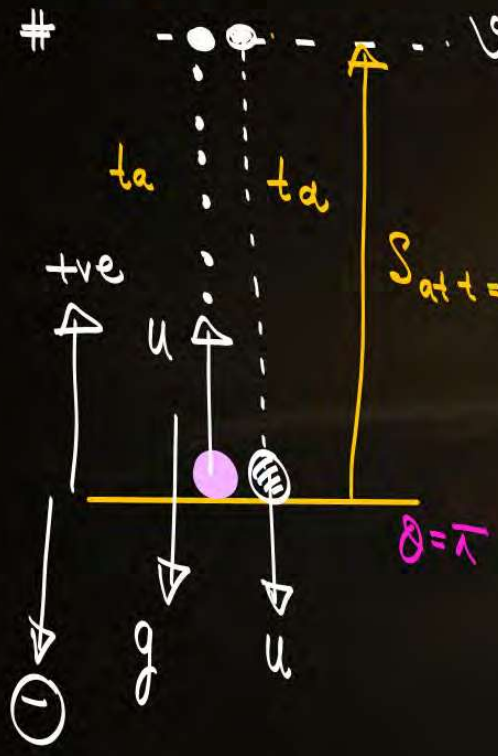
$f = \frac{GMm}{R^2} = mg$

$g = \frac{GM}{R^2}$

Earth Case

$g = 9.8\ m/s^2$

Ball up | down $acc = -g$



a) Time of flight.

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

$-u = +u - gT$

$-2u = -gT$

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

t_{ascent}

$v = u + at$

$0 = +u - gt_a$

$t_a = \frac{u}{g}$

$t_d = \frac{u}{g}$

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

$\vec{S} = 0$

$0 = +uT - \frac{1}{2}gT^2$

$0 = T\left(u - \frac{gT}{2}\right)$

$T = 0$

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

$H_{max} = ?$

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

$\vec{S}$ at $t = \frac{u}{g}$

$S = u\left(\frac{u}{g}\right) - \frac{1}{2}g\left(\frac{u}{g}\right)^2$

$S = \frac{u^2}{2g} = H_{max}$

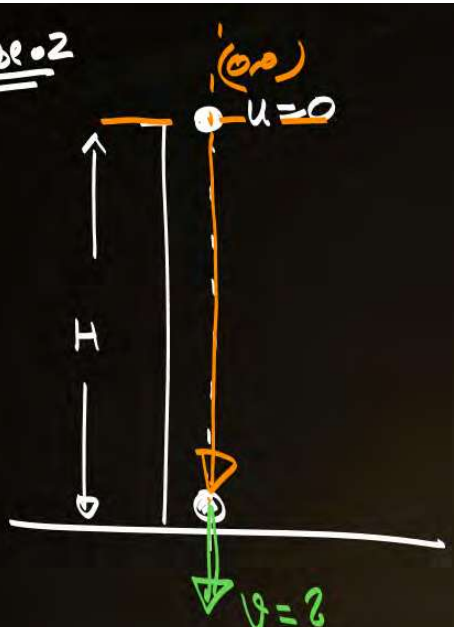
$v^2 - u^2 = 2\vec{a}\vec{s}$

$0^2 - u^2 = 2|a||s|\cos\theta$

$-u^2 = 2gH_{max}\cos\pi$

$\frac{u^2}{2g} = H_{max}$

Case-2



a) Time of flight :-

$$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$$

$$-h = -\frac{1}{2}gt^2$$

$$\sqrt{\frac{2h}{g}} = t$$

Vector Eqtn

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

$$v = 0 - g\sqrt{\frac{2H}{g}}$$

$$\boxed{v = -\sqrt{2gH}}$$

dir

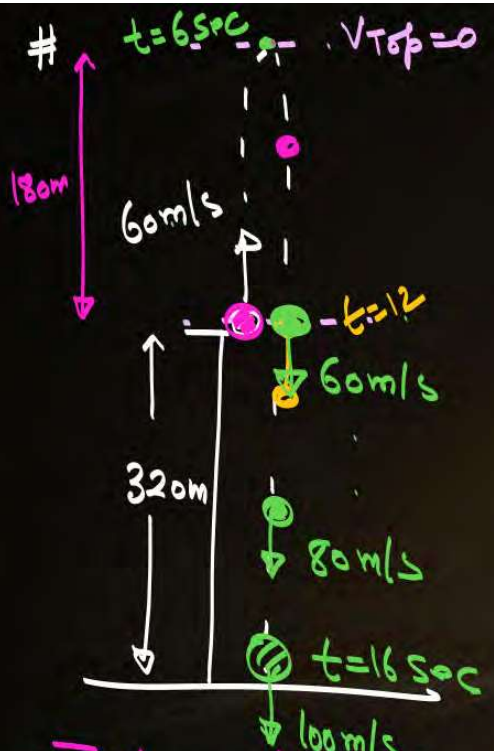
$$v^2 - u^2 = 2\vec{a}\vec{s}$$

$$v^2 = 2|g||H|\cos\theta$$

$$= 2gH\cos\theta$$

$$v = \sqrt{2gH}$$

#



$T = t_{upart} + t_{freeche}$

$= 6 + \sqrt{\frac{2\times 500}{10}}$

$6+10 = 16$ sec.

a) Time to Reach hmax $\Rightarrow \bar{V} = \bar{u} + \bar{a}t \Rightarrow 0 = +60 - 10t$ $\boxed{t = 6\text{ sec}}$

b) Max height from Ground. $\bar{S} = \bar{u}t + \frac{1}{2}\bar{a}t^2 \Rightarrow S = +60\times 6 - \frac{1}{2}\times 10\times 6^2$

$= 360 - 180 = 180$m.

c) Time to Reach ground $S = ut + \frac{1}{2}at^2$

$\boxed{-320 = +60\times T - \frac{1}{2}\times 10T^2}$

ground 320
180
500

$T = 16$ sec.

d) Velocity with which it hits ground. $\rightarrow \bar{V} = \bar{u} + \bar{a}t \Rightarrow V = +60 - 10\times 16$

$= 60 - 160 = -100$ m/s

e) displacement at 10 sec $\rightarrow S = ut + \frac{1}{2}at^2 \Rightarrow +60\times 10 - \frac{1}{2}\times 10\times 10^2 =$

f) Velocity at 14 sec.

$V = u + at$

$= +60 - 10\times 14 = -80$ m/s.

QUESTION 56

A particle start moving from rest state along a straight line under the action of a constant acceleration and travel distance x in first 5 seconds. The distance travelled by it in next five seconds will be

A. x

B. $2x$

C. $3x$ Ans

D. $4x$

$t \to 0 \to t = 5$

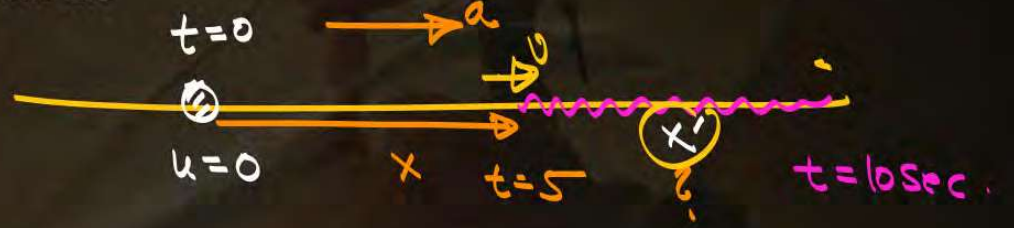
$S = ut + \frac{1}{2}at^2$

$x = \frac{1}{2}a(5)^2$

$t \to 0 \to 10s$

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

$x + x' = \frac{1}{2}a(10)^2$



$$\frac{x+x'}{x} = \frac{\frac{1}{2}a(100)}{\frac{1}{2}a(25)}$$

$$\frac{x+x'}{x} = 4$$

$$1 + \frac{x'}{x} = 4$$

$x' = 3x$

QUESTION 57

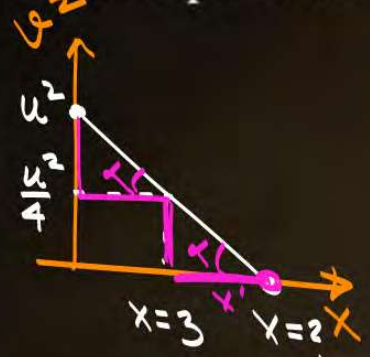
If a body loses half of its velocity on penetrating 3 cm in a wooden block, then how much will it penetrate more before coming to rest ?

A. 1 cm

B. 2 cm

C. 3 cm

D. 4 cm



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

$\left(\frac{u}{2}\right)^2 - u^2 = -2a(3)$

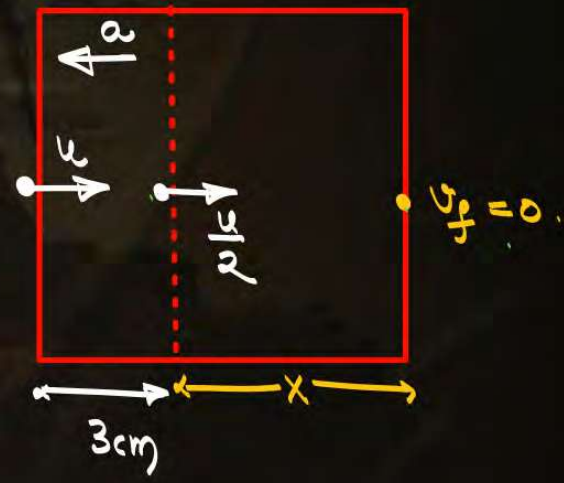
$0^2 - \left(\frac{u}{2}\right)^2 = -2aX$

$\frac{\frac{3u^2}{4}}{3} = \frac{\frac{u^2}{4}}{x'}$

$x' = 1$

$\frac{-\frac{3u^2}{4}}{-\frac{u^2}{4}} = \frac{3}{X}$

$X = 1$



PYQ

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

$u = 0$ $\quad S_n = un + \frac{1}{2}an^2 = \frac{an^2}{2}$.

QUESTION 58

A body starts from rest and moves with a constant acceleration. The ratio of distance covered in the n^{th} second to the distance covered in n second is

Ans

(A) $\frac{2}{n} - \frac{1}{n^2}$

(B) $\frac{1}{n^2} - \frac{1}{n}$

(C) $\frac{2}{n^2} - \frac{1}{n}$

(D) $\frac{2}{n} + \frac{1}{n^2}$

$\frac{S_{nth}}{S_n} = \frac{\frac{a}{2}(2n-1)}{\frac{1}{2}an^2} = \frac{2n-1}{n^2} = \frac{2}{n} - \frac{1}{n^2}$.

QUESTION 59

A particle is moving along straight line with constants acceleration of $-2\ m/s^2$ passes through A on a line with 4 m/s at some moment. Find distance travelled by particle in 5 sec after that moment.

A. 5m

B. 13m

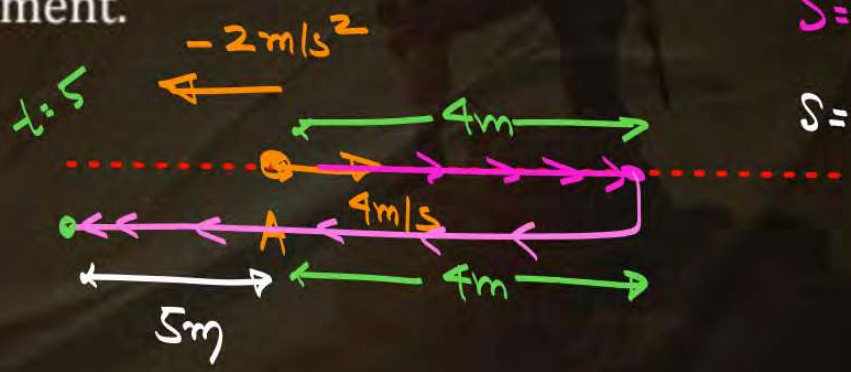
C. 9m

D. 4m

$V = u + at$

$0 = +4 - 2 \times t$

$t = 2$



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

$S = 4 \times 5 - \frac{1}{2} \times 2 \times 25$

$= 20 - 25 = -5$

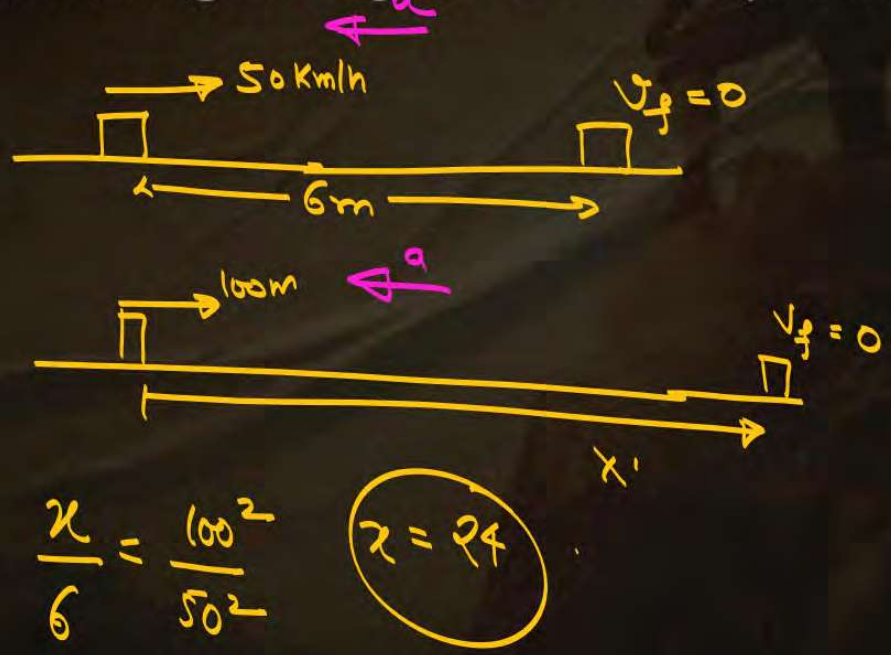
So in $t = 2$

$S = ut + \frac{1}{2}at^2 = 4 \times 2 - \frac{1}{2} \times 2 \times 2^2$

$= 8 - 4 = 4m$

QUESTION 60

A car, moving with a speed of 50 km/hr, can be stopped by brakes after at least 6 m. If the same car is moving at a speed of 100 km/hr, the minimum stopping distance is [2003]



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

$+u^2 = +2ax$

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

$\frac{x}{6} = \frac{100^2}{50^2}$ $x = 24$

(A) 12 m

(B) 18 m

(C) 24 m

Ans

(D) 6 m

QUESTION 61

4 times

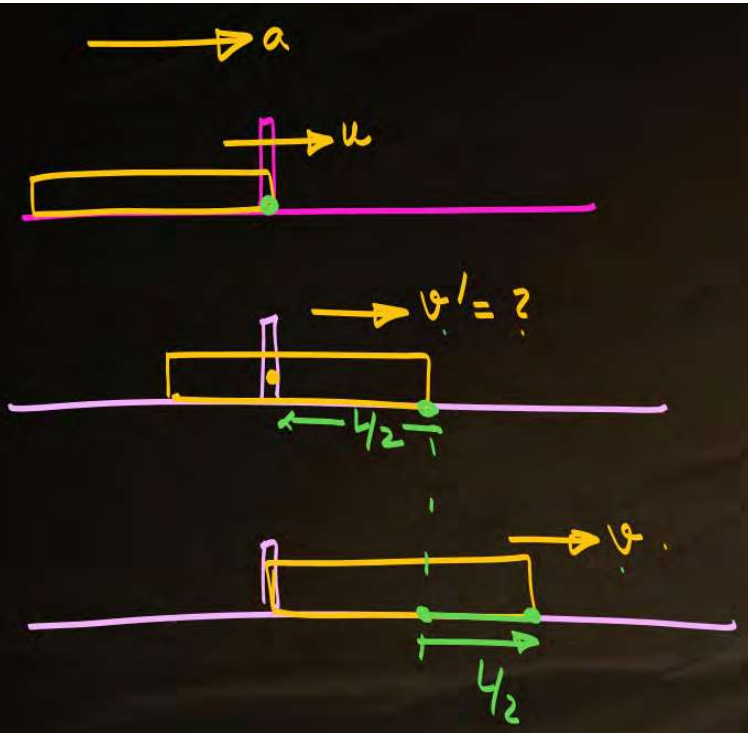
An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is: [JEE (Main)- 2021]

A $\sqrt{\frac{v^2 - u^2}{2}}$

B $\frac{v - u}{2}$

C $\sqrt{\frac{v^2 + u^2}{2}}$

D $\frac{u - v}{2}$



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

$v'^2 - u^2 = 2a\left(\frac{L}{2}\right)$

$v^2 - v'^2 = 2a\left(\frac{L}{2}\right)$

$v'^2 - u^2 = v^2 - v'^2$

$2v'^2 = v^2 + u^2$

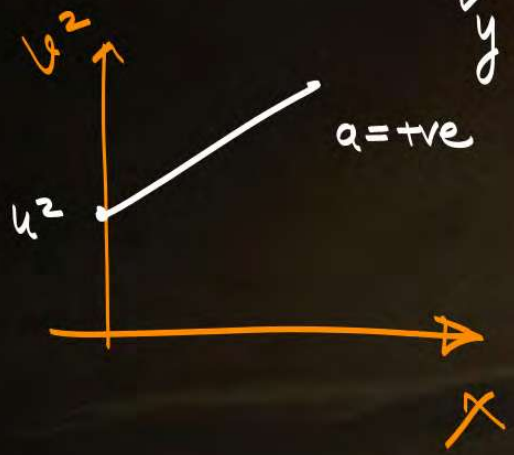
$$v' = \sqrt{\frac{v^2 + u^2}{2}}$$

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

$v^2 = u^2 + 2ax$

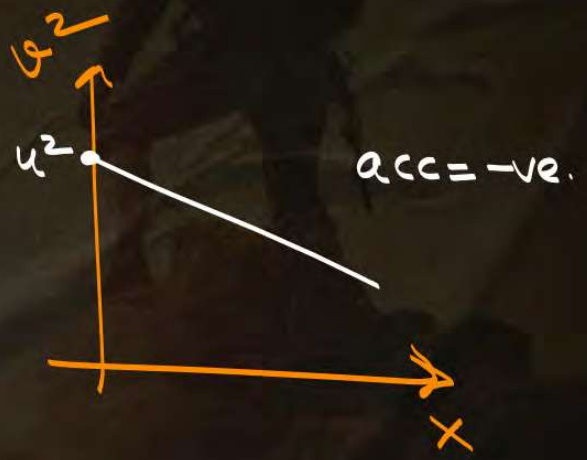
$\Downarrow$

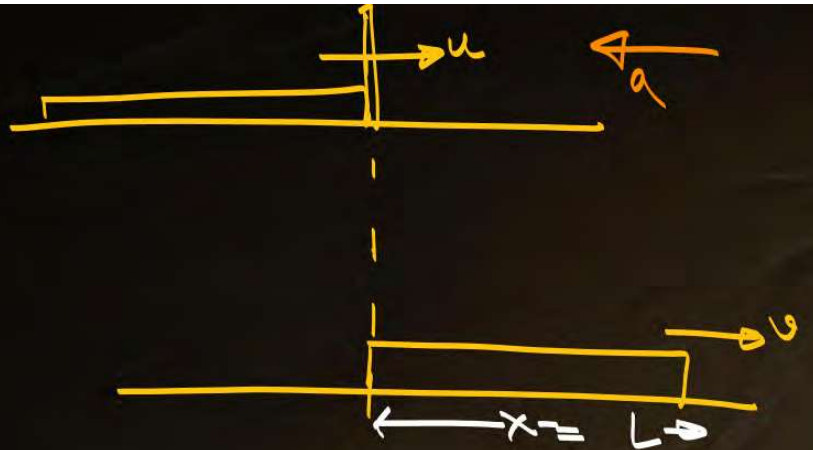
$y = c + mx$

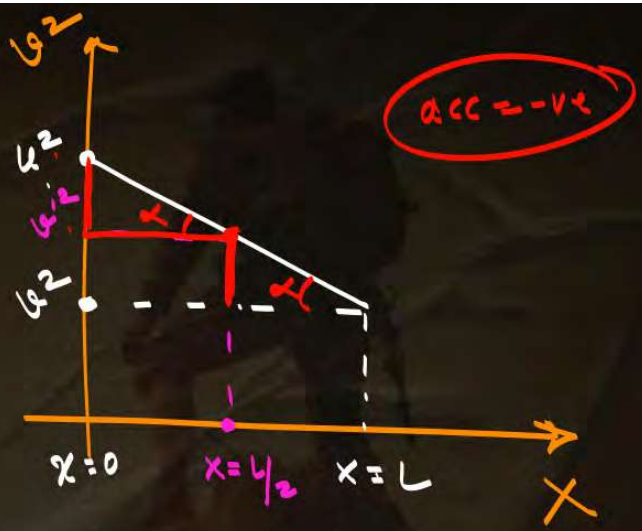


Slope = 2a

Intercept = C







$$\frac{u^2 - v'^2}{L/2} = \frac{v'^2 - v^2}{L/2}$$

QUESTION 62

A train accelerating uniformly from rest attains a maximum speed of 40 ms^{-1} in 20 s. It travels at this speed for 20 s and is brough to rest with uniform retardation in further 40 s. What is the average velocity during this period?

A. 80/3 ms^{-1}

B. 25 ms^{-1}

C. 40 ms^{-1}

D. 30 ms^{-1}

$\frac{2000}{80} = \frac{\text{Total disp}}{\text{Total time}}$.

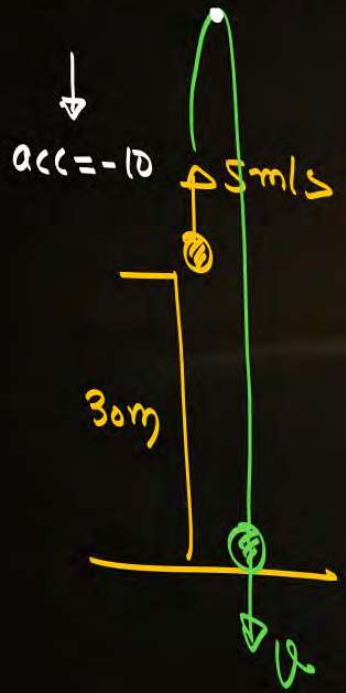
$\text{disp} = \frac{1}{2}(20+80)\times 40$

QUESTION 63

A driver takes 0.20 s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of 6.0 m/s^2, find the distance travelled by the car after he sees the need to put the brakes on.

QUESTION 64

A ball is projected vertically upward from tower with speed 5 m/s from 30 m high tower. Find time of flight of motion. Also find velocity with which it hits the ground.



$\tan\alpha = \frac{P}{B}$

$10 = \frac{5}{t}$

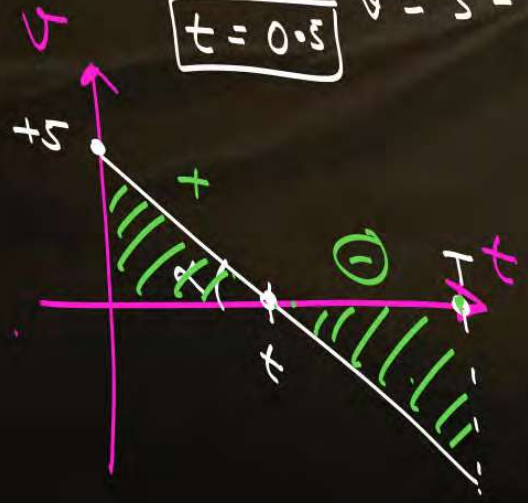
$t = 0.5$

Time of flight = $S = ut + \frac{1}{2}at^2$

$V = u + at$

$V = 5 - 10 \times 3$

$V = 5 - 30 = -25$



$-30 = +5T - \frac{1}{2} \times 10 T^2$

$-30 = 5T - 5T^2$

$-6 = T - T^2$

$T^2 - T - 6 = 0$

$T = 3$

QUESTION 65

A stone thrown with a speed u from the top of the tower reaches. The ground with velocity $3u$. The time of flight and height of tower

Case.1

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

$-3u = +u - gT$

$\frac{-4u}{-g} = T$

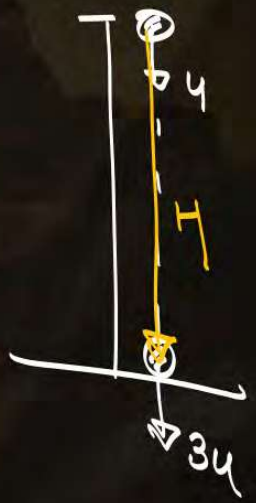
$T = \frac{4u}{g}$

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

$-H = -u\left(\frac{2u}{g}\right) - \frac{1}{2} \times g\left(\frac{2u}{g}\right)^2$

$-H = -ve$

Case.2



$V = u + at$

$-3u = -u - gT$

$+\frac{2u}{+g} = T$

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

QUESTION 66

Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8 m. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop from the floor when the first drop strikes the floor. **[JEE (Main)-2021]**

A 2.45 m

B 7.35 m

C 2.94 m

D 4.18 m

QUESTION 67

A ball is dropped from a bridge 122.5 m above a river. After the ball has been falling for 2 sec, a second ball is thrown straight down after it. What must be the initial velocity of second ball be so that both hit the water at the same time? ($g = 9.8\ m/s^2$)

A 49 m/s

B 55.5 m/s

C 26.1 m/s

D 9.8 m/s

QUESTION 68

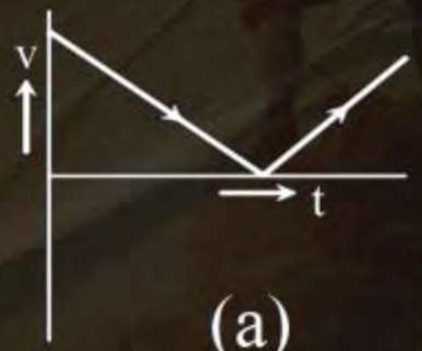
A ball is thrown vertically upwards. Which of the following graph/graphs represent velocity-time graph of the ball during its flight (air resistance is neglected)

A (a)

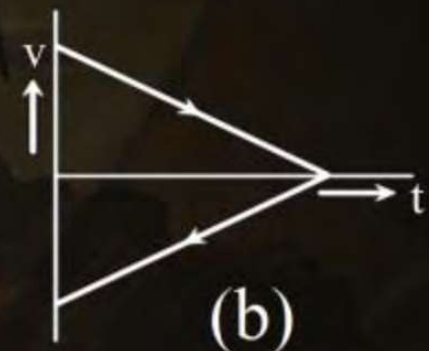
B (b)

C (c)

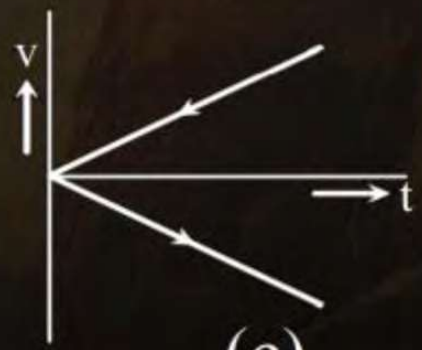
D (d)



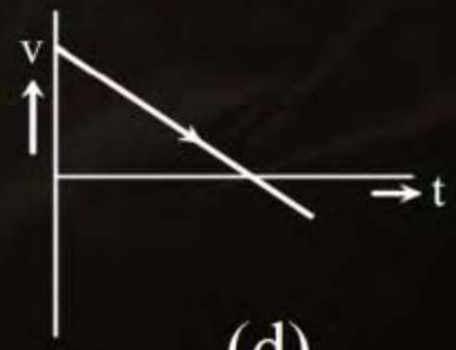
(a)



(b)



(c)



(d)

QUESTION 69

From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is

A $2gH = n^2u^2$

B $gH = (n-2)2u^2$

C $2gH = nu^2\,(n-2)$

D $gH = (n-2)\,u^2$

QUESTION 70

A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around (take the value of g as 10 m/s^2) **[JEE (Main)-2021]**

A 250 m

B 125 m

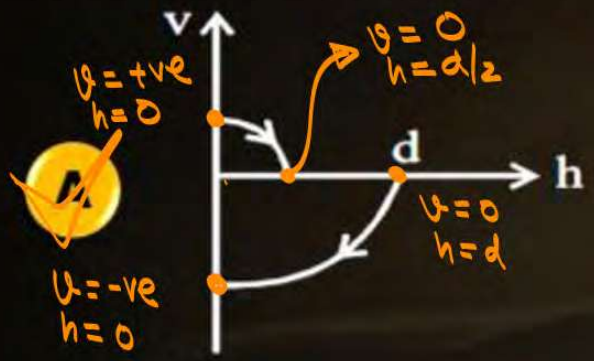
C 300 m

D 200 m

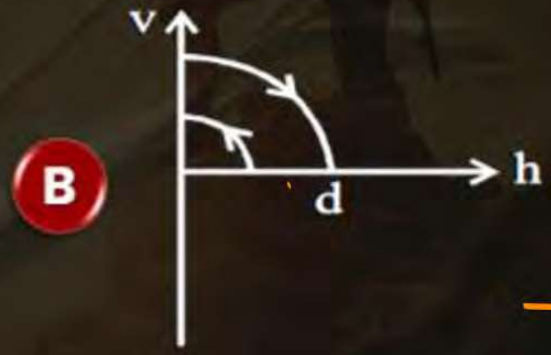
QUESTION 71

Adv

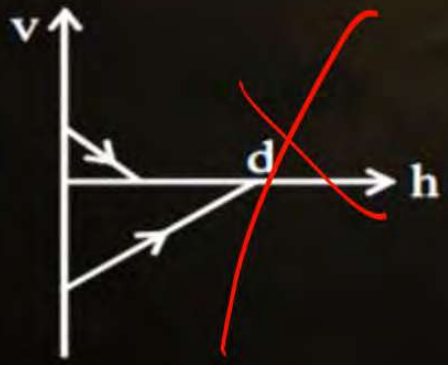
A ball is dropped vertically from a height d above the ground. it hits the ground and bounces up vertically to a height $d/2$. neglecting subsequent motion and air resistance, its velocity v varies with height h above the ground is



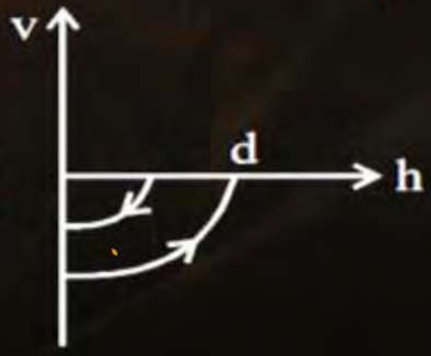
A



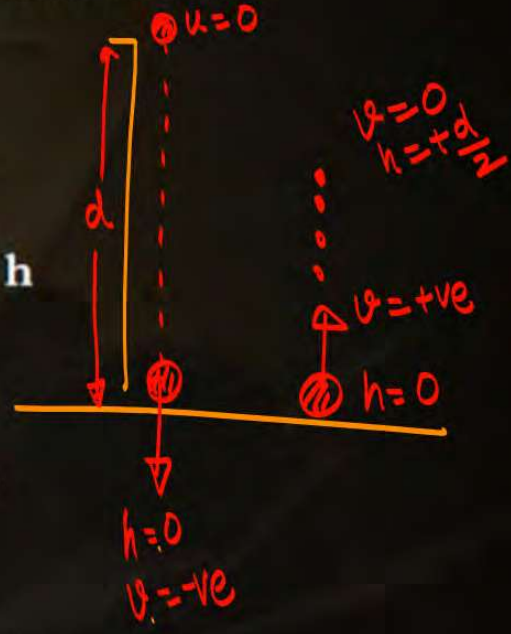
B



C



D



QUESTION- 72 (Level up)

(JEE Mains)

A ball is thrown upward with an initial velocity v_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma v^2$ (where, m is mass of the ball, v is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its zenith is

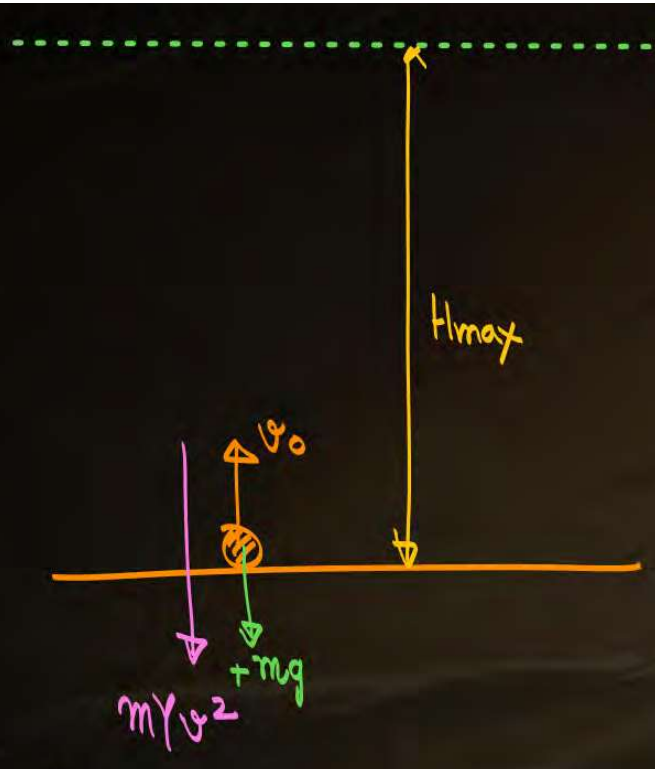
Tufa point

A $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}v_0\right)$

B $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}v_0\right)$

C $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}v_0\right)$

D $\frac{1}{\sqrt{\gamma g}}\ln\left(1+\sqrt{\frac{\gamma}{g}}v_0\right)$



$$f_{net} = -(m\gamma v^2 + mg)$$

$$a_{net} = -(\gamma v^2 + g)$$

$$\frac{dv}{dt} = -(\gamma v^2 + g)$$

$$\int_{v_0}^{0} \frac{dv}{\gamma v^2 + g} = -\int_0^T dt$$

$$\frac{1}{\gamma}\int_{v_0}^{0} \frac{dv}{\frac{g}{\gamma} + v^2} = -\int_0^T dt$$

$$\int_{v_0}^{0} \frac{dv}{\left(\sqrt{\frac{g}{\gamma}}\right)^2 + v^2} = -\gamma\int_0^T dt$$

$$\frac{1}{\sqrt{g\gamma}}\left[\tan^{-1}\frac{v}{\sqrt{g\gamma}}\right]_{v_0}^{0} = -\gamma T$$

$$\int \frac{dx}{a^2+x^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$$

$$a_{net} = -(\gamma v^2 + g)$$

$$v\frac{dv}{dx} = -(\gamma v^2 + g)$$

$$\int_{v_0}^{0} \frac{v\,dv}{(\gamma v^2 + g)} = \int_{0}^{H_{max}} -dx$$

$$\gamma v^2 + g = t$$

$$\gamma(2v\,dv) = dt$$

$$v\,dv = \frac{dt}{2\gamma}$$

QUESTION 73

A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is

[JEE (Main)- 2021]

A 35 m

B 45 m

C 25 m

D 50 m

QUESTION 74

If a body travels half its total path in the last second of its fall from rest, find the time and height of its fall. Take $g = 10\ \text{m/s}^2$

QUESTION 75

A ball is thrown vertically upwards from the ground. It crosses a point at the height of 25 m twice at an interval of 4 sec. The ball was thrown with the velocity of

A. 20 m/sec

B. 25 m/sec

C. 30 m/sec

D. 35 m/sec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