

Question

The maximum and minimum magnitudes of the resultant of two forces are 35 N and 5 N respectively. Find the magnitude of resultant force when act orthogonally (Perpendicularly) to each other.

$$\begin{aligned} A + B &= 35 \\ A - B &= 5 \end{aligned}$$

$$\begin{aligned} A &= 20 \\ B &= 15 \end{aligned}$$

$$Ans = \sqrt{20^2 + (5)^2} = 5 \times 5 = 25$$

Question



Two equal forces (P each) act at a point inclined to each other at an angle of 120° .
The magnitude of their resultant is

$$= \sqrt{P^2 + P^2 + 2 \cdot P \cdot P \cdot \cos 120^\circ}$$

A $\frac{P}{2}$

B $\frac{P}{4}$

C P

D $2P$

Ans : (C)

Question



Maximum and minimum magnitudes of the resultant of two vectors of magnitudes P and Q are in the ratio 3 : 1. Which of the following relations is true?

A

$$P = 2Q$$

B

$$P = Q$$

C

$$PQ = 1$$

D

None of these

$$\frac{P+Q}{P-Q} = \frac{3}{1}$$

$$P + Q = 3P - 3Q$$

$$4Q = 2P$$

$$P = 2Q$$

Ans : (A)

Question



For the resultant of the two vectors to be maximum, what must be the angle between them

- A 0°
- B 60°
- C 90°
- D 180°

Ans : (A)

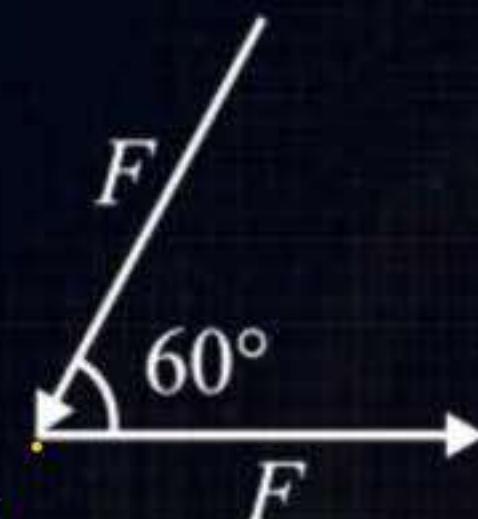
Question

Two forces, each numerically equal to 5 N, are acting as shown in the figure. Then the resultant is

- A 2.5 N
- B 5 N
- C $5\sqrt{3}\text{ N}$
- D 10 N

~~$$\begin{aligned} F_{\text{net}} &= \sqrt{5^2 + 5^2 + 2 \times 5 \times 5 \cos 60^\circ} \\ &= \sqrt{25 + 25 + 25} = 5\sqrt{3} \end{aligned}$$~~

$$\begin{aligned} F_{\text{net}} &= \sqrt{5^2 + 5^2 + 2 \times 5 \times 5 \cos 120^\circ} \\ &= 5 \end{aligned}$$



(B)

Ans : (C)

Question

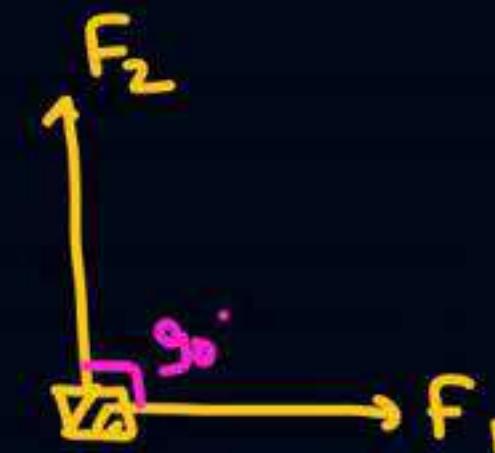
Force F_1 and F_2 act on a point mass in two mutually perpendicular directions. The resultant force on the point mass will be

A $F_1 + F_2$

B $F_1 - F_2$

C $\sqrt{F_1^2 + F_2^2}$

D $F_1^2 + F_2^2$



Ans : (C)

Question

Class Notes

The sum of magnitude of two force \vec{A} and \vec{B} acting at a point is 16 N. If their resultant has magnitude 8 N and direction of resultant is perpendicular to \vec{A} . Find Magnitude of \vec{A} and \vec{B} .

- A 6 N and 10 N
- B 8 N and 8 N
- C 4 N and 12 N
- D 2 N and 14 N

Ans : (A)

Question



The vector sum of the forces of 10 newton and 6 newton can be:

A

2 N



B

8 N



C

18 N



D

20 N



$$C_{\max} = 10 + 6 = 16$$

$$C_{\min} = 10 - 6 = 4$$

$$4 < C < 16$$

Ans : (B)

Question

Which of the following pair of forces will ~~never~~ give a resultant force of 2 N?

A 2 N and 2 N

$$0 \leq C \leq 4$$

B 1 N and 1 N

$$0 \leq C \leq 2$$

C 1 N and 3 N

$$2 \leq C \leq 4$$

D 1 N and 4 N

$$3 \leq C \leq 5$$

~~ans not~~

Ans D

Ans : (D)

Question



If three forces $\vec{F}_1 = \underline{3i} - 4\hat{j} + 5\hat{k}$, $\vec{F}_2 = \underline{-3i} + 4\hat{j}$.and $\vec{F}_3 = 5\hat{k}$ are acted on a body, then the direction of resultant force on the body is:

A Along x-axis

$$\vec{F}_{net} = 0\hat{i} + 0\hat{j} + 10\hat{k}$$

B Along y-axis

$$\vec{F}_{net} = 10\hat{k}$$

C Along z-axis

D In indeterminate form

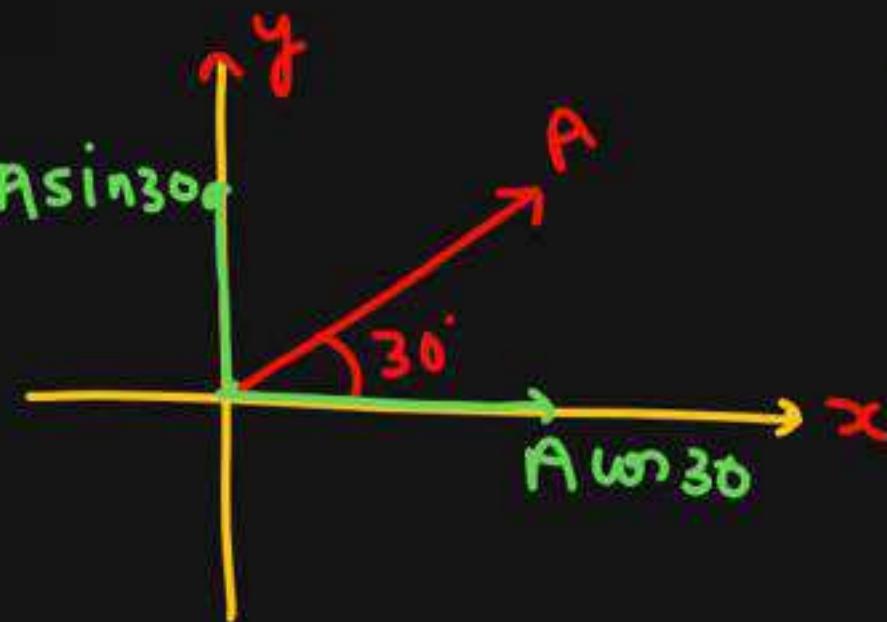
Ans. (C)

Question



A vector lying in x-y plane has a magnitude $\underline{3}$, and makes an angle 30° with the x-axis. Find its components along X axis and Y axis respectively.

- A $\frac{3}{2}, \frac{\sqrt{3}}{2}$
- B $\frac{3}{2}, \frac{3\sqrt{3}}{2}$
- C $\frac{\sqrt{3}}{2}, \frac{3}{2}$
- D $\frac{3\sqrt{3}}{2}, \frac{3}{2}$



$$\begin{aligned}\vec{A} &= 3 \cos 30 \hat{i} + 3 \sin 30 \hat{j} \\ &= 3 \frac{\sqrt{3}}{2} \hat{i} + \frac{3}{2} \hat{j}\end{aligned}$$

Ans. (D)

Question

P
W

$$d_1 =$$

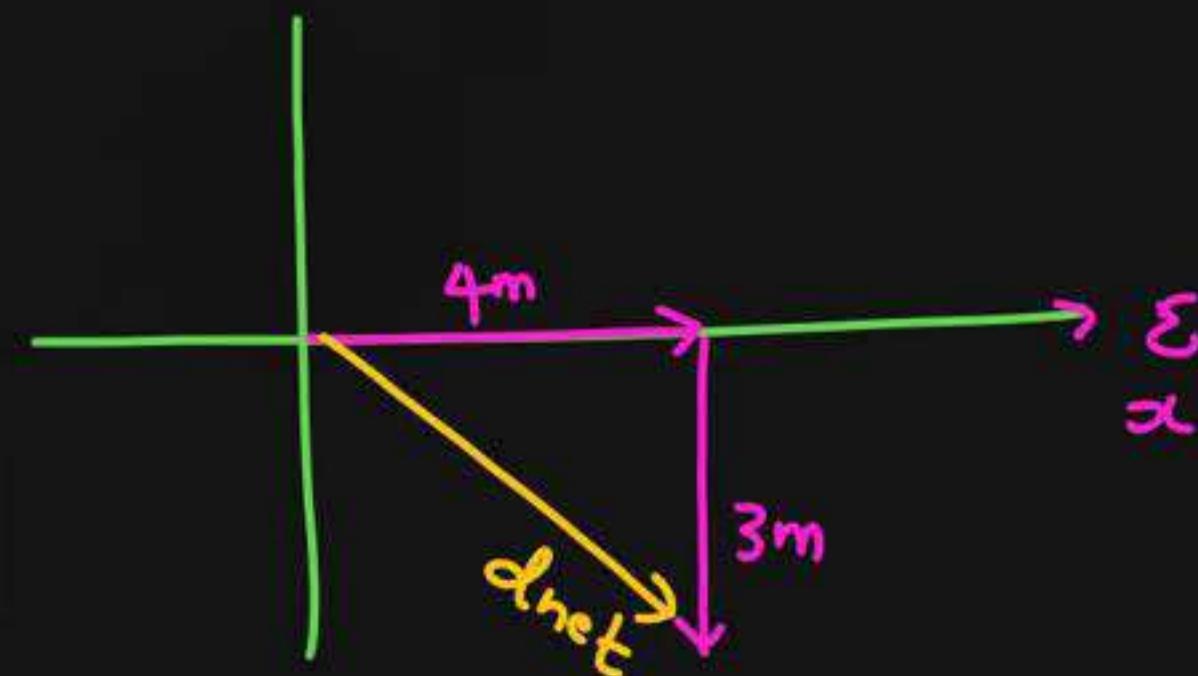
A boy walks 4 m east and then 3 m south. Find the resultant displacement of the boy.

$$d_1 = 4\hat{i}$$

$$\vec{d}_2 = -3\hat{j}$$

$$\vec{d} = 4\hat{i} - 3\hat{j}$$

- A 4 m
- B 5 m
- C 7 m
- D 3 m



Ans. (B)

Question



If a particle moves from point $P(2, 3, 5)$ to point $Q(3, 4, 5)$. Its displacement vector be

$$\overrightarrow{PQ} = \hat{i} + \hat{j}$$

- A $\hat{i} + \hat{j} + 10\hat{k}$
- B $\hat{i} + \hat{j} + 5\hat{k}$
- C $\hat{i} + \hat{j}$
- D $2\hat{i} + 4\hat{j} + 6\hat{k}$

Ans. (C)

Question

$\vec{A} = 2\hat{i} + \hat{j}$, $B = 3\hat{j} - \hat{k}$ and $\vec{C} = 6\hat{i} - 2\hat{k}$. Value of $\underline{\underline{\vec{A} - 2B + 3C}}$ would be

$$-2\vec{B} = -6\hat{j} + 2\hat{k}$$

$$3\vec{C} = 18\hat{i} - 0\hat{j} - 6\hat{k}$$

A $20\hat{i} + 5\hat{j} + 4\hat{k}$

B ~~$20\hat{i} - 5\hat{j} - 4\hat{k}$~~

C $4\hat{i} + 5\hat{j} + 20\hat{k}$

D $5\hat{i} + 4\hat{j} + 10\hat{k}$

Ans. $\Rightarrow 20\hat{i} - 5\hat{j} - 4\hat{k}$

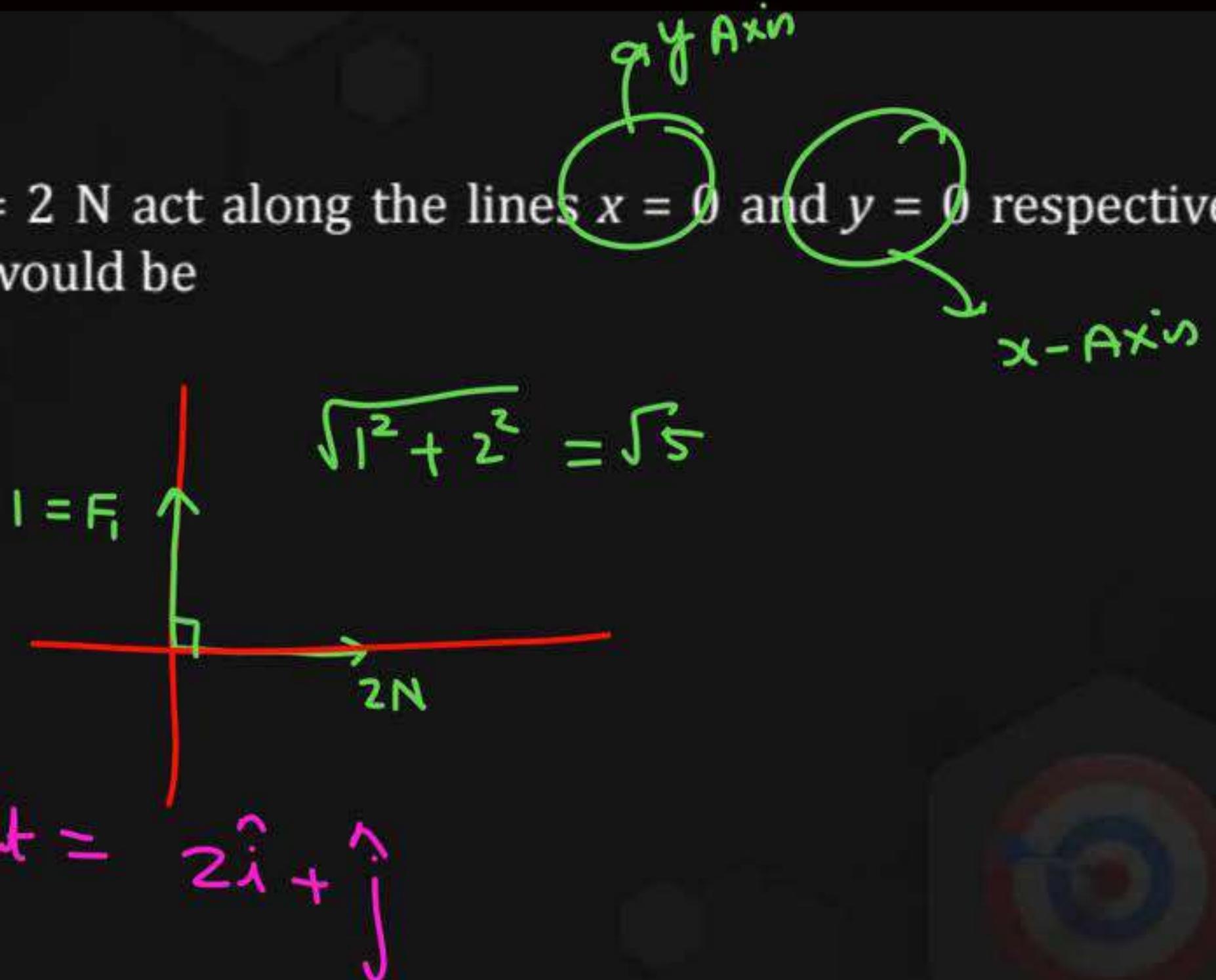
Ans. (B)

Question

P
W

Two force $F_1 = 1 \text{ N}$ and $F_2 = 2 \text{ N}$ act along the lines $x = 0$ and $y = 0$ respectively.
Then the resultant of forces would be

- A $\hat{i} + 2\hat{j}$
- B $\hat{i} + \hat{j}$
- C $3\hat{i} + 3\hat{j}$
- D $2\hat{i} + \hat{j}$



Ans. (D)

Question



Following forces starts acting on a particle at rest at the origin of the co-ordinate system simultaneously

$$\vec{F}_1 = -4\hat{i} - 5\hat{j} + 5\hat{k}, \vec{F}_2 = 5\hat{i} + 8\hat{j} + 6\hat{k},$$
$$\vec{F}_3 = -3\hat{i} + 4\hat{j} - 7\hat{k} \text{ and } \vec{F}_4 = 2\hat{i} - 3\hat{j} - 2\hat{k}$$

then the particle will move

$$\vec{F}_{\text{net}} = 0\hat{i} + 4\hat{j} + 2\hat{k}$$

y, z

- A In x-y plane
- B In y-z plane
- C In x-z plane
- D Along x-axis

Ans. (B)

Question



The vector sum of the forces of 10 newton and 6 newton can be:

A

2 N



B

8 N



C

18 N



D

20 N



$$10 - 6 \leq C \leq 10 + 6$$

$$4 \leq C \leq 16$$

Ans. (B)

Question



The unit vector along $\hat{i} + \hat{j}$ is :

A \hat{k}

B $\hat{i} + \hat{j}$

C $\frac{\hat{i} + \hat{j}}{\sqrt{2}}$

D $\frac{\hat{i} + \hat{j}}{2}$

D $\frac{\hat{i} + \hat{j}}{2}$

Ans. (C)

Question

The unit vector parallel to the resultant of the vectors $\vec{A} = 4\hat{i} + 3\hat{j} + 6\hat{k}$ and $\vec{B} = -\hat{i} + 3\hat{j} - 8\hat{k}$ is:

A $\frac{1}{7}[3\hat{i} + 6\hat{j} - 2\hat{k}]$

B $\frac{1}{7}[3\hat{i} + 6\hat{j} + 2\hat{k}]$

C $\frac{1}{49}[3\hat{i} + 6\hat{j} + 2\hat{k}]$

D $\frac{1}{49}[3\hat{i} + 6\hat{j} - 2\hat{k}]$

$$\vec{A} + \vec{B} = 3\hat{i} + 6\hat{j} - 2\hat{k} = \vec{C}$$

$$\hat{C} = \frac{3\hat{i} + 6\hat{j} - 2\hat{k}}{\sqrt{3^2 + 6^2 + 2^2}}$$

Ans. (A)

Question

If $\vec{A} + \vec{B}$ is a unit vector along x -axis and $\underline{\vec{A} = \hat{i} - \hat{j} + \hat{k}}$, then what is \vec{B} ?

A $\hat{j} + \hat{k}$

B $\hat{j} - \hat{k}$

C $\hat{i} + \hat{j} + \hat{k}$

D $\hat{i} + \hat{j} - \hat{k}$

$$\begin{aligned}\vec{A} + \vec{B} &= \hat{i} \\ \cancel{\hat{i} - \hat{j} + \hat{k}} + \vec{B} &= \cancel{\hat{i}} \\ \underline{\vec{B}} &= \underline{\hat{j} - \hat{k}}\end{aligned}$$

Ans. (B)

Question



The vectors $5\hat{i} + 8\hat{j}$ and $2\hat{i} + 7\hat{j}$ are added. The magnitude of the sum of these vector is

A $\sqrt{274}$

B 38

C 238

D 560

$7\hat{i} + 15\hat{j}$

$\sqrt{7^2 + (15)^2}$

$$\begin{array}{r} 49 \\ 225 \\ \hline 274 \end{array}$$

Ans. (A)

Question

①

P
W

A particle is in a unidirectional potential field where the potential energy (U) of a particle depends on the x -coordinate given by $U_x = k(1 - \cos ax)$ & k and ' a ' are constants. Find the physical dimensions of ' a ' & k .

$$U(x) = k - k \cos ax$$

↓
Pot. Energy

↓
 $m L^2 T^{-2}$

$$m L^2 T^{-2}$$

$$aL = 1$$

$$a = L^{-1}$$

Ans - L^1
 $m L^2 T^{-2}$

Question

②



The time period (T) of a spring mass system depends upon mass (m) and spring constant (k) and length of the spring (l) [$k = \frac{\text{Force}}{\text{Length}}$]. Find the relation among T, m, l and k using dimensional method.

$$T \propto m^x k^y l^z$$

$$m^0 L^0 T^1 = m^x (m T^{-2})^y L^z$$

$$m^0 L^0 T^1 = m^{x+y} L^z T^{-2y}$$

$$-2y = 1$$

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

$$k \equiv \frac{m L T^{-2}}{L}$$

$$k \equiv m^0 L^0 T^{-2}$$

$$z=0$$

$$x+y=0$$

$$x - \frac{1}{2} = 0$$

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

$$\underline{\text{Ans}} \quad T = \alpha \sqrt{\frac{m}{k}}$$

$$\underline{\text{Ans}} \quad T = k' m^{\frac{1}{2}} k^{-\frac{1}{2}} l^0$$

$$T = k' \frac{\sqrt{m}}{\sqrt{k}} = k' \sqrt{\frac{m}{k}}$$

Question

③

P
W

A satellite is orbiting around a planet. Its orbital velocity (v_0) is found to depend upon

- (A) Radius of orbit (R)
- (B) Mass of planet (M)
- (C) Universal gravitation constant (G)

Class Notes
Check

$$V_0 = K \sqrt{\frac{GM}{R}}$$

$$V_0 \propto R^x m^y G^z$$

: : : :
: : : :
: : : :
: : : :
: : : :
: : : :

Question

④



A assume that the largest stone of mass ' m ' that can be moved by a flowing river depends upon the velocity of flow v , the density d and the acceleration due to gravity g . If ' m ' varies as the K^{th} power of the velocity of flow, then find the value of K .

$$m \propto v^K d^\ell g^m$$

$$(L T^{-1})^K (M L^{-3})^\ell (L T^{-2})^m$$

$$M^1 L^0 T^0 = M^\ell L^{K-3\ell+m} \cdot T^{-K-2m}$$

Compare

$$\ell = 1$$

$$K=6$$

$$-K-2m = 0 \Rightarrow -K = 2m$$

$$K-3\ell+m = 0$$

$$m = -\frac{K}{2}$$

$$K-3 \times 1 + m = 0$$

$$K+m = 3$$

$$\frac{K}{2} = 3$$

$$\frac{K}{2} = 3 \cdot K = 6$$

Which of the following functions of A and B may be performed if A and B possess different dimensions?

- A $\frac{A}{B}$ ✓
- B $A + B$ ✗
- C $A - B$ ✗
- D None of these

Ans (A)

Question

⑥

The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a , b and c are constants. The dimensions of a , b and c are respectively:-

- A LT^{-2} , L and T
- B L^2 , T and LT^2
- C LT^2 , LT and L
- D L , LT and T^2

at \longrightarrow velocity

$$aT = LT^{-1}$$

$$a = LT^{-2}$$

$$c = T$$

$\frac{b}{t+c}$ \longrightarrow Velocity

$$\frac{b}{T} = LT^{-1}$$

$$b = L$$

$$\frac{b}{t+c}$$

Ans (A)

Question

7

P
W

If area (A), velocity (v), and density (ρ) are base units, then the dimensional formula of force can be represented as:-

~~A~~ $Av\rho$ $\xrightarrow{L^2 \cdot LT^{-1} \cdot \frac{m}{L^3} = MLT^{-1}}$

B $Av^2\rho$ $\xrightarrow{L^2 \cdot (LT^{-1})^2 \frac{m}{L^3} = MLT^{-2}}$ MLT^{-2} $=$ Force

C $Av\rho^2$

D $A^2v\rho$

Ans (B)

Question

(8)

P
W

F A T

If force, acceleration and time are taken as fundamental quantities, then the dimensions of length will be:

A ~~FT^2~~

B ~~$F^{-1}A^{-2}T^{-1}$~~

C ~~FA^2T~~

D ~~AT^2~~

$m L T^{-2} \cdot T^2 = m L$

$$F^{-1}A^{-2}T^{-1} = \frac{1}{F A^2 T} = \frac{1}{m L T^{-2} (L T^{-2})^2 \cdot T} = \frac{1}{m L^3 T^{-5}}$$
$$L T^{-2} \cdot T^2 = L$$

Ans (C)

P

Question



Find the value of

(i) $\cos(-60^\circ) = \cos 60^\circ = \frac{1}{2}$

(ii) $\tan 210^\circ = \tan(180^\circ + 30^\circ) = -\frac{1}{\sqrt{3}}$

(iii) $\sin 300^\circ$

(iv) $\boxed{\cos 120^\circ}$

\downarrow
 \downarrow
 $\sin(360^\circ - 60^\circ) = -\frac{\sqrt{3}}{2}$

Ans. (i) $\frac{1}{2}$, (ii) $-\frac{1}{\sqrt{3}}$, (iii) $-\frac{\sqrt{3}}{2}$, (iv) $-\frac{1}{2}$

Question



Use the approximation $(1 + x)^n \approx 1 + nx$, $|x| \ll 1$, to find approxima

(i) $\sqrt{99}$

(ii) $\frac{1}{1.01}$

$$\begin{aligned} & \left(1 - \frac{1}{100}\right)^{-\frac{1}{2}} = \left(1 + (-0.01)\right)^{-\frac{1}{2}} = 1 - (-0.01) \\ & = 0.99 \end{aligned}$$

$$\begin{aligned} \sqrt{100-1} &= (100-1)^{\frac{1}{2}} = [100(1-0.01)]^{\frac{1}{2}} = 10(1-0.01)^{\frac{1}{2}} \\ &= 10 \left(1 - \frac{1}{2} \times 0.01\right) \\ &= 10(1 - 0.005) \\ &= 10 \times 0.995 \\ &= \underline{\underline{9.95}} \end{aligned}$$

Ans. (i) 9.95, (ii) 0.99

Question



$$m L^2 T^{-2}$$

In system called the star system we have 1 star kilogram = 10^{20} kg. 1 starmeter = 10^8 m, 1 starsecond = 10^3 s then calculate the value of 1 joule in this system.

$$1 J' = \frac{10^{20} \text{ kg} \cdot (10^8 \text{ m})^2}{(10^3 \text{ s})^2}$$

$$1 J' = 10^{30} \frac{\text{kg m}^2}{\text{sec}^2} = 10^{30} \text{ J}$$

$$\frac{1 J'}{10^{30}} = 1 J = 10^{-30} J'$$

Ans. (10^{-30} star joule)

Question

Find the approximate value of

(i) $(1.003)^3 = (1 + 0.003)^3 = 1.009$

(ii) $(1.003)^{-3} \rightarrow (1 + 0.003)^{-3} = 1 - 0.009 = .991$

(iii) $\left(\frac{1}{1.005}\right)^3$

(iv) $\sqrt{98}$ $\rightarrow (1.005)^{-3} = (1 + 0.005)^{-3} = 1 - 0.015 = .985$

Class $(100-z)^{\frac{1}{2}} = 10(1 - 0.02)^{\frac{1}{2}} = 10(1 - 0.01) = \underline{\underline{9.9}}$

Ans. (i) 1.009, (ii) .991, (iii) .985, (iv) 9.9

Question

Convert following into radian

- (i) 45°
- (ii) 60°
- (iii) 90°
- (iv) 120°
- (v) 150°

$$\frac{\pi}{180}$$

A pink oval containing the word "Class".

$$45 \times \frac{\pi}{180} = \frac{\pi}{4}$$

Ans. (i) $\pi/4$, (ii) $\pi/3$, (iii) $\pi/2$, (iv) $2\pi/3$, (v) $5\pi/6$

Question



Convert following into degree $\pi = 180^\circ$ ✓

(i) $\frac{4\pi}{3}$

(ii) $\frac{8\pi}{3}$

(iii) 4π

$$\frac{8 \times 180}{3} = 480^\circ$$

Ans. (i) 240° , (ii) 480° , (iii) 720°

H/W

P.E.

$$\textcircled{1} \quad U = \frac{A\sqrt{x}}{B+x^2} \quad B = L^2$$

D.F. of A.B is

$$m L^2 T^{-2} = \frac{A L^{\frac{1}{2}}}{L^2} = A L^{3/2}$$

$$A = m L^{\frac{7}{2}} T^{-2}$$

$$m L^{\frac{7}{2}} T^{-2} L^2 = \checkmark$$

P
W

(2)

$$P = \frac{\alpha}{\beta} e^{-\frac{\alpha x}{kT}}$$

$k \rightarrow$ Boltzmann const
 $T \rightarrow$ temp.

$\rightarrow P \rightarrow$ pressure

DF γ kT

$$\text{dim. } \gamma \frac{\alpha x}{kT} = 1$$

$$\frac{\alpha L}{mL^2 T^2} = 1 \Rightarrow$$

$$\alpha = mL T^{-2}$$

JEE mains 2021, 22,

JEE main 2025

kT की dim put कर
 $\frac{RETA}{2}$

Internal Energy

K.E.

$$U = \frac{3}{2} kT$$

$$kT = mL^2 T^{-2}$$

$$\frac{mLT^{-2}}{L^2} = \frac{\alpha}{\beta} = \frac{mLT^{-2}}{\beta}$$

$$\beta = L^2$$

P
W

check the following equation dimensionally

$$(a) h = \frac{\gamma s \cos \theta}{\rho g} \Rightarrow \frac{m L T^{-2}}{L L \frac{m}{L^3} L T^{-2}} = L$$

$h \rightarrow$ height

$s \rightarrow$ surface tension = $\frac{F}{L}$

$r \rightarrow$ radius

$\rho \rightarrow$ density

$g \rightarrow$ acceleration due to gravity

$T^{-1} \neq LT^{-1}$

wrong (b)

frequency $\nu = \sqrt{\frac{P}{\rho}}$

pressure

density

$$\sqrt{\frac{m L T^{-2}}{L^2 \frac{m}{L^3}}} = \sqrt{L^2 T^{-2}}$$

जीव Last pages जरूर देखना



Q. Time period of a simple pendulum depends on 'm' of block
 length of string (l) & acc due to gravity 'g'
 Derived the formula for time period.

$$\left. \begin{array}{l} T \propto m^x \\ T \propto l^y \\ T \propto g^z \end{array} \right\} \text{एक सूत्र में ?}$$

$$T \propto m^x l^y g^z$$

$$T = K m^x l^y g^z$$

dimensionless
const
दोनों पक्षों में



$$T = K m^x l^y g^z$$

$$m^0 l^0 T^1 = m^x l^y (l T^{-2})^z$$

$$= m^x l^y l^z T^{-2z}$$

$$m^0 l^0 T^1 = m^x l^{y+3} T^{-2z}$$

Compare

$$x=0,$$

$$y+3=0$$

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

$$y=-z=-\left(-\frac{1}{2}\right)=\frac{1}{2}$$

$$T = K m^0 l^{\frac{1}{2}} \cdot g^{-\frac{1}{2}} = \frac{K \sqrt{l}}{\sqrt{g}}$$

$$T = K \sqrt{\frac{l}{g}}$$

Q ^(E) Energy of a particle performing SHM depends on

mass (m) of object , Amplitude (A) , frequency f of motion

Derive the relation b/w them.

प्र० सा कदम

जो Dimensionless हैं

$$E \propto m^x A^y f^z$$

$$m L^2 T^{-2} = m^x L^y (T^{-1})^z$$

$$m^x L^y T^{-z}$$

धूस

Compare.

$$x = 1$$

$$y = 2$$

$$-3 = -2$$

$$z = 2$$

$$E = K M A^2 f^2$$

Suppose

Q Force depends on mass(m), speed(v), and radius 'r'

Derive the relation b/w them

$$F = K m^x v^y r^z$$

$$m L T^{-2} = m^x (L T^{-1})^y L^z$$

$$m^1 L T^{-2} = m^x L^y T^{-y}$$

Compare power

$$x = 1$$

$$-y = -2 \quad \boxed{y = 2}$$

$$y + z = 1$$

$$2 + z = 1$$

प्रताग्री

$$F = K m^1 v^2 r^{-1}$$

$$F = K \frac{m v^2}{r}$$

en अभी कुछ
नहीं बता

Q A satellite is revolving around the earth such that
 time period T of satellite depends on M (mass of earth),
 gravitational const (G), and radius of orbit r ,
 Derive the formula for time period of satellite

$$T = K m^{-\frac{1}{2}} G^{\frac{1}{2}} r^{3/2}$$

✓

$2x$

$3 \rightarrow$ একটি
নথি

$$T = K m^x G^y r^z$$

$$T = m^x (m^{-1} L^3 T^{-2})^y L^z$$

$$m^0 L^0 T^1 = m^{x-y} L^{3y+3} T^{-2y}$$

$$\begin{cases} -2y = 1 \\ y = -\frac{1}{2} \end{cases}$$

$$x - y = 0$$

$$x = y \quad \therefore \quad x = -\frac{1}{2}$$

$$G = m^{-1} L^3 T^{-2}$$

$$3y + 3 = 0$$

$$3 = -3y = +3/2$$

~~H/w~~ Q A satellite is revolving around the earth such that
Orbital velocity v_o of satellite depends on M (mass of earth),
, gravitational cons. (G), and radius of orbit r ,

Derive the formula for Orbital velocity of satellite

$$G = m^{-1} L^3 T^{-2}$$

$$G = m^{-1} L^3 T^{-2}$$

Q.

A quantity f is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of:

(JEE Main-2020)

- A** Momentum
- B** Area
- C** Energy
- D** Volume

Ans : (C)

Q.

Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is: (JEE Main-2020)

A $ML^2 T^{-2}$

B MLT^{-2}

C $M^2 L^0 T^{-1}$

D $ML^0 T^{-3}$

Ans : (D)

Q.~~Tough~~ Go... gently (J)P
W

In a typical combustion engine the work done by a gas molecule is given

$W = \alpha^2 \beta e^{\frac{-\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be:

(JEE Main-2021)

- A [MLT⁻²]
- B [M⁰LT⁰]
- C [M²LT⁻²]
- D [MLT⁻¹]

Ans : (B)

Q.

The force is given in terms of time t and displacement x by the equation $F = A \cos Bx + C \sin Dt$. The dimensional formula of AD/B is: **(JEE Main-2021)**

- A** $[M^0 L T^{-1}]$
- B** $[M L^2 T^{-3}]$
- C** $[M^1 L^1 T^{-2}]$
- D** $[M^2 L^2 T^{-3}]$

Ans : (B)

Q.

Match List-I with List-II.

List-I

- (a) Torque
- (b) Impulse
- (c) Tension
- (d) Surface Tension

List-II

- (i) MLT^{-1}
- (ii) MT^{-2}
- (iii) ML^2T^{-2}
- (iv) MLT^{-2}

(JEE Main-2021)

P
W

Choose the most appropriate answer from the option given below :

A

(a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

B

(a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

C

(a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

D

(a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

Ans : (A)

Q.

An expression of energy density is given by $u = \frac{\alpha}{\beta} \sin\left(\frac{\alpha x}{k t}\right)$, where α, β are constants, x is displacement, k is Boltzmann constant and t is the temperature. The dimensions of β will be: **(JEE Main-2022)**

- A** $[ML^2 T^{-2} \theta^{-1}]$
- B** $[M^0 L^2 T^{-2}]$
- C** $[M^0 L^0 T^0]$
- D** $[M^0 L^2 T^0]$

Ans : (D)

Q.

Match the list-I with List -II.

List I

- A. Torque
- B. Stress
- C. Latent Heat
- D. Power

List II

- I. Nms^{-1}
- II. J kg^{-1}
- III. Nm
- IV. Nm^{-2}

Choose the correct answer from the options given below:

(JEE Main-2022)

A

A-III, B-II, C-I, D-IV

B

A-III, B-IV, C-II, D-I

C

A-IV, B-I, C-III, D-II

D

A-II, B-III, C-I, D-IV

Ans : (B)

Q.

In Vander Waals equation $\left[P + \frac{a}{V^2}\right] [V - b] = RT$; P is pressure, V is volume, R is universal gas constant and T is temperature. The ratio of constants a/b is dimensionally equal to: **(JEE Main-2022)**

A P/V

B V/P

C PV

D PV^3

Ans : (C)

⑯ $E = \frac{B^2 - x^2}{At}$

find D.F of A & B

$$B^2 = L^2$$

$$B = \boxed{L}$$

$$\frac{m L^2 T^{-2}}{A} = \frac{L^2}{A \cdot T}$$

$$A = \frac{L^2}{T(m L^2 T^{-2})}$$

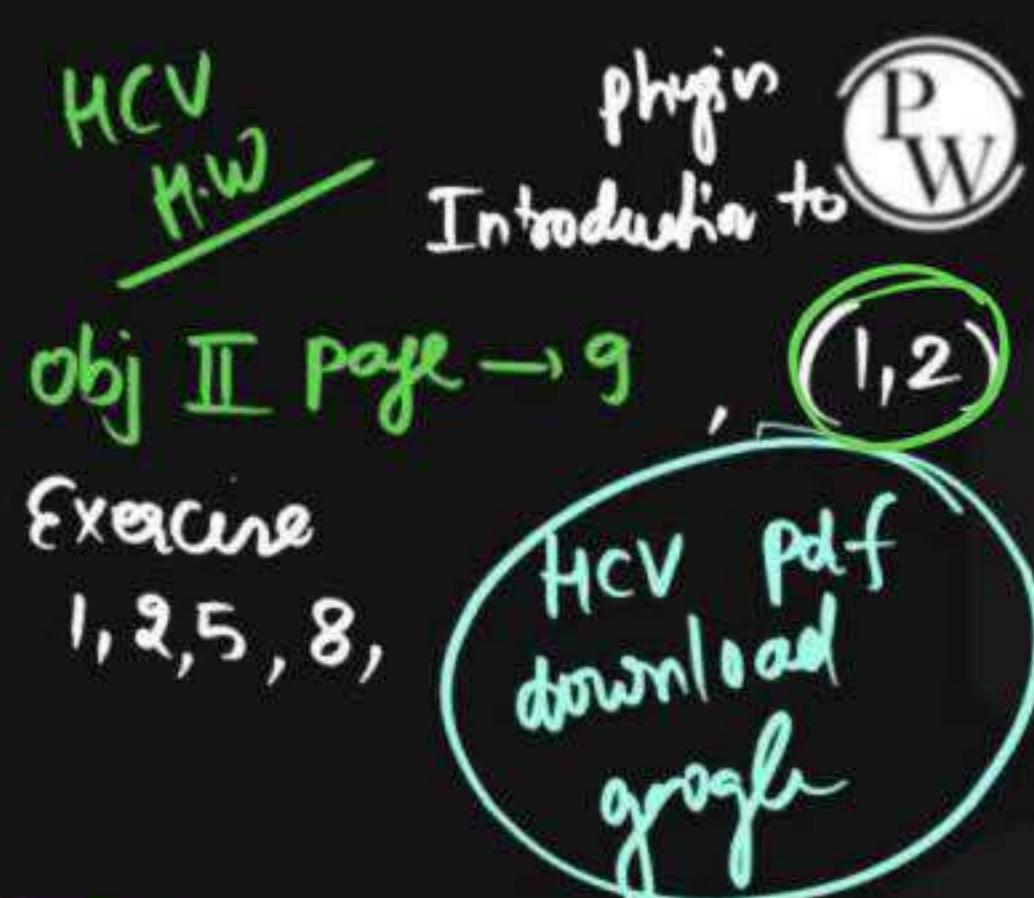
$$\boxed{A = m^{-1} L^0 T^{+1}}$$

H/W (19) $P = \frac{A - t^2}{B + x^2} \cdot C$
 (momentum)

(20) $P = \frac{A + t^2}{B - x^2} \cdot C$
 Pressure \cancel{AT}
 $B + x^2$

to find (21) $F = \frac{A - x^2}{B} + Ct + Dx$

find D.F of $\frac{A \cdot B}{C \cdot D}$



H/W

calculus OP

(let)

$$y = \sin \theta$$

angle \Rightarrow Dimensionless.

Dimensionless, number $[-1, 1]$

$$\textcircled{1} \quad y = \sin A \Rightarrow A = [m^{\circ} l^{\circ} T^{\circ}]$$

$$\textcircled{2} \quad y = \sin(Ax) \quad Ax = 1 \quad (\text{dimensionless})$$

$$A \cdot L = 1$$

$$A = L^{-1}$$

$$\textcircled{3} \quad y = \sin(At)$$

$$AT = 1$$

$$A = T^{-1}$$

$$\textcircled{4} \quad y = \sin\left(\frac{A}{x^2}\right)$$

$$\frac{A}{L^2} = 1$$

$$A = L^2$$

⑤ $y = \sin(Ax^2 + Bt^3)$

2 von Number 2
b/w [-1, 1]

Dimensionally

$$\left\{ \begin{array}{l} Ax^2 = 1 \\ Bt^3 = 1 \\ AL^2 = 1 \\ A = L^{-2} \end{array} \right.$$
$$\left\{ \begin{array}{l} BT^3 = 1 \\ B = T^{-3} \end{array} \right.$$

$y =$ Number
Dimensionen

$$⑥ y = \sin \left(\frac{A}{x^2} + Bt^2 + Ct \right)$$

$$\frac{A}{x^2} = 1 \quad (\text{Dimensionality}) \Rightarrow BT^2 = 1$$

$$B = T^{-2}$$

$$\frac{A}{L^2} = 1 \quad \boxed{A = L^2}$$

$$CT = 1$$

$$C = T^{-1}$$

$$y = m^0 L^0 T^0$$

$$\frac{AB}{C} = \frac{L^2 \cdot T^{-2}}{T^{-1}} = L^2 T^{-1}$$

Velocity

$y = v \sin \left(Ax^2 + \frac{B}{t} \right)$

$$AL^2 = 1 \quad A = L^{-2}$$

$$\frac{B}{T} = 1 \quad B = T$$

$y = \text{Velocity} = LT^{-1}$

P
W

⑧ $y = A \sin(Px^2 + \frac{\theta}{t} + Ru)$

Amplitude (meter)

Velocity

- 1 2
- 2 -3
- 3 -4
- 4 None

P
W

$y = L$

D.F. of $\frac{PQ}{yR}$ is given by $m^\alpha L^\beta T^\gamma$

find $\alpha + \beta + \gamma$

$P = L^{-2}$

$Q = T$

$Ru = 1$

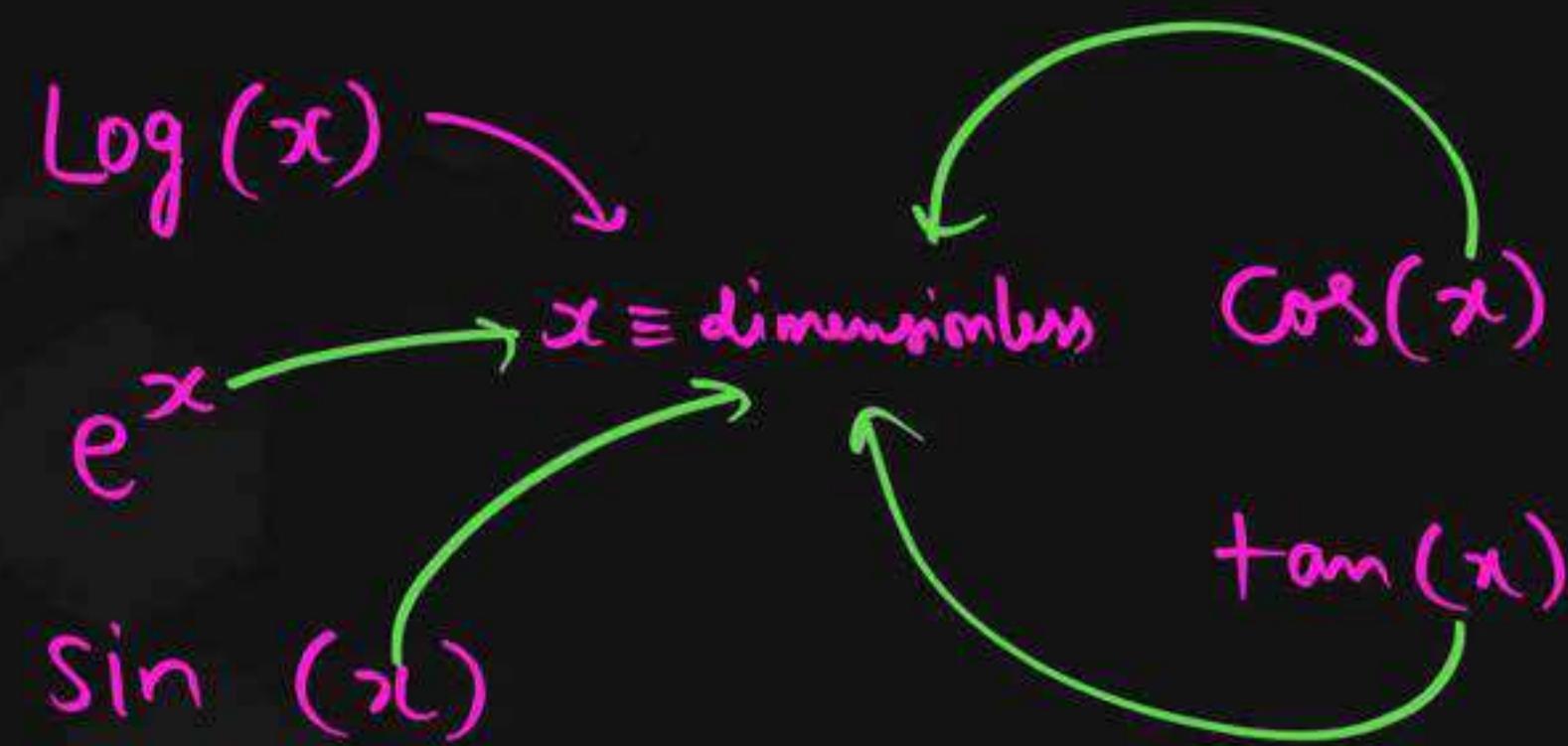
$R LT^{-1} = 1$

$R = L^T T$

$\frac{PQ}{yR}$

$\frac{L^{-2} \cdot T}{L \cdot L^{-1} T} = L^{-2}$

$\alpha = 0$
 $\beta = -2$
 $\gamma = 0$



$$y = \log (x)$$

dimensionality

$$y = \sin \left(Ax^2 + \frac{B}{t} \right)$$

Q

$$y = \log \left(Ax^2 + \frac{B}{t} \right)$$

$$AL^2 = 1$$

$$\frac{B}{T} = 1$$

$$A = L^{-2}$$

$$B = T$$

$$\text{Q} \quad q = Q_0 e^{-\frac{t}{\tau}}$$

find D.F. of τ

$$e = 2.718 \text{ maths}$$

$$\pi = 3.14$$

$$\frac{t}{\tau} = 1 \text{ (dimensionally)}$$

$$t = \tau$$

$$\tau = T^1$$

$$\text{Q} \quad y = \log\left(\frac{A}{t^2} - Bt\right)$$

find D.F. of $A \cdot B$

$$A = L^2$$

$$B \cdot L T^{-1} = 1$$

$$B = L^{-1} T$$

$$\text{Any} \rightarrow T^2 \cdot L^{-1} T$$

$$L^{-1} T^3$$

$$(Ax^2 + B/t^2 - C \cdot Ct)$$

$$(Ax^2 + \frac{B}{t^2} - Ct)$$

P
W

$$\text{Q} \quad y = v e^{\frac{(Ax^2 + B/t^2 - Ct)}{t^2}}$$

find D.F. of $A \cdot B \cdot C$

$$A = L^{-2}, B = T^2, C = T^{-1}$$

$$L^{-2} \cdot T^2 \cdot T^{-1} = L^{-2} T^+ 1$$

Amplitude (m)

$$\text{Ans} \quad y = A \log \left(Bx^2 + \frac{C}{t^3} - 5Dt^3 + \frac{E}{F+t} - \frac{G}{x^2} \right)$$

find D.F. of $A \cdot B \cdot C \cdot D \cdot E \cdot F \cdot G. = ?$

$$A = L, \quad B = L^{-2}, \quad C = T^3, \quad D = T^{-3}, \quad F = T, \quad E = T, \quad G = L^2$$

Ω

Potential
Energy

$$\frac{DF \text{ of } U}{DF \text{ of } K} = \frac{6}{ML^2 T^2}$$

$$ML^2 T^{-2} = K$$

$$U = K(1 - \sin(ax))$$

find D.F. of K & a

$$a = L^{-1}$$

$$ax = 1 \text{ (dimensionally)}$$

 Ω

$$y = A \sin\left(\frac{Bx}{C+t}\right)$$

find D.F. of B & C

$$C = T, A = L,$$

$$\frac{Bx}{C+t} \rightarrow \text{dimensions}$$

$$\frac{BL}{T} = 1$$

$$B = L^{-1} T^{-1}$$

$$q = Q_0 e^{-t/\tau}$$

$$-t/\tau$$

$$-\frac{t}{\tau} \rightarrow \text{dimensionless}$$

$$(-1) \left(\frac{t}{\tau} \right) \Rightarrow 1$$

$$\frac{t}{\tau} = 1$$

$$\tau = T$$

$$P = P_0 e^{5\alpha t^2}$$

$$\alpha t^2 \rightarrow \text{dimension}$$

$$\alpha = T^{-2}$$

$$A = A_0 e^{2t/\tau}$$

$$\frac{2t}{\tau} \rightarrow \text{dimensionless}$$

$$\frac{t}{\tau} \rightarrow 1$$

$$\tau = T$$

H1W

P
W

$$\textcircled{1} \quad U = \frac{A\sqrt{x}}{B+x^2}$$

D.F. of A.B is

②

$$P = \frac{\alpha}{\beta} e^{-\frac{\alpha x}{kT}}$$

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* JEE main 2025

 $K \rightarrow$ Boltzmann const $T \rightarrow$ temp.

check the following equation dimensionally

$$(a) h = \frac{2s \cos \theta}{\gamma \rho g}$$

h → height s → surface tension
 γ → radius ρ → density
 g → acceleration due to gravity

$$(b) v = \sqrt{\frac{P}{\rho}}$$

frequency pressure
 density

अब Last pages जरूर देखना



$$F = \frac{A - x^2}{B} + Ct + Dx$$

$$C \equiv m L T^{-3}$$

$$D = m T^{-2}$$

$$A = L^2$$

$$B = m^{-1} L T^{+2}$$

$$\frac{m^{-1} L^3 T^{+2}}{m^2 L T^{-5}} = \frac{m^{-3} L^2}{T^{+7}}$$

moment

$$P = \frac{A + t^2}{B + x^2} \cdot c$$

$B = l^2$

$A = T^2$

$$MLT^{-1} = \frac{T^2}{l^2} \cdot c$$

$$c = m L^3 T^{-3}$$

pressure

$$P = \frac{A + t^2}{B - x^2} \cdot c$$

$$\frac{MLT^{-2}}{l^2} = \frac{T^2}{l^2} \cdot c$$

$$c = m L T^{-4}$$

P
W

$A = T^2$

$B = l^2$



- Suppose you are told that the linear size of everything in the universe has been doubled overnight. Can you test this statement by measuring sizes with a metre stick? Can you test it by using the fact that the speed of light is a universal constant and has not changed? What will happen if all the clocks in the universe also start running at half the speed?

If all the terms in an equation have same units, is it necessary that they have same dimensions? If all the terms in an equation have same dimensions, is it necessary that they have same units?

 5. If two quantities have same dimensions, do they represent same physical content?
 6. It is desirable that the standards of units be easily available, invariable, indestructible and easily reproducible. If we use foot of a person as a standard unit of length, which of the above features are present and which are not?
 7. Suggest a way to measure:
 - (a) the thickness of a sheet of paper.
 - (b) the distance between the sun and the moon.

OBJECTIVE I

- Which of the following sets cannot enter into the list of fundamental quantities in any system of units ?

 - length, mass and velocity,
 - length, time and velocity,
 - mass, time and velocity,
 - length, time and mass.

A physical quantity is measured and the result is expressed as nu where u is the unit used and n is the numerical value. If the result is expressed in various units then

 - $n = \text{size of } u$
 - $n = u^2$
 - $n = \sqrt{u}$
 - $n = \frac{1}{u}$.

Suppose a quantity x can be dimensionally represented in terms of M , L and T , that is, $[x] = M^a L^b T^c$. The quantity mass

 - can always be dimensionally represented in terms of L , T and x ,
 - can never be dimensionally represented in terms of

(c) may be represented in terms of L, T and x if $a = 0$,
 (d) may be represented in terms of L, T and x if $a \neq 0$.

- A dimensionless quantity
 (a) never has a unit, (b) always has a unit,
 (c) may have a unit, (d) does not exist.

- A unitless quantity

 - (a) never has a nonzero dimension,
 - (b) always has a nonzero dimension,
 - (c) may have a nonzero dimension,
 - (d) does not exist.

$$\int \frac{dx}{\sqrt{2ax - x^2}} = a^n \sin^{-1} \left[\frac{x}{a} - 1 \right].$$

The value of m is

You may use dimensional analysis to solve the problem.

OBJECTIVE II

- The dimensions $ML^{-1}T^{-2}$ may correspond to

 - work done by a force
 - linear momentum
 - pressure
 - energy per unit volume.

Choose the correct statement(s) :

 - A dimensionally correct equation may be correct.
 - A dimensionally correct equation may be incorrect.
 - A dimensionally incorrect equation may be correct.
 - A dimensionally incorrect equation may be incorrect.

- Choose the correct statement(s) :

 - All quantities may be represented dimensionally in terms of the base quantities.
 - A base quantity cannot be represented dimensionally in terms of the rest of the base quantities.
 - The dimension of a base quantity in other base quantities is always zero.
 - The dimension of a derived quantity is never zero in any base quantity.

EXERCISES

- Find the dimensions of
 (a) linear momentum,
 (b) frequency and
 (c) pressure.

- Find the dimensions of
 (a) angular speed ω , (b) angular acceleration α ,
 (c) torque Γ and (d) moment of inertia I .
 Some of the equations involving these quantities are

$$\omega = \frac{\theta_2 - \theta_1}{t_2 - t_1}, \quad \alpha = \frac{\theta_2 - \theta_1}{t_2 - t_1}, \quad F = Fr \text{ and } I = mr^2.$$

The symbols have standard meanings.

3. Find the dimensions of

- (a) electric field E ,
- (b) magnetic field B and
- (c) magnetic permeability μ_r .

The relevant equations are

$$F = qE, \quad F = qvB, \quad \text{and} \quad B = \frac{\mu_r I}{2\pi r};$$

where F is force, q is charge, v is speed, I is current, and a is distance.

4. Find the dimensions of

- (a) electric dipole moment p and
- (b) magnetic dipole moment M .

The defining equations are $p = qd$ and $M = IA$; where d is distance, A is area, q is charge and I is current.

5. Find the dimensions of Planck's constant h from the equation $E = hv$ where E is the energy and v is the frequency.

6. Find the dimensions of

- (a) the specific heat capacity c ,
- (b) the coefficient of linear expansion α and
- (c) the gas constant R .

Some of the equations involving these quantities are $Q = mc(T_2 - T_1)$, $L = L_d[1 + \alpha(T_2 - T_1)]$ and $PV = nRT$.

7. Taking force, length and time to be the fundamental quantities find the dimensions of

- (a) density,
- (b) pressure,
- (c) momentum and
- (d) energy.

8. Suppose the acceleration due to gravity at a place is 10 m/s^2 . Find its value in cm/(minute) 2 .

9. The average speed of a snail is 0.020 miles/hour and that of a leopard is 70 miles/hour. Convert these speeds in SI units.

10. The height of mercury column in a barometer in a Calcutta laboratory was recorded to be 75 cm. Calculate this pressure in SI and CGS units using the following data : Specific gravity of mercury = 13.6 , Density of water = 10^3 kg/m^3 , $g = 9.8 \text{ m/s}^2$ at Calcutta. Pressure = $h\rho g$ in usual symbols.

11. Express the power of a 100 watt bulb in CGS unit.

12. The normal duration of I.Sc. Physics practical period in Indian colleges is 100 minutes. Express this period in microcenturies. $1 \text{ microcentury} = 10^{-4} \times 100 \text{ years}$. How many microcenturies did you sleep yesterday?

13. The surface tension of water is 72 dyne/cm. Convert it in SI unit.

14. The kinetic energy K of a rotating body depends on its moment of inertia I and its angular speed ω . Assuming the relation to be $K = kI^\alpha \omega^\beta$ where k is a dimensionless constant, find α and β . Moment of inertia of a sphere about its diameter is $\frac{2}{5}Mr^2$.

15. Theory of relativity reveals that mass can be converted into energy. The energy E so obtained is proportional to certain powers of mass m and the speed c of light. Guess a relation among the quantities using the method of dimensions.

16. Let I = current through a conductor, R = its resistance and V = potential difference across its ends. According to Ohm's law, product of two of these quantities equals the third. Obtain Ohm's law from dimensional analysis. Dimensional formulae for R and V are ML^2T^{-1} and $ML^2T^{-3}I^{-1}$ respectively.

17. The frequency of vibration of a string depends on the length L between the nodes, the tension F in the string and its mass per unit length m . Guess the expression for its frequency from dimensional analysis.

18. Test if the following equations are dimensionally correct :

- | | |
|--|---|
| (a) $h = \frac{2S \cos\theta}{\rho g}$, | (b) $v = \sqrt{\frac{P}{\rho}}$, |
| (c) $V = \frac{\pi P r^4 t}{8\eta l}$, | (d) $v = \frac{1}{2\pi} \sqrt{\frac{mgf}{I}}$; |

where h = height, S = surface tension, ρ = density, P = pressure, V = volume, η = coefficient of viscosity, v = frequency and I = moment of inertia.

19. Let x and a stand for distance. Is $\int \frac{dx}{\sqrt{a^2 - x^2}} - \frac{1}{a} \sin^{-1} \frac{x}{a}$ dimensionally correct ?

□

ANSWERS

OBJECTIVE I

1. (b) 2. (d) 3. (d) 4. (c) 5. (a) 6. (a)

OBJECTIVE II

1. (c), (d) 2. (a), (b), (d) 3. (a), (b), (c)

EXERCISES

- | | | | |
|--------------------------|---------------------|---|------------|
| 1. (a) MLT^{-1} | (b) T^{-1} | (c) $ML^{-1}T^{-2}$ | |
| 2. (a) T^{-1} | (b) T^{-2} | (c) ML^2T^{-3} | (d) ML^2 |
| 3. (a) $MLT^{-3}I^{-1}$ | (b) $MT^{-2}I^{-1}$ | (c) $MLT^{-4}I^{-1}$ | |
| 4. (a) LTI | (b) L^2I | | |
| 5. ML^2T^{-1} | | | |
| 6. (a) $L^2T^{-2}K^{-1}$ | (b) K^{-1} | (c) $ML^2T^{-2}K^{-1}(\text{mol})^{-1}$ | |

7. (a) $FL^{-1}T^2$ (b) FL^{-1} (c) PT (d) FL
8. 36×10^{-6} cm/(minute)²
9. 0.0089 m/s, 31 m/s
10. 10×10^{-4} N/m², 10×10^2 dyne/cm²
11. 10^6 erg/s
12. 1.9 microcenturies
13. 0.072 N/m
14. $a = 1, b = 2$
15. $E = hmc^2$
16. $V = IR$
17. $\frac{k}{L} \sqrt{\frac{F}{m}}$
18. all are dimensionally correct
19. no

□

Application of dimension Analysis

① Correctness of formula

② We can find D.F. of unknown phy quantity.

$$Q \quad F = \frac{G m_1 m_2}{r^2}$$

D.F. of G = ?

$$G = \frac{F r^2}{m_1 m_2} \Rightarrow \frac{MLT^{-2} \cdot L^2}{MM} = [M^{-1} L^3 T^{-2}]$$

$$Q \quad F = 6\pi r \eta v$$

D.F. of η

$$\eta = \frac{F}{6\pi r v}$$

$$\eta \Rightarrow \frac{MLT^{-2}}{L LT^{-1}} = [ML^{-1} T^{-1}]$$

Q Find DF of specific heat const.

$$\Delta Q = m s \Delta T$$

heat energy given

change in temp

$$\Delta \theta = m s \Delta T$$

$$s = \frac{\Delta \theta}{m \Delta T}$$

$$s = \frac{\Delta \theta}{m \Delta T} = \frac{ML^2T^{-2}}{mK}$$

$$DF \ni k = [M^0 L^2 T^{-2} K^{-1}]$$



$$Q = mL$$

heat given
energy

Def of $L \Rightarrow$

- (A) $m L^2 T^{-2}$
- (B) $m^0 L^2 T^{-2}$
- (C) $m^0 L T^{-2}$
- (D) Other

Latent heat of fusion

$$Q = mL$$
$$L = \frac{Q}{m} \Rightarrow \frac{m^2 T^{-2}}{M}$$

$[m^2 L^2 T^{-2}]$

Ω Boltzmann Const (k)

$$U = \frac{3}{2} k T$$

temp.

internal Energy
(kinetic energy)

find the DF of boltzmann Const.

$$k = \frac{2U}{3T}$$

$$k \Rightarrow \frac{m l^2 T^{-2}}{T} = m l^2 T^{-3}$$

$$k \Rightarrow \frac{m l^2 T^{-2}}{\pi} = [m l^2 T^{-2} K^{-1}]$$

$$\textcircled{4} \quad v = \frac{A}{B+t}$$

find DF of 'B'

B में t जुड़ रहा है

$$B \Rightarrow \text{time} \Rightarrow B = m^o l^o T^{-1}$$

$$\textcircled{5} \quad v = A \sin[B(c+t)]$$

↓
time

find DF of 'c'

$$c = [m^o l^o T^{-1}]$$

(6) $x = At$

Displacement

time

D.F. of A = ?

$At \rightarrow$ Displacement

$$AT = L$$

$$A = \frac{L}{T} = LT^{-1}$$

$$t \rightarrow \text{time}$$

⊕

$$x = At + Bt^2 + Ct^3$$

Displacement

Ct³ → Displacement

CT³ = L

C = LT⁻³

At → Displacement

$$AT = L$$

$$A \Rightarrow \frac{L}{T} = LT^{-1}$$

Bt² → Displacement

$$BT^2 = L$$

B ⇒ LT⁻²

$$(8) \quad v = At + Bx$$

$v \rightarrow$ velocity

$t \rightarrow$ time

$x \rightarrow$ Displacement

find DF of $A \& B$

$At \longrightarrow$ velocity

$$AT = LT^{-1}$$

$$A = \frac{LT^{-1}}{T} = LT^{-2} \quad \checkmark$$

$Bx \longrightarrow$ velocity

$$BL = LT^{-1}$$

$$\boxed{B \Rightarrow T^{-1}}$$

(b) find DF of $\frac{A}{B}$

$$\frac{LT^{-2}}{T^{-1}} = LT^{-1}$$

$$\textcircled{9} \quad v = At^2 + Bx^2 + Ct^3$$

$$CT^3 = LT^{-1}$$
$$C = LT^{-4}$$

find D.F. of A, B, C

v → velocity

t → time

x → displacement

$$AT^2 = LT^{-1}$$

$$BL^2 = LT^{-1}$$

$$A \Rightarrow LT^{-3}$$

$$B \Rightarrow L^{-1}T^{-1}$$

$x \rightarrow$ Displacement

$t \rightarrow$ time

$v \rightarrow$ velocity, speed

$F \rightarrow$ force

$Cx \rightarrow$ displacement

$$CL = L$$

$C = 1 \rightarrow$ dimensionless

$$\text{Ans} C = [m^0 L^0 T^0]$$

$$(10) \quad x = At + \frac{B}{t} + Cx$$

find D.F. of A, B, C

$At \rightarrow$ Displacement

$$A \cdot T = L \Rightarrow A = LT^{-1}$$

$\frac{B}{t} \rightarrow$ Displacement

$$\frac{B}{T} = L \quad B = LT$$

इसका Notes लें एवं
टॉपी साथ Solve
कर

⑪ $v = At + \frac{B}{t} + Cx$

$$AT = LT^{-1}$$

$$\boxed{A = LT^{-2}}$$

$$\frac{B}{t} = LT^{-1}$$

$$\boxed{B = LT^{-1}, T = L}$$

$$CL = LT^{-1}$$

$$\boxed{C = T^{-1}}$$

⑫ $v = Ax^2 + Bx + \frac{C}{t^2}$

$$AL^2 = LT^{-1}$$

$$\boxed{A = L^{-1}T^{-1}}$$

$$BL = LT^{-1}$$

$$\boxed{B = T^{-1}}$$

$$\frac{C}{t^2} = LT^{-1}$$

$$\boxed{C = LT}$$

$$\textcircled{13} \quad F = At + Bx$$

$$AT = m LT^{-2}$$

$$\boxed{A \Rightarrow m LT^{-3}}$$

$$B \cdot L = m LT^{-2}$$

$$\boxed{B \Rightarrow m L^0 T^{-2}}$$

$$\textcircled{14} \quad F = \frac{A}{t} + Bx^2$$

$$mLT^{-2} = \frac{A}{t}$$

$$\boxed{A = m LT^{-1}}$$

$$BL^2 = m LT^{-2}$$

$$\boxed{B = m L^{-1} T^{-2}}$$

$$\textcircled{15} \quad F = AV + \frac{B}{x^2}$$

$$F = AV$$

$$A = \frac{F}{V} = \frac{m LT^{-2}}{L T^{-1}}$$

$$= m L^0 T^{-1}$$

$$mLT^{-2} = \frac{B}{L^2}$$

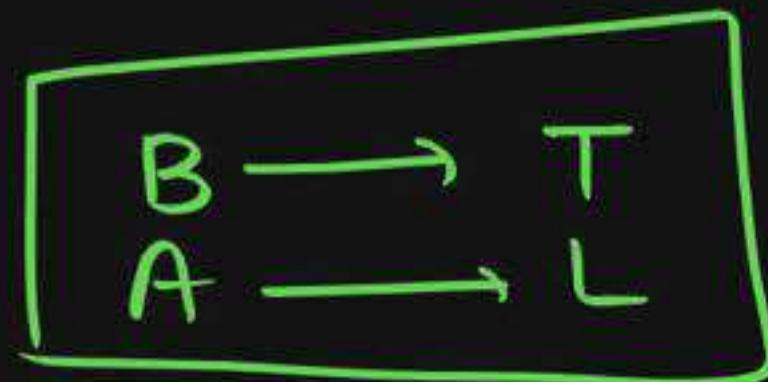
$$\boxed{B = m L^3 T^{-2}}$$

16

$$v = \frac{A}{B+t} \quad \text{find D.F of } A \text{ & } B$$

$$B+t \Rightarrow \boxed{B \geq T}$$

$$v \Rightarrow \frac{A}{\text{time} + \text{time}} = \frac{A}{\text{time}}$$



$$v \Rightarrow \frac{A}{\text{time}}$$

$$LT^{-1} = \frac{A}{T}$$

$$\boxed{A = LT^{-1} \cdot T = L}$$

(7)

$$v = \frac{At}{B^2 - x^2}$$

B^2 से x^2 घट रहा है

DF of B^2 = DF of x^2

$$B^2 = L^2$$

$$\boxed{B = L}$$

$$v = \frac{At}{L^2}$$

$$LT^{-1} = \frac{AT}{L^2}$$

$$A = \frac{LT^{-1} L^2}{T} = L^3 T^{-2}$$

$$\boxed{A = L^3 T^{-2}}$$

style
find DF of
 $A \cdot B$

$$= L^3 T^{-2} \cdot L \\ = L^4 T^{-2}$$

exam

P
W

⑯ $E = \frac{B^2 - x^2}{At}$

find D.F of A & B

$$B^2 = L^2$$

$$\boxed{B = L}$$

$$\frac{m L^2 T^{-2}}{L^2} = \frac{L^2}{A \cdot T}$$

$$A = \frac{L^2}{T(m L^2 T^{-2})}$$

$$\boxed{A = m^1 L^0 T^{+1}}$$

H1W
(1g)

$$P = \frac{A - t^2}{B + x^2} \cdot C$$

(momentum)

(20)

$$P = \frac{A + t^2}{B - x^2} \cdot C$$

Pressure

tough
(21)

$$F = \frac{A - x^2}{B} + Ct + Dx$$

find D.F of $\frac{A \cdot B}{C \cdot D}$

HCV
H.W

plugin
Introduction to 

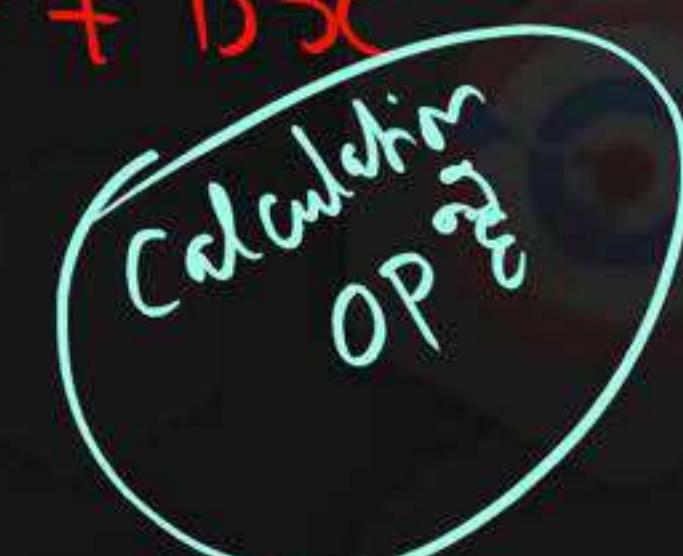
obj II page → 9 , (1,2)

Exercise

1, 2, 5, 8,

 HCV pdf
download
graph

H1W

 calculation
OP2

Q.

Match List-I with List-II :

List-I

- (a) h (Planck's constant) ✓
- (b) E (kinetic energy) ✓
- (c) V (electric potential) ✓
- (d) P (linear momentum) ✓ $m \text{ L T}^{-1}$

List-II

- (i) $[\text{M L T}^{-1}]$
- (ii) $[\text{M L}^2 \text{T}^{-1}]$
- (iii) $[\text{M L}^2 \text{T}^{-2}]$
- (iv) $[\text{M L}^2 \text{I}^{-1} \text{T}^{-3}]$

Choose the correct answer from the options given below:

(JEE Main-2021)

A

(a)→(iii), (b)→(iv), (c)→(ii), (d)→(i)

B

(a)→(ii), (b)→(iii), (c)→(iv), (d)→(i)

C

(a)→(i), (b)→(ii), (c)→(iv), (d)→(iii)

D

(a)→(iii), (b)→(ii), (c)→(iv), (d)→(i)

Ans : (B)

Notes
act
परमाणु

Q.

Match List-I with List-II.

List-I

- (a) Torque
- (b) Impulse
- (c) Tension
- (d) Surface Tension

List-II

- (i) MLT^{-1}
- (ii) MT^{-2}
- (iii) ML^2T^{-2}
- (iv) MLT^{-2}

(JEE Main-2021)

**P
W**

Choose the most appropriate answer from the option given below :

A

(a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

B

(a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

C

(a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

D

(a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

Ans : (A)

Q find dimensional formula of plank const

P
W

$$E = h\nu \rightarrow \text{frequency}$$

$$\rightarrow \text{plank const}$$

Energy of one photon

$$h = \frac{E}{\nu}$$

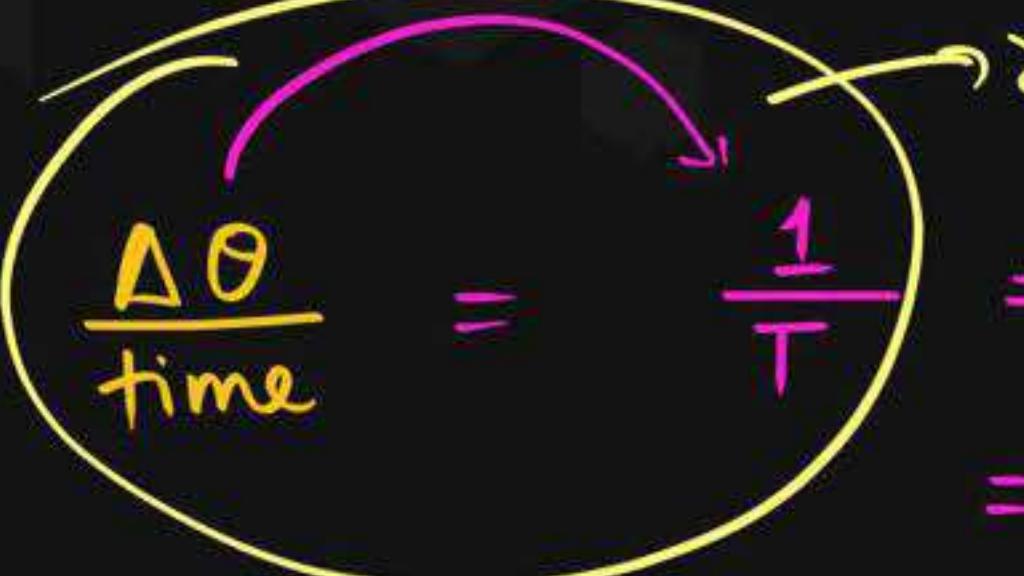
$$\frac{m L^2 T^{-2}}{T^{-1}}$$

$$= [m L^2 T^{-1}]$$

$$\boxed{\text{frequency} = \frac{1}{T} \Rightarrow T^{-1}}$$

$$m L^2 T^{-2+1}$$

Solve


$$\text{Angular velocity} = \frac{\Delta\theta}{\text{time}} = \frac{1}{T} = T^{-1}$$
$$= [m^0 L^0 T^{-1}]$$

Velocity $\rightarrow [m^0 L T^{-1}]$

रवृत्ताली

Angular velocity $\rightarrow [m^0 L^0 T^{-1}]$

Circular motion तथा परिवर्ती

Q5

Resistance = ?

$$V = i R$$

Current
Pot-difference

$$R = \frac{V}{i} \Rightarrow \frac{ML^2T^{-3}A^{-1}}{A}$$

$$[ML^2T^{-3}A^{-2}]$$

PW

ডুবো নথি

Q.

Check the correctness of following formula

$$(a) F = \frac{mv^2}{r^2} \Rightarrow ?$$

$F \rightarrow$ force

$m \rightarrow$ mass

$v \rightarrow$ speed

$r \rightarrow$ radius

Dimension of LHS $\Rightarrow [MLT^{-2}]$

$$\text{Dimension of RHS} \Rightarrow \frac{M(LT^{-1})^2}{L^2}$$

$$= \frac{ML^2T^{-2}}{L^2} = [ML^0T^{-2}]$$

Dimension of LHS \neq dimension of RHS

Relation MLT^{-2} , formula is incorrect

Q A planet is orbiting around earth with orbital velocity V

Correct

$$V = \sqrt{\frac{GM}{r}}$$

= check ?

$$G \Rightarrow [m^{-1} L^3 T^{-2}]$$

RHS

$$\sqrt{\frac{m^{-1} L^3 T^{-2} M}{L}} = \sqrt{L^2 T^{-2}} = LT^{-1}$$

Dimensional formulae

$$LT^{-1} = \underline{LHS}$$

LHS = RHS

Q Time period of simple pendulum is given by

$$T = 2\pi \sqrt{\frac{l}{g}}$$

?

RHS

$$2\pi \sqrt{\frac{l}{g}}$$

$T \rightarrow$ time period

$l \rightarrow$ length of pendulum

$g \rightarrow$ Acc. due to gravity

$$\sqrt{\frac{L}{T^2}} = \sqrt{T^2} = T$$

LHS = RHS

Dimensionally Correct

Q Time period of spring block system is given by

$$T = 2\pi \sqrt{\frac{m}{k}}$$

time period

$m \rightarrow$ mass of block

$k \rightarrow$ spring const

$$\left(k = \frac{\text{Force}}{\text{length}} \right) = \frac{MLT^{-2}}{L} = M T^{-2}$$

RHS

$$\sqrt{\frac{M}{m T^{-2}}} = \sqrt{T^2}$$

$$= T \Rightarrow$$

LHS = RHS

Correct

Kinetic Energy = $\frac{1}{3}mv^2$ (किसी ने कहा)
let

Correct = ?

Incorrect = ?

$$\underline{\text{RHS}} \rightarrow m(LT^{-1})^2 = [mL^2T^{-2}]$$

Dimensionally

But numerically ^{Correct} wrong

Overall formula is ^{wrong}

पूछते हैं

~~$KE = \frac{1}{2}mv^2$~~

Check = ?

$$\underline{\text{RHS}} \rightarrow m(LT^{-1})^2$$

$$[mL^2T^{-2}]$$

Dimensionally

Correct ✓

Numerically correct ✓

Overall correct ✓

$G = ?$

$$F = \frac{G m_1 m_2}{r^2}$$

$$G = \frac{F r^2}{m_1 m_2} \Rightarrow \frac{m \text{ L T}^{-2} \text{ L}^2}{m \text{ m}}$$

$$\left[m^{-1} \text{ L}^3 \text{T}^{-2} \right]$$

$$U_1 + U_2 = U_3 \implies$$



Same Unit

Same dimensional (D.F.)

Same formula

physical Ques

$$U_f - U_i = \Delta U$$

$\Delta U = \text{change in } U$

Q particle initial Speed
= 10 m/s
final speed = 15 m/s

Change in speed = ΔV

$$\Delta V = V_f - V_i$$

$$5 \frac{\text{m}}{\text{s}} = 15 \frac{\text{m}}{\text{s}} - 10 \frac{\text{m}}{\text{s}}$$

Dimensional
formulae

$$\frac{L}{T} = LT^{-1}$$

$$[M^0 LT^{-1}]$$

$$[M^0 LT^{-1}]$$

$$[MLT^{-1}]$$

$$[M L^{-3} T^0]$$

Derived Physical Quantity

$$① \text{ Speed} = \frac{\text{Distance}}{\text{time}} \longrightarrow m/\text{sec} \longrightarrow cm/\text{sec}$$

$$② \text{ Velocity} = \frac{\text{Displacement}}{\text{time}} \longrightarrow m/\text{sec} \longrightarrow cm/\text{sec}$$

$$③ \text{ momentum } p = m \times v$$

$$④ \text{ Density} = \frac{\text{mass}}{\text{Vol}^n} \longrightarrow kg/m^3$$

Unit
(mks)
CGS

Unit
CGS

gm
cm/sec

gm
cm³

$[MLT^{-1}] \neq MLT^{-1} K^0 A^0$

momentum $P = m v$ ^{mass} ^{velocity} = Displacement

$$\text{DF. of } P = M \frac{L}{T} = [MLT^{-1}]$$

dimension of mass
length
time

Next Class

$$\text{Area} = \text{Length} \times \text{width} \Rightarrow$$

Voln

$$L \cdot L = L^2 \Rightarrow [m^0 L^2 T^0]$$

$$L \cdot L \cdot L \Rightarrow L^3 \Rightarrow [m^0 L^3 T^0]$$

$$\text{Density} = \frac{\text{mass}}{\text{Voln}}$$

$$\frac{M}{L^3} \Rightarrow m^1 L^{-3} \Rightarrow [m L^{-3} T^0]$$

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

$$\frac{L}{T} \Rightarrow L T^{-1}$$

$$\text{velocity} = \frac{\text{Displacement}}{\text{time}}$$

$$\frac{L}{T} \Rightarrow L T^{-1}$$

Dimension of Length in Area = 2



Dimensional formulae

Area \longrightarrow Length \times width

Volume \longrightarrow L \times B \times H

$$\text{Density} = \frac{\text{mass}}{\text{Vol}^n}$$

Distance

Displacement

$$\text{Speed} = \frac{\text{Distance}}{\text{time}}$$

$$\text{Velocity} = \frac{\text{Displacement}}{\text{time}}$$

$$L \cdot L \Rightarrow [m^0 L^2 T^0]$$

$$L \cdot L \cdot L \Rightarrow [m^0 L^3 T^0]$$

$$\frac{M}{L^3} \Rightarrow [m L^{-3} T^0]$$

$$[m^0 L^1 T^0]$$

$$[m^0 L^1 T^0]$$

$$\frac{L}{T} \rightarrow [m^0 L T^{-1}]$$

$$\frac{L}{T} \rightarrow [m^0 L T^{-1}]$$

D.F
Same

* velocity $\longrightarrow LT^{-1} = [m^0 LT^{-1}]$

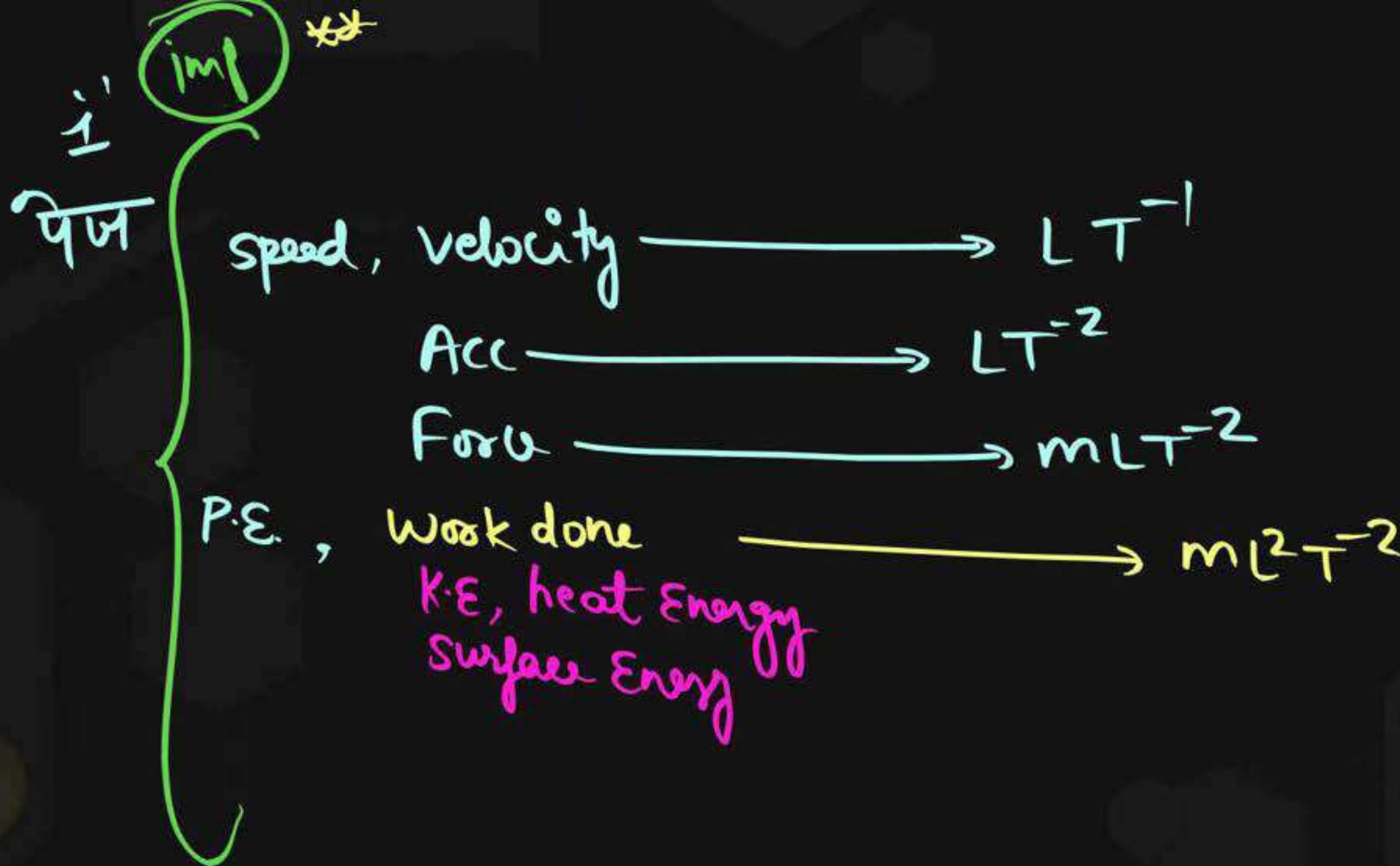
* acceleration = $\frac{\text{Velocity}}{\text{time}}$ (a) $\longrightarrow \frac{LT^{-1}}{T} = LT^{-2} \Rightarrow [m^0 LT^{-2}]$

Force $(F = ma)$ $\longrightarrow [MLT^{-2}]$

momentum $p = mv$ $\longrightarrow [MLT^{-1}]$

Impulse 'J' $= F \times t$ $\longrightarrow [MLT^2 \cdot T] = [MLT]$

D.F same
But ?



- Pressure = $\frac{\text{Force}}{\text{Area}}$ $\Rightarrow \frac{m L T^{-2}}{L^2} \Rightarrow [m L^{-1} T^{-2}]$

रुटा

- Work done

$$W = F \times \text{displacement} \Rightarrow m L T^{-2} \cdot L \Rightarrow [m L^2 T^{-2}]$$

~~सेक्ष.~~
~~सेक्ष.~~

- Torque = Force \times (perpendicular Distance)

$$\Rightarrow [m L T^{-2} \cdot L] \\ = [m L^2 T^{-2}]$$

- moment of inertia $= m R^2$

mass \rightarrow [ML²] ✓

Distance from axis \rightarrow [ML²T⁰] ✓

Ques $G = [m^{-1} L^3 T^{-2}]$

 $\alpha = -1$ $\beta = 3$ $\gamma = -2$

If Dimensional formula of G is given by $m^\alpha L^\beta T^\gamma$

find value of $|\alpha| + |\beta| + |\gamma| = 1 + 3 + 2 = 6$

find

$$\alpha + \beta + \gamma = -1 + 3 - 2 = 0$$

find

$$\frac{\beta\gamma}{\alpha} \Rightarrow \frac{3 \times (-2)}{-1} \Rightarrow 6$$

$$U_1 + U_2 = U_3 \quad \Rightarrow$$

particle initial speed
 $= 10 \text{ m/s}$

final speed $= 15 \text{ m/s}$

Change in speed $= \Delta U$

$$\Delta U = V_f - V_i$$

$$5 \text{ m/s} = 15 \text{ m/s} - 10 \text{ m/s}$$

$$V_f - V_i = \Delta U = \text{change in } U$$

Same Unit

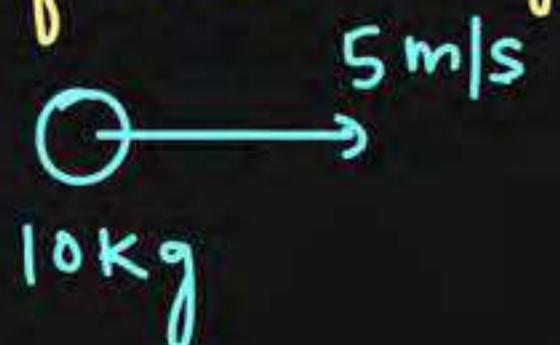
Same dimensional (D.F.)

Same formula

physical Quant

find momentum in mks & CGS system if a particle of mass 10 kg is moving with velocity 5 m/s. (east).

Q.



$$\text{momentum} = P = m \times v$$

$$= 10 \text{ kg} \times 5 \text{ m/s}$$

$$= 50 \frac{\text{kg m}}{\text{sec}} \equiv \text{mks syst}$$

$$5 \times 10^6 \frac{\text{gm cm}}{\text{sec}}$$

$$= 50 \times \frac{1000 \text{ gm} \times 100 \text{ cm}}{\text{sec}}$$

Convert into CGS

Momentum (CGS) system

Q

$$\text{Density} = 6 \text{ kg/m}^3 = 6 \frac{\text{kg}}{\text{m}^3}$$

Convert into CGS system

$$\text{Density} = 6 \times \frac{1000 \text{ gm}}{(100 \text{ cm})^3} = \frac{6 \times 1000 \text{ gm}}{10^6 \text{ cm}^3} = 6 \times 10^{-3} \text{ gm/cm}^3$$

Q Convert into mks system

$$\text{Density} = .6 \text{ gm/cc} = \frac{.6 \text{ gm}}{(\text{cm})^3}$$

$$= \frac{.6 \times \left(\frac{1 \text{ kg}}{1000} \right)}{\left(\frac{1 \text{ m}}{100} \right)^3}$$

$$= \frac{.6 \times 10^6}{1000} = 600 \text{ kg/m}^3$$

$$1 \text{ kg} = 1000 \text{ gm}$$

$$1 \text{ gm} = \frac{1 \text{ kg}}{1000}$$

Derived Physical Quantity

$$\textcircled{1} \quad \text{Speed} = \frac{\text{Distance}}{\text{time}} \rightarrow \text{m/sec} \rightarrow \text{cm/sec}$$

$$\textcircled{2} \quad \text{Velocity} = \frac{\text{Displacement}}{\text{time}} \rightarrow \text{m/sec} \rightarrow \text{cm/sec}$$

$$\textcircled{3} \quad \text{momentum } p = m \times v \rightarrow \text{kg m/s}$$

$$④ \text{ Density} = \frac{\text{mass}}{\text{Vol}^n}$$

$$g/m^3 \rightarrow g/cm^3$$

**Unit
(mks)**

Unit
Gas

Dimensional formula

$$L = LT^{-1}$$

$$[M^0 L T^{-1}]$$

$$[m^\circ L T^{-1}]$$

[MLT⁻¹]

$$[ML^{-3}T^0]$$

P
W

$$\text{Density} = \frac{\text{mass}}{\text{vol}} \Rightarrow \frac{M}{L \cdot L \cdot L} = \frac{m}{L^3} \Rightarrow [M L^{-3} T^0]$$

Dimensional
formulae
of Density

Mass की Dimension क्या है	\Rightarrow	Power = 1
" Length "	\Rightarrow	-3
" time "	\Rightarrow	0
" temp "	\Rightarrow	0

$$\text{Area} = \text{Length} \times \text{width} \Rightarrow$$

Volⁿ

$$\xrightarrow{\hspace{10cm}} \text{Density} = \frac{\text{mass}}{\text{Vol}^n}$$

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

$$\text{velocity} = \frac{\text{Displacement}}{\text{time}} \xrightarrow{\hspace{10cm}} \frac{L}{T} \Rightarrow LT^{-1}$$

$$L \cdot L = L^2 \Rightarrow [m^0 L^2 T^0]$$

$$L \cdot L \cdot L = L^3 \Rightarrow [m^0 L^3 T^0]$$

Dimension of Length in Area = 2



Dimensional
formulae

mv

Q.

If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = EL^2M^{-5}G^{-2}$ are :-

- A** $[M^0 L^1 T^0]$
- B** $[M^{-1} L^{-1} T^2]$
- C** $[M^1 L^1 T^{-2}]$
- D** $[M^0 L^0 T^0]$

$$\frac{EL^2}{m^5 G^2} = \frac{m L^2 T^{-2} (m L^2 T^{-1})^2}{m^5 (m^{-1} L^3 T^{-2})^2}$$

(JEE Main-2021)

$$\frac{m^3 L^6 T^{-4}}{m^3 L^6 T^{-4}} = 1$$

Ans : (D)

Q.

If force (F), length (L) and time (T) are taken as the fundamental quantities.

μ/ω Then what will be the dimension of density: $m L^{-3}$

(JEE Main-2021)

A

$$[FL^{-4} T^2]$$

= संघर्षक ताप

B

$$[FL^{-3} T^2]$$

$$\frac{FT^2}{L^4} = \frac{MLT^{-2}T^2}{L^4} =$$

$$\frac{m}{L^3}$$

C

$$[FL^{-5} T^2]$$

D

$$[FL^{-3} T^3]$$

Ans: (A)

Q.

If momentum $[P]$, area $[A]$ and time $[T]$ are taken as fundamental quantities,
 $\text{H} \backslash \omega$ then the dimensional formula for coefficient of viscosity is: (JEE Main-2022)

A

$$[PA^{-1}T^0]$$

B

$$[PA T^{-1}]$$

C

$$[PA^{-1}T]$$

D

$$[PA^{-1}T^{-1}]$$

$$\frac{P}{A} = \frac{m L T^{-1}}{L^2}$$

$$= m L^{-1} T^{-1}$$

$$F = 6\pi\lambda\eta v$$

$$\eta = \frac{F}{6\pi\lambda v} = \frac{m L T^{-2}}{L L T^{-1}}$$

$$\boxed{\eta = m L^{-1} T^{-1}}$$

class

Ans: (A)

Question

Stan level ques

21179K

Next class π

SET II adda

P
W

The gas equation for n moles of a real gas is: $\left(P + \frac{n^2 a}{V^2} \right) (V - nb) = nRT$ where P is the pressure, V is the volume, T is the absolute temperature, R is the molar gas constant and a, b are arbitrary constants. Which of the following have the same dimensions as those of PV ?

$PV?$

dimensionally

$$P = \frac{n^2 a}{V^2}$$

$$V = nb \quad (\text{dimensionally})$$

$$b = \frac{V}{n}$$

A \cancel{nRT}

B $\cancel{n^2 a/V}$

C \cancel{Pb}

D $\cancel{ab/V^2}$

$$PV = \frac{n^2 a}{V}$$

$$PV \cdot \frac{1}{n} = \frac{PV}{n} = \frac{PV}{\text{mol}}$$

Try $\frac{PV}{n}$

Question

$$m l^2 T^{-2}$$

In a new unit system, 1 unit of time is equal to 10 second, 1 unit of mass is 5 kg and 1 unit of length is 20 m. In this new system of units, 1 unit of energy is equal to

$$= \frac{5 \text{ kg} \times (20 \text{ m})^2}{(10 \text{ sec})^2}$$

$$= 20 \text{ J}$$

- A** 20 Joule
- B** 1/20 Joule
- C** 4 Joule
- D** 16 Joule

(A)

Question

Which of the following statements is correct about conversion of units, for example

$$1 \text{ m} = 100 \text{ cm}$$

- A** Conversion of units have identical dimensions on each side of the equal sign but not the same units.
- B** Conversion of units have different dimensions on each side of the equal sign but have same unit
- C** If a larger unit is used then numerical value of physical quantity is large.
- D** Due to conversion of units physical quantity to be measured will change.

(A)

Question

Class

$$\textcircled{Q} \quad -\frac{5}{6} + \frac{1}{2} + \frac{1}{3} = \frac{-5+3+2}{6} = 0$$



A gas bubble oscillates with a time period T proportional to $P^a d^b E^c$ where P is pressure, d is the density and E is the energy. The values of a, b & c are

A

$$a = \frac{3}{2}, b = -\frac{1}{3}, c = \frac{1}{2}$$

B

$$a = -\frac{5}{6}, b = \frac{1}{3}, c = \frac{1}{2}$$

C

$$a = -\frac{5}{6}, b = \frac{1}{2}, c = \frac{1}{3}$$

D

$$a = \frac{3}{2}, b = -\frac{1}{3}, c = \frac{1}{2}$$

$$T = K P^a d^b E^c$$

$$= \cdot (m L^{-1} T^{-2})^a (m L^{-3})^b (m L^2 T^{-2})^c$$

$$\frac{F}{A}$$

$$M^0 L^0 T^1 = M^{a+b+c} L^{-a-3b+2c} T^{-2a-2c}$$

$$\begin{aligned} a+b+c &= 0 \\ -a-3b+2c &= 0 \end{aligned}$$

$$-2a-2c = 1$$

$$-2a-2c =$$

$$2 \times \frac{5}{6} - \frac{2}{3} = \frac{5}{3} - \frac{2}{3} = 1$$

(c)

Question**Class**

$$\textcircled{Q} \quad -\frac{5}{6} + \frac{1}{2} + \frac{1}{3} = \frac{-5+3+2}{6} = 0$$



A gas bubble oscillates with a time period T proportional to $P^a d^b E^c$ where P is pressure, d is the density and E is the energy. The values of a, b & c are

A

$$a = \frac{3}{2}, b = -\frac{1}{3}, c = \frac{1}{2}$$

B

$$a = -\frac{5}{6}, b = \frac{1}{3}, c = \frac{1}{2}$$

C

$$a = -\frac{5}{6}, b = \frac{1}{2}, c = \frac{1}{3}$$

D

$$a = \frac{3}{2}, b = -\frac{1}{3}, c = \frac{1}{2}$$

$$T = K P^a d^b E^c P^d d^d$$

$$M^0 L^0 T^1 = \frac{(M L^{-1} T^{-2})^a (M L^{-3})^b (M L^2 T^{-2})^c (M L T^{-1})^d}{P^d d^d}$$

Variable

Unknown

तीन बराबर

 $a, b, c, d = ?$ Variable

Question

The energy E of an oscillating body in simple harmonic motion depends on its mass m , frequency n and amplitude A as $E = k(m)^x(n)^y(A)^z$. Find the value of $(2x + y + z)$.

$$\frac{1}{T^{-1}}$$

Class

Question

P
W

The value of Stefan's constant in CGS system is $\sigma = 5.67 \times 10^{-5} \text{ erg s}^{-1} \text{ cm}^{-2} \text{ K}^{-4}$. Its value in SI units is

$$\begin{aligned}\sigma &= \frac{5.67 \times 10^{-5} \text{ J}}{\text{s.} \left(\frac{1}{100} \text{ m}\right)^2 \text{ K}^4} \times \frac{1 \text{ J}}{10^7} \\&= 5.67 \times 10^{-5+4-7} \left(\frac{\text{J}}{\text{sec. m}^2 \cdot \text{K}^4} \right) \\&= 5.67 \times 10^{-8}\end{aligned}$$

Ans - $5.67 \times 10^{-8} \text{ J} \cdot \text{s}^{-1} \text{m}^{-2} \text{ K}^{-4}$

$$1 \text{ J} = 10^7 \text{ erg}$$

$$1 \text{ erg} = \frac{1 \text{ J}}{10^7}$$

Question

$$x \cdot y = \cancel{\text{m/s}}$$

$$x \cdot x = \cancel{\text{m/s}}$$

$$x^2 = \cancel{\text{m/s}}$$

$$x = \sqrt{\cancel{\text{m/s}}} \equiv y = 3$$

Consider three physical quantities x, y and z . Operations $x + y$ and $y - z$ are valid with these physical quantities. Which of the following conclusions can you make?

A

The operation $x \pm z$ is also valid

B

If dimension of any of the three is known, dimension of other two can be predicted.

C

If dimension of product of any two of them is known, dimension of all of them can be predicted.

D

If dimension of quotient of any two of them is known, dimension of all of them can be predicted.

$$\boxed{x, y, z} \equiv \text{Same D.F. Einheit}$$

$$x \cdot y = L^2 \text{ (let)}$$

$$x \cdot x = x^2 = L^2$$

$$x = L$$

A, B, C

Question

Viscous force acting on a spherical ball is given by $F = 6\pi\eta rv$, where r is radius of the ball, v is the velocity of the ball & η is coefficient of viscosity. Dimension formula of η is given by $[\eta] = M^a L^{-b} T^{-c}$. Find the value of $a + b + c$

Class

$$\eta = \frac{F}{6\pi rv}$$

Q

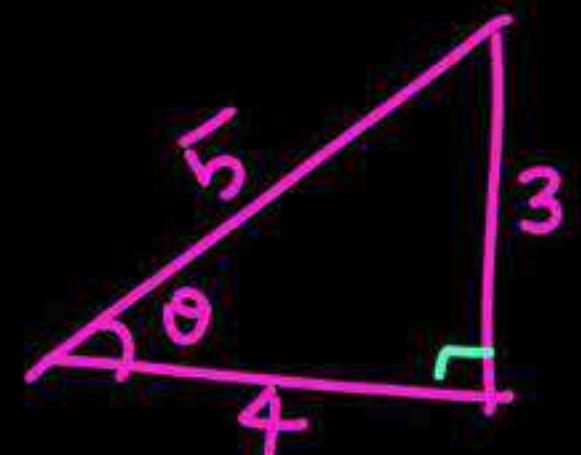
$$\cos \theta = \frac{4}{5}$$

find $\sin \theta = \frac{3}{5}$

$$\tan \theta = \frac{3}{4}$$

$$\cot \theta = \frac{4}{3}$$

$$\sec \theta = \frac{5}{4}$$



Q. In a hypothetical system

$$1 \text{ unit of mass} = 10 \text{ kg}$$

$$1 \text{ Unit of length} = 4 \text{ m}$$

$$1 \text{ Unit of Sec} = 2 \text{ sec}$$

$$\text{m L T}^{-2}$$

① Find value of 1 unit of force

$$1 \text{ Unit of force} = 10 \text{ kg} \cdot 4 \text{ m} \cdot (2 \text{ sec})^{-2} = \frac{10 \times 4}{4} \frac{\text{kg m}}{\text{sec}^2}$$

- ② Find value of 5 Unit of force in newton = 10 N
- ③ what is numerical value of 1 Newton in this new system. = 5 N

In a hypothetical system (Alien system)

1 Unit of mass = 10 kg

" " length = 4 m

" " time = 2 sec

- ① ✓
- ② ✗

① 1 Unit of force = 10 N

② Numerical value of 1 N in this system.

10 N = 1 Unit of force in new system

$$10 \text{ N} = 1 \text{ N}' = 1 \text{ ong}$$

$$1 \text{ N} = \frac{1}{10} \text{ N}'$$

Q In a alien system

$$1 \text{ unit of mass} = 5 \text{ kg}$$

$$1 \text{ unit of length} = \frac{1}{2} \text{ m}$$

$$1 \text{ unit of time} = 10 \text{ sec.}$$

C value of $20N$ in new system

$$1N = 40N'$$

$$20N = 20 \times 40N' = 800N'$$

① 1 unit of force in new system in terms of newton. $= \frac{5 \times \frac{1}{2}}{100} \frac{\text{kg m}}{\text{sec}^2}$
 $(1N')$
 $= \frac{1}{40} N$

② Numerical value of $1N$ in this system.

$$1N' = \frac{1}{40} N$$

$$1N = 40 N$$

Q In a alien system

$$1 \text{ unit of mass} = 5 \text{ kg}$$

$$1 \text{ unit of length} = \frac{1}{2} \text{ m}$$

$$1 \text{ unit of time} = 10 \text{ sec.}$$

$$m L^2 T^{-2}$$

④ 1 unit of Energy in new system in terms of Joule = $\frac{5 \text{ kg} \cdot \left(\frac{1}{2} \text{ m}\right)^2}{(10 \text{ sec})^2}$

$$1 J' = \frac{5}{400} \frac{\text{kg m}^2}{\text{sec}^2} = \frac{1}{80} \text{ J}$$

⑤ Numerical value of $1 J'$ in this system.

$$1 J' = \frac{1}{80} \text{ J}$$

$$1 J = 80 J'$$

⑥ Value of $20 J$ in this system.
 $= 1600 J'$

PW

Q Convert 1N in dyne

Value of $1N$ in dyne

S.I., इमरा	उत्तम (CGS)
$m_1 = 1 \text{ kg}$	$m_2 = 1 \text{ gm} = \frac{1}{1000} \text{ kg}$
$L_1 = 1 \text{ m}$	$L_2 = 1 \text{ m} = \frac{1}{100} \text{ m}$
$T_1 = 1 \text{ sec}$	$T_2 = 1 \text{ sec}$
1 N	
$n_1 = 1$	$n_2 = \infty$
$n_1 \cdot v - n_2 \cdot v$	MLT^{-2}

$$1 \times \cancel{\frac{kg \cdot m}{s^2}} = x \cancel{\frac{kg \cdot 1 \cdot m}{1000 \cdot 100}} \underline{\underline{s^2}}$$

$$I = \frac{x}{100000}$$

• ~~प्रतिकृति का तरीका~~ प्रतिकृति का तरीका
• ~~प्रतिकृति का तरीका~~ प्रतिकृति का तरीका

In a hypothetical system

$$\begin{aligned} \text{1 unit of mass} &= 20 \text{ kg} \\ \text{length} &= 2 \text{ m} \\ \text{time} &= 2 \text{ sec.} \end{aligned}$$

Find the numerical value of 40N
in this system

EMRT

$$1N' = \frac{20 \text{ kg} \cdot 2 \text{ m.}}{(2 \text{ sec})^2} = 10 \frac{\text{kg m}}{\text{sec}^2}$$

$$1N' = 10 \text{ N}$$

$$\underline{4N' = 40N}$$

Avg

4

$$\begin{aligned} 10N &= 1N' \\ 1N &= \frac{1}{10} N' \\ 40N &= \frac{40}{10} N' \\ &= 4N' \end{aligned}$$

BOOK	$40N = x N'$
EHTII	
$m_1 = 1 \text{ kg}$	$m_2 = 20 \text{ kg}$
$L_1 = 1 \text{ m}$	$L_2 = 2 \text{ m}$
$T_1 = 1 \text{ sec}$	$T_2 = 2 \text{ sec}$
$n_1 = 40$	$n_2 = ?$

$$n_1 U_1 = n_2 U_2$$

$$40 \times \frac{\text{kg m}}{\text{sec}^2} = n_2 \cdot \frac{20 \text{ kg} \cdot 2 \text{ m}}{(2 \text{ sec})^2}$$

$$n_2 = \frac{40 \times 4}{40}$$

$$\boxed{n_2 = 4}$$

Q In a hypothetical system

$$m^2 t^{-2}$$

$$1 \text{ unit of mass} = 10 \text{ kg}$$

$$\text{.. .. Length} = 2 \text{ m}$$

$$\text{.. .. time} = 2 \text{ sec}$$

① 1 unit of energy in this system

$$1 J' = \frac{10 \text{ kg} (2 \text{ m})^2}{(2 \text{ sec})^2} = 10 \frac{\text{kg m}^2}{\text{sec}^2}$$

$$1 J' = 10 J$$

Numerical value

② Value of 20 J in this system

$$10 J = 1 J'$$

$$20 J = 2 J'$$

$$\underline{\text{Ans}} \quad \underline{\frac{2}{2}}$$

$$20 = n_2 \times \frac{10 \times 2}{2}$$

$$n_2 = 2$$

Q.

If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is:

मुक्त

P
W

(JEE Main-2020)

- A** $[PA^{-1} T^{-2}]$
- B** $[PA^{1/2} T^{-1}]$
- C** $[P^2 AT^{-2}]$
- D** $[P^{1/2} AT^{-1}]$

 m_1

$$\begin{aligned} E &= P^x A^y T^z \\ &= (m L T^{-1})^x (L^2)^y T^z \end{aligned}$$

$$m L^2 T^{-2} = m^x L^{x+2y} T^{-x+z}$$

Compare

$$x=1, x+2y=2$$

$$1+2y=2$$

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

$$-x+z=-2$$

$$-1+z=-2$$

$$z=-1$$

$$E = P^1 A^{\frac{1}{2}} T^{-1}$$

Ans : (B)

Q.

If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is:

(JEE Main-2020)

A

$$[PA^{-1} T^{-2}]$$

B

$$[PA^{1/2} T^{-1}]$$

C

$$[P^2 A T^{-2}]$$

D

$$[P^{1/2} A T^{-1}]$$

m^{-2} = Optimal check \checkmark

$$m L^2 T^{-2}$$

(A) $\frac{P}{AT^2} = \frac{m L T^{-1}}{L^2 T^2} = m L^{-1} T^{-3}$ \times
 match

(B) $\frac{P \cdot A^{\frac{1}{2}}}{T} \equiv \frac{m L T^{-1} \cdot \sqrt{L^2}}{T} = m L^2 T^{-2}$

Ans : (B)

Q.

$$mvr \Rightarrow M L^2 T^{-1}$$

If time (t), velocity (v), and angular momentum (ℓ) are taken as the fundamental units. Then the dimension of mass (m) in terms of t , v and ℓ is:

P
W

(JEE Main-2021)

A ~~$[t^{-1} v^1 \ell^{-2}]$~~

$$m = t^x v^y \ell^z$$

B ~~$[t^1 v^2 \ell^{-1}]$~~

$$= T^x (L T^{-1})^y (M L^2 T^{-1})^z$$

C ~~$[t^{-2} v^1 \ell^1]$~~

$$M^1 L^0 T^0 = M^{\frac{1}{2}} L^{y+2z} T^{x-y-z}$$

D ~~$[t^{-1} v^2 \ell^1]$~~

$$\boxed{y+2z=0}$$

$$x-y-z=0$$

$$x+2-1=0$$

$$\boxed{x=-1}$$

Ans : (D)

Q.

If E , L , M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = EL^2M^{-5}G^{-2}$ are :-

A $[M^0 L^1 T^0]$

B $[M^{-1} L^{-1} T^2]$

C $[M^1 L^1 T^{-2}]$

D $[M^0 L^0 T^0]$

(JEE Main-2021)

Ans : (D)

Q.

If force (F), length (L) and time (T) are taken as the fundamental quantities.

μ Then what will be the dimension of density:

(JEE Main-2021)

A

$$[FL^{-4} T^2]$$

B

$$[FL^{-3} T^2]$$

C

$$[FL^{-5} T^2]$$

D

$$[FL^{-3} T^3]$$

Ans : (A)

Q.

If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is : (JEE Main-2022)

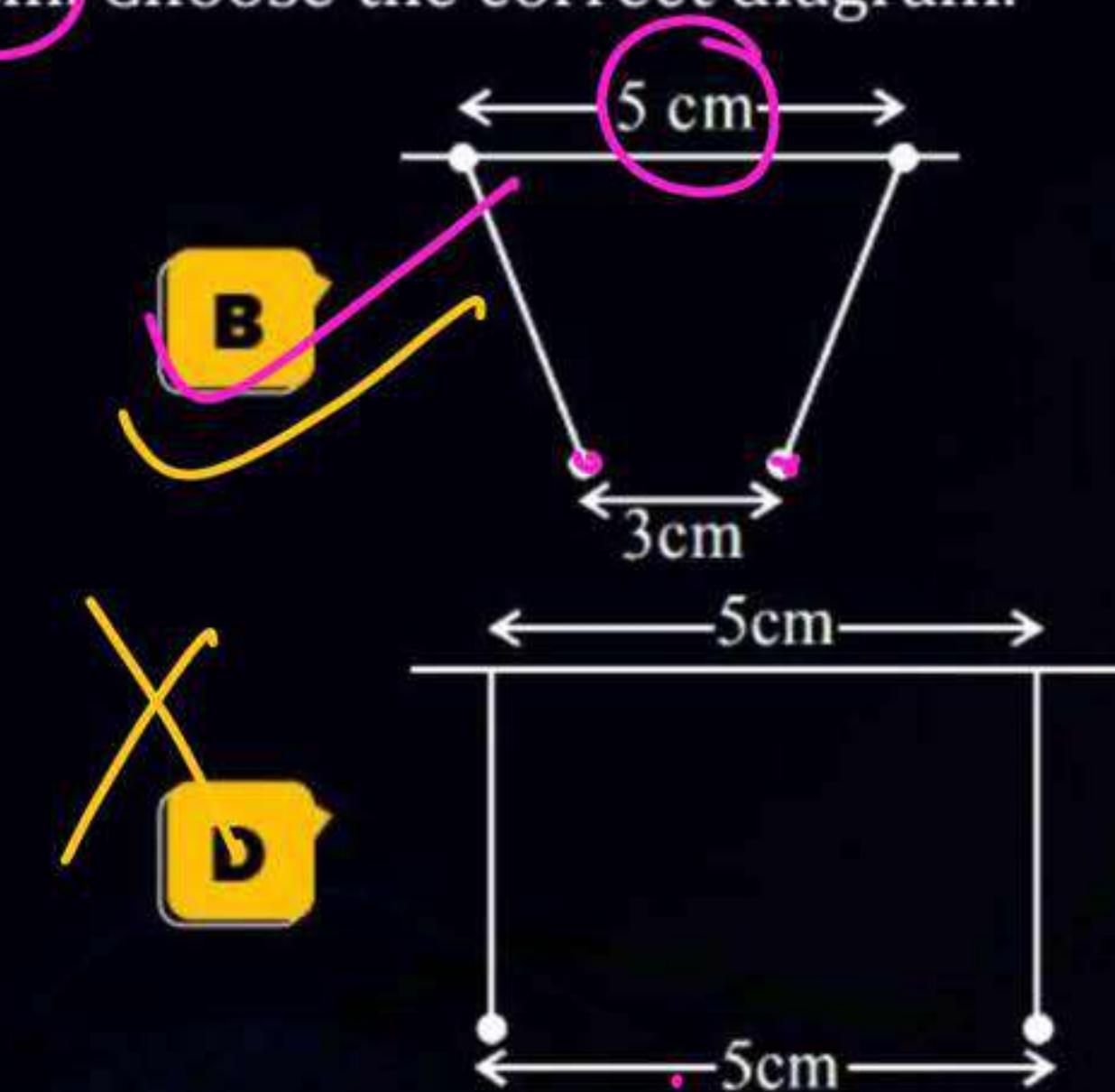
$$\eta = \frac{F}{A} \frac{V}{\tau}$$

- A** $[P A^{-1} T^0]$
- B** $[PA T^{-1}]$
- C** $[P A^{-1} T]$
- D** $[P A^{-1} T^{-1}]$

Ans : (A)

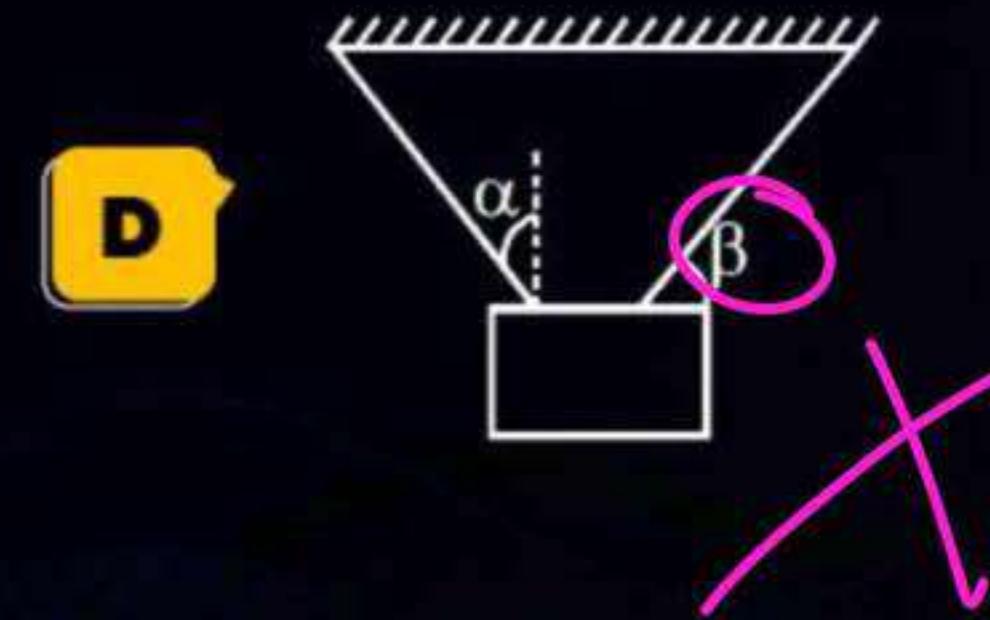
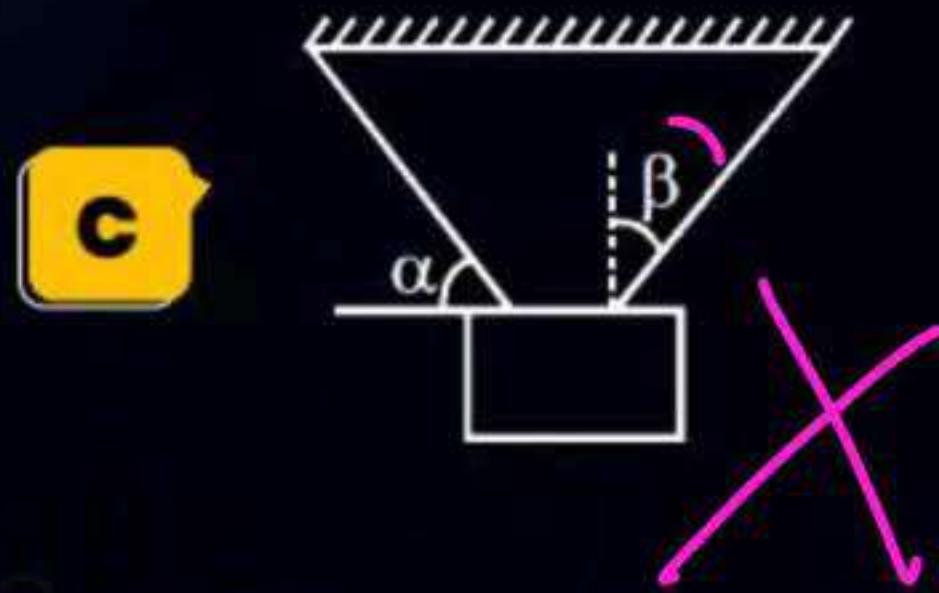
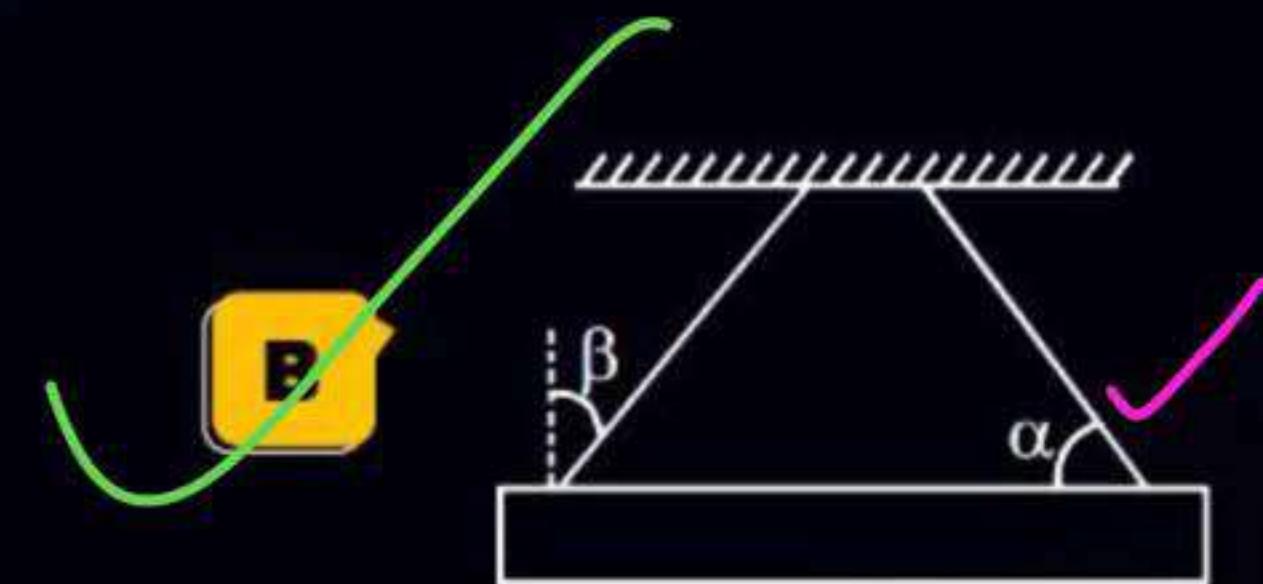
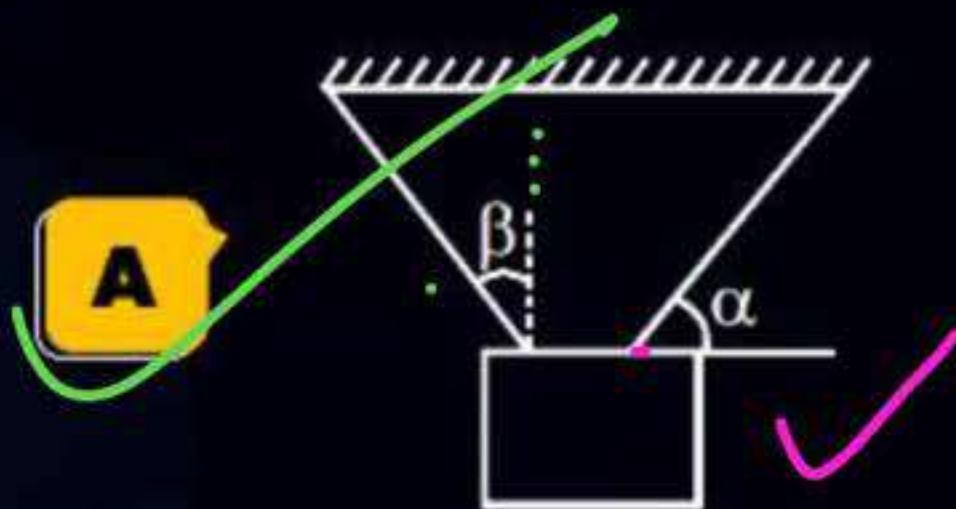
Question

Two oppositely charge particles attract to each other. Two charge particles having equal and opposite charge are suspended from a horizontal rod through two string of same length the separation between the suspension points being 5 cm. In equilibrium, the separation between the particles is 3 cm. Choose the correct diagram.



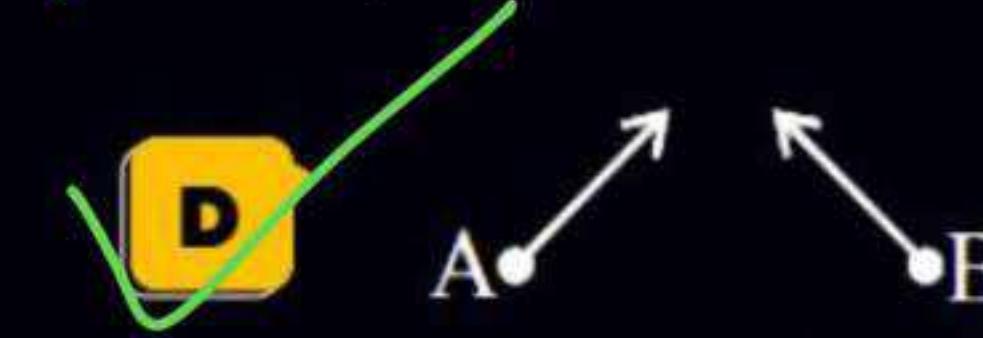
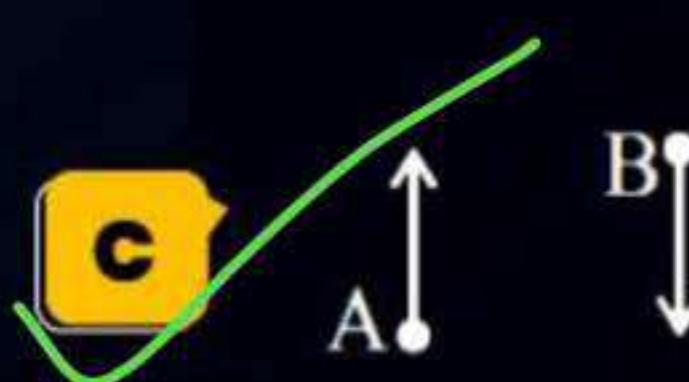
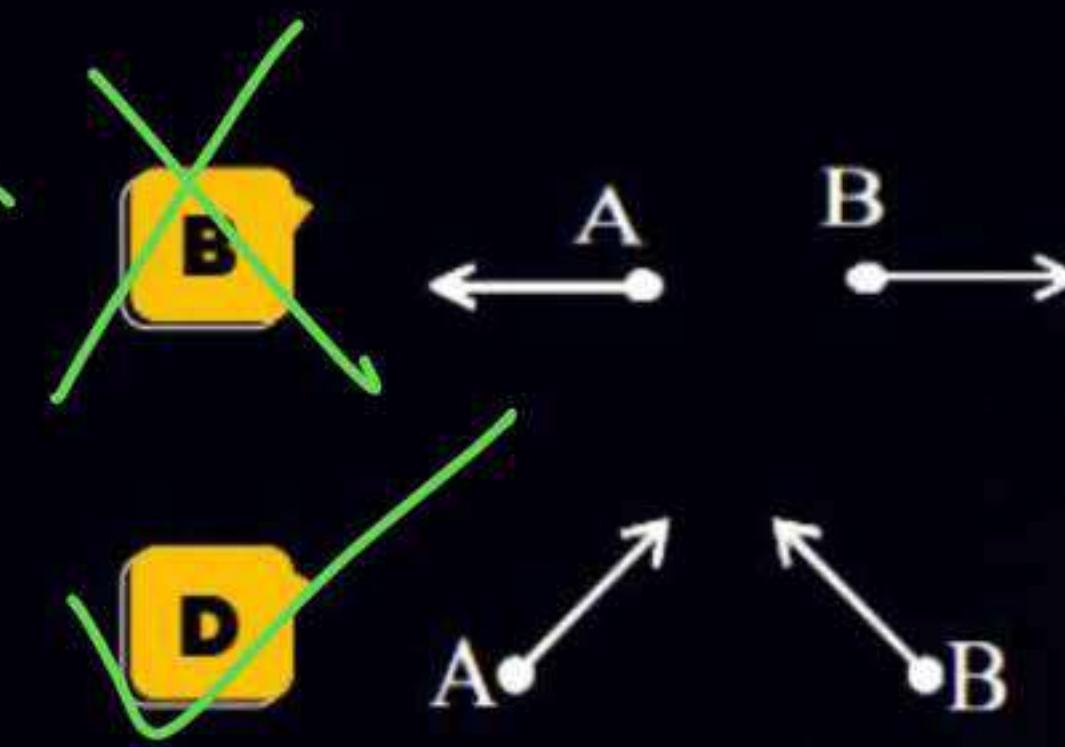
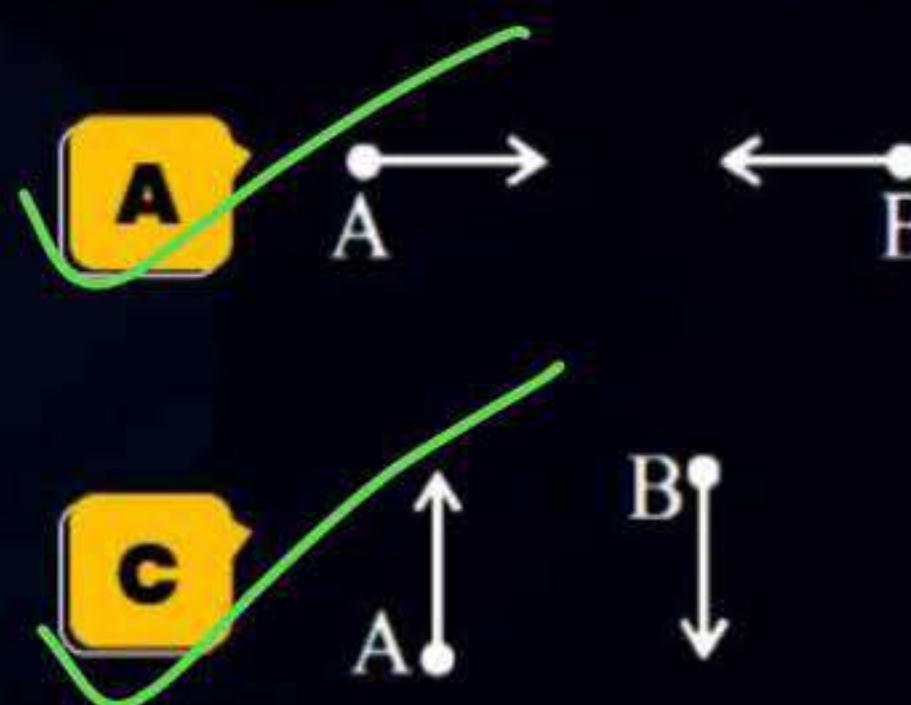
Question

A body of mass m is suspended by two strings (right string equals an angle α with horizontal & left an angle β with vertical). Choose the correct diagrams showing the situation.



Question

Two objects are said to approach each other if separation between them is decreasing and recede if separation between them is increasing with time. The following diagrams show location and direction of velocity of the two objects. Choose the situation in which they are approaching



Question

E, m, L, G denote energy, mass, angular momentum & gravitation constant respectively.

The dimensions of $\frac{E L^2}{m^5 G^2}$ will be that of :

A angle

Class

B length

C mass

D time

$$m L^2 T^{-2}$$

$$\frac{m L^2 T^{-2} \cdot (m L^2 T^{-2})^2}{m^5 (m^{-1} L^3 T^{-2})^2} = 1$$

Dimension

Question

Which of the following combinations of three dimensionally different physical quantities P, Q, R can never be a meaningful quantity?

A $PQ - R$

B PQ/R

C $(P - Q)/R$

D $(PR - Q^2)/QR$

Ans C =

Question

~~21179K~~ Next class

The gas equation for n moles of a real gas is: $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$ where P is the pressure, V is the volume, T is the absolute temperature, R is the molar gas constant and a, b are arbitrary constants. Which of the following have the same dimensions as those of PV ?

A nRT

B n^2a/V

C Pb

D ab/V^2

Question

P
W

The answer to Q.5.226 of I.E. Irodov is $\Delta\lambda = -\lambda \sqrt{\frac{2\Psi}{mv^2}} \cos \theta$. Here symbols have their usual notations. Ψ can represent

- A kinetic energy
- B power
- C force
- D pressure

Handwritten notes and equations:

- Wavelength λ (circled in green)
- Change in Wavelength $\Delta\lambda$ (circled in blue)
- Equation: $\Delta\lambda = -\lambda \sqrt{\frac{2\Psi}{mv^2}} \cos \theta$ (circled in green)
- Dimensionless (circled in pink)
- Dimensionless (underlined)
- $\Psi \equiv mv^2$ (circled in green)

Question

Class Notes

The dimensions of $\frac{a}{b}$ in the equation $P = \frac{a-t^2}{bx}$ where P is pressure, x is distance and t is time, are

Solve

$$a = T^2$$

$$a = T^2$$

$$m^{-1}L^{-2} = \frac{T^2}{b \cdot L}$$

$$b = m^{-1} L^0 T^4$$

$$\frac{a}{b} = \frac{T^2}{m^{-1} L^0 T^4} = m^1 L^0 T^{-2}$$

- A $[M^2 L T^{-3}]$
- B $[MT^{-2}]$
- C $[LT^{-3}]$
- D $[ML^3 T^{-1}]$

Question

Which of the following physical quantities represents the dimensional formula

$$[M^1 L^{-2} T^{-2}]$$

Clue

$$\frac{ML^2T^{-2}}{L^2} = \underline{ML^0T^{-2}}$$

- A** Energy/Area
- B** Pressure
- C** Force \times length
- D** Pressure per unit length

$$\frac{MLT^{-2}}{L^2 \cdot L} = \underline{ML^2T^{-2}}$$

Question

The time dependence of a physical quantity p is given by $p = p_0 e^{(-\alpha t^2)}$ where α is constant and t is time. The constant α

- A is dimensionless
- B has dimensions T^{-2}
- C has dimensions T^2
- D has dimensions of p

$$\propto t^2 = 1$$

$$\propto T^2 = 1$$

$$\propto = T^{-2}$$

Conversion of Unit

P
W

① $P = 20 \frac{\text{Kg m}}{\text{sec}}$ Convert into CGS $\rightarrow \frac{20 \times 1000 \text{ gm.} \times 100 \text{ cm}}{\text{sec}}$
 $= 2 \times 10^6 \frac{\text{gm cm}}{\text{sec}}$ ✓

$$\text{force} \rightarrow \text{MLT}^{-2}$$

Q Convert 1N into dyne dyne \rightarrow Unit of force
 Convert 1N into CGS system in CGS System.

SOL

$$\begin{aligned}
 1\text{N} &= \frac{1\text{Kg m}}{\text{sec}^2} && \xrightarrow{\text{convert into CGS system}} \\
 & & & \frac{1 \times 1000 \text{gm}}{\text{sec}^2} \times 100 \text{cm} \\
 & & & = 10^5 \frac{\text{gm} \cdot \text{cm}}{\text{sec}^2} && \text{Unit of force CGS system} \\
 & & & = 10^5 \text{ dyne}
 \end{aligned}$$

Q $375 \text{ N} \xrightarrow[\text{CGS}]{\text{convert into}}$

$$375 \frac{\text{kg m}}{\text{sec}^2} \xrightarrow[\text{CGS ✓}]{\text{CGS}} \frac{375 \times 1000 \text{ gm} \times 100 \text{ cm}}{\text{sec}^2}$$

$$= 37500000$$

$$= 375 \times 10^5$$

$\frac{\text{gm cm}}{\text{sec}^2}$
dynes

Q

Convert 1 Joule into CGS system
 " " " erg

(erg → Unit of energy in
 CGS system)

$$1 \text{ J} = 1 \frac{\text{kg m}^2}{\text{sec}^2}$$

convert
into CGS

$$\frac{1 \times 1000 \text{ gm} \times (100 \text{ cm})^2}{\text{sec}^2}$$

$$= 10^7 \frac{\text{gm cm}^2}{\text{sec}^2}$$

$$= 10^7 \text{ erg.}$$

MLT^{-2}

$$\text{Q} m=5\text{kg}, a=3\text{m/sec}^2$$

$$F = m \cdot a$$

$$= 5\text{kg} \cdot 3\text{m/sec}^2$$

$$= 15 \boxed{\text{kg m/sec}^2}$$

$$= 15 \text{ N}$$

SKC

$$1 \text{N} = \frac{1 \text{kgm}}{\text{sec}^2}$$

$$1 \text{ dyne} = \frac{1 \text{ gm cm}}{\text{sec}^2}$$

$$1 \text{ Joule} = \frac{1 \text{ kgm}^2}{\text{sec}^2}$$

$$1 \text{ erg} = \frac{1 \text{ gm} \cdot \text{cm}^2}{\text{sec}^2}$$

$$1 \text{m} = 100 \text{cm}$$

Q.

कार्य

In a hypothetical system

EMRI Method

$$1 \text{ unit of mass} = 20 \text{ kg}$$

$$1 \text{ unit of length} = 5 \text{ m}$$

$$1 \text{ unit of time} = 2 \text{ sec.}$$

a) Find value of 1 unit of force

$$1 \text{ unit of force} = 20 \text{ kg} \cdot 5 \text{ m} (2 \text{ sec})^{-2}$$

$$= \frac{20 \times 5}{4} \frac{\text{kg} \cdot \text{m.}}{\text{sec}^2}$$

$$= 25 \text{ N}$$

(b) find the value
of 1 unit of energy

$$20 \text{ kg} (5 \text{ m})^2 (2 \text{ sec})^{-2}$$

$$= \frac{20 \times 25}{4} \frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2}$$

$$= 125 \text{ Joule.}$$

Q.

In a hypothetical system

P
W

1 unit of mass = 20 kg

1 Unit of length = 5 m

1 Unit of sec = 2 sec.

① Find value of 1 unit of force

m-2 Book वाली method.

Q.

In a hypothetical system

BY

P
W

1 unit of mass = 5 kg

1 unit of length = 2 m

1 Unit of Sec = 2 sec.

② Find the value of
1 Unit of energy

① Find value of 1 unit of force

$$5 \text{ kg} \cdot 2 \text{ m} \cdot (2 \text{ sec})^{-2}$$

$$= \frac{10}{4} \text{ kg m/sec}^2 = 2.5 \text{ N}$$

$$\frac{5 \text{ kg} \cdot (2 \text{ m})^2}{(2 \text{ sec})^2} = \frac{5 \text{ kg m}^2}{\text{sec}^2}$$

= 5 Joule.

Q. Time period of a simple pendulum depends on 'm' of block
length of string (l) & acc due to gravity g
Derived the formula for time period.

P
W

$$T = k m^x l^y g^z$$
$$m^0 L^0 T^1 = m^x L^y (L T^{-2})^z$$



$$T = K m^x l^y g^z$$

$$m^0 l^0 T^{-1} = m^x l^y (LT^{-2})^z$$

$$= m^x l^y L^z T^{-2z}$$

$$m^0 l^0 T^1 = m^x l^{y+3} T^{-2z}$$

Compare

$$x=0,$$

$$y+3=0$$

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

$$\rightarrow y=-z=-\left(-\frac{1}{2}\right)=\frac{1}{2}$$

$$T = K m^0 l^{\frac{1}{2}} \cdot g^{-\frac{1}{2}} = \frac{K \sqrt{l}}{\sqrt{g}}$$

$$T = K \sqrt{\frac{l}{g}}$$

(E) $E = K m^x A^y f^z$ Ans
 Q Energy of a particle performing SHM depends on
 mass (m) of object , Amplitude (A) , frequency f of motion
 Derive the relation b/w them.

प्रत्यक्ष कदम्

जिते आवश्यक
जीवन की दिमानें

$$E \propto m^x A^y f^z$$

$$m L^2 T^{-2} = m^x L^y (T^{-1})^z$$

$$m L^2 T^{-2} = m^x L^y T^{-z}$$

Compare.

$$x = 1$$

$$y = 2$$

$$-3 = -2$$

$$z = 2$$

$$E = K M A^2 f^2$$

Q Suppose Force depends on mass(m), speed(v), and radius 'r'
 Derive the relation b/w them

$$F = K m^x v^y r^z$$

$$m L T^{-2} = m^x (L T^{-1})^y L^z$$

$$m^1 L T^{-2} = m^x L^y T^{-y}$$

Compare power

$$x=1$$

$$-y = -2$$

$$y=2$$

$$y+z=1$$

$$2+3=1$$

प्रताग्री

$$F = K m^1 v^2 r^{-1}$$

$$f = K \frac{m v^2}{r}$$

en अभी कुछ
नहीं पता

Q A satellite is revolving around the earth such that

time period T of satellite depends on M (mass of earth), gravitational const (G), and radius of orbit r ,

Derive the formula for time period of satellite

$$T = K m^{\frac{1}{2}} G^{\frac{1}{2}} r^{\frac{3}{2}}$$

✓

$2 \times$

$3 \rightarrow$ इवान्टी
नोटी

$$T = K m^x G^y r^z$$

$$T = m^x (m^{-1} L^3 T^{-2})^y L^z$$

$$m^0 L^0 T^1 = m^{x-y} L^{3y+z} T^{-2y}$$

$$x - y = 0$$

$$x = y \Rightarrow x = -\frac{1}{2}$$

$$\begin{cases} -2y = 1 \\ y = -\frac{1}{2} \end{cases}$$

$$G = m^{-1} L^3 T^{-2}$$

$$\begin{aligned} 3y + z &= 0 \\ 3 &= -3y = +3/2 \end{aligned}$$

H/W A satellite is revolving around the earth such that
 Q Orbital velocity v_o of satellite depends on M (mass of earth),
 gravitational cons. (G), and radius of orbit r ,
 Derive the formula for orbital velocity of satellite

$$v_o = k m^{\frac{1}{2}} G^{\frac{1}{2}} r^{-\frac{1}{2}}$$

$$v_o = k M^x G^y r^z$$

$$LT^{-1} = M^x (m^{-1} L^3 T^{-2})^y L^z$$

$$m^0 L T^{-1}$$

$$= m^{x-y} L^{3y+z} T^{-2y}$$

① ✓

② ✗

③ try to fit

$$G = m^{-1} L^3 T^{-2}$$

$$y = \frac{1}{2}, x-y=0$$

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

$$3y+z=1$$

$$\frac{3}{2} + z = 1 \Rightarrow z = -\frac{1}{2}$$

Q.

$$E = h\nu \quad h = \frac{E}{\nu}$$

A quantity f is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of:

(IIT Main-2020)

- A** Momentum
- B** Area
- C** Energy
- D** Volume

$$\sqrt{\frac{m L^2 T^{-2}}{T^{-1}} \times \frac{(L T^{-1})^5}{m^{-1} L^3 T^{-2}}} = \sqrt{m^2 L^4 T^{-4}} \\ = \boxed{m L^2 T^{-2}}$$

Ans : (C)

Q.

Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is: (JEE Main-2020)

- A $ML^2 T^{-2}$
- B MLT^{-2}
- C $M^2 L^0 T^{-1}$
- D $ML^0 T^{-3}$

$$\text{Solar const} = \frac{E}{\text{Area of one square meter}} = \frac{m L^2 T^{-2}}{L^2 \cdot T^{-1}}$$

⇒ $m^1 L^0 T^{-3}$

Ans : (D)

Q.

Tough Go... gently (J)

In a typical combustion engine the work done by a gas molecule is given

$W = \alpha^2 \beta e^{\frac{-\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be:

(JEE Main-2021)

- A [MLT⁻²]
- B [M⁰LT⁰]
- C [M²LT⁻²]
- D [MLT⁻¹]

$$\frac{\beta L^2}{m^2 T^{-2}} = 1$$

$$\boxed{\beta = m T^{-2}}$$

$$W = \alpha^2 \beta e^{(\quad)}$$

~~$$ML^2 T^{-4} = \alpha^2 m T^{-2}$$~~

~~$$\alpha^2 = L^2$$~~

$$\alpha = L$$

Ans : (B)

Q.

The force is given in terms of time t and displacement x by the equation $F = A \cos(Bx) + C \sin(Dt)$. The dimensional formula of AD/B is: (JEE Main-2021)

A

$$[M^0 L T^{-1}]$$

B

$$[M L^2 T^{-3}]$$

C

$$[M^1 L^1 T^{-2}]$$

D

$$[M^2 L^2 T^{-3}]$$

$$\begin{aligned} D &= T^{-1} \\ B &= L^{-1} \end{aligned}$$

$A \rightarrow$ force

$$\frac{AD}{B} = \frac{MLT^{-2} \cdot T^{-1}}{L^{-1}}$$

$$ML^2 T^{-3}$$

Ans : (B)

Q.

Match List-I with List-II.

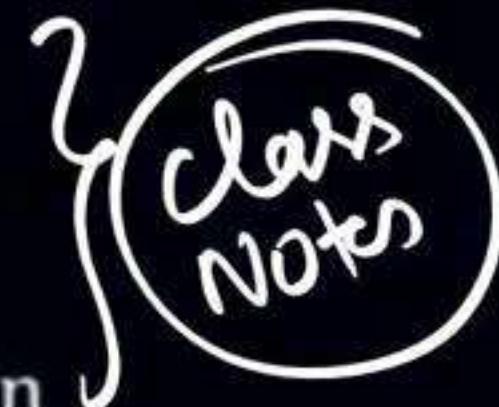
(JEE Main-2021)

List-I

- (a) Torque
- (b) Impulse
- (c) Tension
- (d) Surface Tension

List-II

- (i) MLT^{-1}
- (ii) MT^{-2}
- (iii) ML^2T^{-2}
- (iv) MLT^{-2}



Choose the most appropriate answer from the option given below :

A

(a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

B

(a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

C

(a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

D

(a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

Ans : (A)

$$Q \quad \vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

$$\vec{B} = 2\hat{i} + 3\hat{j} - 2\hat{k}$$

$$\vec{A} + \vec{B} = 5\hat{i} + 7\hat{j} + 3\hat{k}$$

$$Q \quad \vec{A} = 3\hat{i} + 4\hat{j} + 6\hat{k}$$

$$2\vec{A} = 6\hat{i} + 8\hat{j} + 12\hat{k}$$

$$= 2(3\hat{i} + 4\hat{j} + 6\hat{k})$$

$$-3\vec{A} = -9\hat{i} - 12\hat{j} - 18\hat{k}$$

$$Q \quad \vec{A} = 6\hat{i} + 3\hat{j} + 2\hat{k}$$

$$\vec{B} = \hat{i} + 6\hat{j} + 5\hat{k}$$

$$\vec{A} + \vec{B} = 7\hat{i} + 9\hat{j} + 7\hat{k}$$

$$Q \quad \vec{A} = 7\hat{i} + 3\hat{j} + 8\hat{k}$$

$$\vec{B} = 5\hat{i} + \hat{j} + 2\hat{k}$$

$$\vec{A} - \vec{B} = 2\hat{i} + 2\hat{j} + 6\hat{k}$$

$$\textcircled{1} \quad \vec{A} = 3\hat{i} + 2\hat{j} + 5\hat{k}$$

$$\vec{B} = 2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$\textcircled{2} \quad \vec{A} + \vec{B} = 5\hat{i} + 5\hat{j} + 9\hat{k}$$

$$\textcircled{3} \quad \vec{A} - \vec{B} = \hat{i} - \hat{j} + \hat{k} \equiv$$

$$\textcircled{4} \quad |\vec{A} + \vec{B}| = \sqrt{5^2 + 5^2 + 9^2}$$

$$\textcircled{5} \quad |\vec{A} - \vec{B}| = \sqrt{3}$$

$$\textcircled{6} \quad 2\vec{A} + 3\vec{B} = 12\hat{i} + 13\hat{j} + 22\hat{k}$$

$$(6) \quad |2\vec{A} + 3\vec{B}| = \sqrt{(12)^2 + (13)^2 + (22)^2}$$

$$\textcircled{7} \quad 2\vec{A} - 3\vec{B} = 0\hat{i} + (4-9)\hat{j}$$

$$+ (10-12)\hat{k}$$

$$= -5\hat{j} - 2\hat{k}$$

Q $\vec{A} = 2\hat{i} + \hat{j} + \hat{k}$
 $\vec{B} = 4\hat{i} + \hat{j} + 4\hat{k}$

find a vector \vec{C} whose magnitude is 20 and dir^n is opposite to $4\vec{A} + \vec{B}$

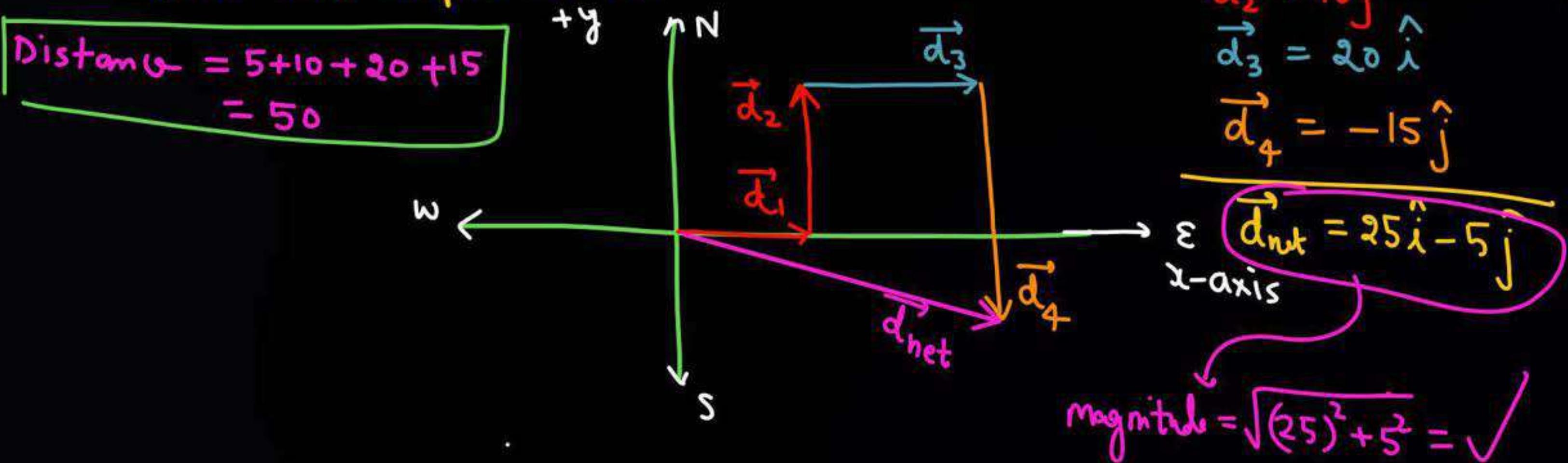
$$4\vec{A} + \vec{B} = 12\hat{i} + 5\hat{j} + 8\hat{k}$$

Ans $\Rightarrow -20 \times \left(\frac{12\hat{i} + 5\hat{j} + 8\hat{k}}{\sqrt{12^2 + 5^2 + 8^2}} \right)$

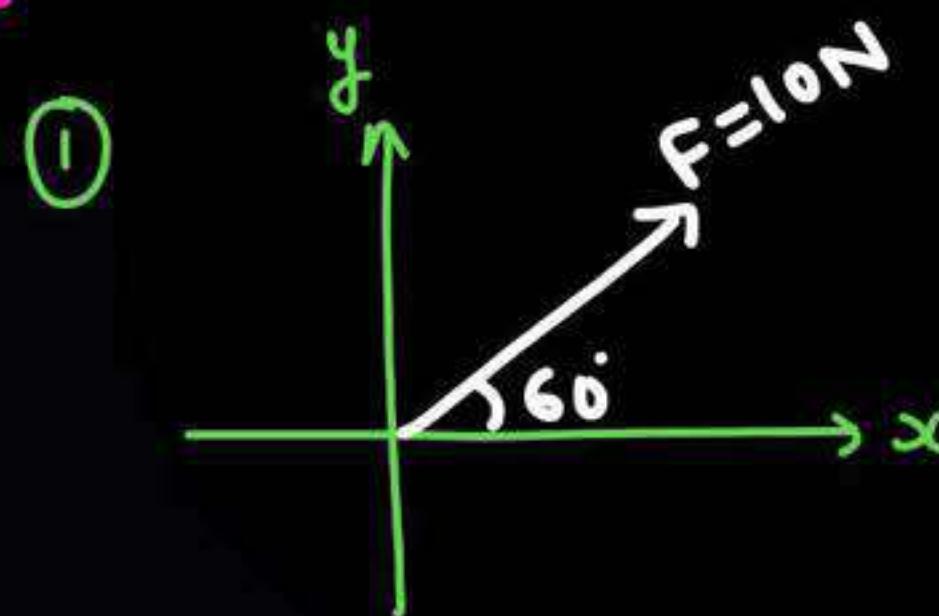
minus

Kinematics

Q A man move 5m along east, then turn left & move 10m along north, then turn right and move 20m east & then turn right to south & move 15m. find net displacement, Distance travel



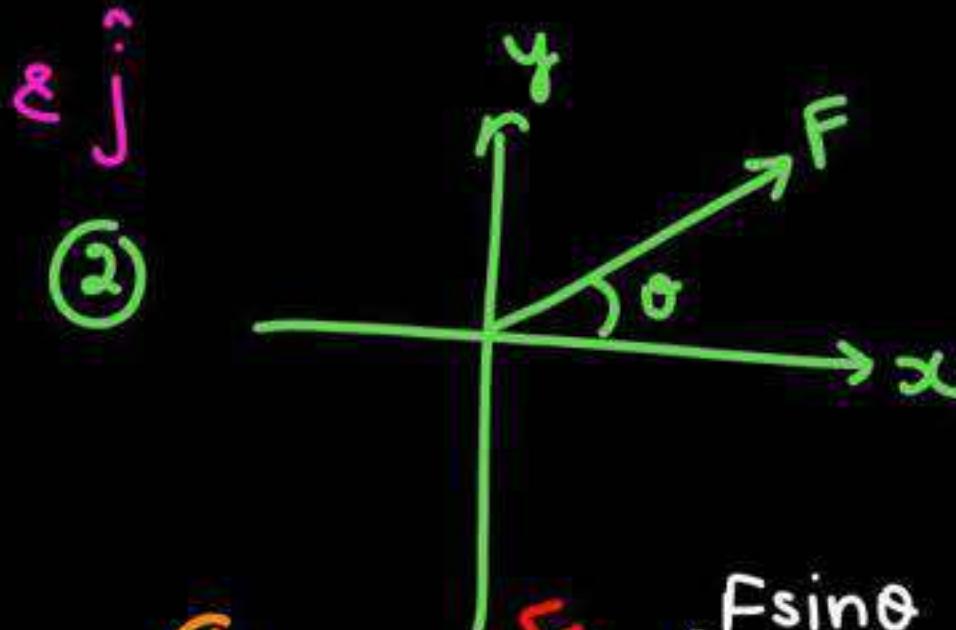
Q Resolve the vector into \hat{i} & \hat{j}



$$\vec{F} = 10\cos 60 \hat{i} + 10\sin 60 \hat{j}$$

$$= 10 \times \frac{1}{2} \hat{i} + 10 \frac{\sqrt{3}}{2} \hat{j}$$

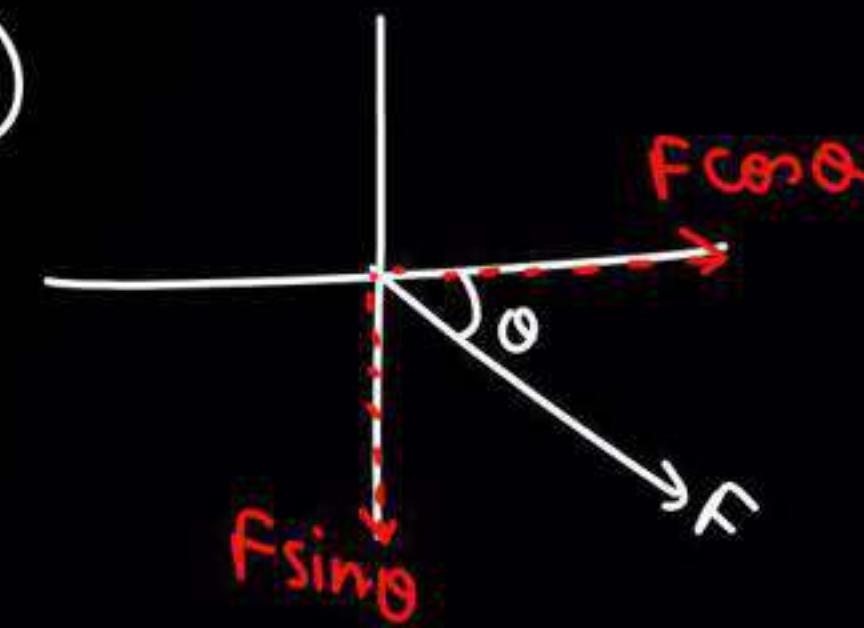
$$\boxed{\vec{F} = 5\hat{i} + 5\sqrt{3}\hat{j}}$$



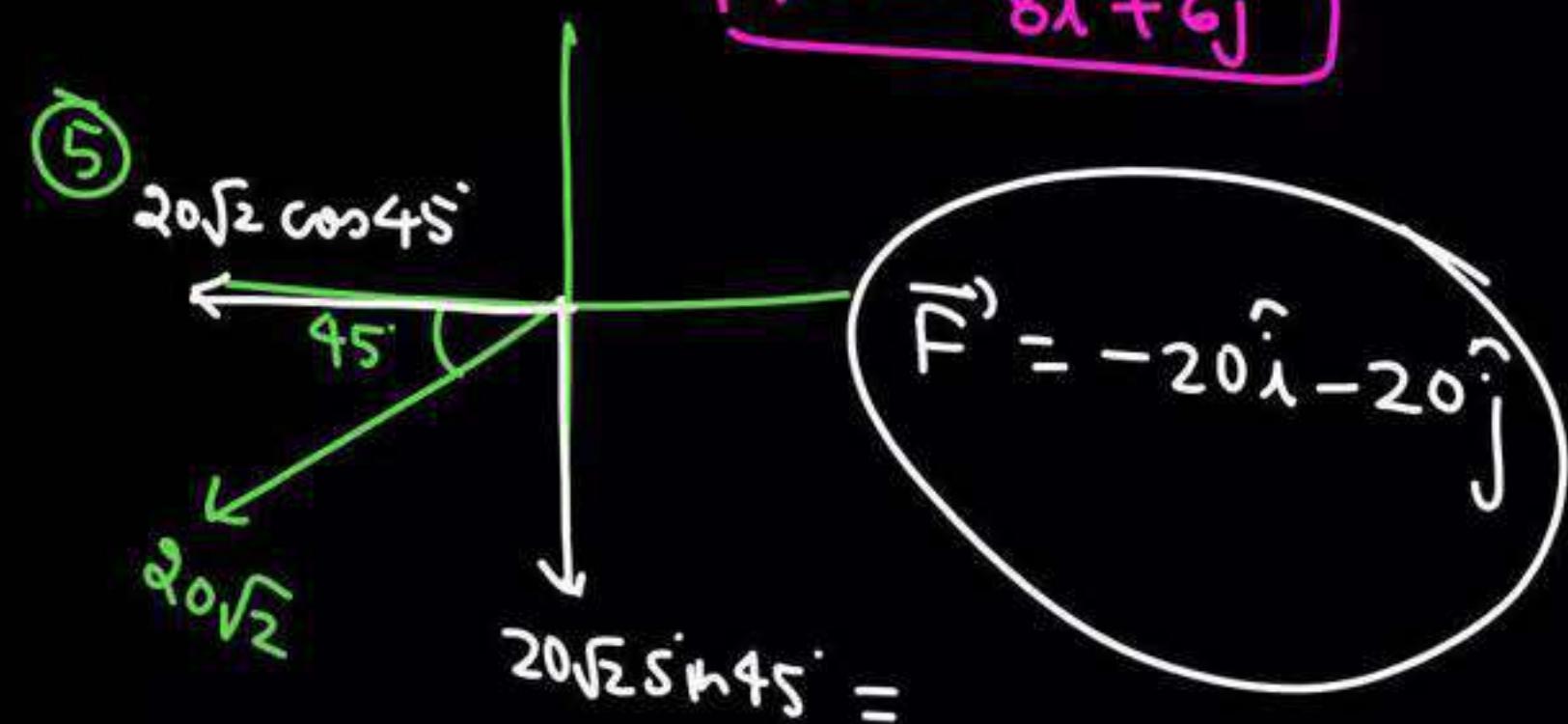
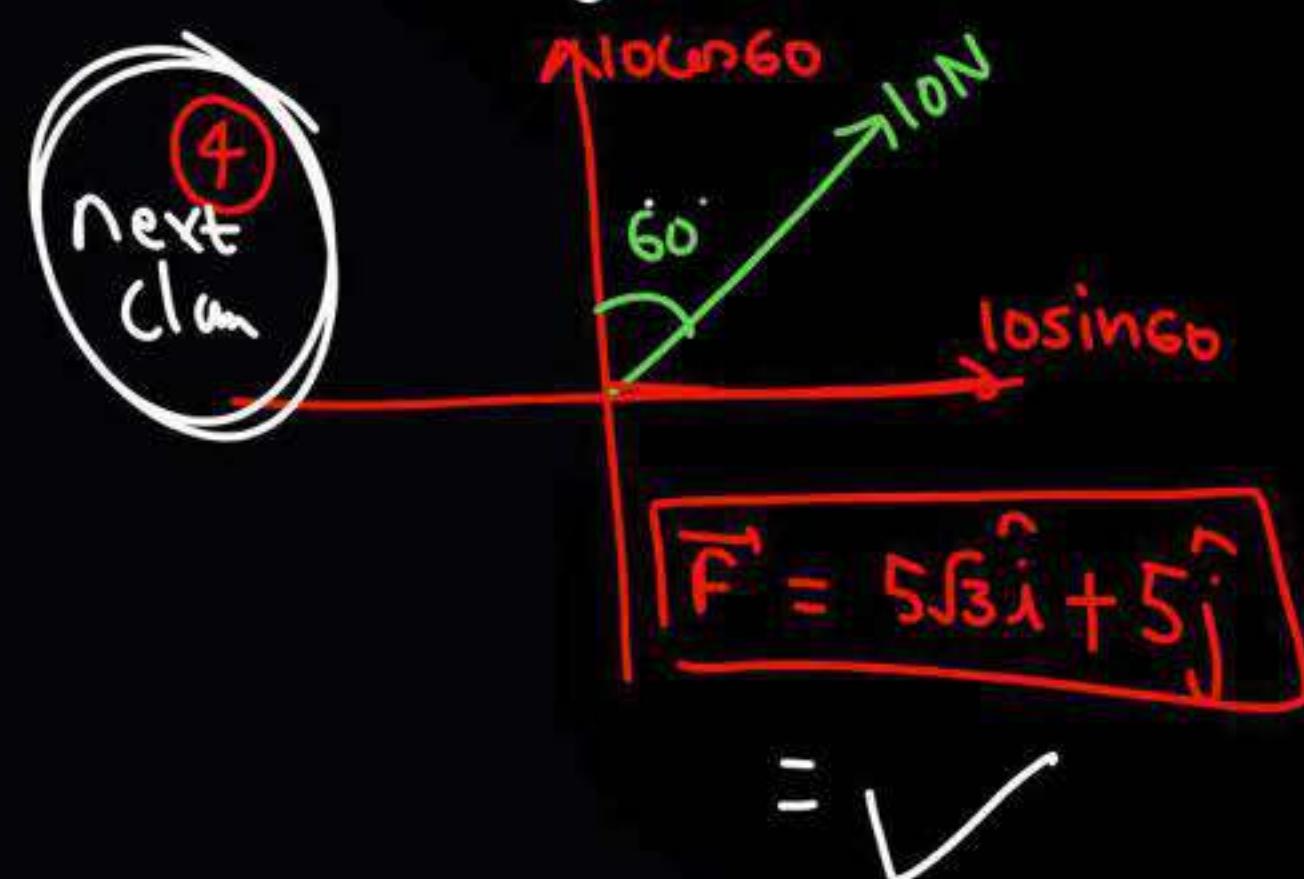
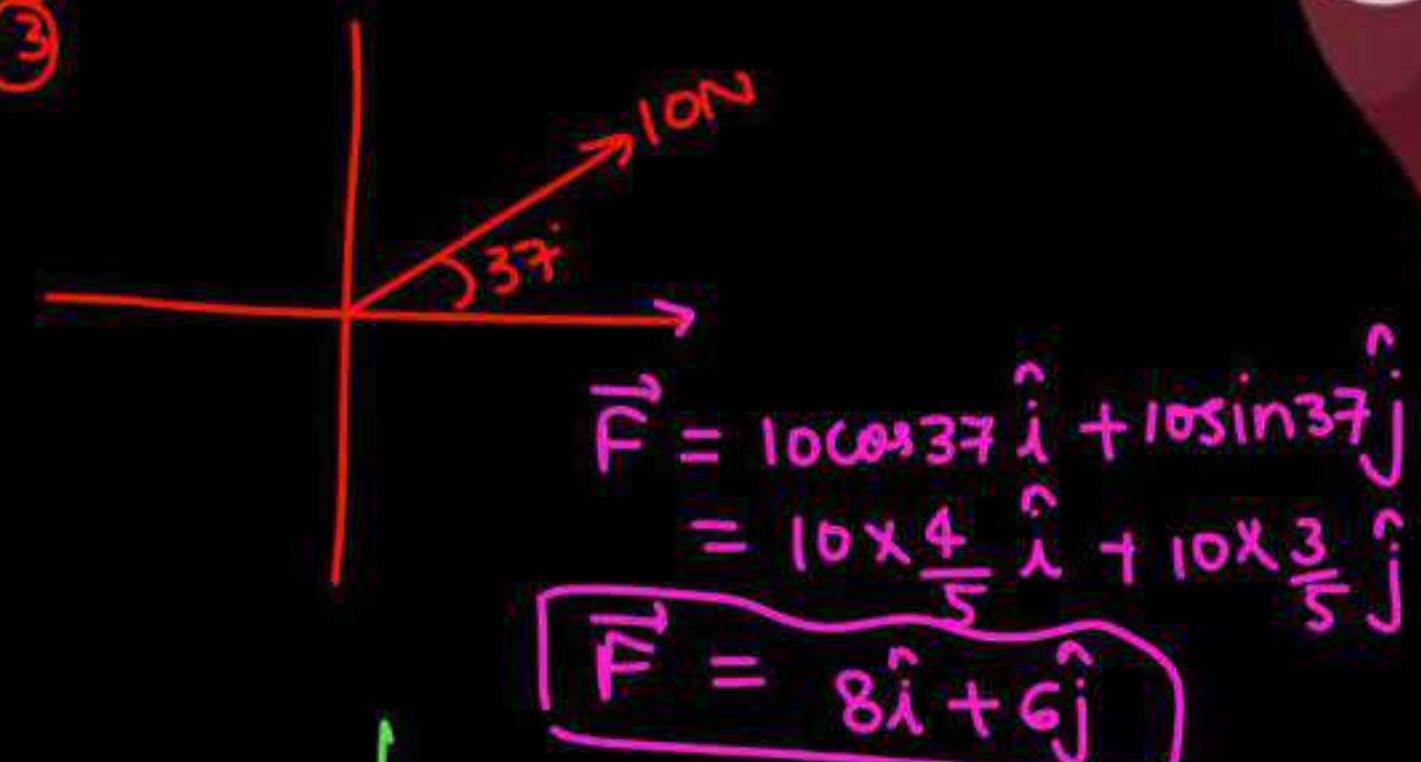
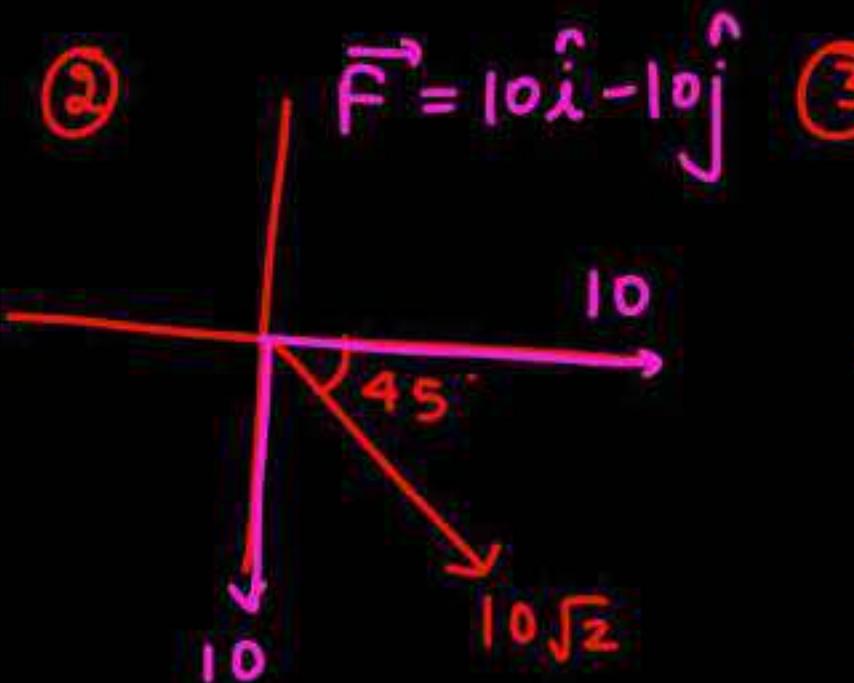
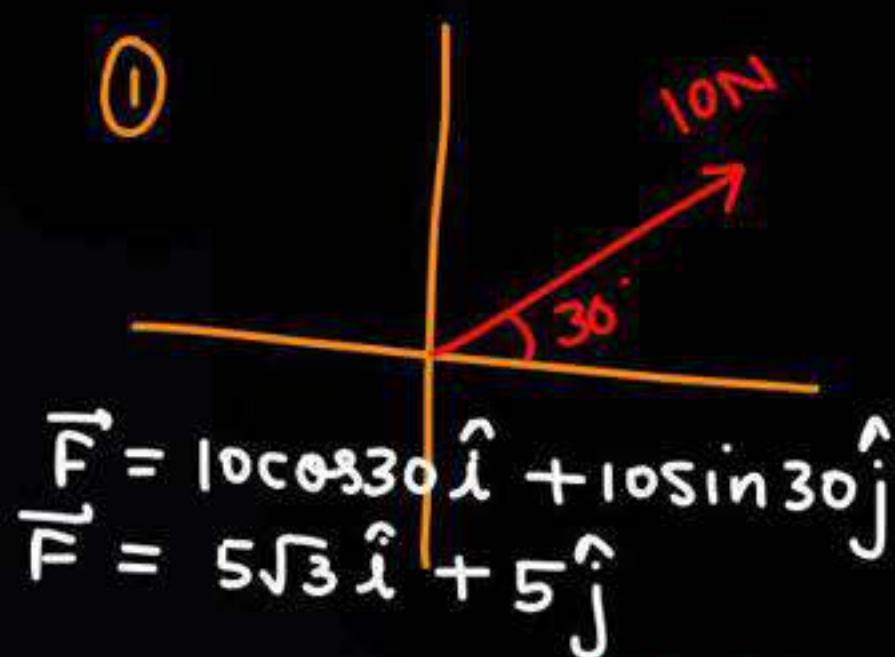
$$\vec{F} = F \cos \theta \hat{i} + F \sin \theta \hat{j}$$



$$\begin{aligned} \vec{F} &= -F \cos \theta \hat{i} \\ &\quad + F \sin \theta \hat{j} \end{aligned}$$



$$\begin{aligned} \vec{F} &= F \cos \theta \hat{i} \\ &\quad - F \sin \theta \hat{j} \end{aligned}$$



Q If angle b/w \vec{A} & \vec{B} is 30° .

$$A = 10$$

$$B = 20$$

find $|\vec{A} - \vec{B}|$ = magnitude of $\vec{A} - \vec{B}$

① m₁ direct

$$D = \sqrt{A^2 + B^2 - 2AB \cos \theta}$$

\vec{A} & \vec{B} form
acute angle

(m₂)

$$\begin{aligned} D &= \sqrt{A^2 + B^2 + 2AB \cos(180 - \theta)} \\ &= \sqrt{100 + 400 + 2 \times 10 \times 20 \cos 150^\circ} \\ &= \sqrt{500 + 2 \times 10 \times 20 \left(-\frac{\sqrt{3}}{2}\right)} \\ &= \sqrt{500 - 200\sqrt{3}} \end{aligned}$$

$$\begin{aligned} D &= \sqrt{100 + 400 - 2 \times 10 \times 20 \frac{\sqrt{3}}{2}} \\ &= \sqrt{500 - 200\sqrt{3}} \end{aligned}$$



$$\begin{aligned}\vec{AB} &= \text{P.V. of } B - \text{P.V. of } A \\ &= (7-2)\hat{i} + (8-3)\hat{j} + (9-4)\hat{k} \\ &= 5\hat{i} + 5\hat{j} + 5\hat{k}\end{aligned}$$

(2, 4, 7)

P

$\vec{r} = \hat{i} + 5\hat{j} - \frac{1}{2}\hat{k}$

(3, 9, 5)

A diagram illustrating a point P in 3D space. The point P is located at coordinates (2, 4, 7). A position vector \vec{r} is shown originating from the origin and ending at point P. The coordinates of the tip of the vector \vec{r} are explicitly labeled as (3, 9, 5).

magnitude of a vector.

$$\vec{A} = 2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$\begin{aligned}\text{magnitude of } A &= \sqrt{2^2 + 3^2 + 4^2} \\ &= \sqrt{4 + 9 + 16} \\ &= \sqrt{29}\end{aligned}$$

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

$$\text{mag. of } \vec{A} = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

Q $\vec{A} = 2\hat{i} - 3\hat{j} + 4\hat{k}$

$$\text{mag. of } \vec{A} = \sqrt{2^2 - 3^2 + 4^2} \quad \times$$

$$= \sqrt{2^2 + 3^2 + 4^2} \quad \checkmark$$

find magnitude of \vec{A} in following cases

$$\textcircled{1} \quad \vec{A} = 3\hat{i} + 4\hat{j}$$

$$A = \sqrt{3^2 + 4^2} = 5$$

$$\textcircled{2} \quad \vec{A} = -3\hat{i} + 4\hat{j}$$

$$A = \sqrt{3^2 + 4^2} = 5$$

$$\textcircled{3} \quad \vec{A} = 3\hat{i} - 4\hat{j}$$

$$A = 5$$

$$\textcircled{4} \quad \vec{A} = -3\hat{i} - 4\hat{j}$$

$$A = 5$$

$$\textcircled{5} \quad \vec{A} = 6\hat{i} + 2\hat{j} + 3\hat{k}$$

$$A = \sqrt{6^2 + 2^2 + 3^2} = 7$$

$$\textcircled{6} \quad \vec{A} = 5\hat{i} - 12\hat{j} + 13\hat{k}$$

$$A = \sqrt{5^2 + 12^2 + 13^2} = 13\sqrt{2}$$

$$\textcircled{7} \quad \vec{A} = \hat{i} + \hat{j} + \hat{k}$$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

$$\textcircled{8} \quad \vec{A} = \hat{i} - \hat{j} + \hat{k}$$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

find magnitude of \vec{A} in following cases

$$\textcircled{1} \quad \vec{A} = 3\hat{i} + 4\hat{j}$$

$$A = \sqrt{3^2 + 4^2} = 5$$

$$\textcircled{2} \quad \vec{A} = -3\hat{i} + 4\hat{j}$$

$$A = \sqrt{3^2 + 4^2} = 5$$

$$\textcircled{3} \quad \vec{A} = 3\hat{i} - 4\hat{j}$$

$$A = 5$$

$$\textcircled{4} \quad \vec{A} = -3\hat{i} - 4\hat{j}$$

$$A = 5$$

$$\vec{A} = 6\hat{i} + 2\hat{j} + 3\hat{k}$$

$$\hat{A} = \frac{6\hat{i} + 2\hat{j} + 3\hat{k}}{7}$$

$$\textcircled{5} \quad \vec{A} = 6\hat{i} + 2\hat{j} + 3\hat{k}$$

$$A = \sqrt{6^2 + 2^2 + 3^2} = 7$$

$$\textcircled{6} \quad \vec{A} = 5\hat{i} - 12\hat{j} + 13\hat{k}$$

$$A = \sqrt{5^2 + 12^2 + 13^2} = 13\sqrt{2}$$

$$\textcircled{7} \quad \vec{A} = \hat{i} + \hat{j} + \hat{k}$$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

$$\textcircled{8} \quad \vec{A} = \hat{i} - \hat{j} + \hat{k}$$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

$$\textcircled{9} \quad \vec{A} = \hat{i} - \hat{j}$$

$$A = \sqrt{1^2 + 1^2} = \sqrt{2}$$

$$\textcircled{10} \quad \vec{A} = \hat{i} - \hat{k}$$

$$A = \sqrt{1^2 + 0^2 + 1^2} = \sqrt{2}$$

$$\textcircled{11} \quad \vec{A} = \hat{i}$$

$$A = 1$$

$$\textcircled{12} \quad \vec{A} = \hat{k}$$

$$A = 1$$

Unit vector

$$\textcircled{13} \quad \vec{A} = \hat{j} - \hat{k}$$

$$A = \sqrt{1^2 + 1^2} = \sqrt{2}$$

$$\textcircled{14} \quad \vec{A} = \frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}$$

$$A = \sqrt{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2} = \sqrt{\frac{1}{2} + \frac{1}{2}} = 1$$

$$\textcircled{15} \quad \vec{A} = \frac{\hat{i}}{\sqrt{3}} - \frac{\hat{j}}{\sqrt{3}} - \frac{\hat{k}}{\sqrt{3}}$$

$$A = \sqrt{\left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2} = 1$$

Unit vector = ऐसा vector whose magnitude is 1

Q $\vec{A} = 3\hat{i} + 4\hat{j}$

mag. of $\vec{A} = \sqrt{3^2 + 4^2} = 5$

Unit vector along \vec{A}

or

$$\hat{A} = \frac{\vec{A}}{|A|} = \frac{3\hat{i} + 4\hat{j}}{5} = \frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$$

$$\vec{A} = |A| \cdot \hat{A}$$

→ **div**
 → unit vector
 → magnitude

$$\hat{A} = \frac{\vec{A}}{|A|}$$

$$\text{Q} \quad \vec{A} = 3\hat{i} - 4\hat{j}$$

$$\hat{A} = \frac{\vec{A}}{|A|} = \frac{3\hat{i} - 4\hat{j}}{5}$$

$$\text{Q} \quad \vec{A} = \hat{i} + \hat{j}$$

$$\hat{A} = \frac{\hat{i} + \hat{j}}{\sqrt{2}}$$

$$\text{Q} \quad \vec{A} = \hat{i} - \hat{j} - \hat{k}$$

$$\hat{A} = \frac{\hat{i} - \hat{j} - \hat{k}}{\sqrt{3}}$$

$$\text{Q} \quad \vec{A} = 2\hat{i} + 6\hat{j} - 3\hat{k}$$

$$\hat{A} = \frac{2\hat{i} + 6\hat{j} - 3\hat{k}}{7} = \frac{2}{7}\hat{i} + \frac{6}{7}\hat{j} - \frac{3}{7}\hat{k}$$

$$\text{Q} \quad \vec{A} = 5\hat{i} + 5\hat{j}$$

$$\hat{A} = \frac{5\hat{i} + 5\hat{j}}{5\sqrt{2}} = \frac{5(\hat{i} + \hat{j})}{5\sqrt{2}} = \frac{\hat{i} + \hat{j}}{\sqrt{2}}$$

Q

A bird is flying with speed 10m/s in the direction of a vector $\vec{A} = 3\hat{i} + 4\hat{j}$. find velocity of bird.

$$Ev = 10 \text{ m/s}$$

$\vec{v} = (\text{magnitude})(\text{direction})$

$$\vec{v} = 10 \cdot \hat{A} = 10 \times \left(\frac{\hat{3i} + \hat{4j}}{5} \right) = 2(\hat{3i} + \hat{4j})$$

$$\hat{A} = \frac{\hat{3i} + \hat{4j}}{5}$$

$$\vec{v} = 6\hat{i} + 8\hat{j} \text{ (m/s)}$$

Q Find a vector whose magnitude is 20 and dir is parallel to (or along or towards) $\vec{A} = 6\hat{i} - 8\hat{j}$

Ans $20 \hat{A} = 20 \frac{6\hat{i} - 8\hat{j}}{\sqrt{6^2 + 8^2}} = 20 \left(\frac{6\hat{i} - 8\hat{j}}{10} \right)$

$$= 12\hat{i} - 16\hat{j}$$

Q find force \vec{F} in vector form if its magnitude is 21 N

and direction is (a) parallel to $6\hat{i} - 3\hat{j} + 2\hat{k} = \vec{A}$

(b) opposite to $6\hat{i} - 3\hat{j} + 2\hat{k} = \vec{A}$

(a) $\vec{F} = 21 \cdot \hat{A} = 21 \left(\frac{6\hat{i} - 3\hat{j} + 2\hat{k}}{\sqrt{6^2 + (-3)^2 + 2^2}} \right) = 18\hat{i} - 9\hat{j} + 6\hat{k}$

(b) $\vec{F} = 21(-\hat{A}) = -21 \hat{A} = - (18\hat{i} - 9\hat{j} + 6\hat{k})$
 $= -18\hat{i} + 9\hat{j} - 6\hat{k}$

Q

A bird is flying with speed 10 m/s from point A to directly point B. find Velocity of bird.



$$\vec{AB} = 4\hat{i} + 0\hat{j} - 3\hat{k} = 4\hat{i} - 3\hat{k}$$

$$\vec{v} = 10 \times \frac{\vec{AB}}{5} = 10 \times \left(\frac{4\hat{i} - 3\hat{k}}{5} \right) = 8\hat{i} - 6\hat{k}$$

प्र० ४ ग्व

Q Initial speed of मिडिय is 10 m/s along $\vec{A} = 3\hat{i} - 4\hat{j}$
and net force on the मिडिय is 50 N in the Dirⁿ of \vec{B}
mass of मिडिय is 2 kg $\vec{B} = [6\hat{i} + 8\hat{j}]$

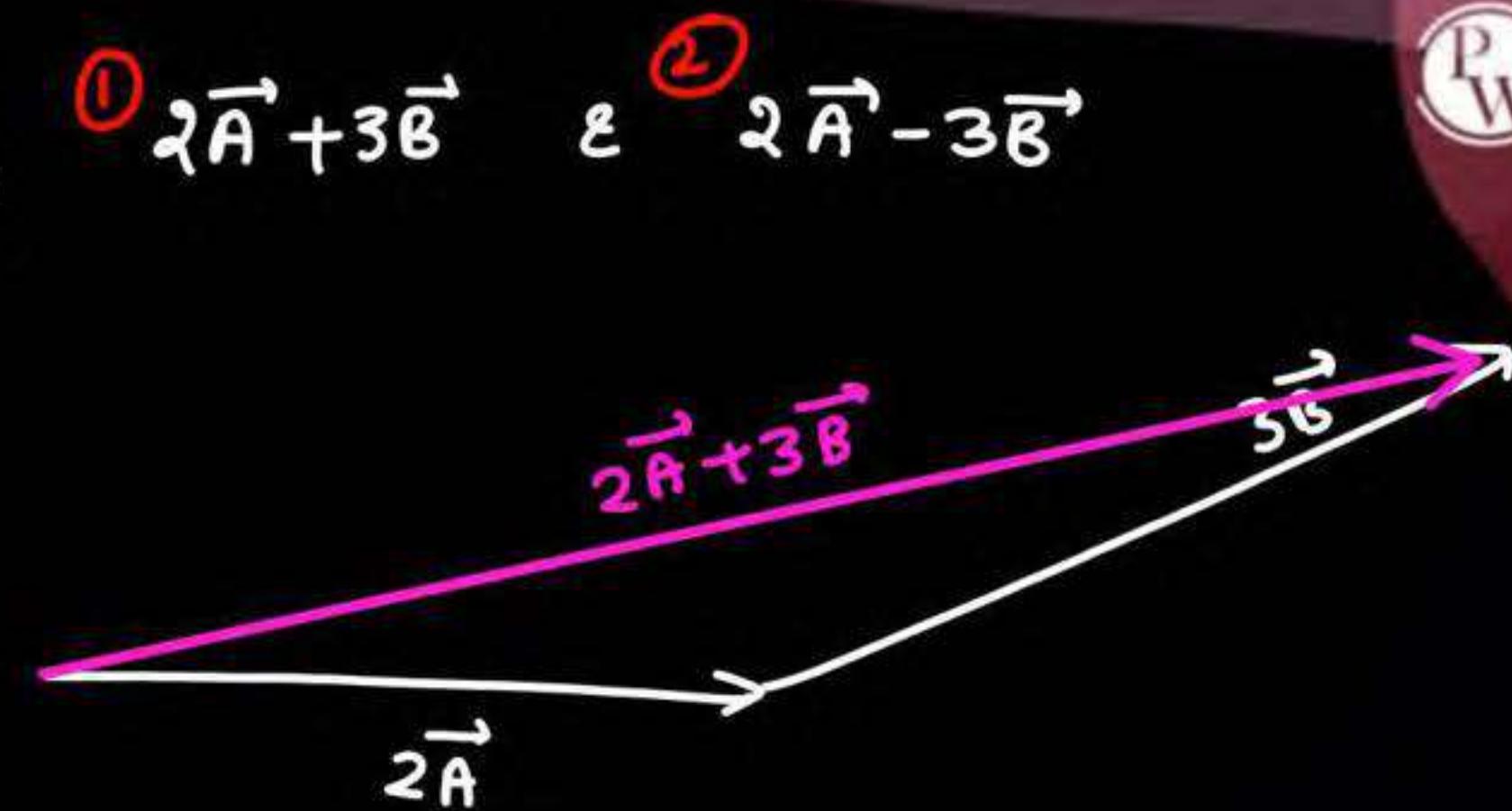
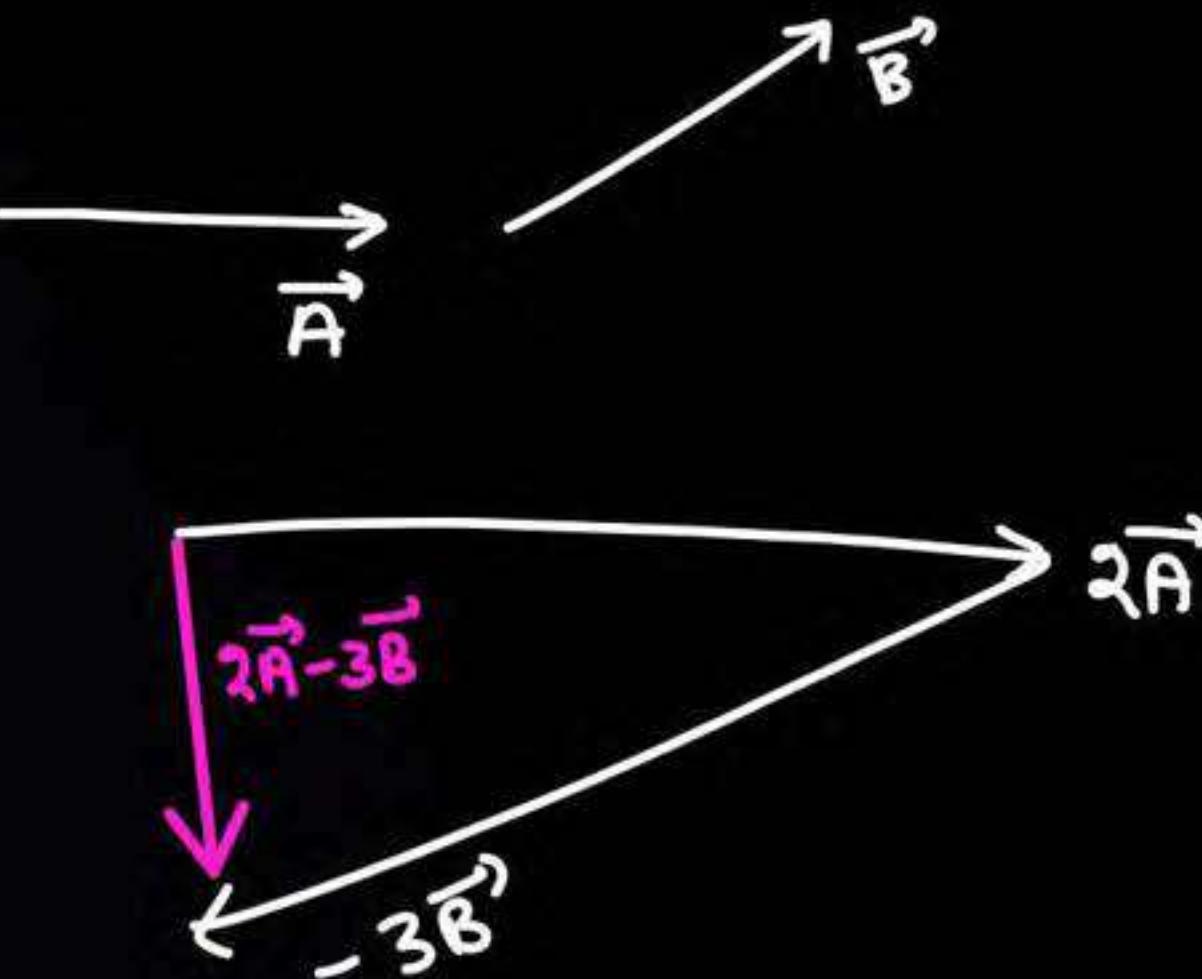
① find velocity of मिडिय at $t = 14 \text{ sec}$

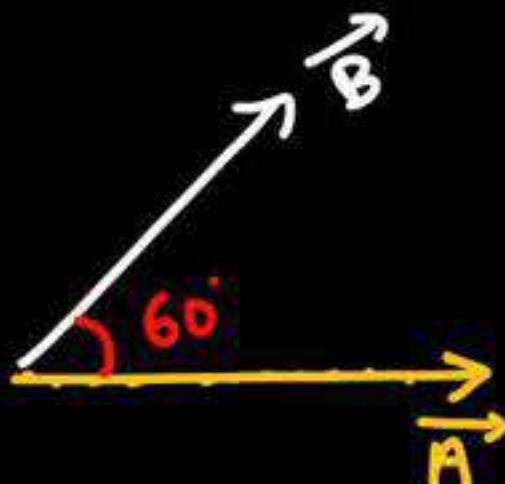
$$u_i = 10, \vec{A} = 10 \frac{3\hat{i} - 4\hat{j}}{5}$$
$$\vec{v} = \vec{u} + \vec{a}t$$

$$\vec{F} = 50 \hat{B} = 50 \times \frac{6\hat{i} + 8\hat{j}}{10}$$
$$\vec{a} = \frac{\vec{F}}{m} = 15\hat{i} + 20\hat{j}$$

Q

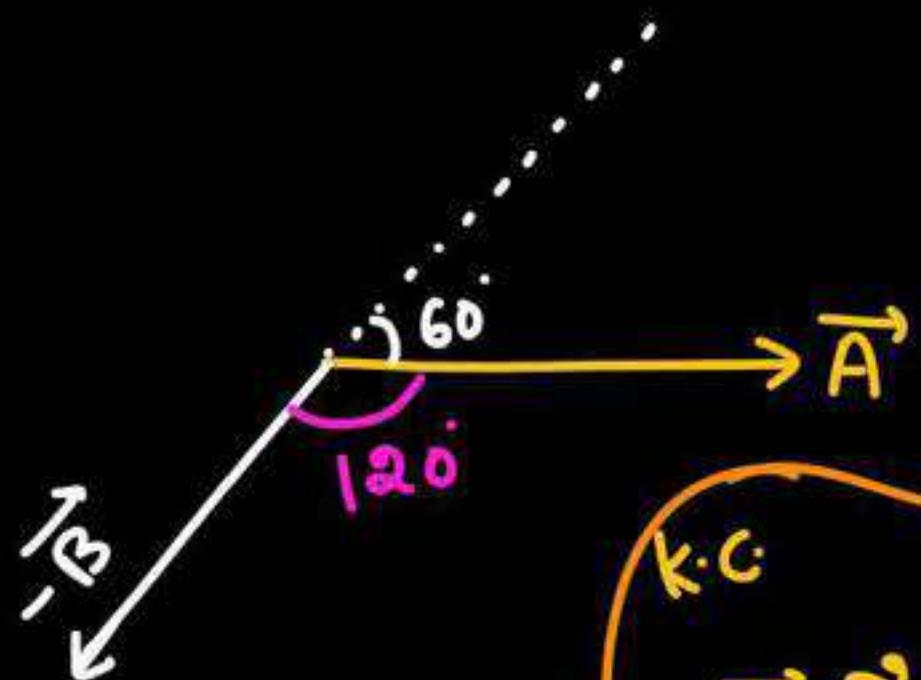
Draw rough diagram of ① $2\vec{A} + 3\vec{B}$ & ② $2\vec{A} - 3\vec{B}$





Angle between \vec{A} & \vec{B} = 60°

$$\begin{aligned} \text{Angle between } \vec{A} \text{ & } -\vec{B} &= 180^\circ - 60^\circ \\ &= 120^\circ \end{aligned}$$



K.C

\vec{A} और \vec{B} के बीच
आगे angle θ है
तो \vec{A} और $-\vec{B}$ के
बीच $180^\circ - \theta$ होगा।

Q magnitude of \vec{A} & \vec{B} is 10 & 20 Unit, angle between \vec{A} & \vec{B} is 60°

(A) find mag. of resultant of \vec{A} & \vec{B} and angle made by this resultant

$$\vec{C} = \vec{A} + \vec{B}$$

$$C = \sqrt{10^2 + 20^2 + 2 \times 10 \times 20 \cos 60^\circ} = 10\sqrt{7}$$

$$\tan \alpha = \frac{B \sin \theta}{A + B \cos \theta} = \frac{20 \sin 60^\circ}{10 + 20 \cos 60^\circ}$$

(B) If vector \vec{B} is reversed and added to \vec{A} , find mag. of new resultant and angle made by this with \vec{A}

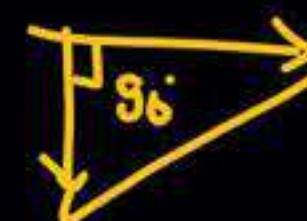
$$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

$$C = \sqrt{10^2 + 20^2 - 2 \times 10 \times 20 \times \cos 60^\circ}$$

$$= \sqrt{360}$$

$$\tan \alpha = \frac{B \sin \theta}{A - B \cos \theta} = \frac{20 \sin 60^\circ}{10 - 20 \cos 60^\circ} = \frac{10\sqrt{3}}{0}$$

$$\alpha = 90^\circ$$



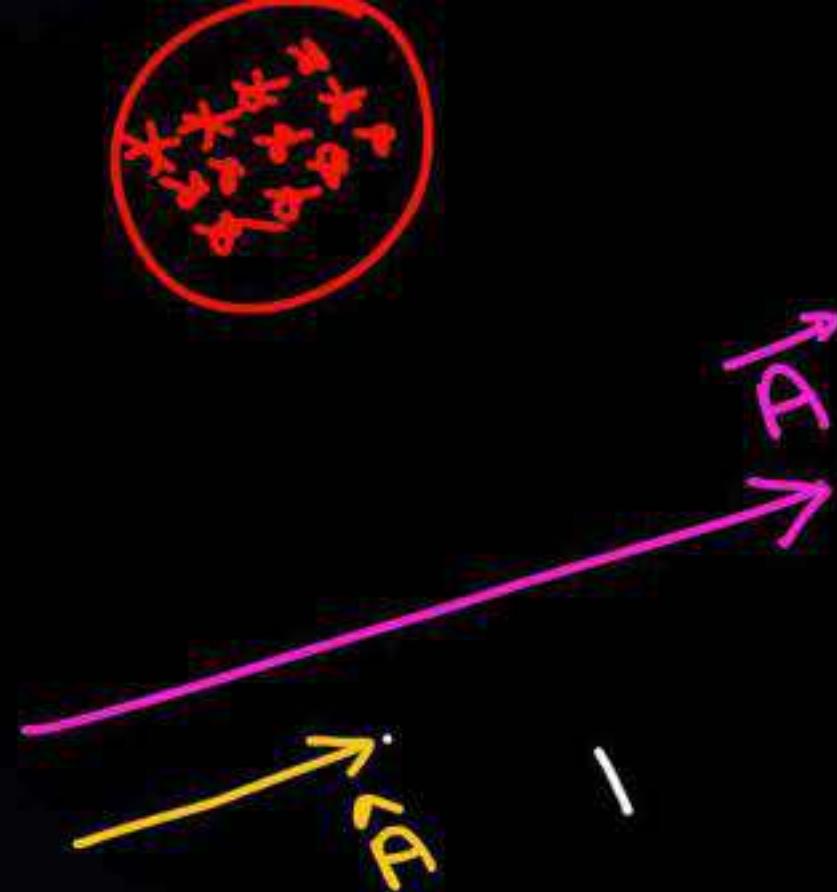
(B) $\vec{A} \text{ तथा } \vec{B}$ के बीच angle = 60°
 $\vec{A} \perp \vec{B}$ = 120°

$$\vec{D} = \vec{A} - \vec{B}$$

$$\begin{aligned}
 D &= \sqrt{10^2 + (20)^2 + 2 \times 10 \times 20 \times \cos 120^\circ}, \quad \tan \alpha = \frac{20 \sin 120^\circ}{10 + 20 \cos 120^\circ} \\
 D &= \sqrt{10^2 + 20^2 + 2 \times 10 \times 20 \cos(180^\circ - 60^\circ)} \\
 &= \sqrt{10^2 + 20^2 + 2 \times 10 \times 20 \left(-\frac{1}{2}\right)} \\
 &= \sqrt{100 + 400 - 200} \\
 &= \sqrt{300} \\
 &= \frac{20 \sqrt{3}/2}{10 + 20 \left(-\frac{1}{2}\right)} = \frac{10\sqrt{3}}{0}
 \end{aligned}$$

$\alpha = 90^\circ$

\vec{A}, \hat{A} = parallel vectors



*** K.C.

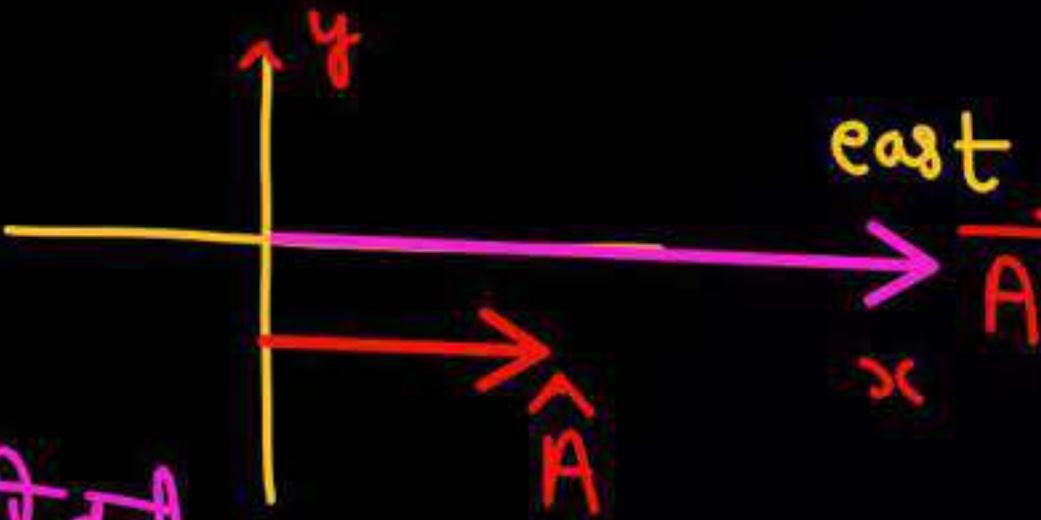
\hat{A} → Unit vector

ये ऐसा Vector हैं
जिसकी magnitude 1
और dirⁿ \vec{A} की तरफ की है

Q $\vec{A} = 5\text{ N east}$

$\hat{A} = \text{east}$

dirⁿ ही की



Q A particle is moving with speed 10 m/s along +x Axis

find velocity $\vec{v} = 10 \text{ m/s } \hat{i}$

"
Dir"

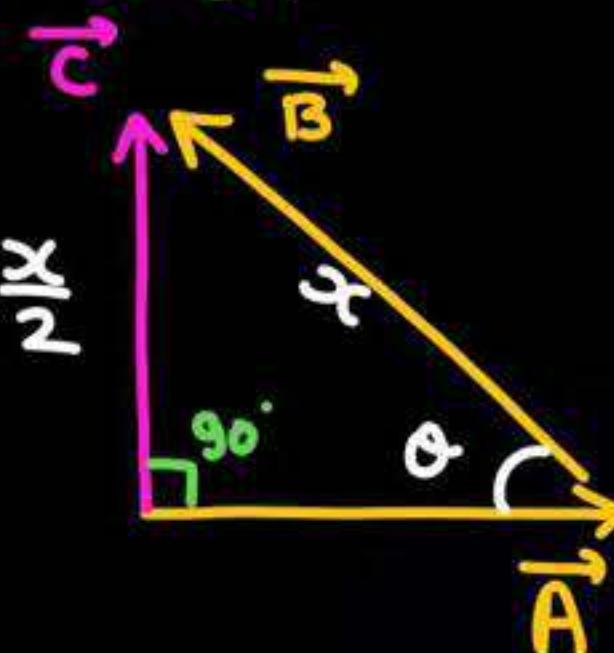
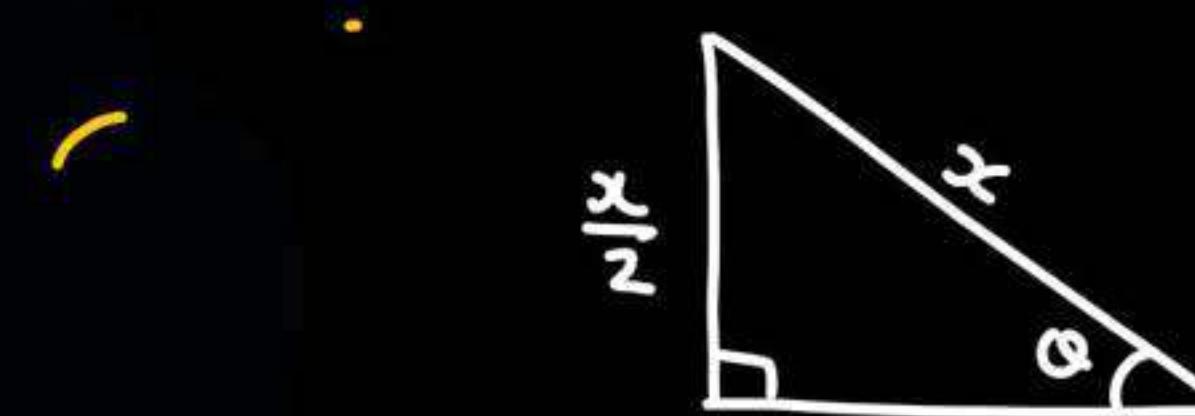
Q A particle is moving with speed 20 m/s along -y Axis

$$\vec{v} = 20 \text{ m/s } (-\hat{j}) = -20\hat{j}$$

Q Resultant of \vec{A} & \vec{B} is perpendicular to \vec{A}
 and its magnitude is equal to half of magnitude of \vec{B}
 Find the angle between \vec{A} & \vec{B} .

m-2

$$\vec{A} + \vec{B} = \vec{C}$$



$$\sin \theta = \frac{x/2}{x} = \frac{1}{2}$$

$$\theta = 30^\circ$$

~~$\text{Ans} \rightarrow 30^\circ$~~

$$\begin{aligned}\text{Ans} &\rightarrow 180 - 30^\circ \\ &= 150^\circ\end{aligned}$$

Q

Two vector \vec{A} & \vec{B} have same magnitude a and resultant has magnitude R . Now \vec{B} is doubled and added to \vec{A} and now new resultant become $a\sqrt{3}$. Find angle between \vec{A} & \vec{B} .

$$\vec{A} + \vec{B} = \vec{R}$$

$$R = \sqrt{a^2 + a^2 + 2 \cdot a \cdot a \cos \theta}$$

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

$$\theta = 120^\circ$$

$$R_{\text{new}} = \sqrt{a^2 + (2a)^2 + 2 \cdot a \cdot 2a \cos \theta}$$

$$a\sqrt{3} = \sqrt{a^2 + 4a^2 + 4a^2 \cos \theta}$$

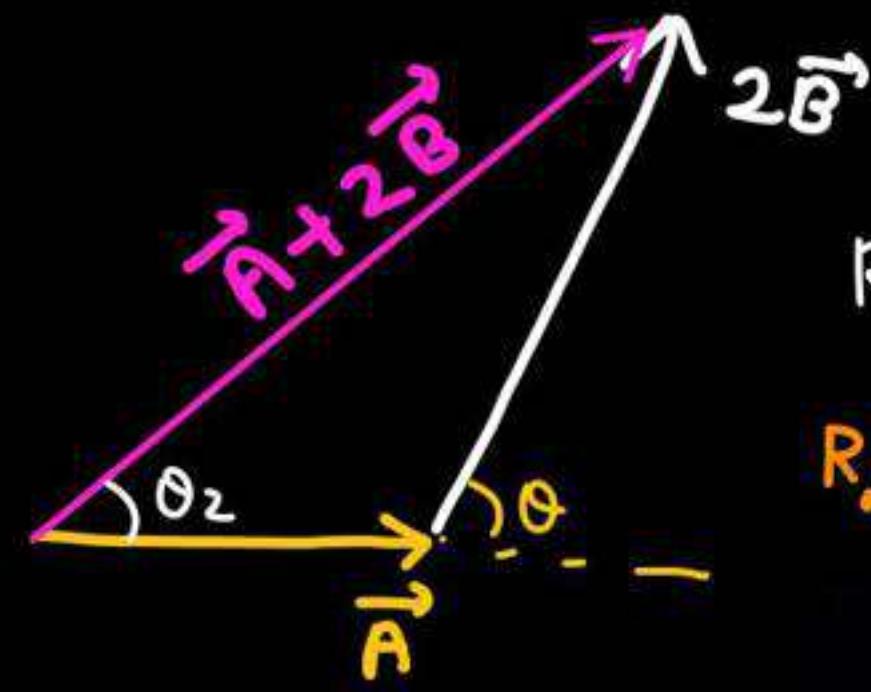
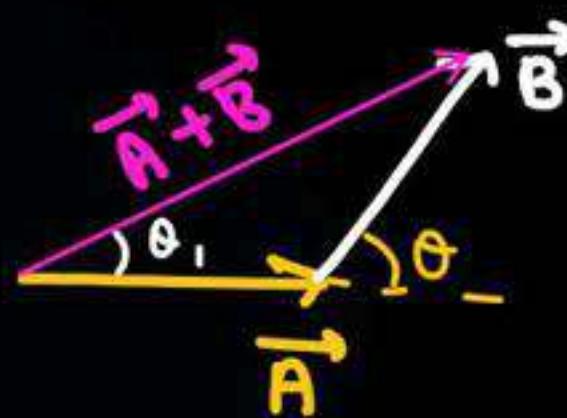
$$3a^2 = 5a^2 + 4a^2 \cos \theta$$

$$-2a^2 = 4a^2 \cos \theta$$

~~$2B+A$~~ ✓
 ~~$2\vec{B}+\vec{A}$~~ ✓

Q \vec{A} has magnitude 10N, \vec{B} has magnitude 20N
 angle between \vec{A} & \vec{B} is 60° . If \vec{B} is doubled
 and added to \vec{A} find new resultant.

उत्तर = 40



$$\begin{aligned}
 R_{\text{नया}} &= \sqrt{10^2 + (40)^2 + 2 \times 10 \times 40 \cos 60^\circ} \\
 R_{\text{नया}} &= \sqrt{100 + 1600 + 800 \times \frac{1}{2}} \\
 &= \sqrt{2100} \\
 &= 10\sqrt{21} \text{ N}
 \end{aligned}$$



$$C_{\max} = A + B$$

$$C_{\min} = |A - B|$$

Q. \vec{A} has magnitude 10 N
 \vec{B} " " 6 N

find Range of magnitude of resultant of $\vec{A} \pm \vec{B}$

$$C_{\max} = A + B = 10 + 6 = 16$$

$$C_{\min} = |A - B| = 10 - 6 = 4$$

$$\boxed{4 \leq C \leq 16} \Rightarrow [4, 16]$$

Q magnitude of \vec{A} is 8 N
" " \vec{B} is 6 N (angle not given)

which of the following can be the magnitude of $\vec{A} + \vec{B}$

- (A) 10 N ✓
- (B) 12 N ✓
- (C) 4 N ✓
- (D) 2 N ✓
- (F) 2.0001 ✓
- (F) 1.9999 ✗

- (G) 13 N ✓
- (H) 14 N ✓
- (I) 13.999 N ✓
- (J) 14.0001 N ✗
- (K) 16 N ✗

$$C_{\max} = A + B = 14$$

$$C_{\min} = A - B = 2$$

$$2 \leq C \leq 14$$

Q.

If magnitude of resultant of $\vec{A} \in \vec{B}$ has max value 30 N and has min value 20 N. Find $\frac{A}{B}$ (Ratio of magnitudes)

$$\vec{C} = \vec{A} + \vec{B}$$

$$C_{\max} = A + B = 30$$

$$C_{\min} = \underline{A - B = 20}$$

$$\boxed{\begin{array}{l} A = 25 \\ B = 5 \end{array}}$$

Q. magnitude of resultant of \vec{A} & \vec{B} is 5 Unit.

where magnitude of \vec{A} is $5\sqrt{3}$ Unit & magnitude of \vec{B} is 5 Unit.

Find angle between \vec{A} & \vec{B} .

$$\vec{C} = \vec{A} + \vec{B}$$

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$5 = \sqrt{(5\sqrt{3})^2 + 5^2 + 2 \times 5\sqrt{3} \times 5 \cos \theta}$$

$$25 = 75 + 25 + 50\sqrt{3} \cos \theta$$

$$50\sqrt{3} \cos \theta = -75$$

$$\cos \theta = \frac{-75}{50\sqrt{3}} = -\frac{\sqrt{3}}{2}$$

(A)

60°

(B)

150°

(C)

120°

(D)

-30°

(E)

30°

(F)

120°

(G)

150°

(H)

60°

(I)

180°

(J)

210°

(K)

300°

(L)

330°

(M)

240°

(N)

270°

(O)

300°

(P)

330°

(Q)

210°

(R)

150°

(S)

120°

(T)

60°

(U)

30°

(V)

300°

(W)

270°

(X)

240°

(Y)

330°

(Z)

210°

(AA)

150°

(BB)

120°

(CC)

60°

(DD)

30°

(EE)

300°

(FF)

270°

(GG)

240°

(HH)

330°

(II)

210°

(JJ)

150°

(KK)

120°

(LL)

60°

(MM)

30°

(NN)

300°

(OO)

270°

(PP)

240°

(QQ)

330°

(RR)

210°

(SS)

150°

(TT)

120°

(UU)

60°

(VV)

30°

(WW)

300°

(XX)

270°

(YY)

240°

(ZZ)

330°

Basic
maths
461

Q magnitude of \vec{A} is 10

" " \vec{B} is 20

angle between $\vec{A} \& \vec{B}$ is 60° .

① find magnitude of resultant of $\vec{A} \& \vec{B}$

$$C = \sqrt{(10)^2 + (20)^2 + 2 \times 10 \times 20 \times \cos 60^\circ} = \sqrt{700}$$

② find angle made by resultant of $\vec{A} \& \vec{B}$ with \vec{A}

$$\tan \alpha = \frac{B \sin \theta}{A + B \cos \theta} = \frac{20 \sin 60^\circ}{10 + 20 \cos 60^\circ} = \frac{20 \frac{\sqrt{3}}{2}}{10 + 20 \times \frac{1}{2}}$$

$$\tan \alpha = \frac{\sqrt{3}}{2}$$

Q

Two vectors \vec{A} & \vec{B} having equal magnitude 'a' are at angle 60° . find magnitude of $\vec{A} + \vec{B}$ and angle made by resultant of $\vec{A} + \vec{B}$ with \vec{A}

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$\begin{aligned} c &= \sqrt{a^2 + a^2 + 2aa \cos 60^\circ} \\ &= a\sqrt{3} \end{aligned}$$

$$\tan \alpha = \frac{B \sin \theta}{A + B \cos \theta} = \frac{a \sin 60^\circ}{a + a \cos 60^\circ}$$

$$\tan \alpha = \frac{\sqrt{3}/2}{1 + \frac{1}{2}} = \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}}$$

$$\boxed{\alpha = 30^\circ}$$

tough दूरी कर सोल्व

Q2 Sum of magnitude of \vec{A} & \vec{B} is 16N. magnitude of resultant of \vec{A} & \vec{B} is 8N when resultant is perpendicular to the \vec{A} .
find magnitude of \vec{A} & \vec{B} .

$\theta \rightarrow$ नहीं पता

$$\vec{A} + \vec{B} = 16 \times$$

$$A + B = 16$$

$$\vec{A} + \vec{B} = \vec{C}$$

$$\text{mag. of } \vec{C} = 8$$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$64 = A^2 + B^2 + 2AB \cos \theta$$

\vec{C} ने \vec{A} के साथ 90° Angle बनाया

$$\alpha = 90^\circ$$

$$\tan \alpha = \frac{B \sin \theta}{A + B \cos \theta}$$

$$\tan 90^\circ = \frac{B \sin \theta}{A + B \cos \theta}$$

$$A + B \cos 90^\circ = 0$$

$$A + B = 16$$

$$A + B \cos 30^\circ = 0 \Rightarrow B \cos 30^\circ = -A$$

$$64 = A^2 + B^2 + 2AB \cos 30^\circ$$

$$64 = A^2 + B^2 + 2A(-A)$$

$$64 = A^2 + B^2 - 2A^2$$

$$64 = B^2 - A^2 = (B+A)(B-A)$$

$$64 = (B+A)(B-A)$$

$$64 = 16(B-A)$$

$$4 = B-A$$

$$B - A = 4$$

$$B + A = 16$$

$$\begin{cases} B = 10 \\ A = 6 \end{cases}$$

Ans

tough

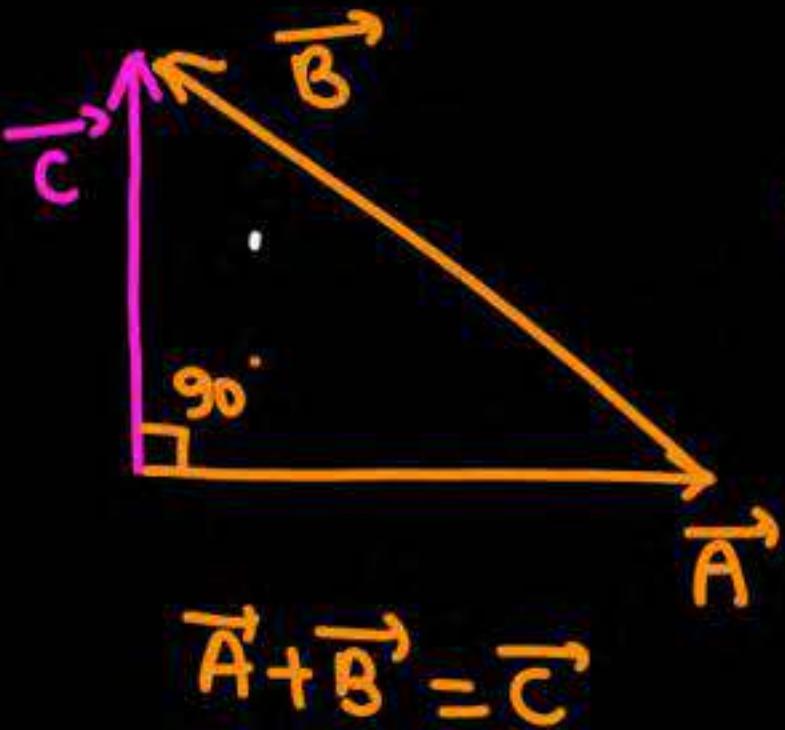
Q2

Sum of magnitude of \vec{A} & \vec{B} is 16N. magnitude of resultant of \vec{A} & \vec{B} is 8N when resultant is perpendicular to the \vec{A} .
 find magnitude of \vec{A} & \vec{B} .

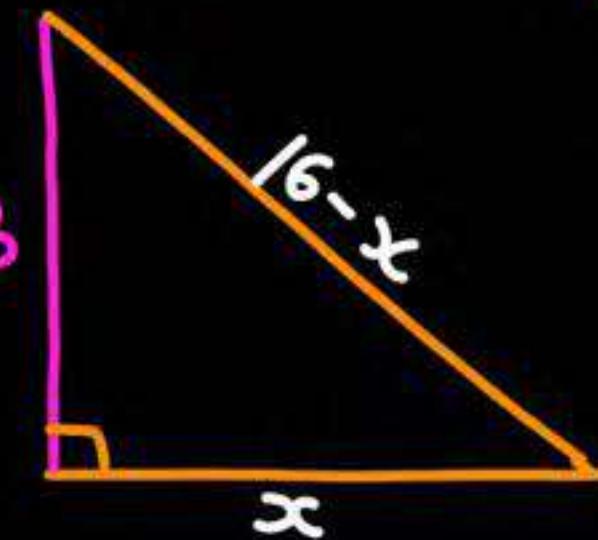
सरल
method

Method
2

△ बनाने की क्रिया करो



=



$$8^2 + x^2 = (16-x)^2$$

Solve

$$x = 6$$

$$\begin{cases} A = 6 \\ B = 16 - x = 16 - 6 \\ B = 10 \end{cases}$$

Q

Two vector \vec{A} & \vec{B} having same magnitude x (given)

Find magnitude of resultant of \vec{A} & \vec{B} if angle between them is 60° .

$$A = x$$

$$B = x$$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$= \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cos 60^\circ}$$

$$= \sqrt{x^2 + x^2 + 2x^2 \frac{1}{2}}$$

$$\boxed{C = x\sqrt{3}}$$

Q

Two vector \vec{A} & \vec{B} having same magnitude x .

Find magnitude of resultant of \vec{A} & \vec{B} if angle between them is 120° .

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$C = \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cdot \cos 120^\circ}$$

$$= \sqrt{2x^2 + 2x^2 \left(-\frac{1}{2}\right)}$$

$$\boxed{C = x}$$

Q

Two vector \vec{A} & \vec{B} having same magnitude x .

Find magnitude of resultant of \vec{A} & \vec{B} if angle between them is 90°

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$C = \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cdot \cos 90^\circ}$$

$$= \sqrt{x^2 + x^2 + 0}$$

$$\boxed{C = x\sqrt{2}}$$

Q If magnitude of \vec{A} is 10N
and magnitude of \vec{B} is 6N

$$\vec{A} + \vec{B} = \vec{C}$$

① If angle between \vec{A} & \vec{B} is 60° find magnitude of resultant of \vec{A} & \vec{B}

$$C = \sqrt{100 + 36 + 2 \times 10 \times 6 \cos 60^\circ} = \sqrt{136 + 60} = \sqrt{196} = 14$$

② If angle between \vec{A} & \vec{B} is 90° find magnitude of resultant of \vec{A} & \vec{B}

$$C = \sqrt{10^2 + 6^2 + 2 \times 10 \times 6 \cos 90^\circ} = \sqrt{10^2 + 6^2} = \sqrt{136}$$

③ If angle between \vec{A} & \vec{B} is 60°
and \vec{B} become twice to its initial value & added to \vec{A} find magni of new resultat

Q If magnitude of \vec{A} is 10N

and magnitude of \vec{B} is 6N

$$\vec{A} + \vec{B} = \vec{C}$$

(3)

If angle between \vec{A} & \vec{B} is 60°

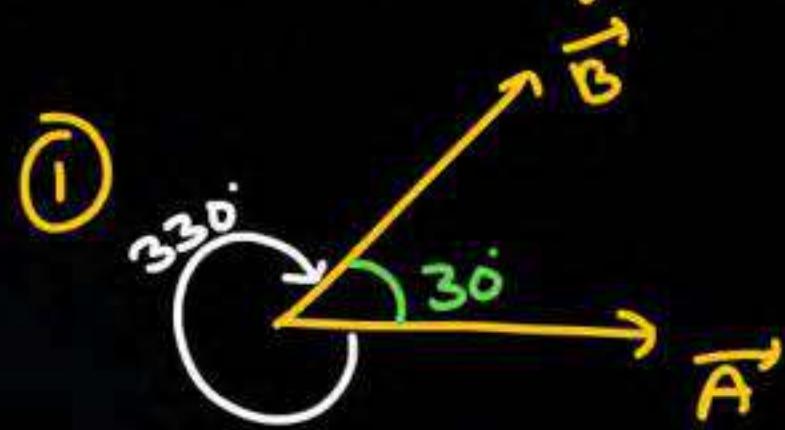
and \vec{B} become twice to its initial value

added to \vec{A} find magnitude of new resultant

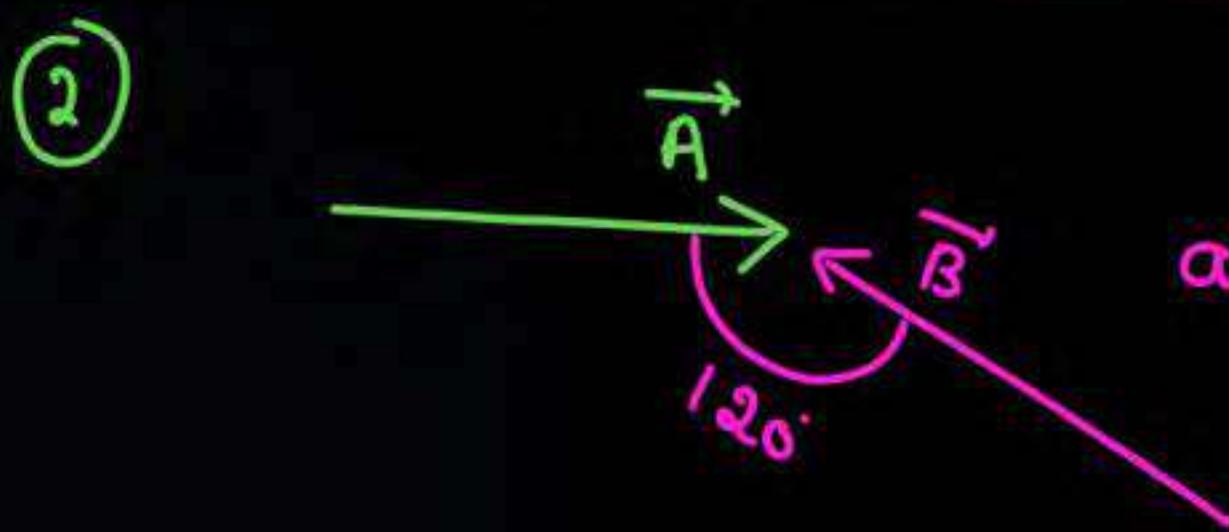
$$\begin{aligned} C &= \sqrt{100 + 144 + 120} \\ &= \sqrt{364} \end{aligned}$$

$$C_{\text{new}} = \sqrt{10^2 + (12)^2 + 2 \times 10 \times 12 \cos 60^\circ}$$

find angle b/w \vec{A} & \vec{B}



angle b/w vectors = 30° ✓
= 330° ✗

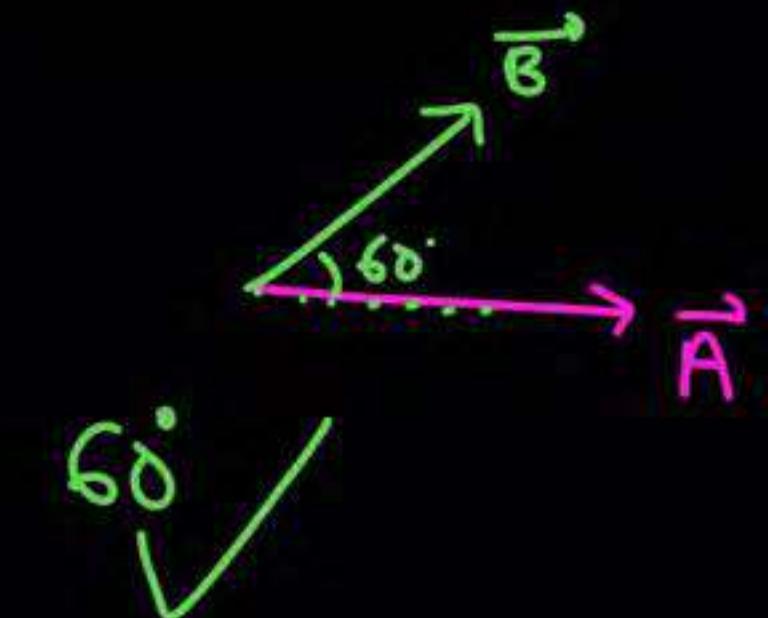


angle between Vectors
= 120°

③

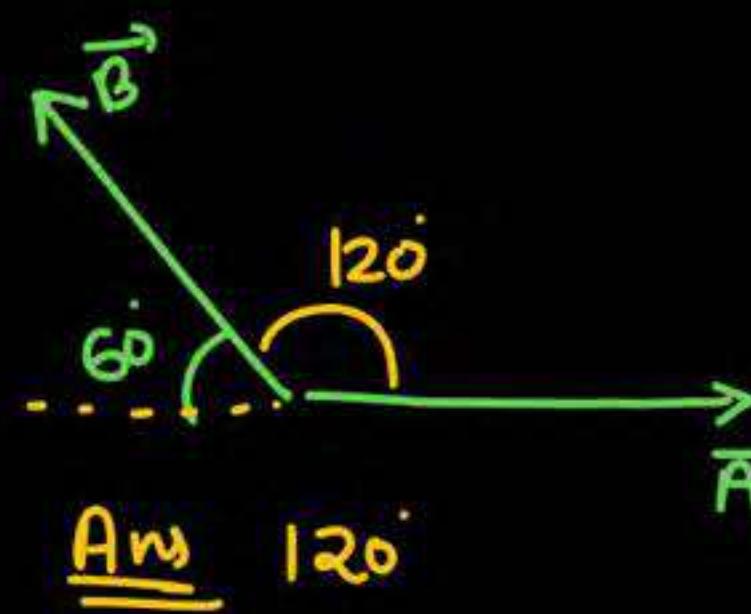
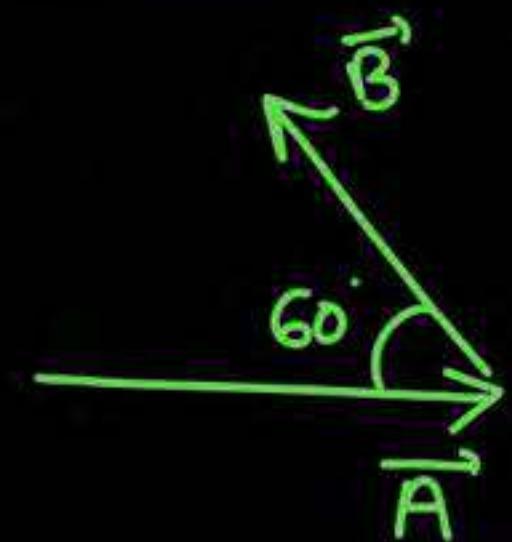


Soln



PW

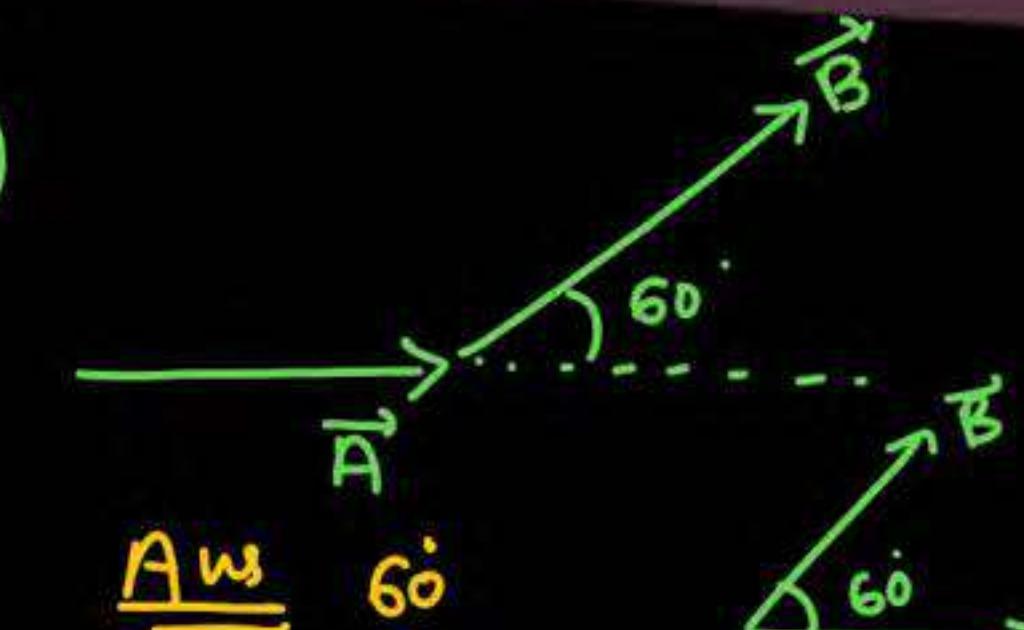
④



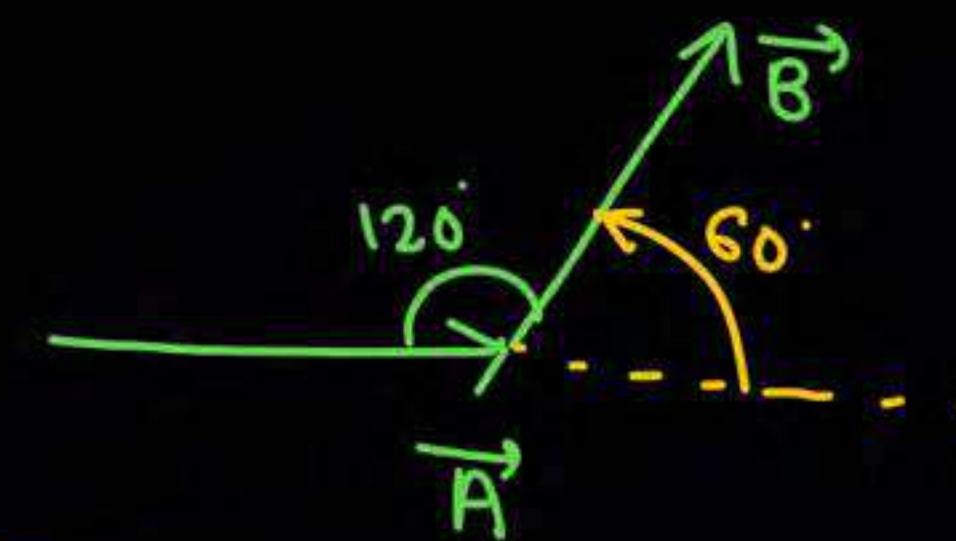
⑤



⑥

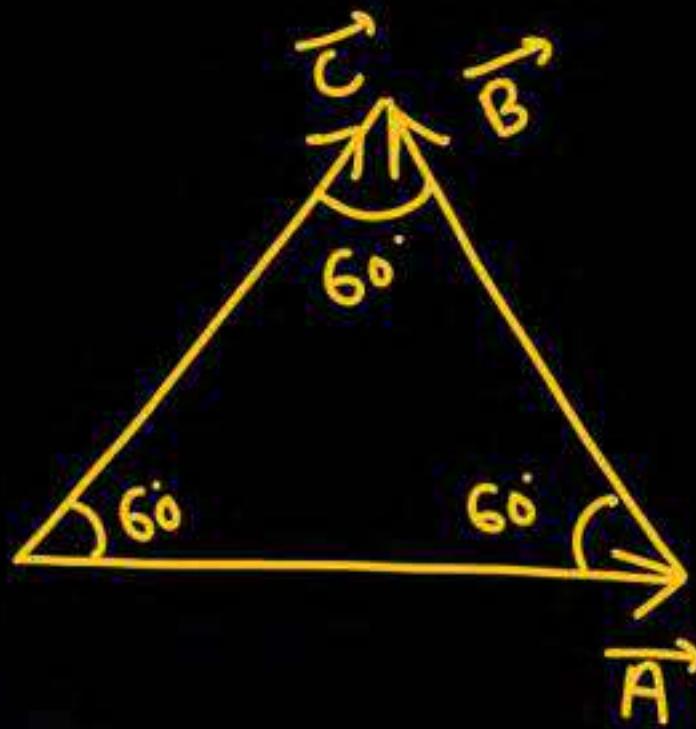


⑦



$$\boxed{A_{WS} = 60^\circ}$$

⑧

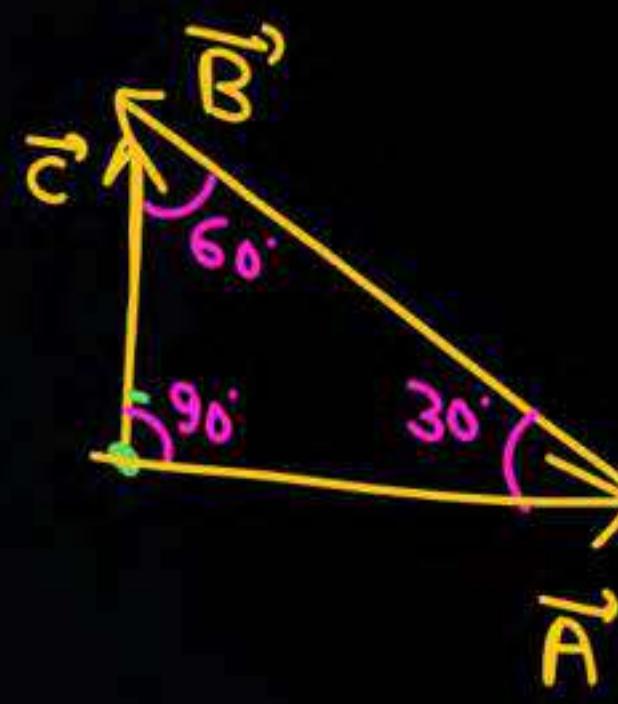


Angle between \vec{a} & \vec{b} = 120°

$$\begin{matrix} \text{“} & \text{“} & \vec{b} & \text{“} & \vec{c} \\ \text{“} & \text{“} & \cdot & \text{“} & = 60^\circ \end{matrix}$$

$$\vec{a} & \text{“} & \vec{c} & = 60^\circ$$

⑨

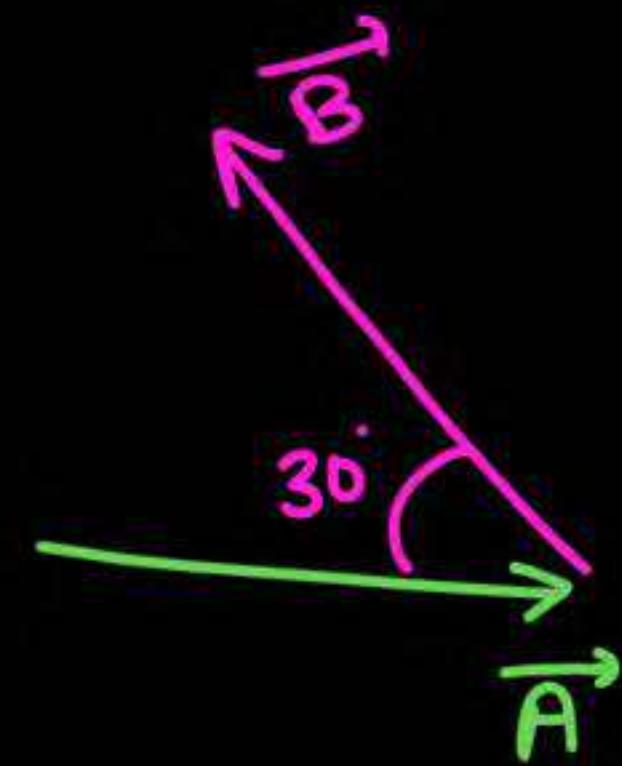


Angle between \vec{a} & \vec{b} = $180 - 30 = 150^\circ$

$$\begin{matrix} \text{“} & \text{“} & \vec{b} & \text{“} & \vec{c} \\ \text{“} & \text{“} & \cdot & \text{“} & = 60^\circ \end{matrix}$$

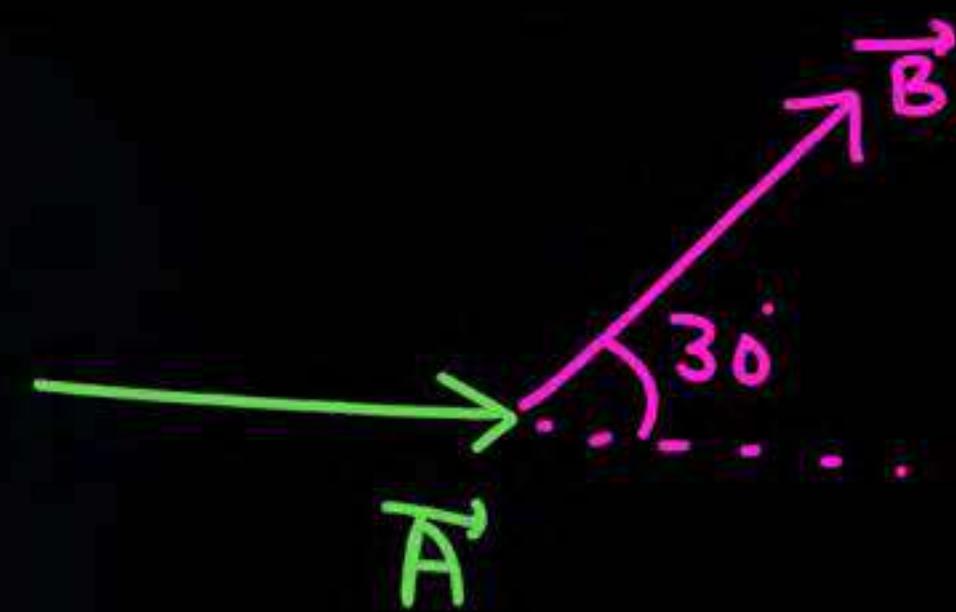
$$\begin{matrix} \text{“} & \text{“} & \vec{a} & \text{“} & \vec{c} \\ \text{“} & \text{“} & \cdot & \text{“} & = 90^\circ \end{matrix}$$

Q
R



Angle b/w \vec{A} & \vec{B} = $180 - 30 = 150^\circ$

Q
R



Angle b/w \vec{A} & \vec{B} = 30°

$\vec{A} + \vec{B}$  Addition of \vec{A} & \vec{B} = ?
Resultant of \vec{A} & \vec{B} = ?

$\vec{A} + \vec{B}$ और $A + B$ = दोनों अलग-चीज़ें

प्र० Derivation
कास का नहीं है
इस अल विज्ञा

$$\vec{A} + \vec{B} = \vec{C}$$

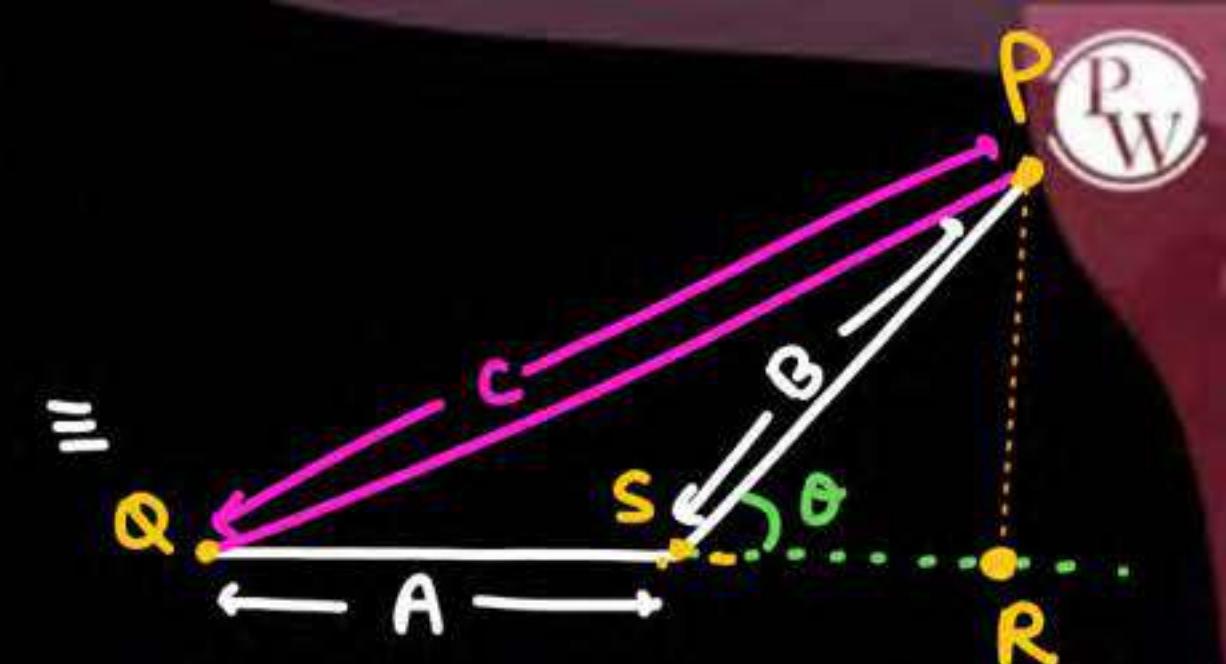
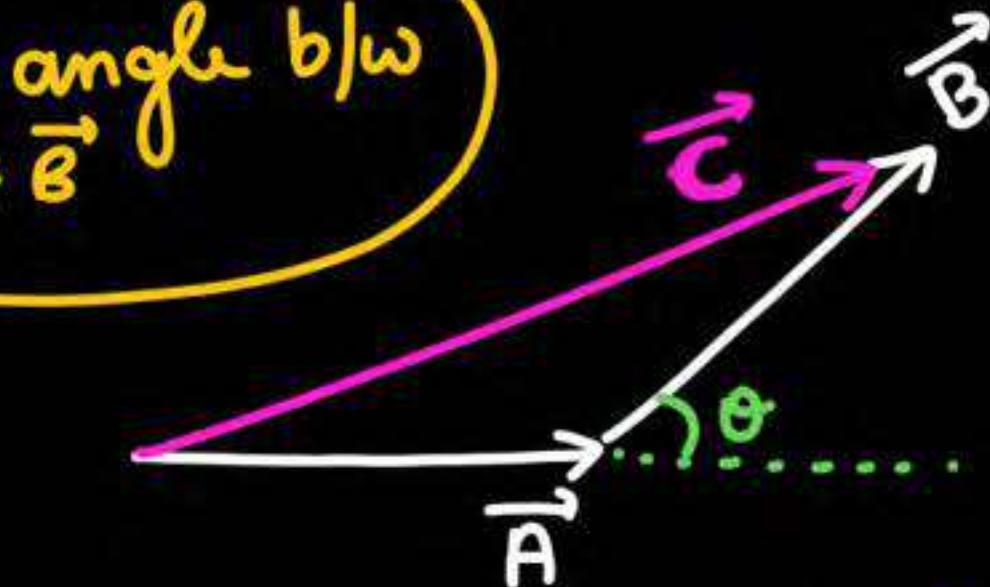
$$\text{magnitude of } \vec{A} = A$$

$$\text{'' } \quad \vec{B} = B$$

$$\text{'' } \quad \vec{C} = C$$

$$\text{length of } \vec{C} = \text{mag. of } \vec{C}$$

$\theta \rightarrow \text{angle b/w}$
 $\vec{A} \& \vec{B}$



$$(PR)^2 + (QR)^2 = (PQ)^2$$

$$(BS \sin \theta)^2 + (A + B \cos \theta)^2 = C^2$$

$$B^2 \sin^2 \theta + A^2 + B^2 \cos^2 \theta + 2AB \cos \theta = C^2$$

$$A^2 + B^2 (\sin^2 \theta + \cos^2 \theta) + 2AB \cos \theta = C^2$$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$\cos \theta = \frac{SR}{B}$$

$$SR = B \cos \theta$$

$$\sin \theta = \frac{PR}{B}$$

$$PR = B \sin \theta$$

Q

Two forces 10N and 20N are acting on a block having 60° angle between them. find magnitude of resultant of them

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$= \sqrt{(10)^2 + (20)^2 + 2 \times 10 \times 20 \times \cos 60^\circ}$$

$$= \sqrt{500 + 200} = \sqrt{700} \text{ Ans}$$

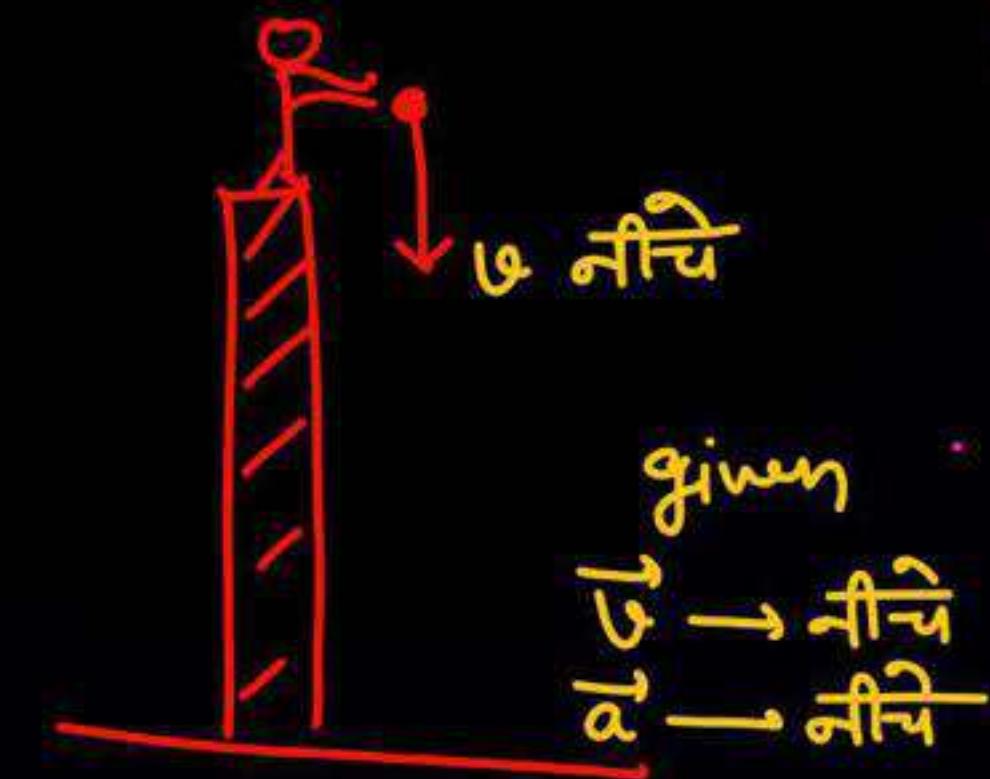
Q



$\vec{v} \rightarrow$ ऊपर
 $\vec{a} \rightarrow$ नीचे } Kinematics
 \vec{v}, \vec{a} are antiparallel.

No lag \Rightarrow thumb up
 lag \Rightarrow " down

②



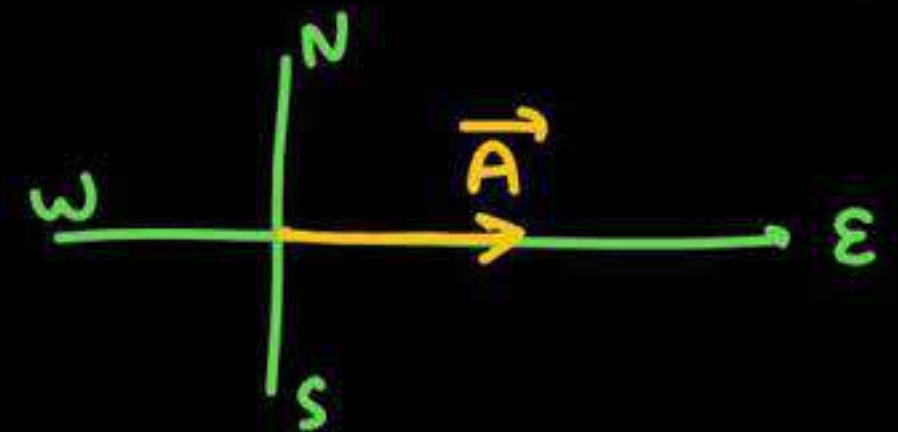
given
 $\vec{v} \rightarrow$ नीचे
 $\vec{a} \rightarrow$ नीचे

\vec{v}, \vec{a} one parallel
vector

Q

$$\vec{F} = 10N \text{ (along east)}$$

newton
(force)



find, draw

$$2\vec{A} = 20N \text{ (along east)}$$

$$3\vec{A} = 30N \quad (" ")$$

$$\frac{\vec{A}}{2} = \frac{1}{2}\vec{A} = 5N \quad (")$$



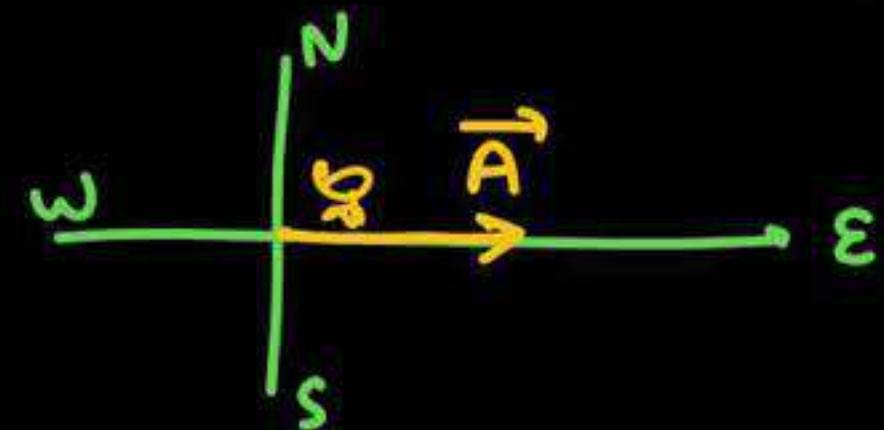
$$-2\vec{A} = 20N \text{ (west)}$$

$$-5\vec{A} = 50N \text{ (west)}$$

/

Q

$$\vec{v} = 10 \text{ m/s (along east)}$$

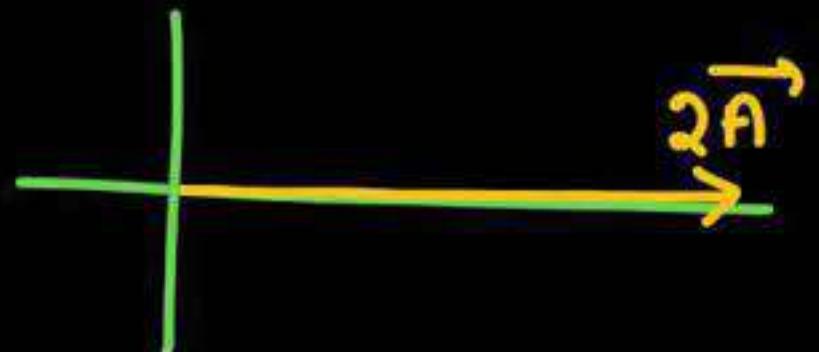


find, draw

$$2\vec{v} = 20 \text{ m/s (along east)}$$

$$3\vec{v} = 30 \text{ m/s (" ")}$$

$$\frac{\vec{v}}{2} = \frac{1}{2}\vec{A} = 5 \text{ m/s (" ")}$$



Q $t^2 - 3t + 2 = 0$

find t_1 & t_2

$$t_1 = \frac{3 + \sqrt{9 - 4 \times 2 \times 1}}{2} = \frac{3+1}{2} = 2$$

$$t_2 = \frac{3 - \sqrt{9 - 4 \times 2 \times 1}}{2} = \frac{3-1}{2} = 1$$

$$ax^2 + bx + c = 0$$

* $b^2 - 4ac > 0 \longrightarrow$ two root

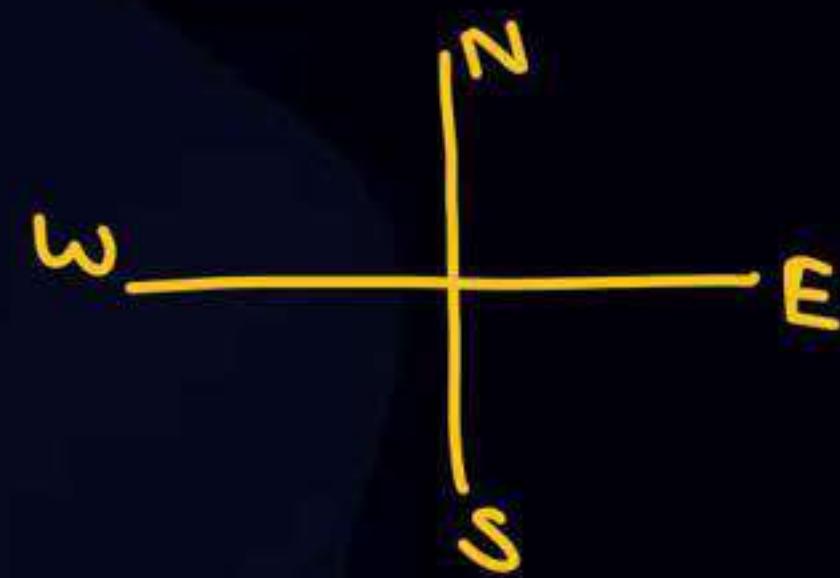
* $b^2 - 4ac = 0 \longrightarrow$ 1 root

* $b^2 - 4ac < 0 \longrightarrow$ No real root
imaginary root

Q Represent vector \vec{P} & vector \vec{Q}

$\vec{P} = 20\text{ N}$ along east

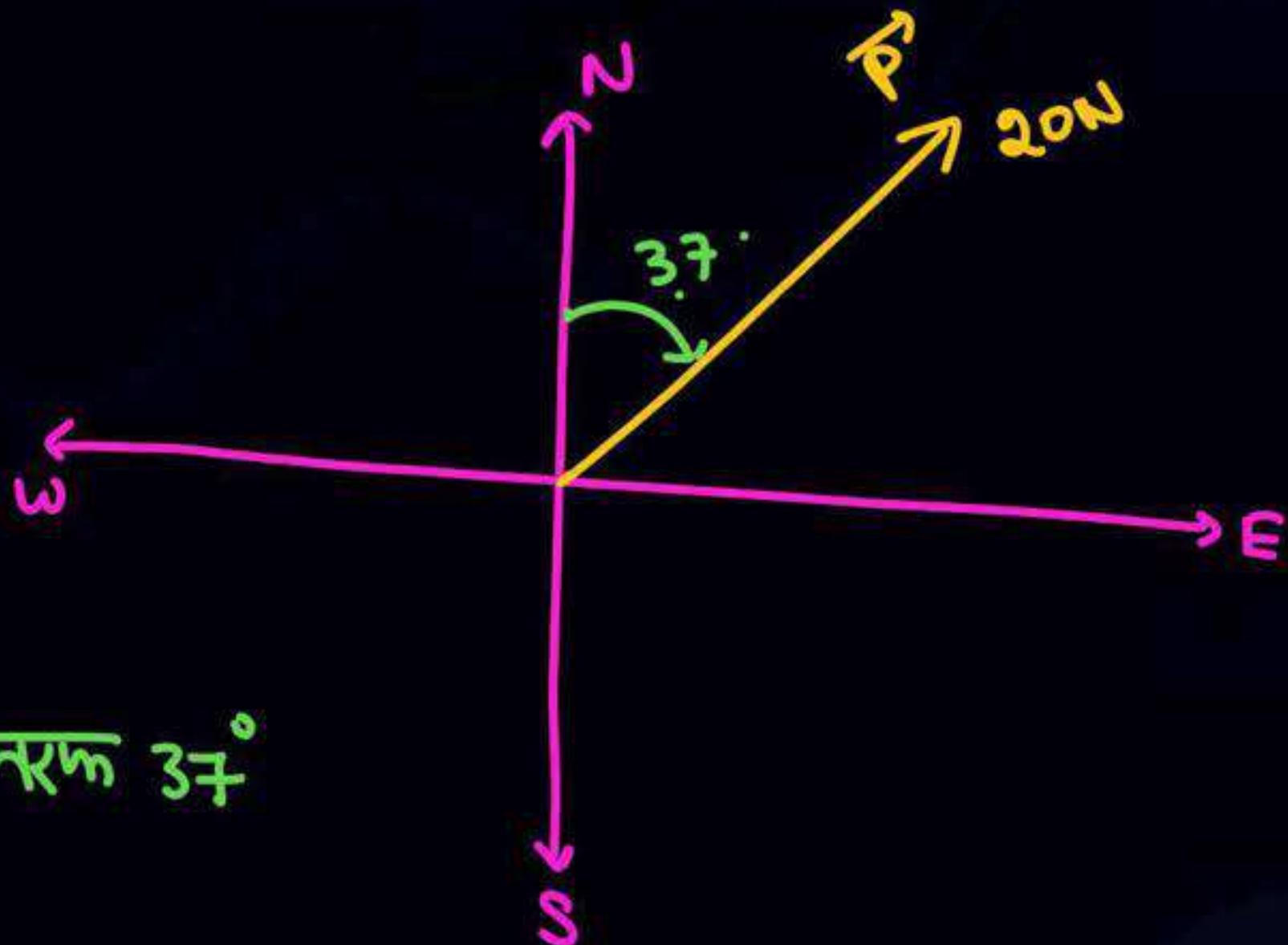
$\vec{Q} = 40\text{ N}$ along North



Q Represent
 \vec{P} of magnitude
20 N in direction
of 37° east of
north.

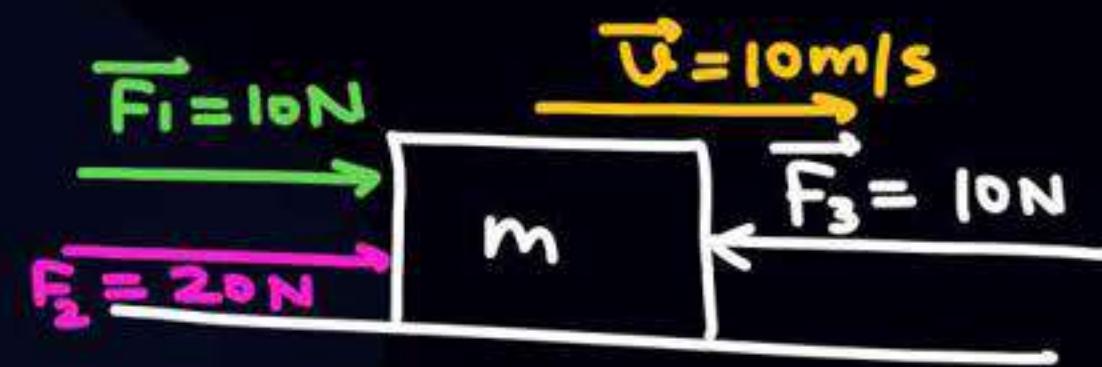
Q Represent
 \vec{P} of magnitude
20N in direction
of 37° east of
north

III
North से East की तरफ 37°



② parallel vector → Two vectors are said to be parallel if they have same direction.

Q Block is moving with velocity 10 m/s along east dirⁿ



here

$\vec{F}_1 \& \vec{F}_2$ are parallel vector ✓

" " " " ^ equal vector ✗

$\vec{F}_1 \& \vec{v}$ one parallel vector ✓

$\vec{F}_2 \& \vec{v}$

$\vec{F}_1 \& \vec{F}_3$ are antiparallel

$\vec{v} \& \vec{F}_3$ " "

" "

" "



$$\textcircled{1} \quad \vec{A} = 4\hat{i} - 2\hat{j}$$

$$\vec{B} = 3\hat{i} + 4\hat{j}$$

$$264 - 264 = 0$$

$$\textcircled{1} \quad \text{Component of } \vec{A} \text{ parallel to } \vec{B} = A \cos \theta = \frac{\vec{A} \cdot \vec{B}}{|\vec{B}|} = \frac{12 - 8}{5} = \frac{4}{5}$$

"

"

Vector
form

$$= \frac{4}{5} \cdot \hat{B} = \frac{4}{5} \left(\frac{3\hat{i} + 4\hat{j}}{5} \right) = \frac{12\hat{i} + 16\hat{j}}{25}$$

$$\textcircled{2} \quad \text{Component of } \vec{A} \text{ perpendicular to } \vec{B} = \vec{A} - \vec{A}_{||}$$

$$= (4\hat{i} - 2\hat{j}) - \frac{12\hat{i} + 16\hat{j}}{25}$$

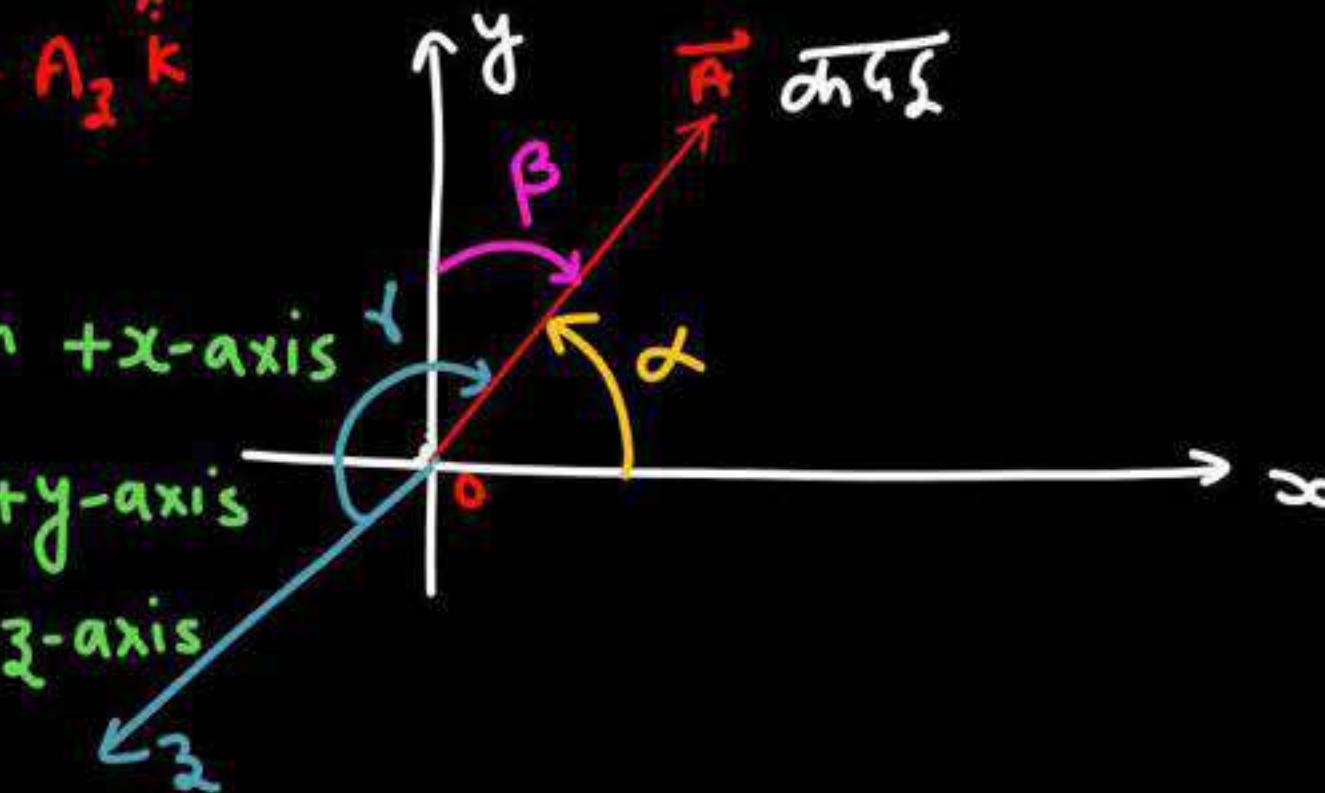
$$= \frac{88\hat{i} - 66\hat{j}}{25}$$

Direction Cosine

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

If \vec{A} makes angle α with $+x$ -axis

" " " +y-axis
" " " +z-axis



Component of \vec{A} along x -Axis = $A \cos \alpha = A_x$

" " " y " " = $A \cos \beta = A_y$

" " " z " " = $A \cos \gamma = A_z$

$$\cos \alpha = \frac{A_x}{A}$$

$$\cos \beta = \frac{A_y}{A}$$

$$\cos \gamma = \frac{A_z}{A}$$

$$\text{Q} \quad \vec{A} = 2\hat{i} + 3\hat{j} + 6\hat{k}$$

$$A = |\vec{A}| = \sqrt{2^2 + 3^2 + 6^2} = 7$$

$$\begin{aligned}\cos \alpha &= \frac{A_x}{A} = \frac{2}{7} \\ \cos \beta &= \frac{A_y}{A} = \frac{3}{7} \\ \cos \gamma &= \frac{A_z}{A} = \frac{6}{7}\end{aligned}$$

} direction cosine

Silly

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

$$\begin{aligned}\sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma &= 1 \times \\ &= 2 \checkmark\end{aligned}$$

$$\begin{aligned}1 - \sin^2 \alpha + 1 - \sin^2 \beta + 1 - \sin^2 \gamma &= 1 \\ \sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma &= 2.\end{aligned}$$

Q $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$

$$A = \sqrt{3^2 + 4^2 + 5^2} = 5\sqrt{2}$$

① Direction cosine

$$\cos \alpha = \frac{3}{5\sqrt{2}}$$

$$\cos \beta = \frac{4}{5\sqrt{2}}$$

$$\cos \gamma = \frac{5}{5\sqrt{2}} = \frac{1}{\sqrt{2}}, \quad Y = 45^\circ$$

②

Component of \vec{A} along x-axis = $3\hat{i}$

③

" " y " = $4\hat{j}$

④

" " z " = $5\hat{k}$

*⑤

" on x-y plane = $3\hat{i} + 4\hat{j}$

⑥

" on y-z plane = $4\hat{j} + 5\hat{k}$

$i^j k^l i^m j^n k^o$

K.C.

Same seq = + Remainder }
Different seq = - Remainder }

Q

$$\vec{a} = 3\hat{i} + 4\hat{j}$$

$$\vec{b} = 2\hat{i} + 5\hat{j}$$

$$\hat{i} \times \hat{i} = 0$$

$$\hat{j} \times \hat{j} = 0$$

Q

$$\vec{a} = 4\hat{i} + 7\hat{j}$$

$$\vec{b} = 2\hat{i} + 3\hat{j}$$

$$\textcircled{1} \quad \vec{a} \times \vec{b} = ?$$

$$\textcircled{2} \quad \vec{b} \times \vec{a} = ?$$

$$\vec{a} \times \vec{b} = (3\hat{i} + 4\hat{j}) \times (2\hat{i} + 5\hat{j})$$

$$= 6\hat{i} \times \hat{i} + 15\hat{i} \times \hat{j} + 8\hat{j} \times \hat{i} + 20\hat{j} \times \hat{j}$$

$$= 0 + 15\hat{k} - 8\hat{k} + 0$$

$$= 7\hat{k} = \vec{c}$$

$$\vec{c} \perp \vec{a}, \vec{c} \perp \vec{b}$$

$$Q \quad \vec{a} = 4\hat{i} + 7\hat{j}$$

$$\vec{b} = 2\hat{i} + 3\hat{j}$$

$$\vec{a} \times \vec{b} = (4\hat{i} + 7\hat{j}) \times (2\hat{i} + 3\hat{j})$$

$$= 0 + 12\hat{k} - 14\hat{k} + 0$$

$$= -2\hat{k}$$

$$\vec{b} \times \vec{a} = (2\hat{i} + 3\hat{j}) \times (4\hat{i} + 7\hat{j})$$

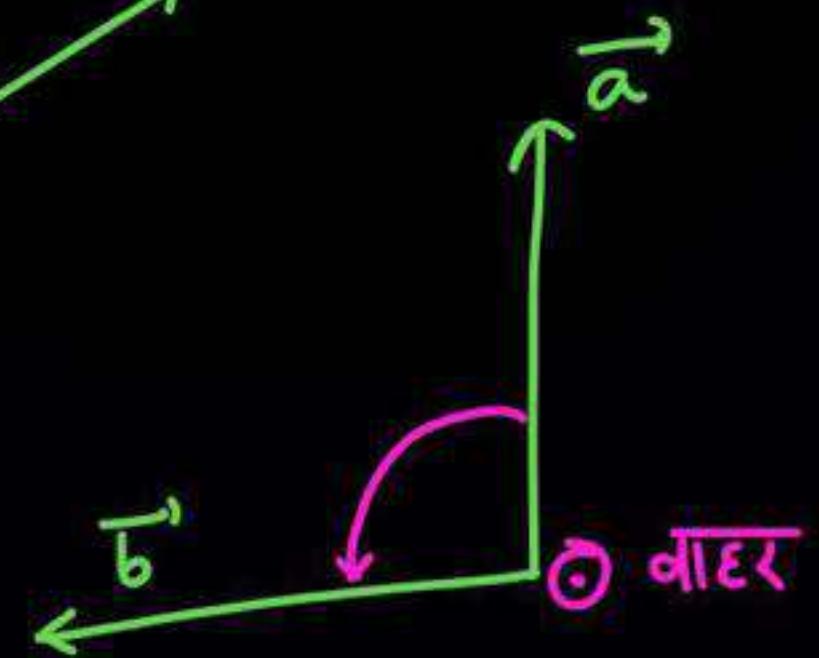
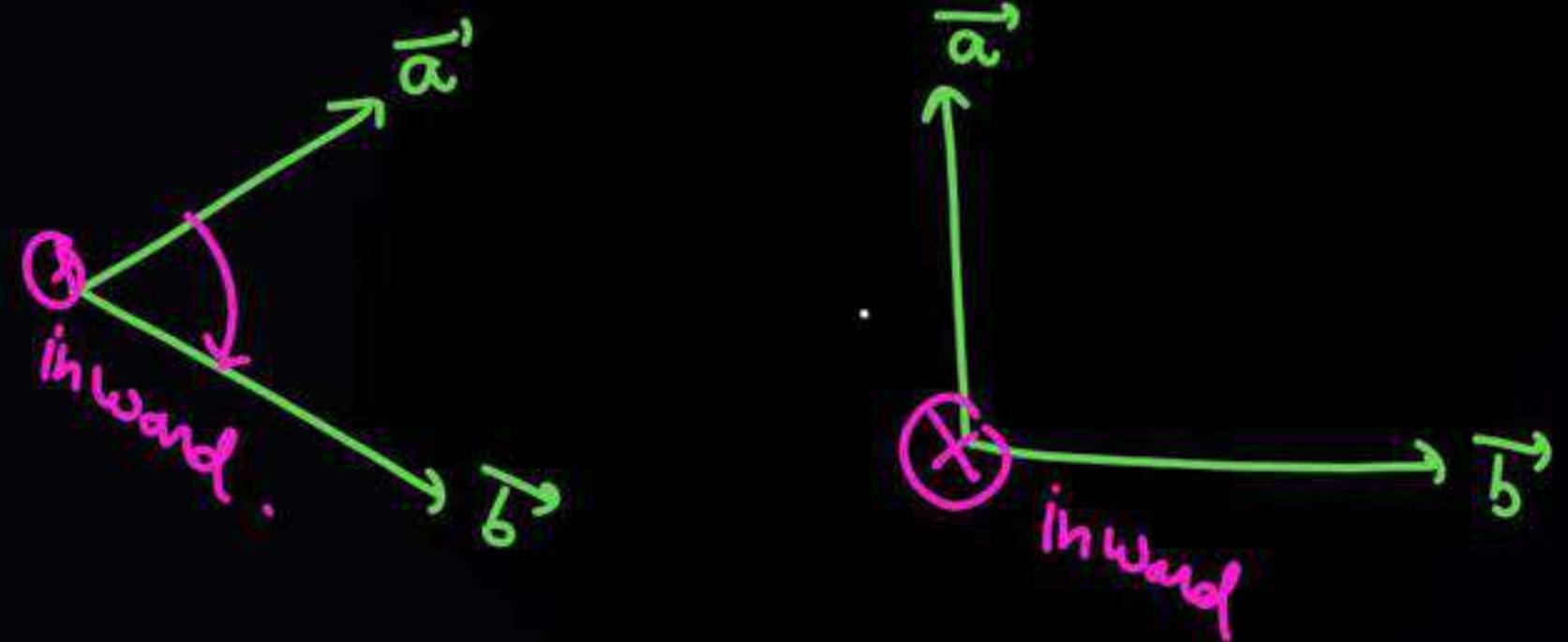
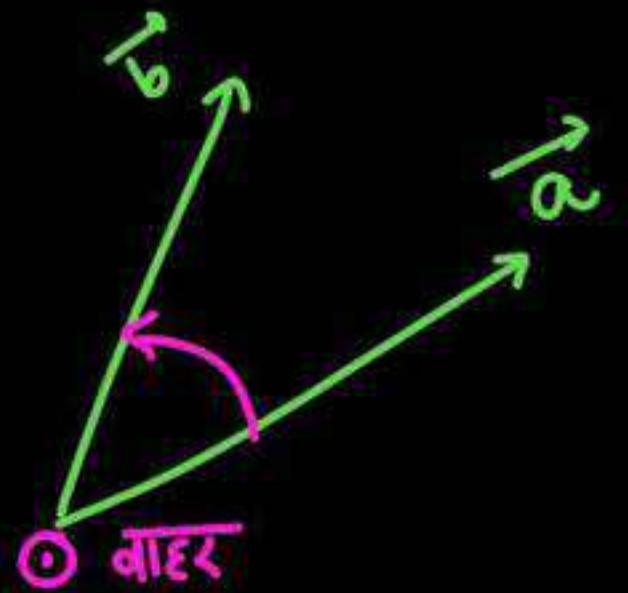
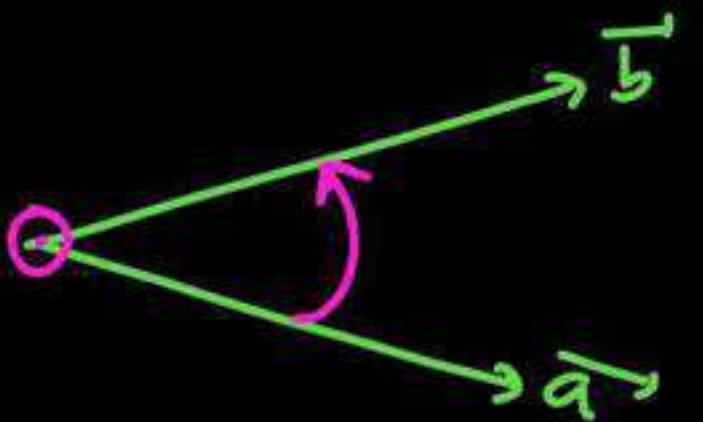
$$= 0 + 14\hat{k} - 12\hat{k} + 0$$

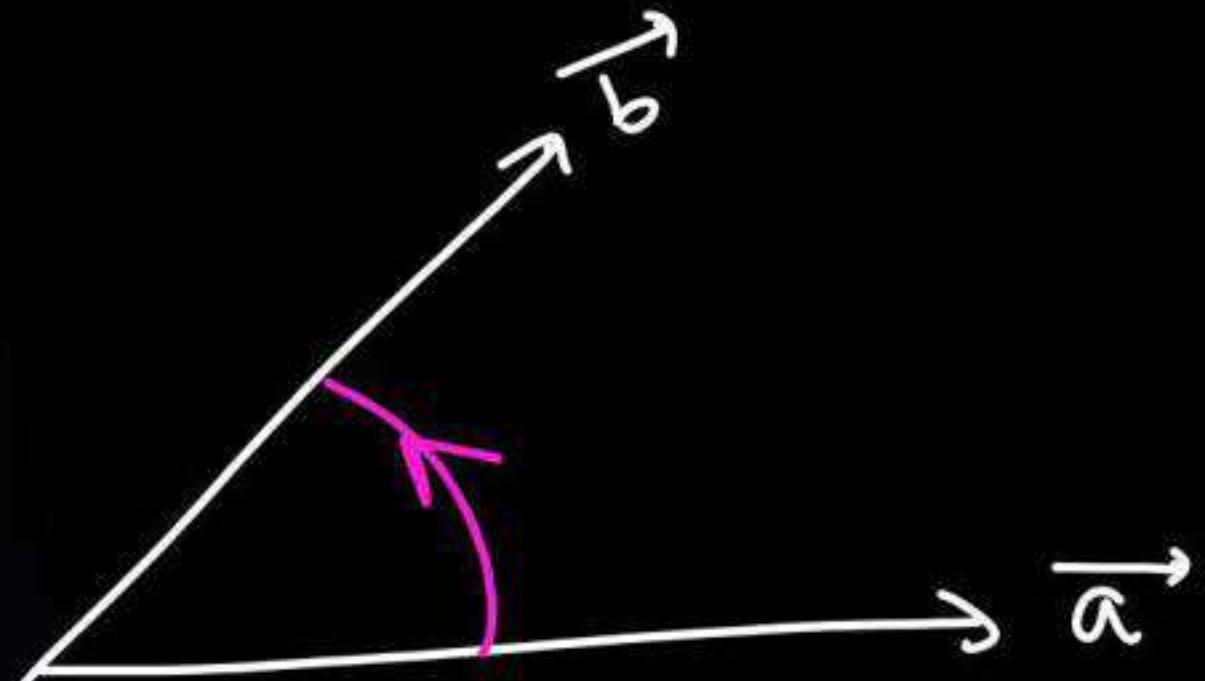
$$\boxed{\vec{b} \times \vec{a} = + 2\hat{k}}$$

$$\boxed{\vec{a} \times \vec{b} = - \vec{b} \times \vec{a}}$$

Q Find dir of $\vec{a} \times \vec{b}$

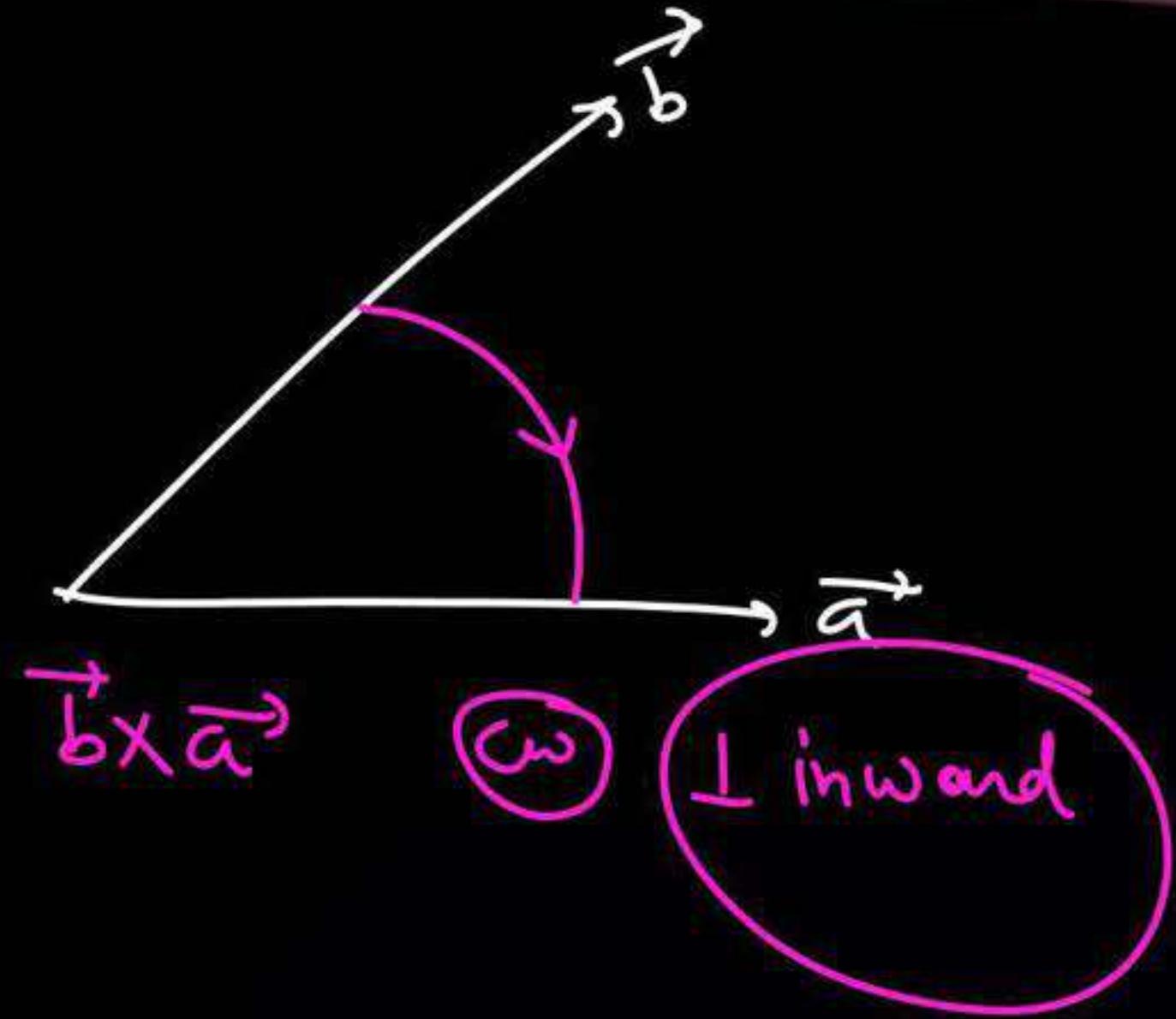
PW





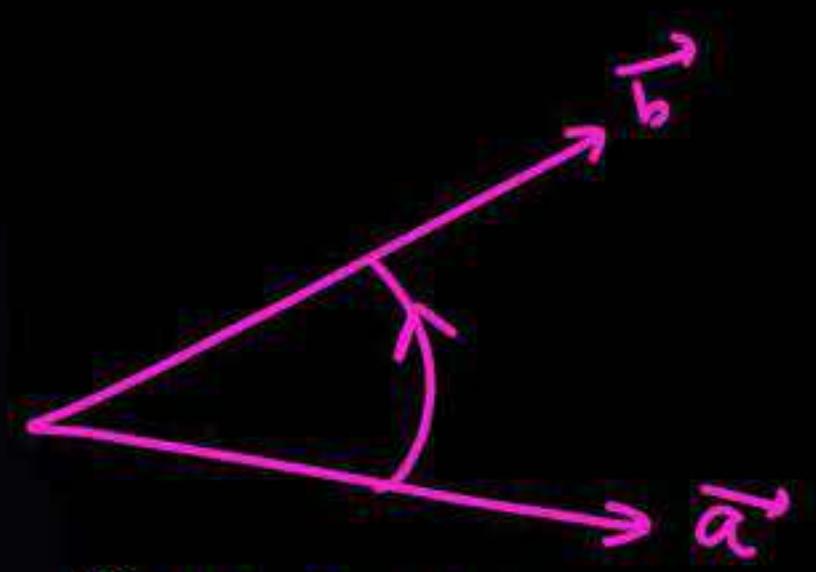
$$\vec{a} \times \vec{b} = \text{dir}^n$$

Acw =



cw

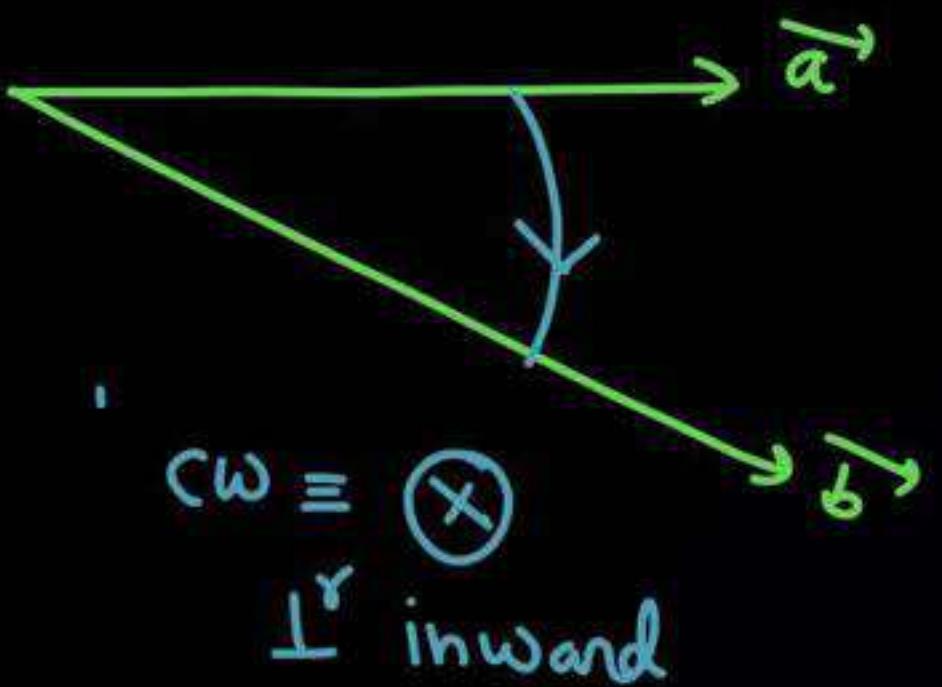
L inward



ACW sense

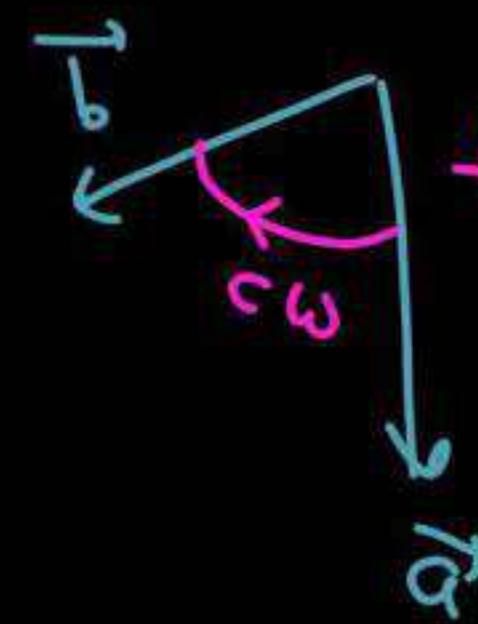
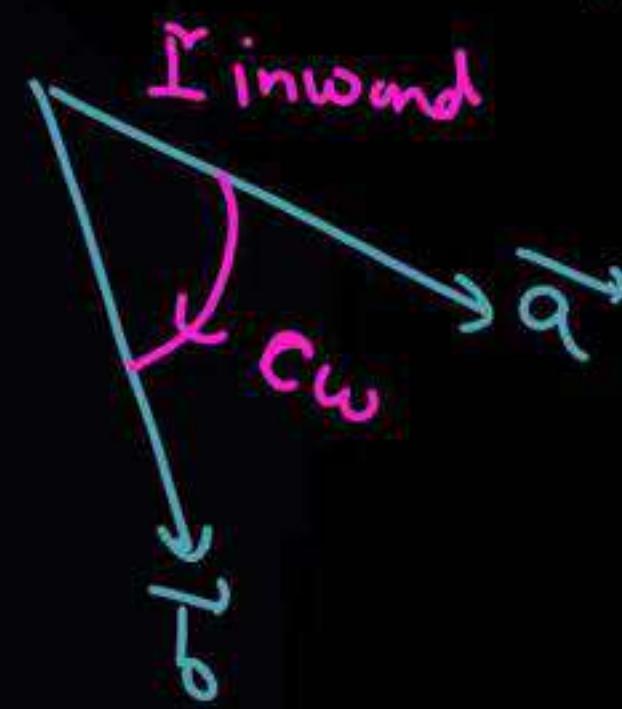
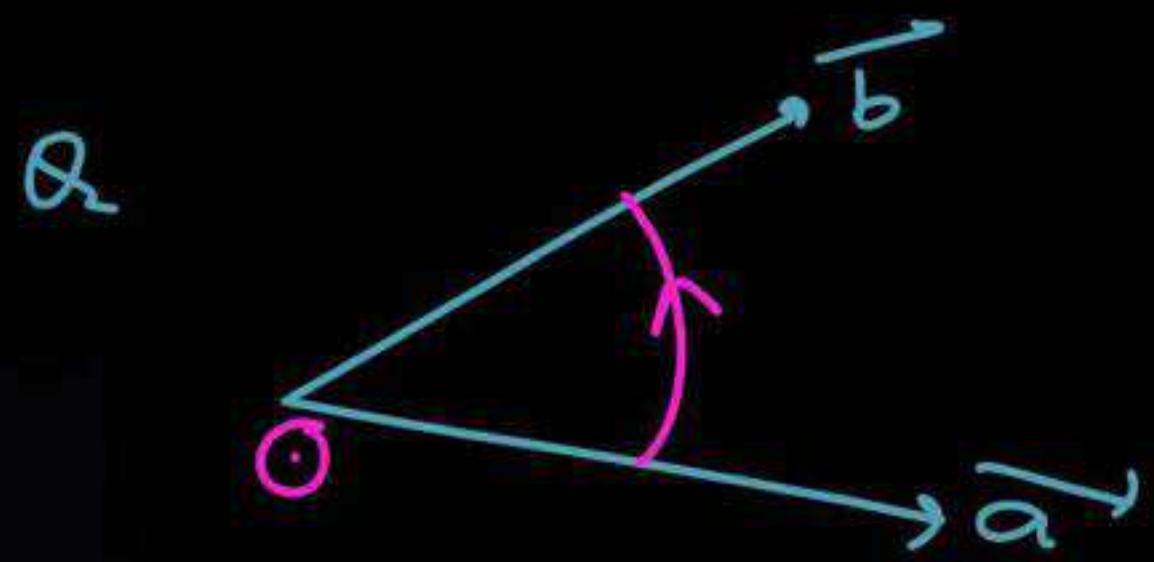
III

$\odot = (\perp^y \text{ outward})$



CW = \odot

\perp^y inward



\perp inward
 $\vec{a} \times \vec{b}$ st dirn

Imp. Points

$$\hat{i} \cdot \hat{i} = 1$$

$$\hat{i} \cdot \hat{j} = \hat{j} \cdot \hat{k} = \hat{i} \cdot \hat{k} = 0$$

$\vec{A} \cdot \vec{B} = AB \cos \theta$

$$\hat{j} \cdot \hat{j} = 1$$

$$\hat{k} \cdot \hat{k} = 1$$

$$\text{If } \vec{A} \perp \vec{B} \Rightarrow \vec{A} \cdot \vec{B} = 0$$

$$\vec{A} \cdot \vec{A} = A^2$$

$$(\vec{A} + \vec{B}) \cdot (\vec{C} + \vec{D}) = \vec{A} \cdot \vec{C} + \vec{A} \cdot \vec{D} + \vec{B} \cdot \vec{C} + \vec{B} \cdot \vec{D} = 0$$

$$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A} = AB \cos 30^\circ$$

$$\vec{A} = 2\hat{i} - 5\hat{j} + 7\hat{k}$$

$$\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

$$\vec{A} \cdot \vec{B} = 6 - 20 + 35 = 21$$

Q find $\vec{A} \cdot \vec{B}$

① $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$
 $\vec{B} = 2\hat{i} - 3\hat{j} - 4\hat{k}$
 $\vec{A} \cdot \vec{B} = 6 - 12 - 20 = -26$

② $\vec{A} = \hat{i} - \hat{k}$
 $\vec{B} = \hat{j} + \hat{k}$
 $\vec{A}' = \hat{i} + 0\hat{j} - \hat{k}$
 $\vec{B}' = 0\hat{i} + \hat{j} + \hat{k}$

 $\vec{A} \cdot \vec{B} = 0 + 0 - 1 = -1$

③ $\vec{A} = \hat{i} - \hat{j} + 2\hat{k}$
 $\vec{B} = 4\hat{i} + 8\hat{j} + 2\hat{k}$
 $\vec{A} \cdot \vec{B} = 4 - 8 + 4 = 0$

④ $\vec{A} = \hat{i} - \hat{j} = \hat{i} - \hat{j} + 0\hat{k}$
 $\vec{B} = \hat{i} + \hat{k} = \hat{i} + 0\hat{j} + \hat{k}$
 $\vec{A} \cdot \vec{B} = 1 + 0 + 0 = 1$

अमर द्वी वेक्टर
उपरोक्ते उनका डॉट प्रोडक्ट
JEE main =
गणित
सूत्र

$$\text{Q} \quad \vec{A} = 2\hat{i} - 3\hat{j} + 4\hat{k}$$

$$\vec{B} = \alpha\hat{i} + 2\hat{j} + 5\hat{k}$$

If $\vec{A} \perp \vec{B}$ find α

$$\vec{A} \cdot \vec{B} = 0$$

$$2\alpha - 6 + 20 = 0$$

$$2\alpha + 14 = 0$$

$$\boxed{\alpha = -7}$$

Q Find angle b/w \vec{A} & \vec{B}

$$\vec{A} = \hat{i} + \hat{j}$$

$$\vec{B} = 3\hat{i} + 4\hat{j}$$

$$\underline{\vec{A} \cdot \vec{B} = AB \cos \theta}$$

$$7 = \sqrt{2} \cdot 5 \cos \theta$$

$\frac{\cos \theta}{\text{Ans}}$

$$\cos \theta = \frac{7}{5\sqrt{2}}$$

$$\theta = \cos^{-1}\left(\frac{7}{5\sqrt{2}}\right)$$

$$\vec{A} \cdot \vec{B} = 3+4$$

$$= 7$$

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$\cos \theta = \frac{\vec{A} \cdot \vec{B}}{AB}$$

Q $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ $A = \sqrt{3^2 + 4^2 + 5^2}$

$$\vec{B} = 2\hat{i} + 3\hat{j} + 6\hat{k}$$

$$\underline{\vec{A} \cdot \vec{B} = 6 + 12 + 30 = 48}$$

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$48 = 5\sqrt{2} \cdot 7 \cos \theta$$

$$\cos \theta = \frac{48}{35\sqrt{2}}$$

Q Find the angle between \vec{A} & \vec{B}

$$\begin{aligned} \textcircled{1} \quad \vec{A} &= \hat{i} + \hat{j} + \hat{k} \\ \vec{B} &= \hat{i} - \hat{j} + \hat{k} \\ \vec{A} \cdot \vec{B} &= 1 - 1 + 1 = 1 \end{aligned}$$

$$1 = \sqrt{3} \sqrt{3} \cos \theta$$

$$\boxed{\cos \theta = \frac{1}{3}} \quad \theta = \cos^{-1}\left(\frac{1}{3}\right)$$

$$\begin{aligned} \textcircled{2} \quad \vec{A} &= \hat{i} + \hat{j} \\ \vec{B} &= \hat{i} - \hat{j} \\ \vec{A} \cdot \vec{B} &= 1 - 1 = 0 \end{aligned}$$

$$\theta = 90^\circ$$

$$\begin{aligned} \textcircled{3} \quad \vec{A} &= 3\hat{i} + 4\hat{j} + 5\hat{k} \\ \vec{B} &= 2\hat{i} - 4\hat{j} + 2\hat{k} \\ \vec{A} \cdot \vec{B} &= 6 - 16 + 10 = 0 \end{aligned}$$

$$\theta = 90^\circ$$

$$\begin{aligned} \textcircled{4} \quad \vec{A} &= 3\hat{i} + 4\hat{j} + 5\hat{k} \\ \vec{B} &= 6\hat{i} + 8\hat{j} + 10\hat{k} \end{aligned}$$

$$A = 5\sqrt{2}$$

$$B = 10\sqrt{2}$$

$$\vec{A} \cdot \vec{B} = 18 + 32 + 50 = 100$$

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$100 = 5\sqrt{2} \cdot 10\sqrt{2} \cos \theta$$

$$\cos \theta = 1$$

\vec{A} & \vec{B} are parallel

$$\theta = 0^\circ$$

$$\overrightarrow{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

$$\overrightarrow{B} = B_x \hat{i} + B_y \hat{j} + B_z \hat{k}$$

Q $\overrightarrow{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$

$$\overrightarrow{B} = 6\hat{i} + 8\hat{j} + 10\hat{k} = 2[3\hat{i} + 4\hat{j} + 5\hat{k}]$$

$$\frac{3}{6} = \frac{4}{8} = \frac{5}{10} = \frac{1}{2}$$

$\overrightarrow{A} \uparrow \uparrow \text{ to } \overrightarrow{B}$

$$\overrightarrow{B} = 2\overrightarrow{A}$$

If

$$\frac{A_x}{B_x} = \frac{A_y}{B_y} = \frac{A_z}{B_z} = n$$

$n > 0 \Rightarrow \overrightarrow{A}$ is parallel to \overrightarrow{B}

$n < 0 \Rightarrow \overrightarrow{A}$ is antiparallel to \overrightarrow{B}

Q $\overrightarrow{A} = 4\hat{i} + 6\hat{j}$

$$\overrightarrow{B} = 12\hat{i} + 18\hat{j}$$

$$\frac{4}{12} = \frac{6}{18}$$

$$\overrightarrow{A} \uparrow \uparrow \overrightarrow{B}$$

$$\Omega \quad \vec{A} = 3\hat{i} - 4\hat{j} + 5\hat{k}$$

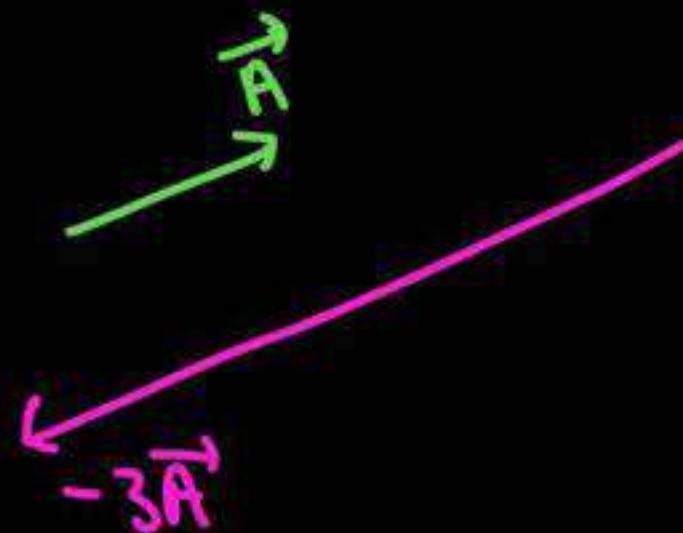
$$\vec{B} = -9\hat{i} + 12\hat{j} - 15\hat{k}$$

$$= -3(3\hat{i} - 4\hat{j} + 5\hat{k})$$

$$\boxed{\begin{aligned} \frac{3}{-9} &= \frac{-4}{12} = \frac{5}{-15} \\ &= -\frac{1}{3} \end{aligned}}$$

Antiparallel

$$\vec{B} = -3\vec{A}$$



$$\Omega \quad \vec{A} = 2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$\vec{B} = 4\hat{i} + 6\hat{j} - 8\hat{k}$$

~~(a)~~
~~(b)~~
(c)

\vec{A} is parallel to \vec{B}

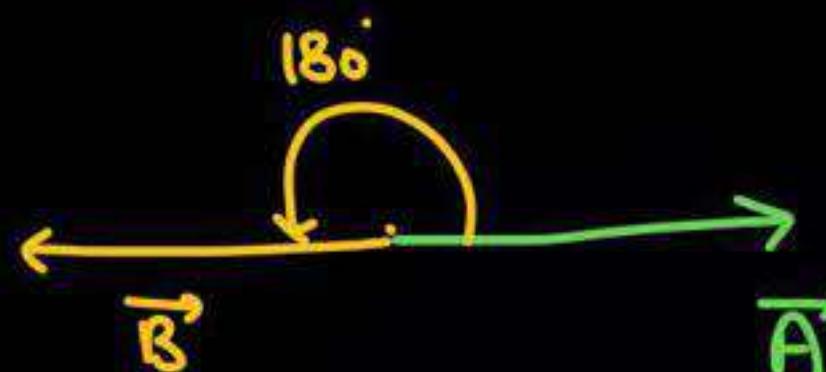
∴ antiparallel

कुप्र-पर्याप्ती एवं कटदृश्य

\vec{A}, \vec{B} |||| एं anti parallel एं या \perp हैं, या $\overline{\text{नहीं}}$

$$\cos\theta = \frac{\vec{A} \cdot \vec{B}}{AB} = \text{निकालती}$$

If	$\theta = 0$	parallel
	$\theta = 180$	Antiparallel
	$\theta = 90$	\perp



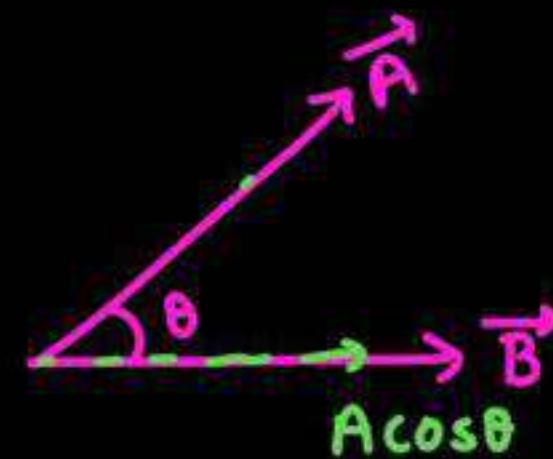
Ω

$$\vec{A} = 3\hat{i} + 4\hat{j}$$

$$\vec{B} = \hat{i} + \hat{j}$$

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$A \cos \theta = \frac{\vec{A} \cdot \vec{B}}{B}$$



Component of \vec{A} along \vec{B} = $A \cos \theta$

towards parallel to $= -\frac{\vec{A} \cdot \vec{B}}{B} = \frac{3+4}{\sqrt{2}} = \frac{7}{\sqrt{2}}$ (scalar)

Component of \vec{A} along \vec{B} (in vector form)

$$= \frac{7}{\sqrt{2}} \cdot \hat{B} = \frac{7}{\sqrt{2}} \left(\frac{\hat{i} + \hat{j}}{\sqrt{2}} \right) = \frac{7}{2} (\hat{i} + \hat{j}) = \frac{7}{2} \vec{B}$$

$$\text{Q} \quad \vec{A} = \hat{i} + 3\hat{j}$$

$$\vec{B} = 3\hat{i} + 4\hat{j}$$

Component of \vec{A} along \vec{B} = $A \cos \theta = \frac{\vec{A} \cdot \vec{B}}{B} = \frac{3+12}{5} = 3$

 Vector form $\Rightarrow 3\hat{B} = 3 \cdot \left(\frac{3\hat{i} + 4\hat{j}}{5} \right) = \frac{3}{5}(3\hat{i} + 4\hat{j})$

ऐसा vector बताओ whose magnitude is 3 & dir is along \vec{B}

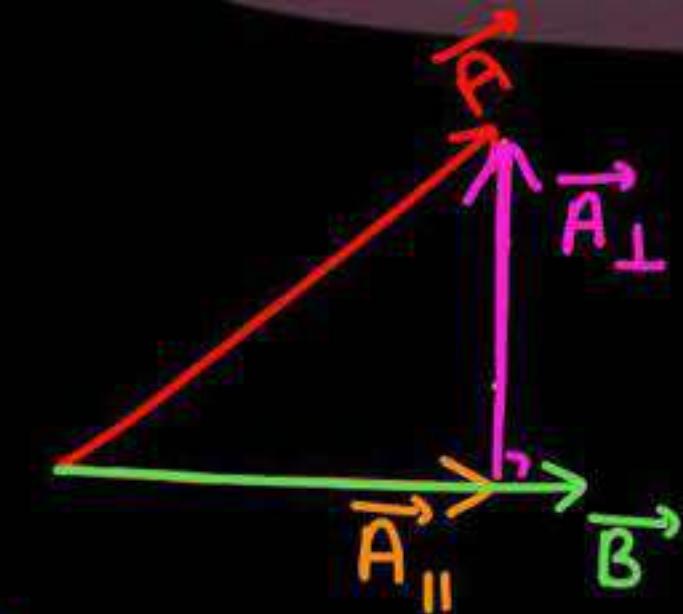
Component of \vec{A} along $\vec{B} = \frac{\vec{A} \cdot \vec{B}}{B}$

Vector form = $\left(\frac{\vec{A} \cdot \vec{B}}{B} \right) \cdot \hat{B}$

Q

$$\vec{A} = \hat{i} + 3\hat{j}$$

$$\vec{B} = 3\hat{i} + 4\hat{j}$$



Component of \vec{A} parallel to \vec{B} = $\frac{3}{5}(3\hat{i} + 4\hat{j}) = \vec{A}_{||}$
or along

$$\vec{A}_{||} + \vec{A}_{\perp} = \vec{A}$$

Component of \vec{A} perpendicular to \vec{B} =

Vector form = ?

$$\boxed{\vec{A}_{\perp} = \vec{A} - \vec{A}_{||}}$$

$$\vec{A}_{\perp} = \vec{A} - \vec{A}_{||} = (\hat{i} + 3\hat{j}) - \frac{3}{5}(3\hat{i} + 4\hat{j})$$

$$= \underline{-\frac{4\hat{i} + 3\hat{j}}{5}}$$

Q

$$\vec{A} = 2\hat{i} + 3\hat{j}$$

$$\vec{B} = \hat{i} + \hat{j}$$

① Component of \vec{A} along \vec{B} = $\frac{\vec{A} \cdot \vec{B}}{|\vec{B}|} = \frac{2+3}{\sqrt{2}} = \frac{5}{\sqrt{2}}$

Vector = $\frac{5}{\sqrt{2}} \cdot \hat{B} = \frac{5}{\sqrt{2}} \cdot \frac{\hat{i} + \hat{j}}{\sqrt{2}} = \frac{5}{2}(\hat{i} + \hat{j}) =$

②

Component of \vec{A} perpendicular to \vec{B} = $\vec{A} - \vec{A}_{||} = 2\hat{i} + 3\hat{j} - \frac{5\hat{i} + 5\hat{j}}{2}$

$$= \frac{-\hat{i} + \hat{j}}{2}$$

Q which of the following vector is must be Unit vector

X ① $\vec{A} = \hat{i} + \hat{j}$

$$|\vec{A}| = \sqrt{1^2 + 1^2} = \sqrt{2}$$

$\vec{A} \rightarrow$ not Unit vector.

✓ ② $\vec{A} = \frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}$

$$|\vec{A}| = \sqrt{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(-\frac{1}{\sqrt{2}}\right)^2}$$

✓ ③ $\vec{A} = \frac{\hat{j}}{\sqrt{2}} + \frac{\hat{k}}{\sqrt{2}}$

$$= \sqrt{\frac{1}{2} + \frac{1}{2}} = 1$$

✓ ④ $\vec{A} = \frac{\hat{i}}{\sqrt{3}} + \frac{\hat{j}}{\sqrt{3}} + \frac{\hat{k}}{\sqrt{3}}$

$$|\vec{A}| = \sqrt{\left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2}$$
$$= \sqrt{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}} = 1$$

$$\textcircled{5} \quad \vec{A} = \frac{\vec{P} + \vec{Q} + \vec{R}}{|\vec{P} + \vec{Q} + \vec{R}|}$$

$$\textcircled{6} \quad \vec{A} = \frac{\vec{P} + \vec{Q} - \vec{R}}{|\vec{P} + \vec{Q} - \vec{R}|} = \frac{\vec{S}(\text{let})}{|\vec{S}|}$$

$$\vec{P} + \vec{Q} + \vec{R} = \vec{S} \text{ (let)}$$

$$\vec{A} = \frac{\vec{S}}{|\vec{S}|}$$

$$\textcircled{7} \quad \vec{A} = \frac{\vec{P} + \vec{Q} + \vec{R}}{|\vec{P} + \vec{Q} - \vec{R}|}$$

\vec{A} must be Unit vector \equiv wrong

$$\textcircled{7} \quad \vec{A} = \frac{\vec{P} + \vec{Q} + \vec{R}}{|\vec{P} + \vec{Q} - \vec{R}|} = \frac{9\hat{i} + 14\hat{j}}{\sqrt{5}} = \text{magnitude } \sqrt{\left(\frac{9}{\sqrt{5}}\right)^2 + \left(\frac{14}{\sqrt{5}}\right)^2} \neq 1$$

Let

$$\begin{cases} \vec{P} = 2\hat{i} + 3\hat{j} \\ \vec{Q} = 3\hat{i} + 5\hat{j} \\ \vec{R} = 4\hat{i} + 6\hat{j} \end{cases}$$

$$\vec{P} + \vec{Q} - \vec{R} = \hat{i} + 2\hat{j}$$

$$|\vec{P} + \vec{Q} - \vec{R}| = \sqrt{1^2 + 2^2} = \sqrt{5}$$

$$\vec{P} + \vec{Q} + \vec{R} = 9\hat{i} + 14\hat{j}$$

Q If \vec{A} is Unit vector find Value of α

$$\vec{A} = 6\hat{i} + \alpha\hat{j}$$

$$|\vec{A}| = 1$$

$$\sqrt{(6)^2 + \alpha^2} = 1$$

$$36 + \alpha^2 = 1$$

$$\alpha^2 = 1 - 36$$

$$\alpha^2 = -64$$

$$\boxed{\alpha = \pm 8}$$

$$\alpha = 8 \quad \checkmark$$

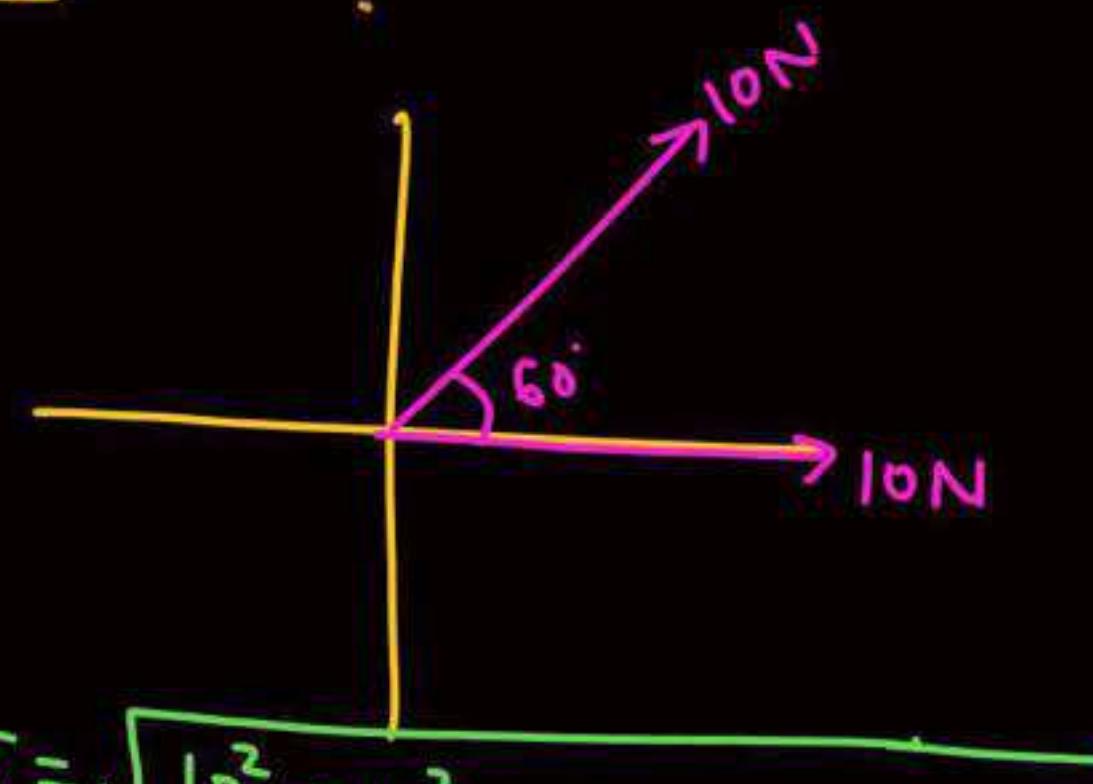
$$\alpha = -8 \quad \checkmark$$

$$\vec{A} = 6\hat{i} + 8\hat{j}$$

$$\vec{A} = 6\hat{i} - 8\hat{j}$$

Q

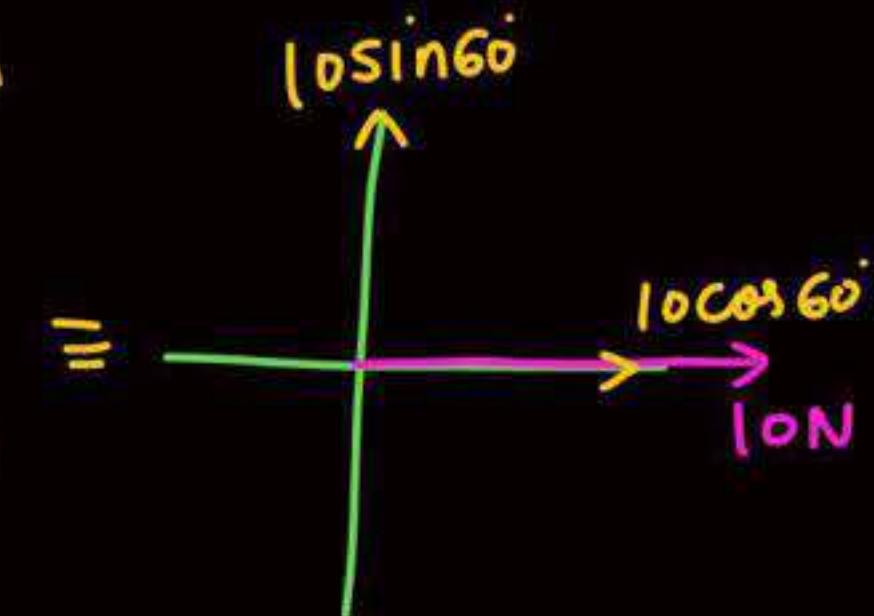
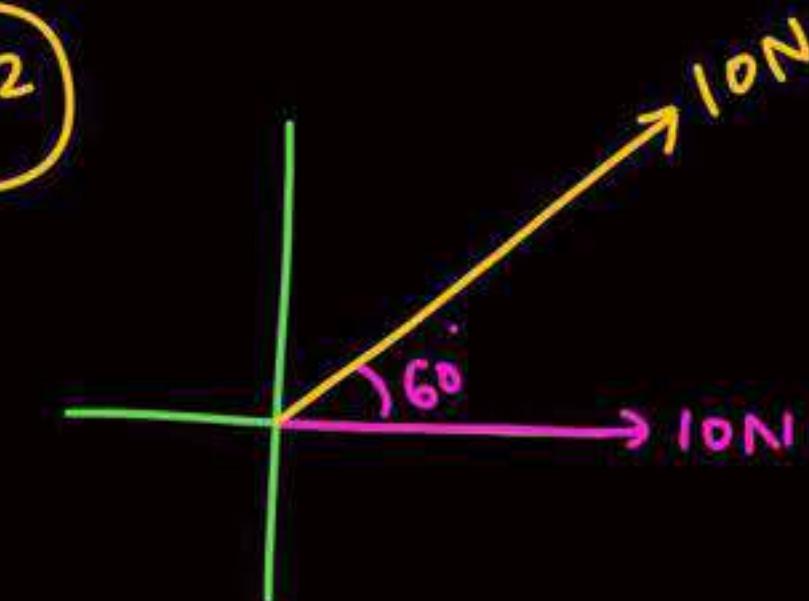
Find net force



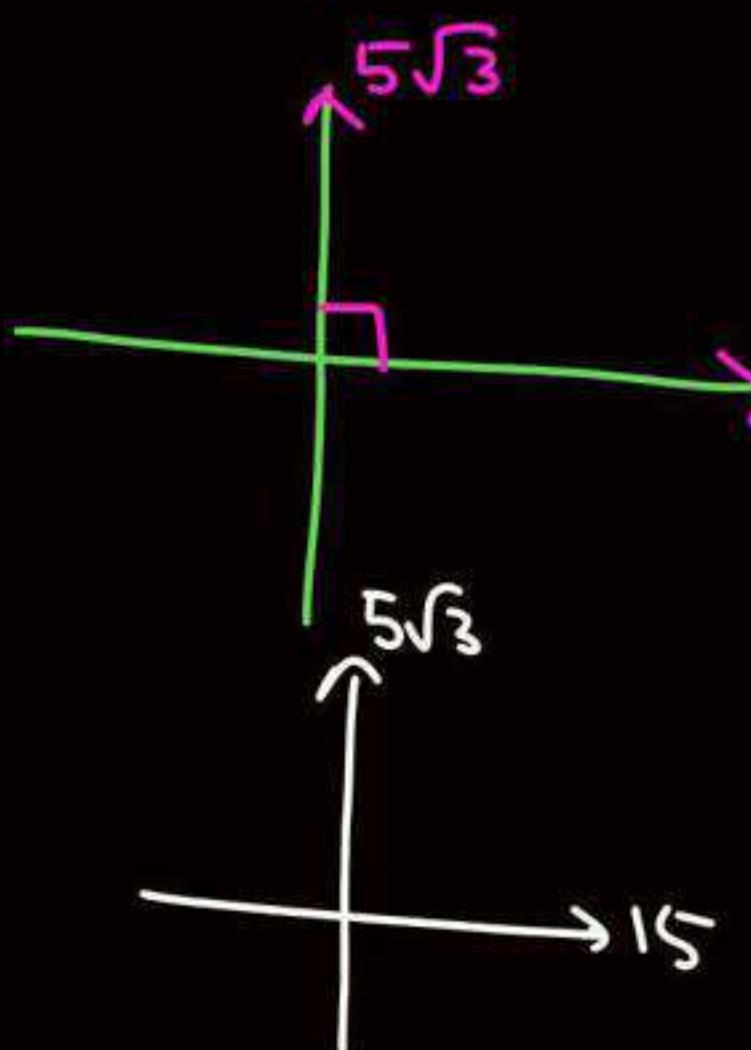
$$c = \sqrt{10^2 + 10^2 + 2 \times 10 \times 10 \cos 60}$$

$$= 10\sqrt{3}$$

m-2



$$\vec{F}_{\text{net}} = 15\hat{i} + 5\sqrt{3}\hat{j}$$

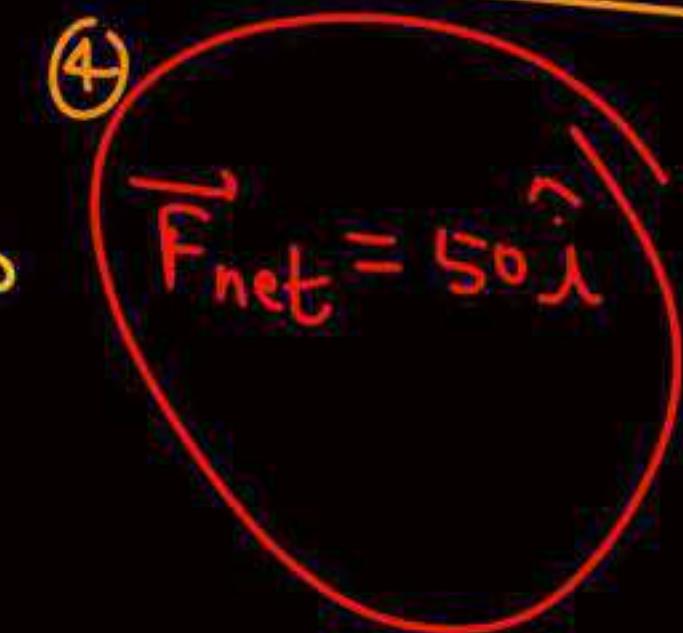
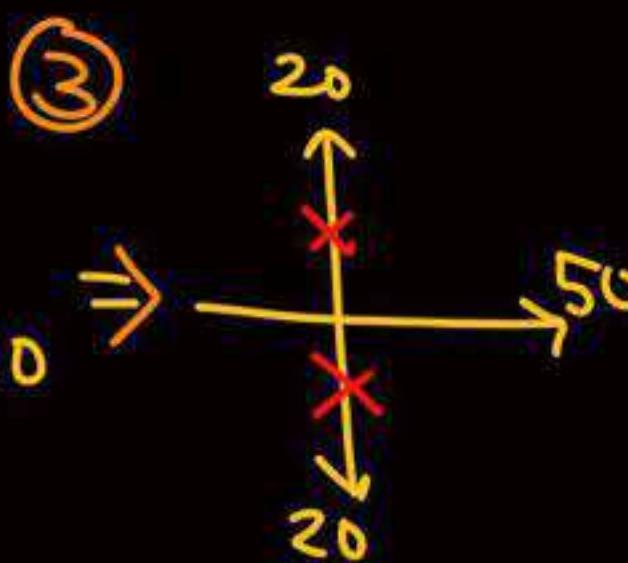
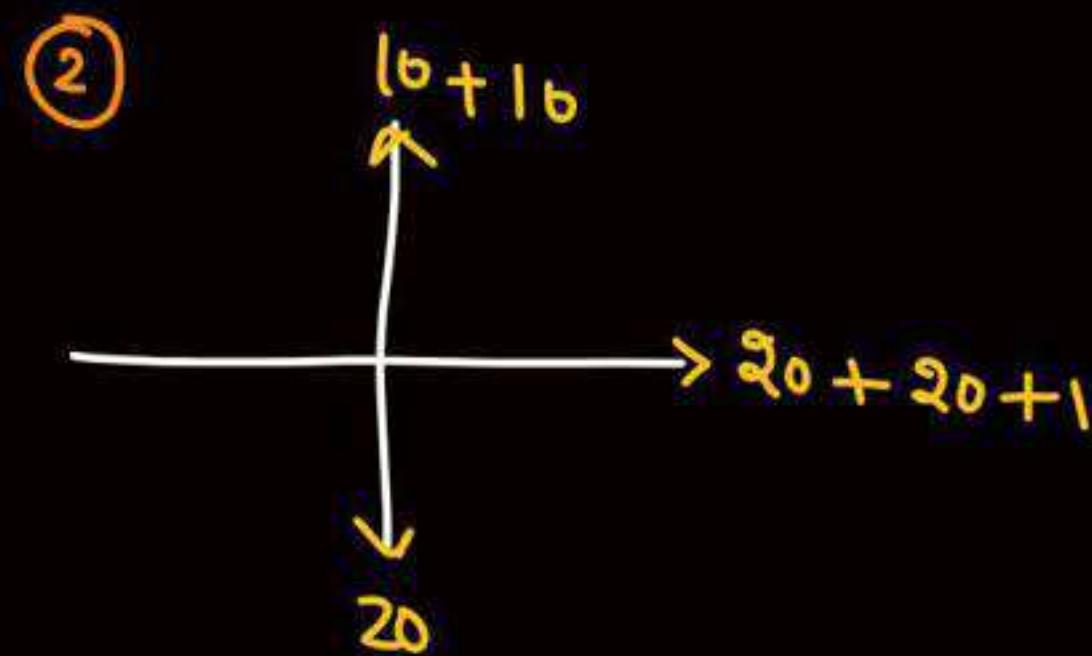
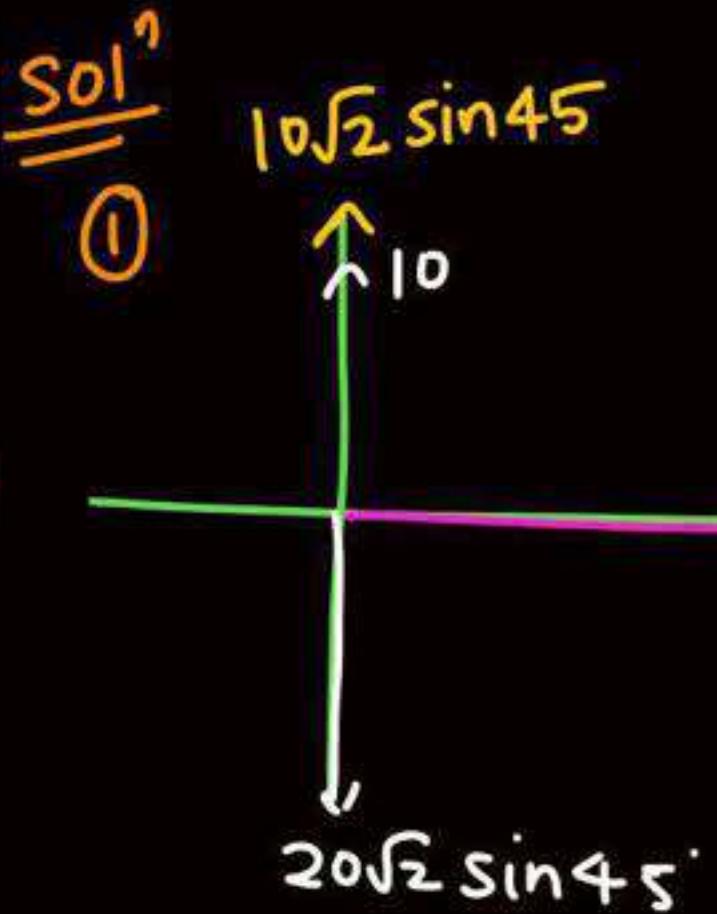
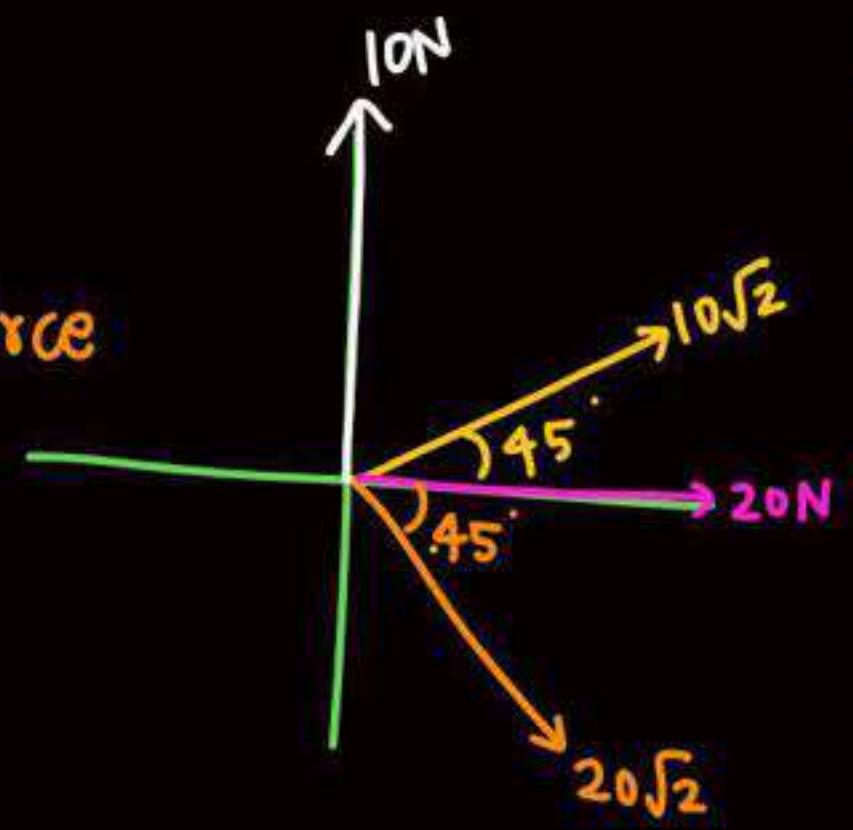


$$|\vec{F}_{\text{net}}| = \sqrt{15^2 + (5\sqrt{3})^2}$$

$$= \sqrt{225 + 75}$$

$$= 10\sqrt{3}$$

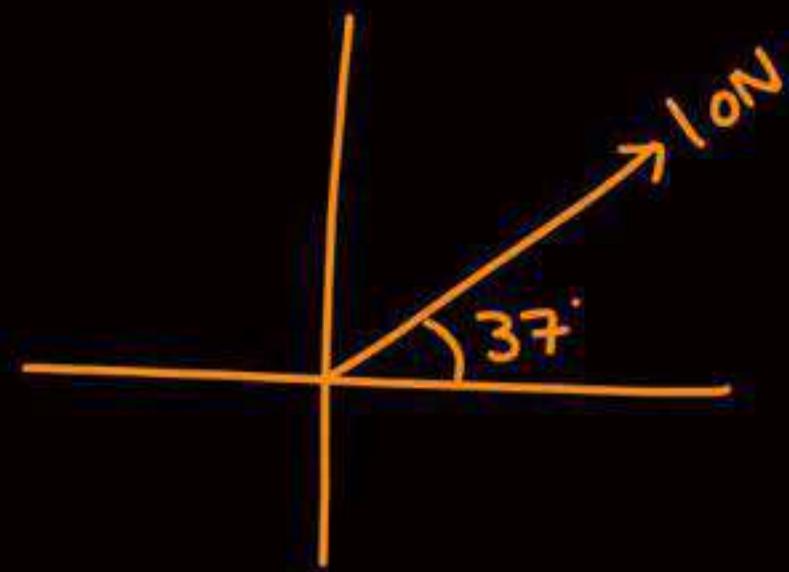
Q find net force



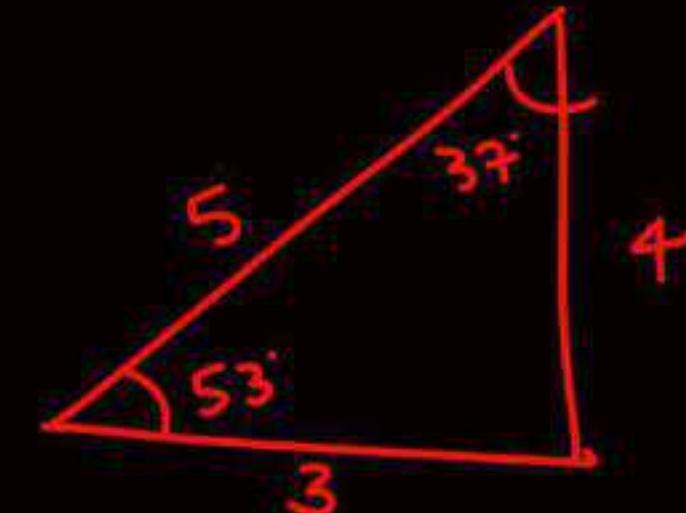
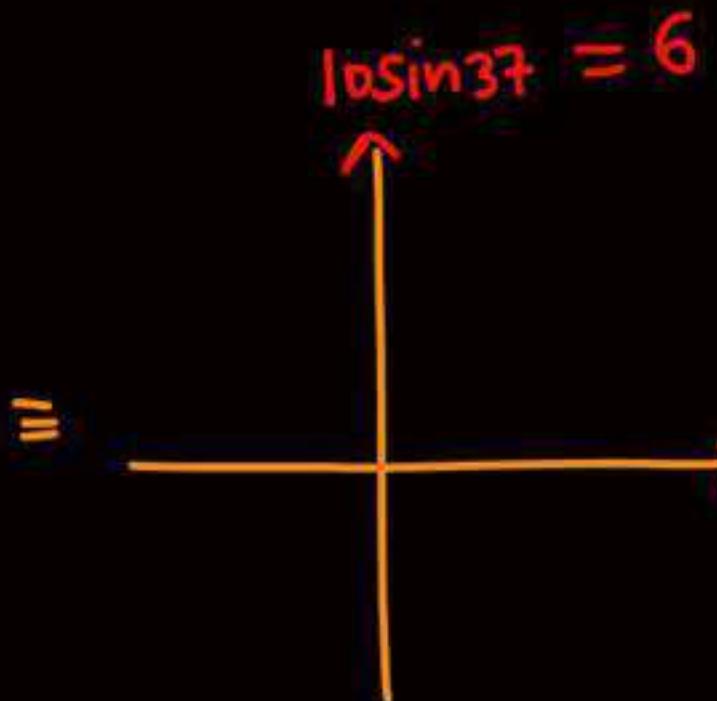
K.C.

- * सभी forces को x-y में तात्पुरी
- * (x-y) में collect

#



≡

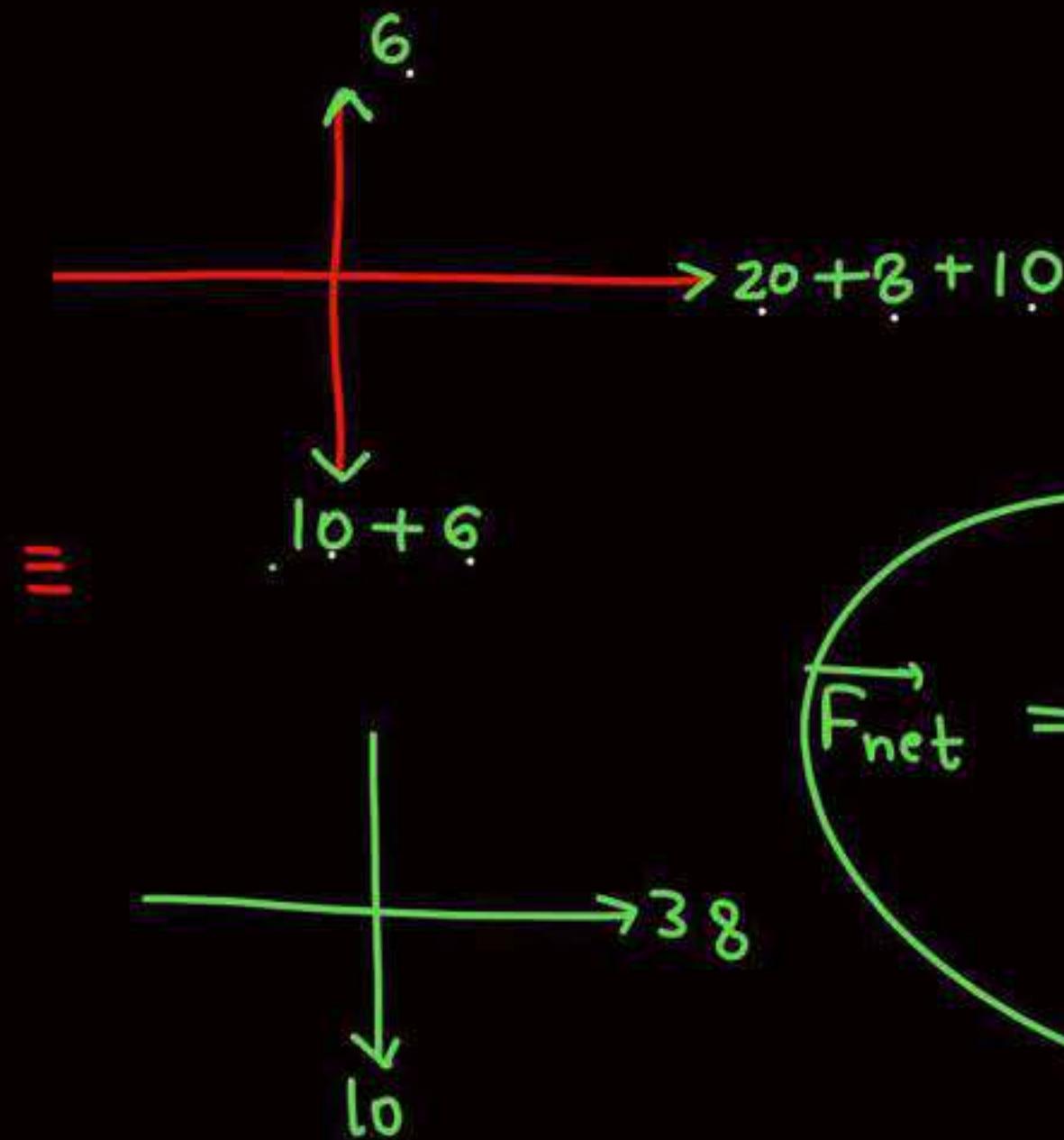
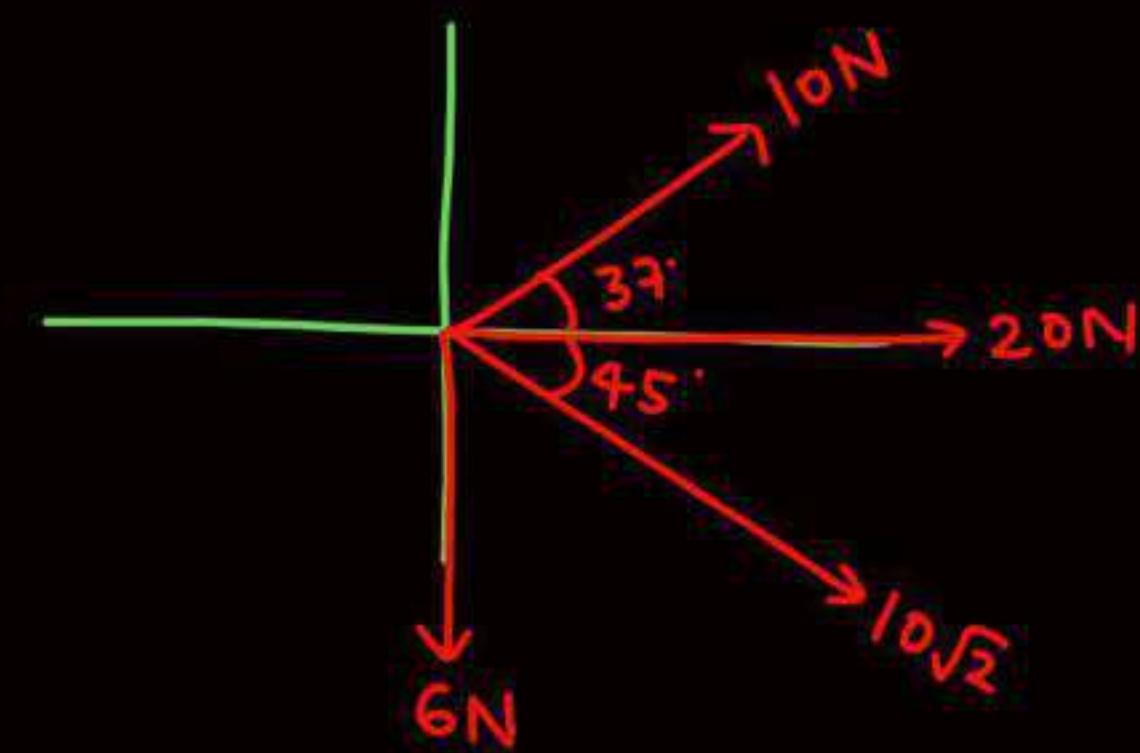


$\sin 37^\circ = \frac{3}{5} = \cos 53^\circ$

$\cos 37^\circ = \frac{4}{5} = \sin 53^\circ$

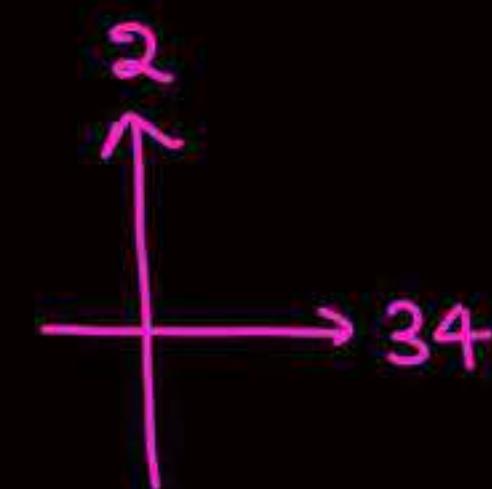
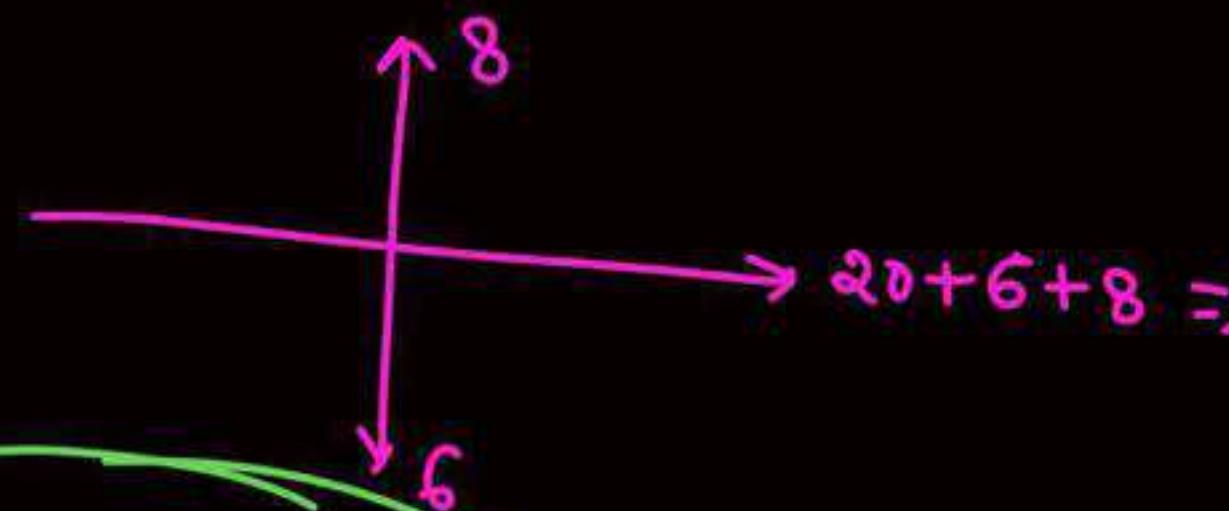
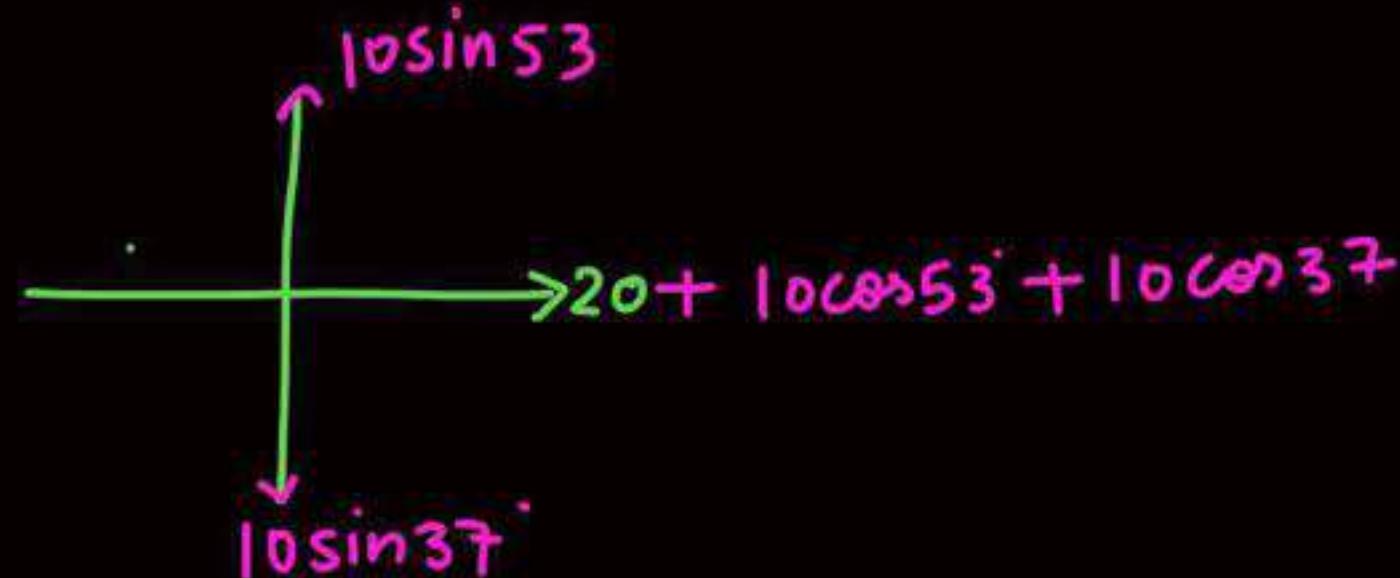
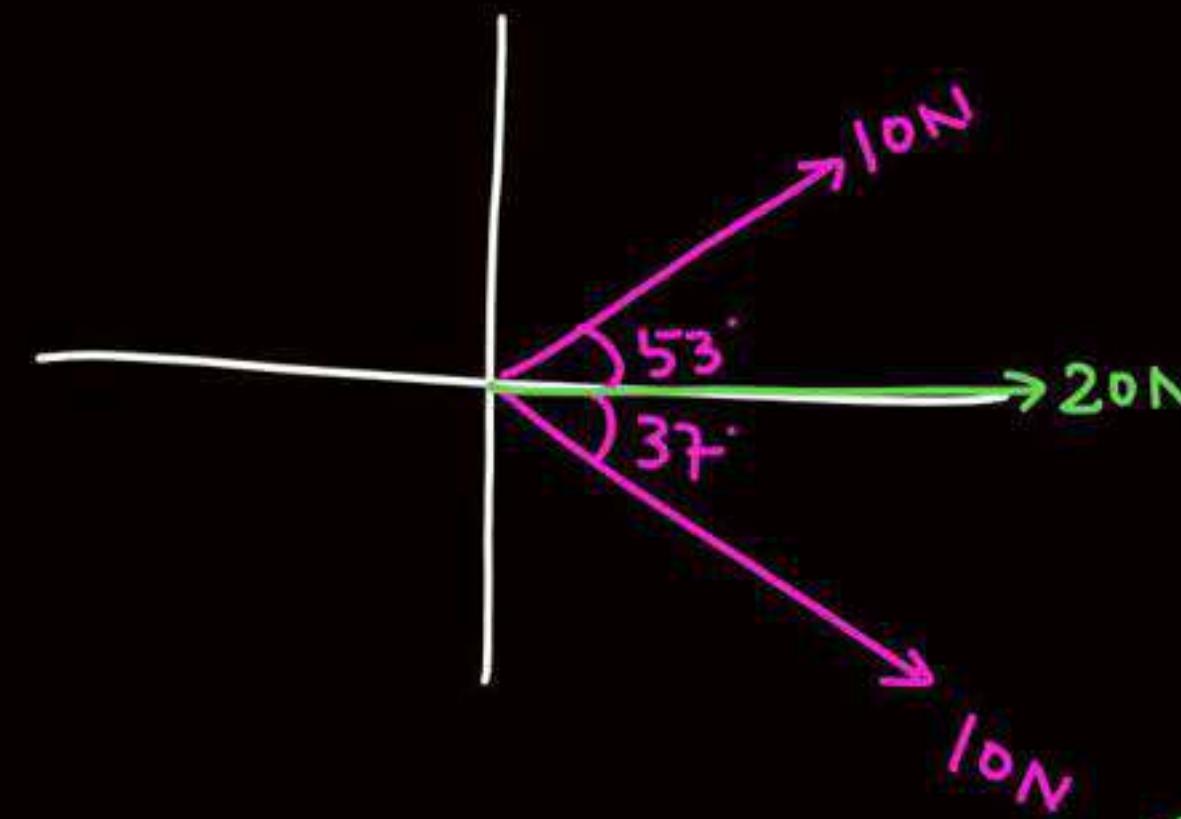
Q

Find net force



$$F_{net} = 38\hat{i} - 16\hat{j}$$

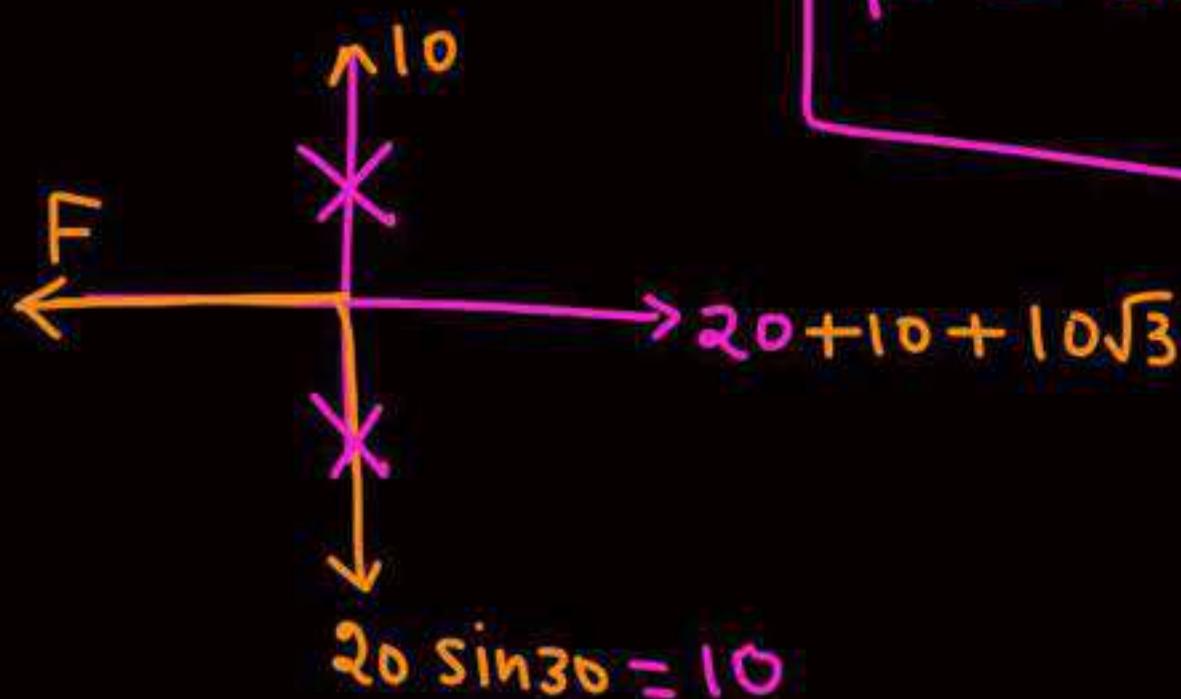
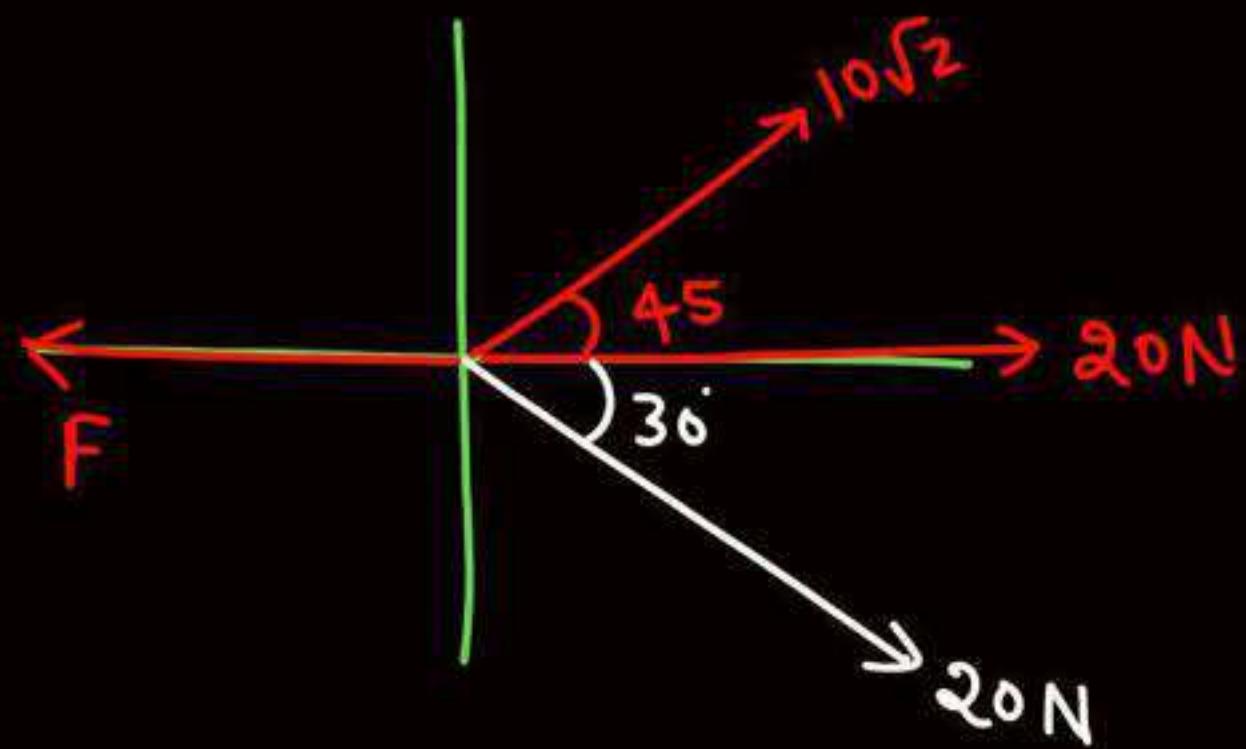
Q Find net force



$$\vec{F}_{\text{net}} = 34\hat{i} + 2\hat{j}$$

Q

Find the value of F so that net force is zero.

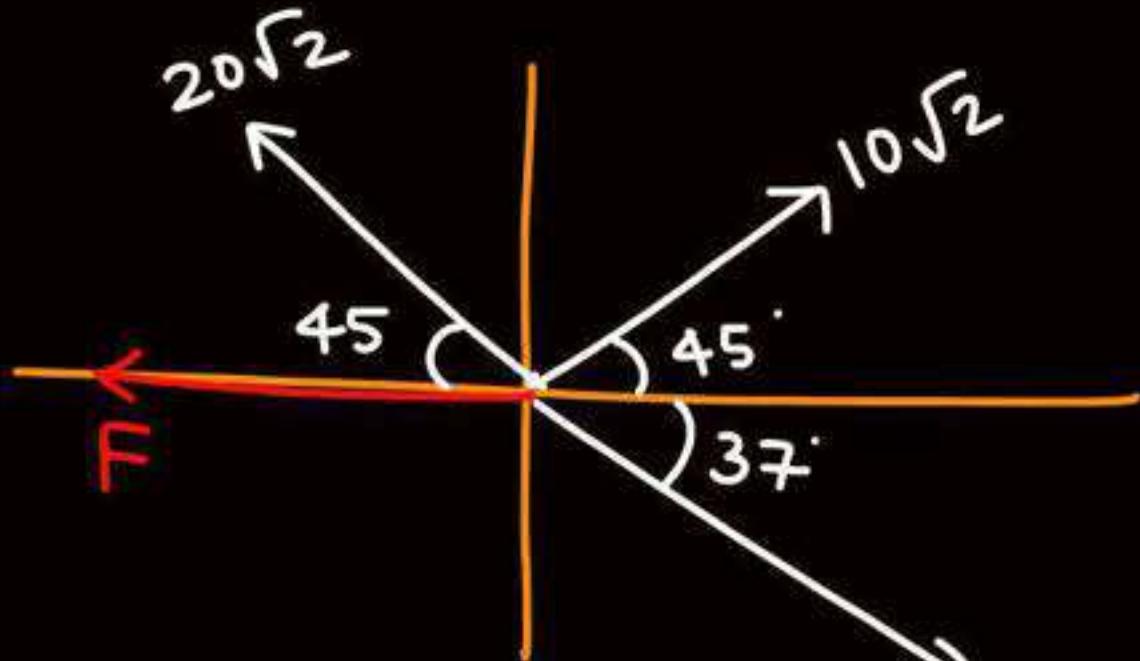


$$F = 30 + 10\sqrt{3}$$

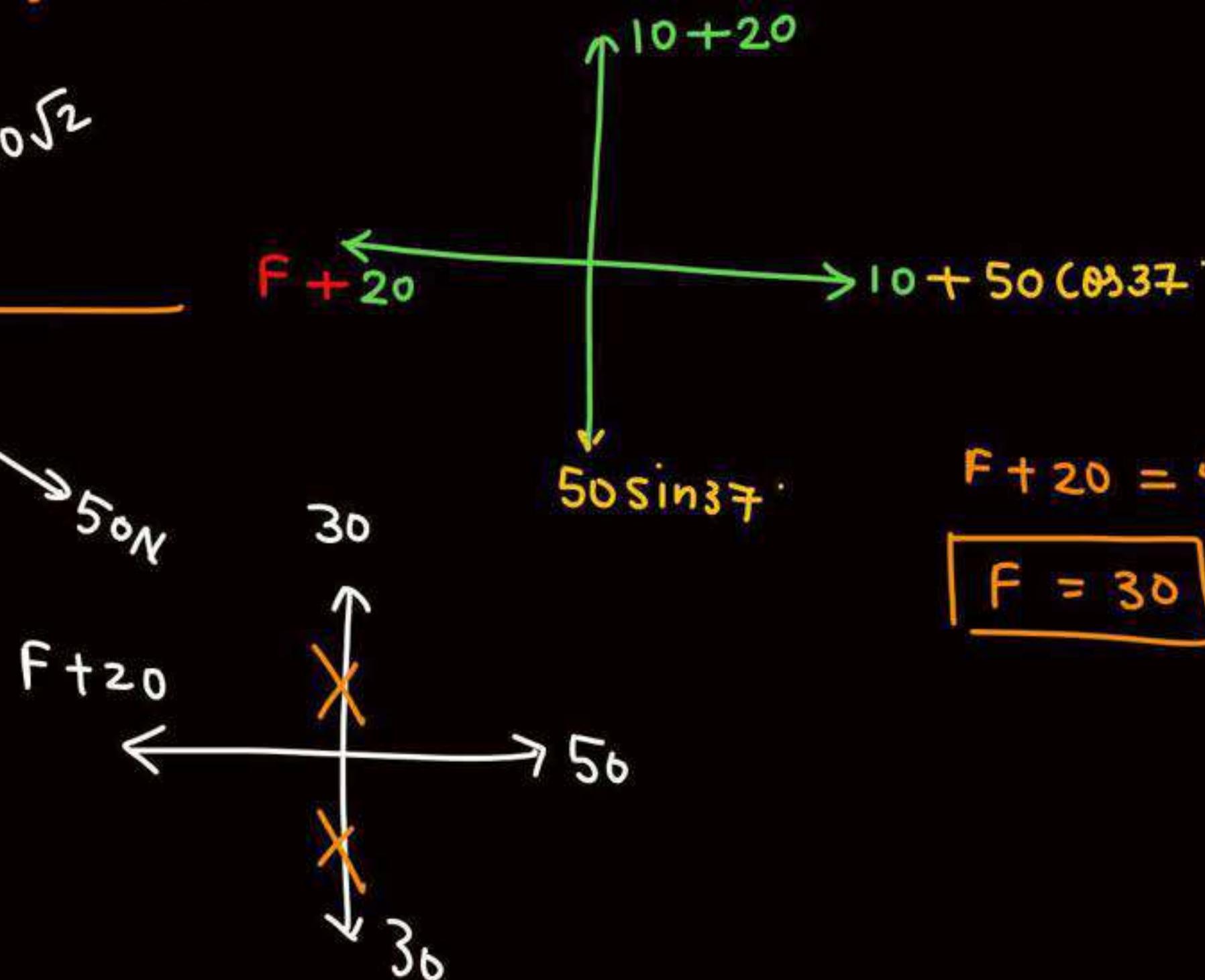
Ans

Q

Find value of F if $\vec{F}_{\text{net}} = 0$



$$\boxed{\vec{F} = -30\hat{i}}$$



$$F+20 = 50$$

$$\boxed{F = 30}$$

①

$$\begin{aligned}\vec{A} &= 2\hat{i} + 3\hat{j} \\ \vec{B} &= 4\hat{i} + 5\hat{j} \\ \hline \vec{A} \cdot \vec{B} &= 8 + 15 = 23\end{aligned}$$

②

$$\begin{aligned}\vec{A} &= 5\hat{i} + 3\hat{j} \\ \vec{B} &= 4\hat{i} + 10\hat{j} \\ \hline \vec{A} \cdot \vec{B} &= 20 + 30 = 50\end{aligned}$$

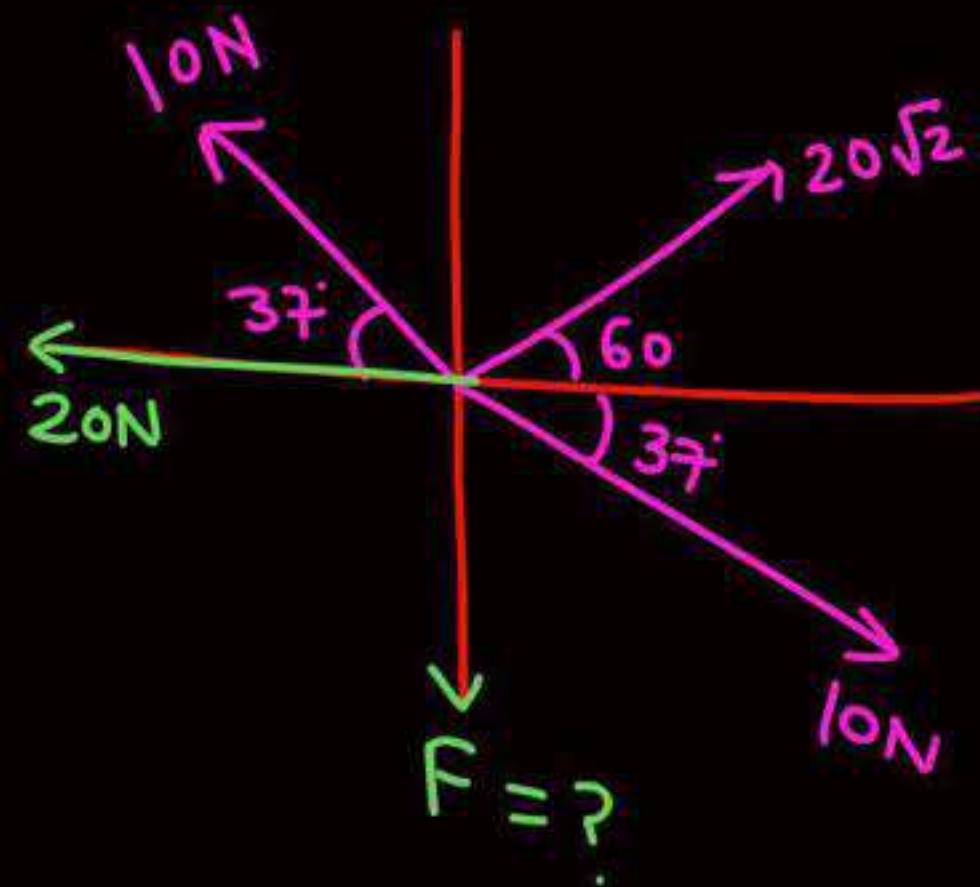
$$\begin{array}{l} \textcircled{3} \\ \theta \\ \begin{array}{l} \overrightarrow{A} = 2\hat{i} + 3\hat{j} + 4\hat{k} \\ \overrightarrow{B} = 3\hat{i} + 4\hat{j} + 5\hat{k} \end{array} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 6 + 12 + 20 \\ = 38 \end{array}$$

$$\begin{array}{l} \textcircled{5} \\ \overrightarrow{A} = 2\hat{i} - 3\hat{j} \\ \overrightarrow{B} = 5\hat{i} + 2\hat{j} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 10 - 6 = 4 \end{array}$$

$$\begin{array}{l} \textcircled{4} \\ \theta \\ \begin{array}{l} \overrightarrow{A} = 3\hat{i} + 2\hat{j} + 3\hat{k} \\ \overrightarrow{B} = 2\hat{i} + 3\hat{j} + 4\hat{k} \end{array} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 6 + 6 + 12 = 24 \end{array}$$

Q

Find the value of F so that \vec{F}_{net} is zero



Ans $\rightarrow 20$

Q Find value of a & b so that $\vec{F}_{\text{net}} = 0$

$$\vec{F}_1 = a\hat{i} + 5\hat{j} + 3\hat{k}$$

$$\vec{F}_2 = (b-3)\hat{i} - b\hat{j} - 3\hat{k}$$

SOL' next page

But पहले सम्भव करो

Soln

$$\vec{F}_1 = a\hat{i} + 5\hat{j} + 3\hat{k}$$

$$\vec{F}_2 = (b-3)\hat{i} - b\hat{j} - 3\hat{k}$$

$$\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 = (a+b-3)\hat{i} + (5-b)\hat{j} + (3-3)\hat{k}$$

$$\vec{F}_{\text{net}} = 0 \Rightarrow a+b-3=0, \quad 5-b=0$$
$$a+b=3 \quad b=5$$

$$b=5, \quad a+b=3$$

$$a+5=3$$

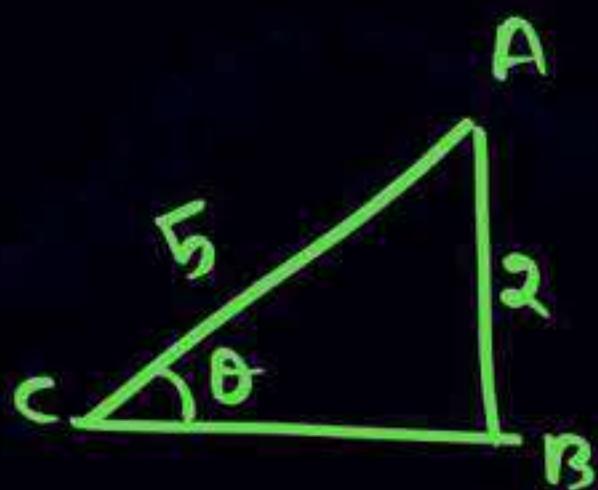
$$a=-2$$

Trigonometry

Q

$$\sin \theta = \frac{2}{5}$$

$$\tan \theta = \frac{2}{\sqrt{21}}$$



$$CB = \sqrt{25 - 4} = \sqrt{21}$$

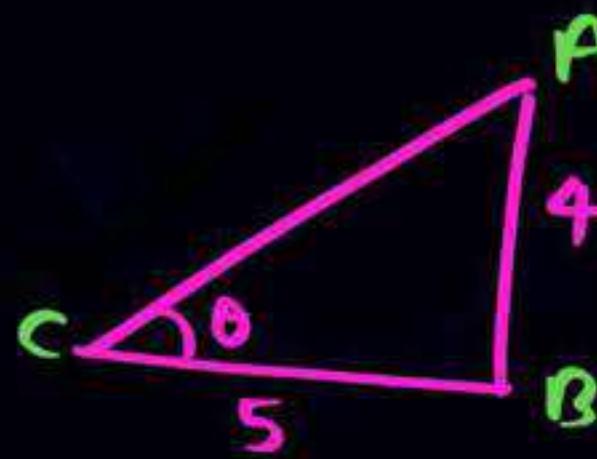
Vector & Matrices

P
W

$$\tan \theta = \frac{4}{5}$$

~~$$\sin \theta = \frac{3}{5}$$~~

$$\sin \theta = \frac{AB}{AC} = \frac{4}{\sqrt{41}}$$



$$\begin{aligned}AC &= \sqrt{25 + 16} \\&= \sqrt{41}\end{aligned}$$

$$\cos 120^\circ = \cos(180^\circ - 60^\circ) = -\frac{1}{2}$$

$$\cos 150^\circ = \cos(180^\circ - 30^\circ) = -\frac{\sqrt{3}}{2}$$

$$\cos 210^\circ = \cos(180^\circ + 30^\circ) = -\frac{\sqrt{3}}{2}$$

$$\cos 240^\circ = \cos(180^\circ + 60^\circ) = -\frac{1}{2}$$

$$\sin 120^\circ = \sin(180^\circ - 60^\circ) = +\frac{\sqrt{3}}{2}$$

$$\sin 240^\circ = \sin(180^\circ + 60^\circ) = -\frac{\sqrt{3}}{2}$$

$$\sin 150^\circ = \sin(180^\circ - 30^\circ) = +\frac{1}{2}$$

$$\tan 150^\circ = \tan(180^\circ - 30^\circ) = -\frac{1}{\sqrt{3}}$$

$$\tan 210^\circ = \tan(180^\circ + 30^\circ) = +\frac{1}{\sqrt{3}}$$

$$\tan 300^\circ = \tan(360^\circ - 60^\circ) = -\sqrt{3}$$

$$\sin 300^\circ = \sin(360^\circ - 60^\circ) = -\frac{\sqrt{3}}{2}$$

$$\cos 300^\circ = \cos(360^\circ - 60^\circ) = +\frac{1}{2}$$

* * *

$$\cos 0^\circ = 1$$

$$\cos 180^\circ = -1$$

$$\sin 0^\circ = \sin 180^\circ = \sin 360^\circ = 0$$

$$\sin 270^\circ = \sin(180^\circ + 90^\circ) = -1$$

$$\sin 270^\circ = -1$$

$$\cos 270^\circ = 0$$

* * *

$$\cos 0^\circ = 1$$

$$\cos 120^\circ = -\frac{1}{2}$$

$$\cos 150^\circ = -\frac{\sqrt{3}}{2}$$

$$\cos 135^\circ = -\frac{1}{\sqrt{2}}$$

$$\cos 180^\circ = -1$$

Homework

$$\cos 330^\circ =$$

$$\cos 300^\circ =$$

$$\tan 240^\circ =$$

$$\tan 210^\circ =$$

$$\sin 210^\circ =$$

$$\sin 135^\circ =$$

$$\cos 150^\circ =$$

$$\cos 180^\circ =$$

$$\sin 180^\circ =$$

$$\tan 180^\circ =$$

$$\tan 0^\circ =$$

$$\sin 150^\circ =$$

$\sin 127^\circ =$

$\cos 127^\circ =$

$\sin 143^\circ =$

$\cos 143^\circ =$

$\tan 143^\circ =$

$$\sin 217^\circ =$$

$$\cos 217^\circ =$$

$$\tan 217^\circ =$$

Basic maths =

① → ये physics का chapter नहीं है

- * ② * यहाँ १८th maths के only के topic पढ़ो / revise
जैसे जिनकी जरूरत हो । ११th class की phy. से पड़ने
वाली है
- ③ ये हल्के maths हैं . . . detail में पढ़ो। तो १ साल की
कम है

Conversion of rad into degree.

① $\frac{\pi}{2}$ rad. Convert
into degree $\frac{180}{2} = 90^\circ$

② $\frac{\pi}{3}$ rad. " $\frac{180}{3} = 60^\circ$

③ $\frac{\pi}{6}$ rad. $\frac{180}{6} = 30^\circ$

π की खजा
180° रख दे

④ $\frac{2\pi}{3}$ rad $\xrightarrow[\text{degree}]{\text{Convert into}} \frac{2 \times 180}{3} = 120^\circ$

⑤ $\frac{5\pi}{6}$ rad $\xrightarrow[\text{v}]{\text{v}} \frac{5 \times 180}{6} = 150^\circ$

⑥ 2π rad. $\xrightarrow[\text{v}]{\text{v}} 2 \times 180 = 360^\circ$

⑦ $\frac{2\pi}{3}$ rad $\xrightarrow[\text{v}]{\text{v}} \frac{2 \times 180}{3} = 120^\circ$

⑧ $\frac{7\pi}{6}$ rad $\xrightarrow[\text{v}]{\text{v}} 210^\circ$

Conversion of degree into radian

$$90^\circ \xrightarrow[\text{radian}]{\text{Convert into}} 90 \times \frac{\pi}{180} = \frac{\pi}{2} \text{ rad}$$

$$60^\circ \xrightarrow[""]{} 60 \times \frac{\pi}{180} = \frac{\pi}{3} \text{ rad}$$

$$45^\circ \xrightarrow{} 45 \times \frac{\pi}{180} = \frac{\pi}{4} \text{ rad}$$

$\frac{\pi}{180}$ से multiply कर दो

$$\pi \text{ rad} \equiv 180^\circ$$

$$1^\circ = \frac{\pi}{180} \text{ rad.}$$

**

rad

$$2^\circ \longrightarrow \frac{2\pi}{180} = \frac{\pi}{90} \text{ rad}$$

$$4^\circ \longrightarrow \frac{\pi}{45} \text{ rad}$$

$$3^\circ \longrightarrow \frac{3\pi}{180} = \frac{\pi}{60} \text{ rad}$$

$$5^\circ \longrightarrow \frac{5\pi}{180} = \frac{\pi}{36} \text{ rad}$$

Convert into
radian

 120°

$$\frac{120\pi}{180} = \frac{2\pi}{3} \text{ rad}$$

 240°

$$\frac{4\pi}{3} \text{ rad}$$

 210°

$$\frac{210\pi}{180} = \frac{7\pi}{6} \text{ rad}$$

 720°

$$4\pi \text{ rad}$$

 750°

$$\frac{750\pi}{180} = \frac{25\pi}{6} \text{ rad}$$

 150°

$$\frac{5\pi}{3} \text{ rad}$$

$$\textcircled{1} \quad \sin 2^\circ \approx 2 \times \frac{\pi}{180} \approx \frac{\pi}{90} = \frac{3.14}{90} \approx 0.03488$$

$$\textcircled{2} \quad \sin 3^\circ \approx 3 \frac{\pi}{180} = \frac{\pi}{60} = \frac{3.14}{60}$$

$$\textcircled{3} \quad \sin 4^\circ = 4 \frac{\pi}{180} = \frac{\pi}{45}$$

$$\textcircled{4} \quad \sin 8^\circ \approx \frac{8\pi}{180}$$

Small angle approximation

P
W

* $\sin \theta \approx \theta$

($\theta < 10^\circ$ Best)

* $\tan \theta \approx \theta$

($\theta < 10^\circ$ Best)

* $\sin \theta \approx \tan \theta \approx \theta$

(if θ is very small)
 $\theta < 10^\circ$ Best

① $\tan 8^\circ = \frac{8\pi}{180}$

② $\sin 8^\circ = \frac{8\pi}{180}$

③ $\sin 10^\circ = \frac{10\pi}{180}$

④ $\tan 5^\circ = \frac{5\pi}{180}$

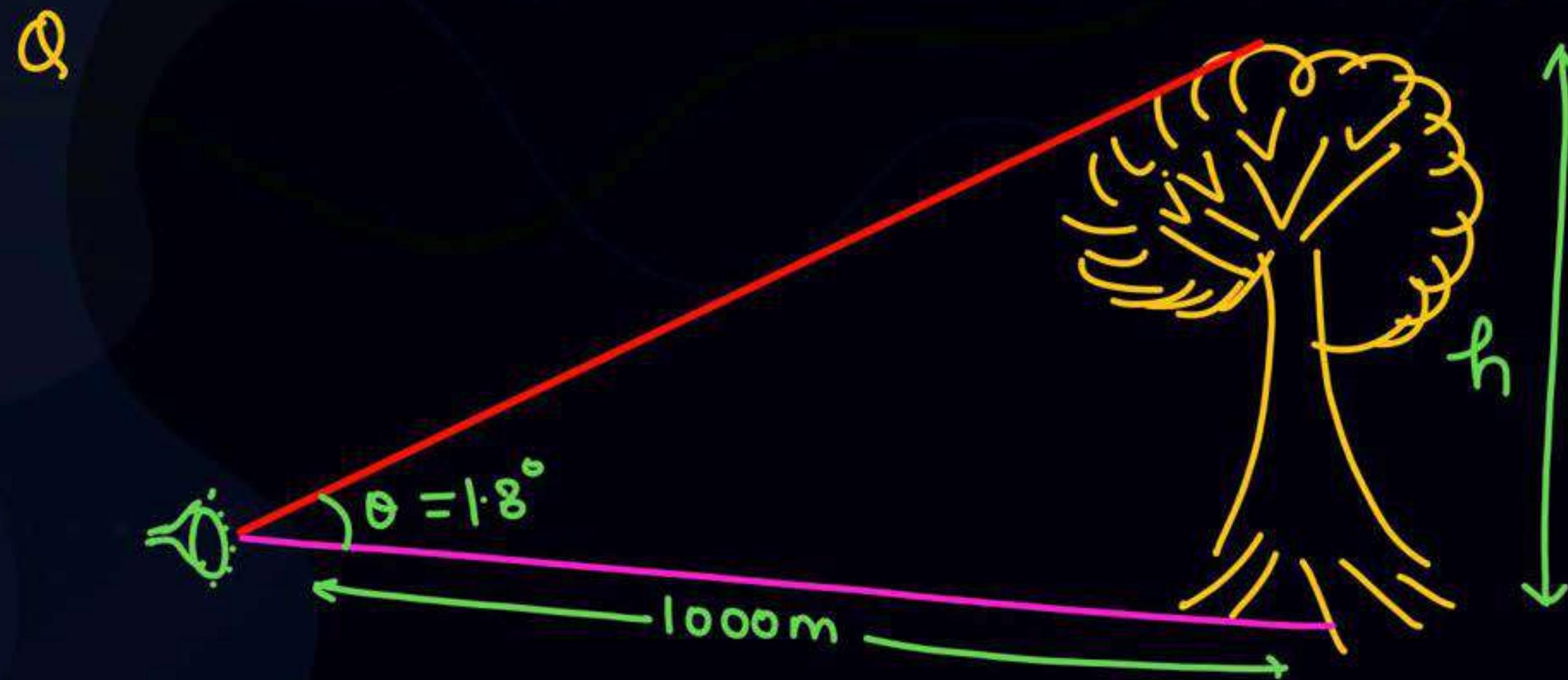
if θ is very small

$\theta < 5^\circ$

$\cos \theta \rightarrow 1$

$\sin 2^\circ \approx \tan 2^\circ$

$\sin 5^\circ \approx \tan 5^\circ$



$$\tan 1.8^\circ = \frac{h}{1000}$$

$$\begin{aligned} h &= 1000 \cdot \tan 1.8^\circ = 1000 \times 1.8 \times \frac{\pi}{180} \\ &= 10\pi = \underline{31.4\text{ m}} \end{aligned}$$

$$\sin 2^\circ \approx \underline{.0348}^{99} (\text{calc})$$

$$\tan 2^\circ \approx \underline{.0349}$$

$$\sin 2^\circ \approx 2 \cdot \frac{\pi}{180} = \frac{\pi}{90} = \frac{3.14}{90} = .0348$$

$(\sin \theta \approx \theta)$

$$\sin 5^\circ \approx .0871$$

$$\tan 5^\circ = .0874$$

|||

Approx equal

$$\sin \theta \approx \theta \text{ rad}$$

$$\sin 2^\circ \approx 2 \cdot \frac{\pi}{180} = \frac{\pi}{90} = \frac{3.14}{90} = \underline{\underline{0.03488}}$$

$$\sin 3^\circ \approx 3 \cdot \frac{\pi}{180} = \frac{\pi}{60} = \frac{3.14}{60} = 0.0523$$

- * $\pi \text{ rad} = 180^\circ$
- * $1^\circ = 60' \text{ (minute)}$

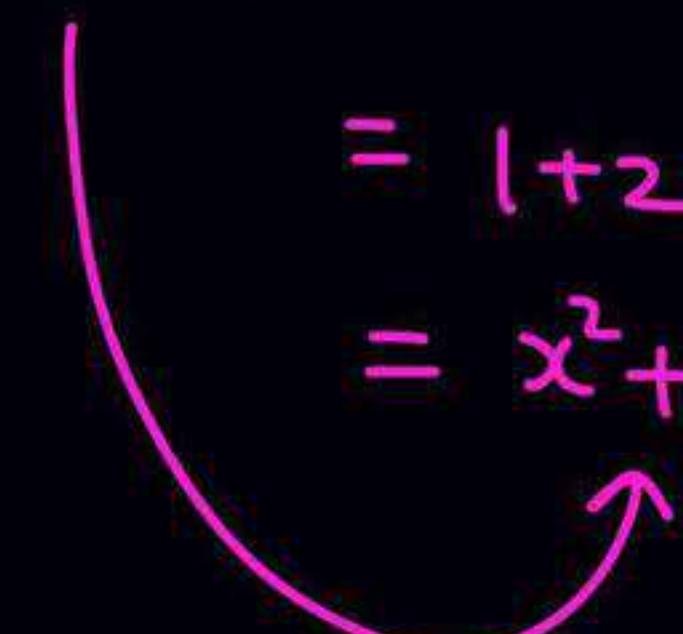
Binomial Expansion

अभी
हमारे काम का तरीका

$$(1+x)^n = 1 + nx + \frac{n(n-1)x^2}{1 \times 2} + \frac{n(n-1)(n-2)x^3}{1 \times 2 \times 3} + \dots$$

$n=2$ put

$$\begin{aligned}(1+x)^2 &= 1 + 2x + \frac{2 \cdot 1 \cdot x^2}{1 \cdot 2} + \dots \\ &= 1 + 2x + x^2 \\ &= x^2 + 1 + 2x\end{aligned}$$



$$(1+x)^n = 1 + nx + \dots$$

$$\frac{n(n-1)x^2}{1 \times 2} + \dots$$

Neglect it

If $x \ll 1$

$$(1+x)^n \approx 1+nx$$

Q. $(1.0003)^5 = (1 + .0003)^5$

$$= 1 + 5 \times .0003$$

$$= \underline{1.0015}$$

$$\text{Q} \quad (1.004)^2 \approx (1 + 0.004)^2 = 1.008$$

$$\text{Q} \quad (1.006)^3 \approx 1.018$$

$$\text{Calc} \approx 1.01810$$

$$\text{Q} \quad (1.007)^4 \approx 1.028$$

Approximat.

$$\text{Q} \quad \sqrt{1.008} = (1 + 0.008)^{\frac{1}{2}}$$

$$= (1 + \frac{1}{2} \times 0.008)$$

$$= \frac{1.004}{\text{.}}$$

$$\text{Q} \quad \sqrt{1.00} \approx 1.003$$

Revision

$$\textcircled{1} \quad \frac{3\pi}{2} \longrightarrow \frac{3 \times 180}{2} = 270^\circ$$

θ is very small
 $\cos \theta \longrightarrow 1$

$$\textcircled{2} \quad 210^\circ \longrightarrow 210 \times \frac{\pi}{180} = \frac{7\pi}{6}$$

$$\begin{aligned} \textcircled{3} \quad \sin \theta &\approx \theta \\ \tan \theta &\approx \theta \\ \sin \theta \approx \theta = \tan \theta \end{aligned} \quad \left. \begin{array}{l} \vdots \\ \theta < 10^\circ \\ \text{Best} \end{array} \right\}$$

$$(1+x)^n \approx 1+nx$$

(If $x \ll 1$)

$$(1-x)^n = 1-nx \quad (\text{if } x \ll 1)$$

Q $(1 + 0.003)^4 \approx 1 + 4 \times 0.003 = \underline{\underline{1.012}}$.

Calc $\rightarrow \underline{\underline{1.01205}}$

$$(1 + 0.003)^{-3} = 1 + (-3) \times 0.003 = 1 - 3 \times 0.003 = 1 - 0.009 = 0.991$$

$$(1 + 0.004)^{-2} = 1 - 0.008 = 0.992$$

$$(1 - 0.007)^{-2} = 1 - 0.014 = 0.986$$

$$(1 - 0.002)^3 = 1 - 3 \times 0.002 = 1 - 0.006 = 0.994$$

$$(0.996)^3 = (1 - 0.004)^3 = 1 - 0.012 = \underline{0.988}$$

$$(1 \pm x)^n = 1 \pm nx$$

if $x \ll 1$

$$(1.007)^3 = 1.021$$

$$(1.009)^{\frac{1}{3}} \approx 1 + \frac{1}{3} \times 0.009 = 1.003$$

$$(1.008)^{\frac{1}{2}} \approx (1+0.008)^{\frac{1}{2}} = 1.004$$

$$\sqrt{1.006} \approx (1+0.006)^{\frac{1}{2}} \approx 1 + \frac{1}{2} \times 0.006 \\ = \underline{1.003}$$

$$\frac{1}{1.006} = (1.006)^{-1} \\ = (1+0.006)^{-1} \\ = 1 - 0.006 = 0.994$$

$$\frac{1}{0.998} \approx (0.998)^{-1} = (1-0.002)^{-1}$$

$$\left(\frac{1}{0.997}\right)^2 \approx (0.997)^{-2} = (1-0.003)^{-2} \\ = 1+0.006 \\ = \underline{1.006}$$

find

$$\tan 4^\circ = \frac{4 \cdot \pi}{180}$$

$$\tan 5^\circ = \frac{5 \cdot \pi}{180} \quad \checkmark$$

$$\tan 8^\circ = \frac{8 \cdot \pi}{180} \quad \checkmark$$

S.K.C

$$\begin{aligned}\pi &= 180^\circ \quad \times \\ \pi \text{ rad} &= 180^\circ \\ \pi &= \frac{22}{7} = 3.14\end{aligned}$$

$$\sin 120^\circ = \sin(180^\circ - 60^\circ) = +\frac{\sqrt{3}}{2}$$

हमारा ✓
उसे follow करेंगे.

$$\sin(90^\circ + 30^\circ) = +\cos 30^\circ = +\frac{\sqrt{3}}{2} = \text{दूसरी}$$

$90^\circ, 270^\circ$ में तोड़े
तो

$$\sin \rightleftharpoons \cos$$

$$\tan \rightleftharpoons \cot$$

$180^\circ, 360^\circ$ में
तोड़ रहे हो तो
मत Change करो

① $\sin 150^\circ = \sin(180^\circ - 30^\circ) = +\sin 30^\circ = +\frac{1}{2}$

↳ $\sin(90^\circ + 60^\circ) = +\cos 60^\circ = +\frac{1}{2}$

② $\sin 210^\circ = \sin(180^\circ + 30^\circ) = -\sin 30^\circ = -\frac{1}{2}$

↳ $\sin(270^\circ - 60^\circ) = -\cos 60^\circ = -\frac{1}{2}$

$$\textcircled{3} \quad \sin 240^\circ = \sin(180^\circ + 60^\circ) = -\sin 60^\circ = -\frac{\sqrt{3}}{2}$$

$$\hookrightarrow \sin(270^\circ - 30^\circ) = -\cos 30^\circ = -\frac{\sqrt{3}}{2}$$

$$\textcircled{4} \quad \cos 240^\circ = \cos(180^\circ + 60^\circ) = -\cos 60^\circ = -\frac{1}{2}$$

$$\hookrightarrow \cos(270^\circ - 30^\circ) = -\sin 30^\circ = -\frac{1}{2}$$

$$\textcircled{3} \quad \tan 240^\circ = \tan(180^\circ + 60^\circ) = +\tan 60^\circ = \sqrt{3}$$

$$\hookrightarrow \tan(270^\circ - 30^\circ) = +\cot 30^\circ = \sqrt{3}$$

$$\textcircled{4} \quad \cos 300^\circ = \cos(360^\circ - 60^\circ) = +\cos 60^\circ = \frac{1}{2}$$

$$\hookrightarrow \cos(270^\circ + 30^\circ) = +\sin 30^\circ = \frac{1}{2}$$

$$\textcircled{5} \quad \sin 300^\circ = \sin(360^\circ - 60^\circ) = -\frac{\sqrt{3}}{2}$$

$$\hookrightarrow \sin(270^\circ + 30^\circ) = -\cos 30^\circ = -\frac{\sqrt{3}}{2}$$

$\sin(90^\circ - \theta) = \cos \theta$
 $\cos(90^\circ - \theta) = \sin \theta$
 $\tan(90^\circ - \theta) = \cot \theta$
 $\cot(90^\circ - \theta) = \tan \theta$

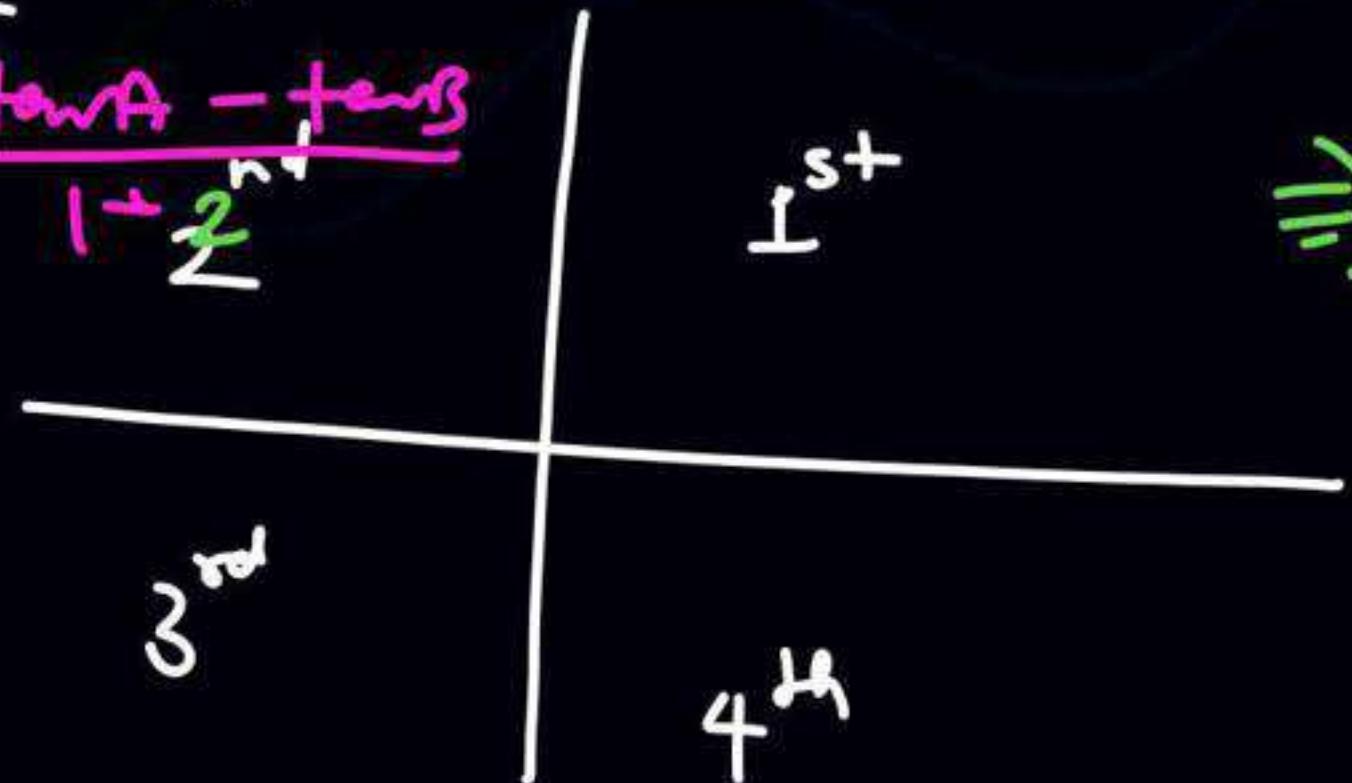
10th class

$$\tan 15^\circ = \tan(45^\circ - 30^\circ)$$

$$\tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$$

$$\tan 45^\circ = 1^0$$

Sign



$\Rightarrow \text{Im} \lambda \in \uparrow$

Q2

$$\text{Displacement} = \vec{d} = 3\hat{i} + 4\hat{j}$$

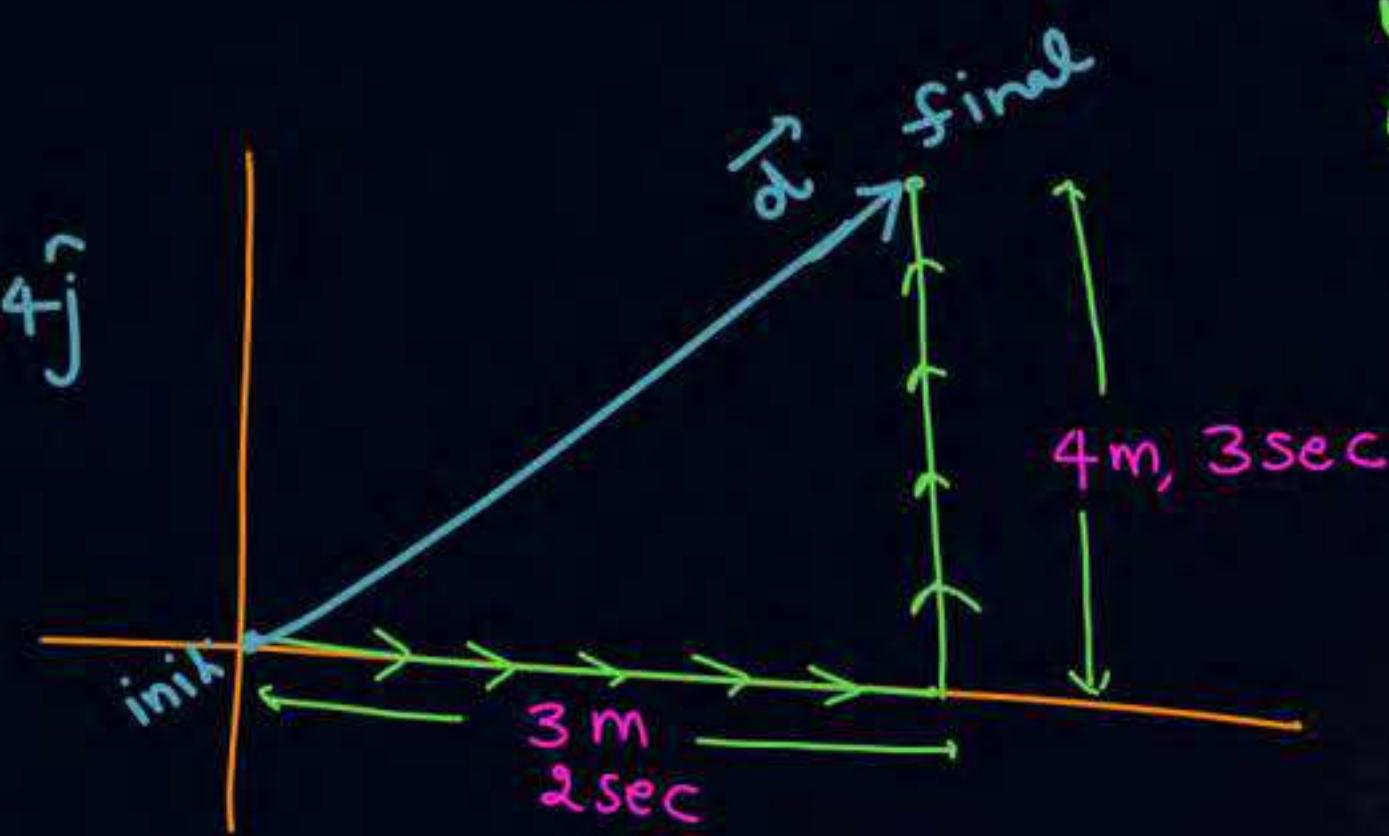
$$\text{Average Velocity} = \frac{3\hat{i} + 4\hat{j}}{2+3}$$

$$= \frac{3\hat{i} + 4\hat{j}}{5}$$

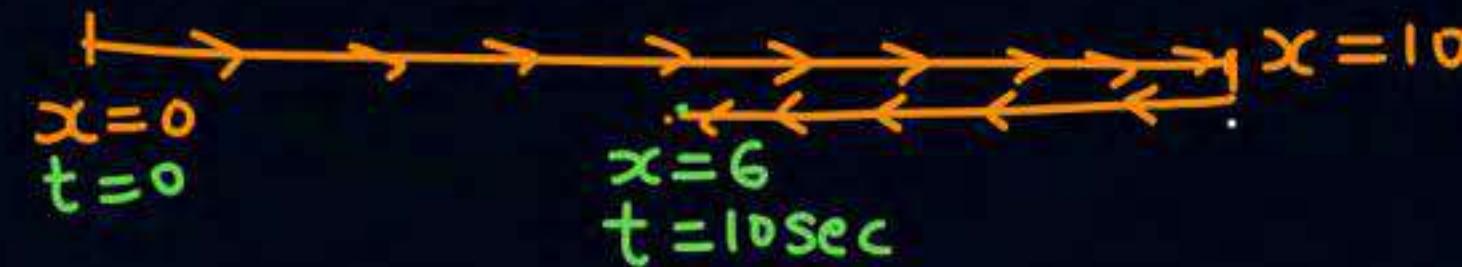
magnitude \Rightarrow Displacement = 5

time = $2+3 = 5 \text{ sec}$

$$\text{Avg velocity} = \frac{5}{5} = 1 \text{ m/s}$$



if displacement = 0
Avg velocity = 0

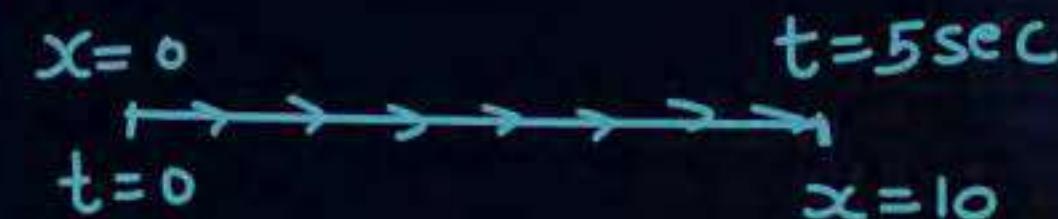
Q₁

$$\text{Displacement} = 6$$

$$\text{Avg Velocity} = \frac{6}{10}$$

$$\text{Distance} = 10 + 4 \\ = 14$$

$$\text{Avg speed} = \frac{14}{10}$$

Q₂

$$\text{distance} = 10$$

$$\text{displacement} = 10 \text{ (magnitude)}$$

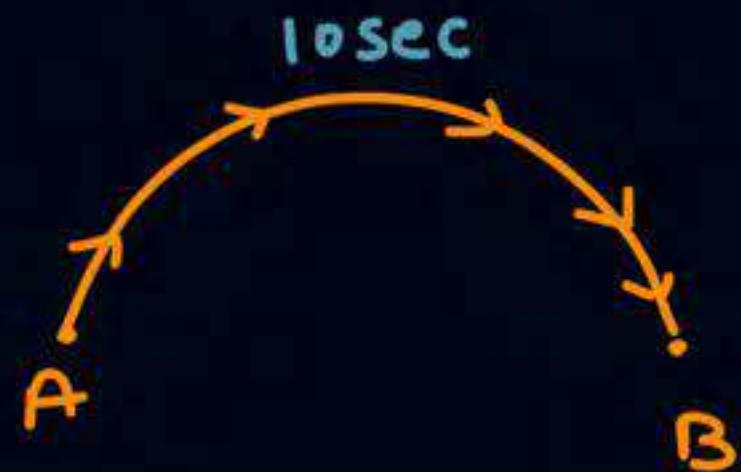
$$\text{Avg velocity} = \frac{10}{5} \text{ (magnitude)}$$

$$\text{Avg speed} = \frac{10}{5}$$

Q

$$\text{Avg. Speed} = \frac{\pi R}{10}$$

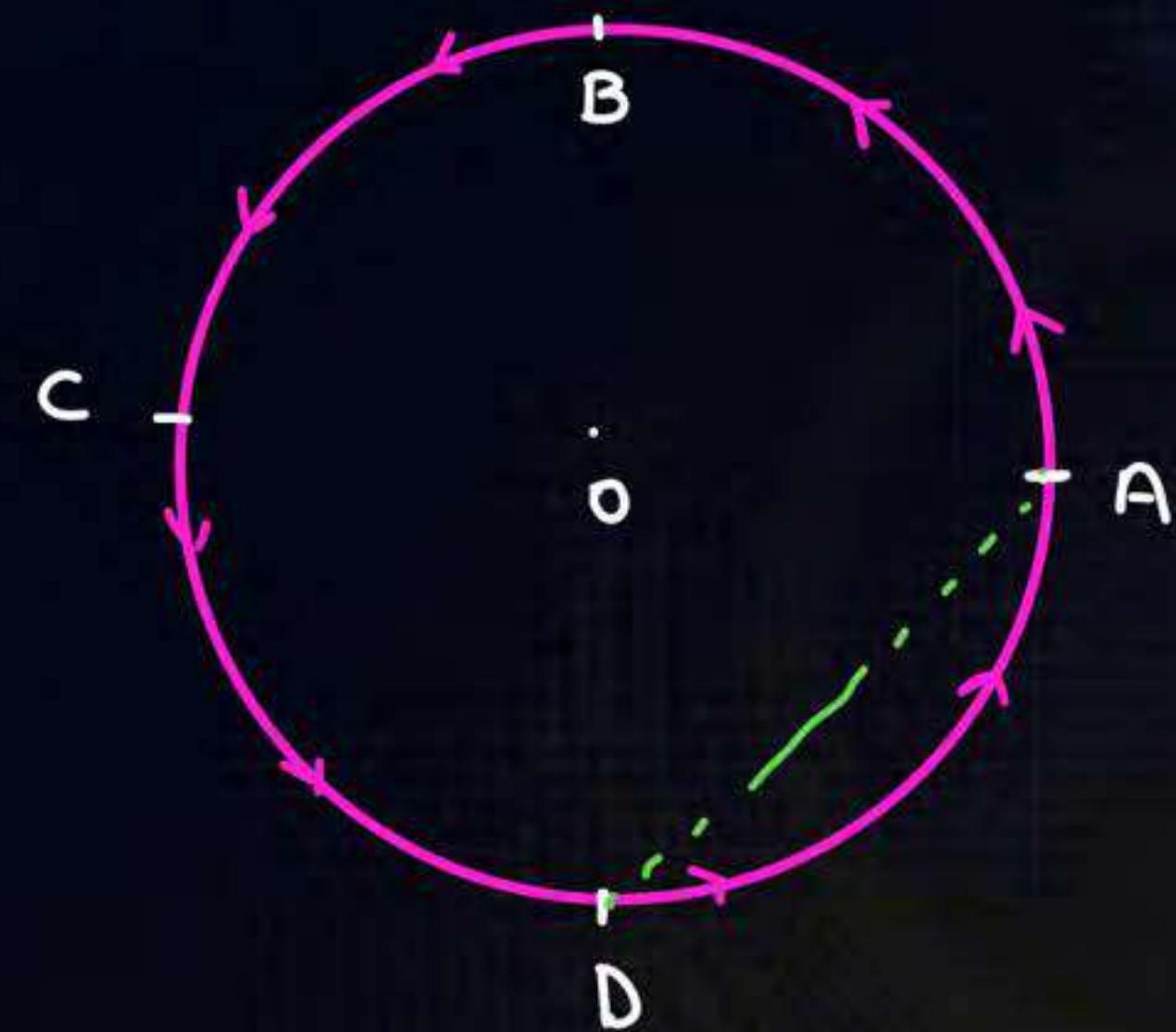
$$\text{Avg Velocity (magnitude)} = \frac{2R}{10} = \frac{R}{5}$$



Q

A particle is performing Uniform circular motion with
 const speed v , having time period T anticlockwise.

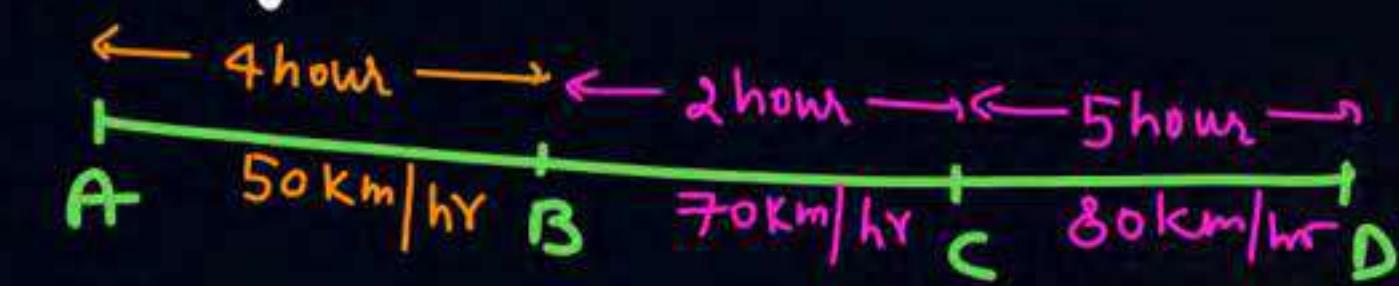
	Avg Speed	Avg Velocity
$A \rightarrow B$	$\frac{2\pi R/4}{T/4} = \frac{2\pi R}{T}$	$\frac{R\sqrt{2}}{T/4}$
$A \rightarrow B \rightarrow C$	$\frac{\pi R}{T/2} = \frac{2\pi R}{T}$	$\frac{2R}{T/2}$
$A \rightarrow B \rightarrow C \rightarrow D$	$\frac{\frac{3}{4}2\pi R}{3T/4} = \frac{2\pi R}{T}$	$\frac{R\sqrt{2}}{3T/4}$
$A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$	$\frac{2\pi R}{T}$	O



9th class

P
W

Q A car is moving along $+x$ axis, in 1st four hour it travel with speed 50 km/hr, in next 2 hour it move with 70 km/hr and in last part of journey it travel for 5 hour with 80 km/hr find Avg speed.



$$\text{Avg Speed} = \frac{50 \times 4 + 70 \times 2 + 80 \times 5}{4 + 2 + 5} = \frac{200 + 140 + 400}{11} = \checkmark$$

$$\text{Avg velocity} = \frac{\Delta \vec{x}}{\Delta t} = \frac{\vec{x}_f - \vec{x}_i}{\Delta t}$$

time interval.

1D motion.



If a particle is moving on x-axis only

$$\text{Avg Velocity} = \frac{\vec{x}_f - \vec{x}_i}{\text{time}} = \frac{\Delta \vec{x}}{\Delta t}$$

Q A particle is moving on the x-axis. St its x-co-ordinate w.r.t time changes as

$$① t=0 \rightarrow t=2 \text{ sec}$$

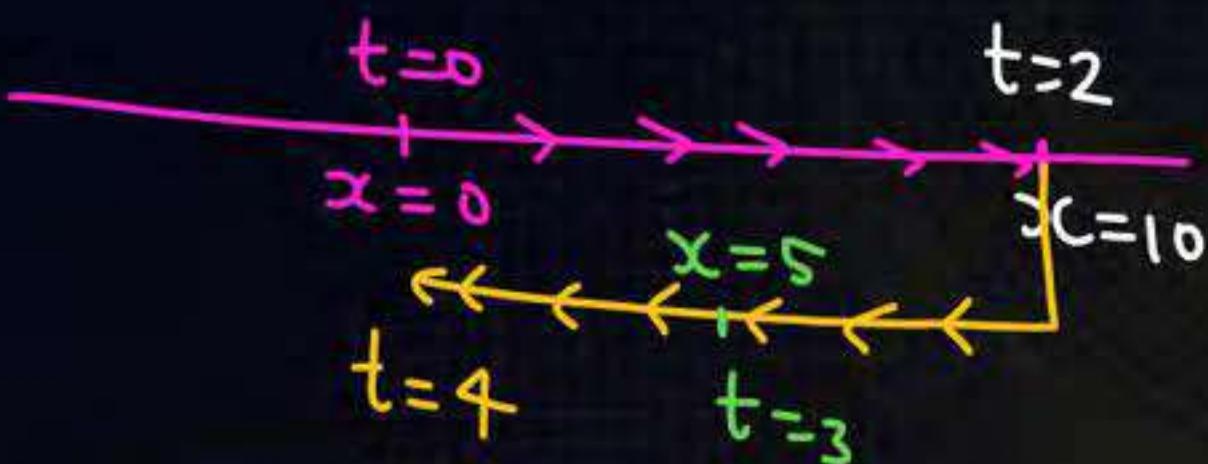
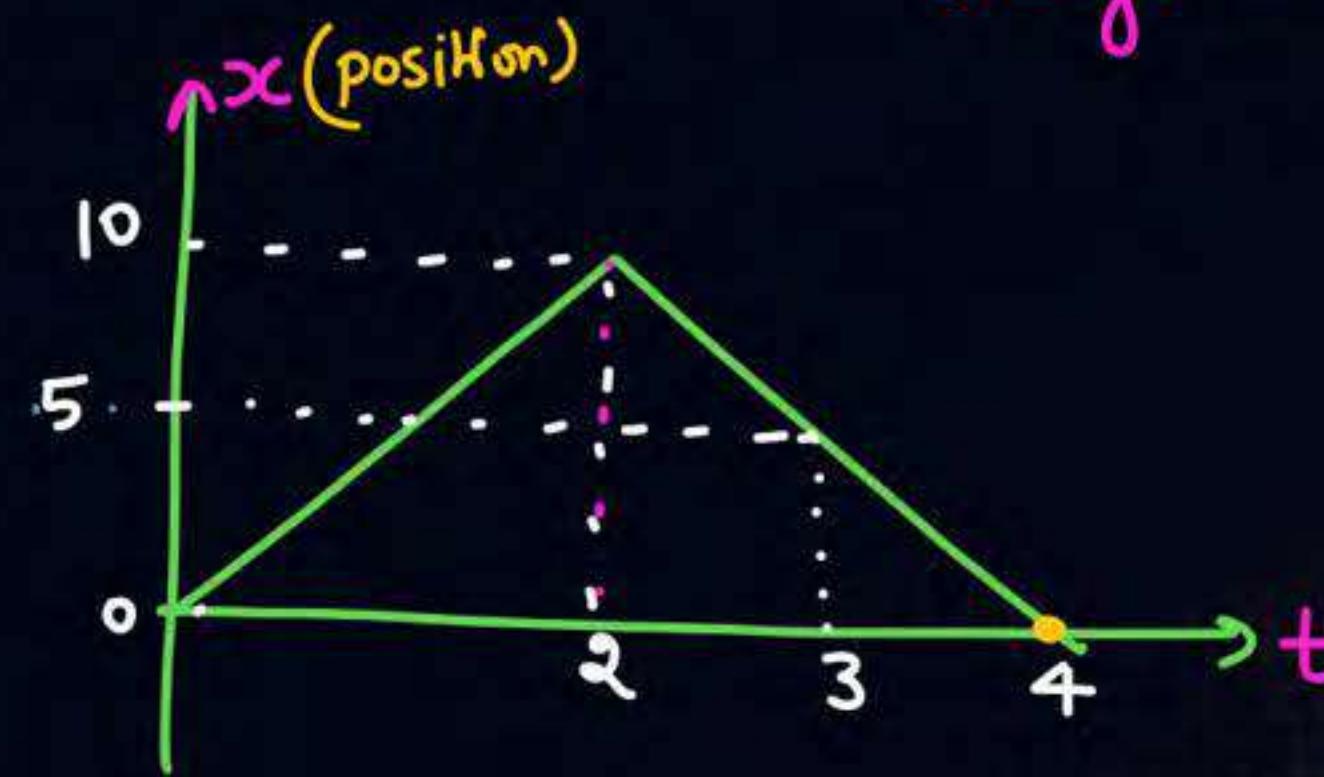
$$\text{Avg velocity} = \frac{10}{2} = 5$$

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{time}} = \frac{10 - 0}{2}$$

$$② t=0 \rightarrow t=3$$

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{time}} = \frac{5 - 0}{3}$$

$$\text{Avg speed} = \frac{15}{3} = 5$$

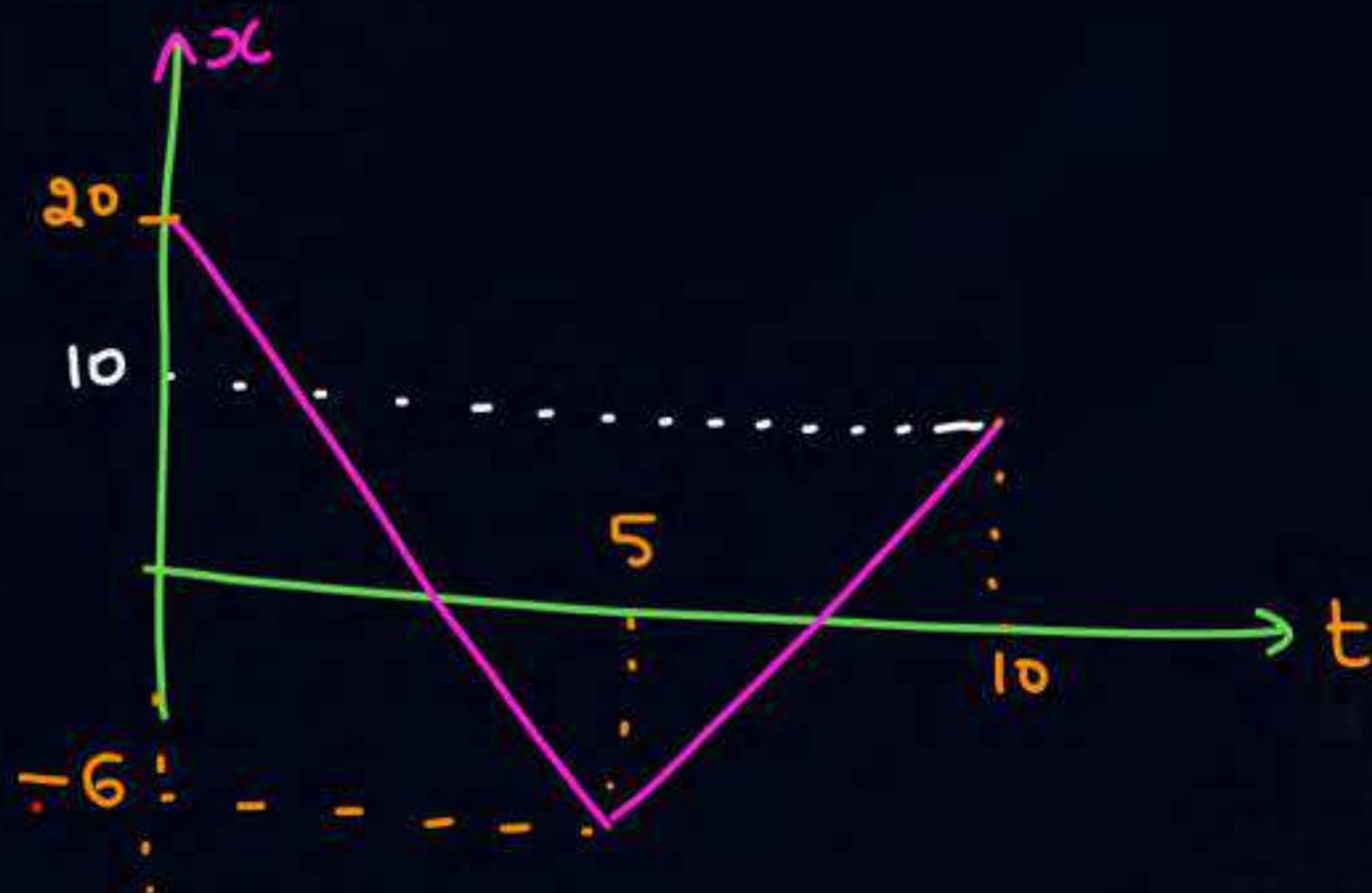


Q t = 0 → t = 5

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{time}}$$
$$= \frac{(-6) - (+20)}{5}$$
$$= -\frac{26}{5}$$

Q2 t = 0 → t = 10

$$\text{Avg velocity} = \frac{10 - 20}{10}$$



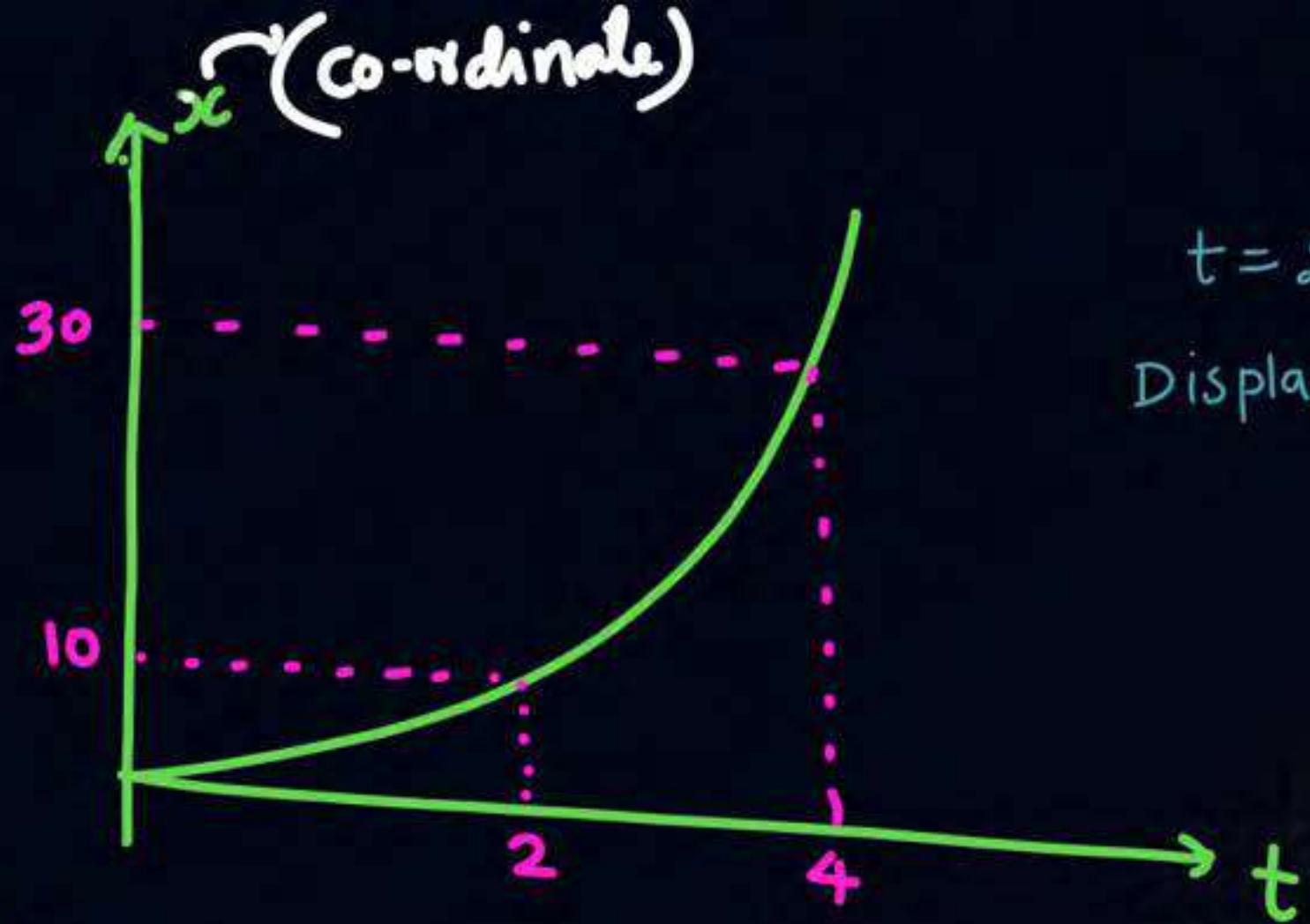
Q

find average velocity from

$t = 2 \rightarrow t = 4 \text{ sec}$

Avg velocity = $\frac{x_f - x_i}{\text{total time}}$

$$= \frac{30 - 10}{4 - 2} = \frac{20}{2} = 10$$



$$t = 2 \rightarrow t = 4$$

$$\text{Displacement} = 20$$

$$= 30 - 10 = 20$$



thank you



Q

initial

$$(2, 3, 4)$$

final

$$(7, 5, 9)$$

$$\vec{d} = \text{displacement} = \vec{r}_f - \vec{r}_i = 5\hat{i} + 2\hat{j} + 5\hat{k}$$

Q

final

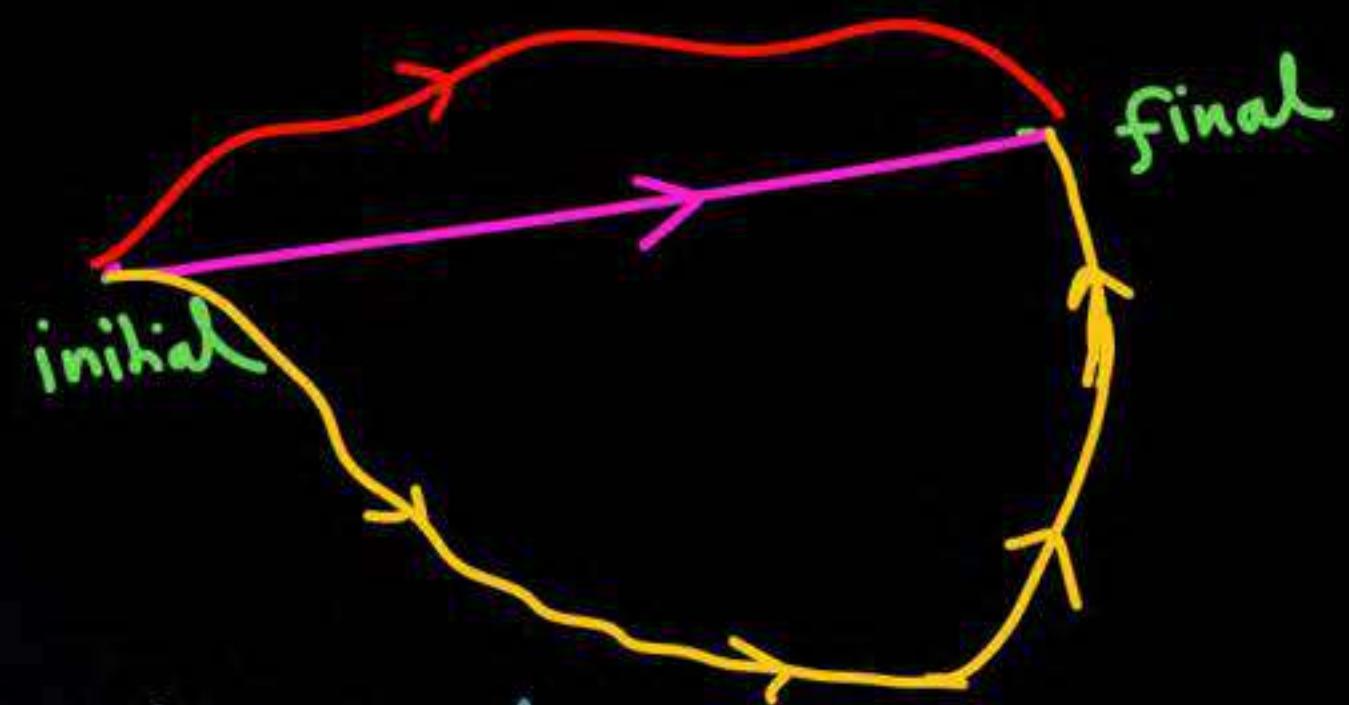
$$(-5, 0, 0)$$

initial

$$(0, 0, 0)$$

$$\text{Displacement} = -5\hat{i}$$

Q



- Displacement \rightarrow Same
- Distance \rightarrow $\overline{314159} = \text{diff} \checkmark = \text{depends on path.}$

Q

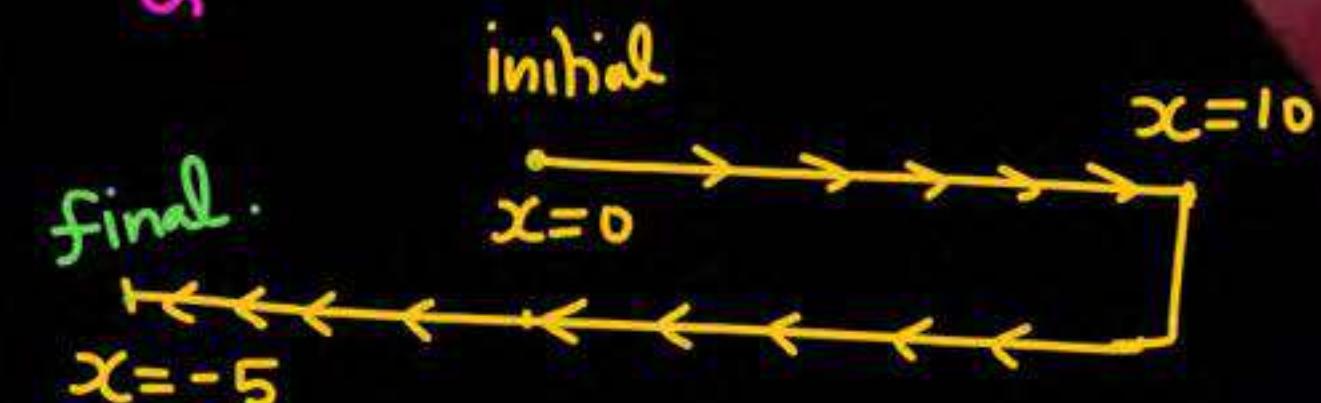


$$\text{Distance travelled} = 10 + 4 = 14$$

$$\text{Displacement} = 6 \text{ (magnitude)}$$

$$\text{Displacement (vector)} = 6\hat{i}$$

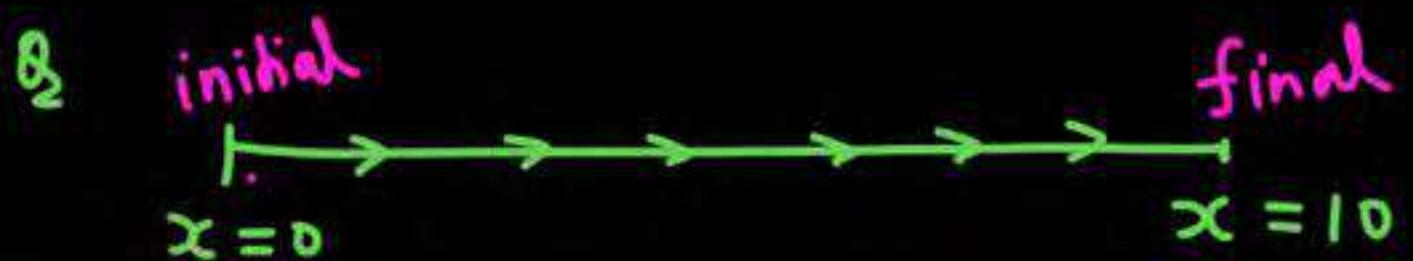
Q



$$\begin{aligned}\text{Distance} &= 10 + 10 + 5 \\ &= 25\end{aligned}$$

$$\text{Displacement} = -5\hat{i}$$





distance = 10

Displacement = $10\hat{i}$



Distance = | Displacement |

Q₂

$$\text{Distance} = 4 + 3 = 7 \text{ m}$$

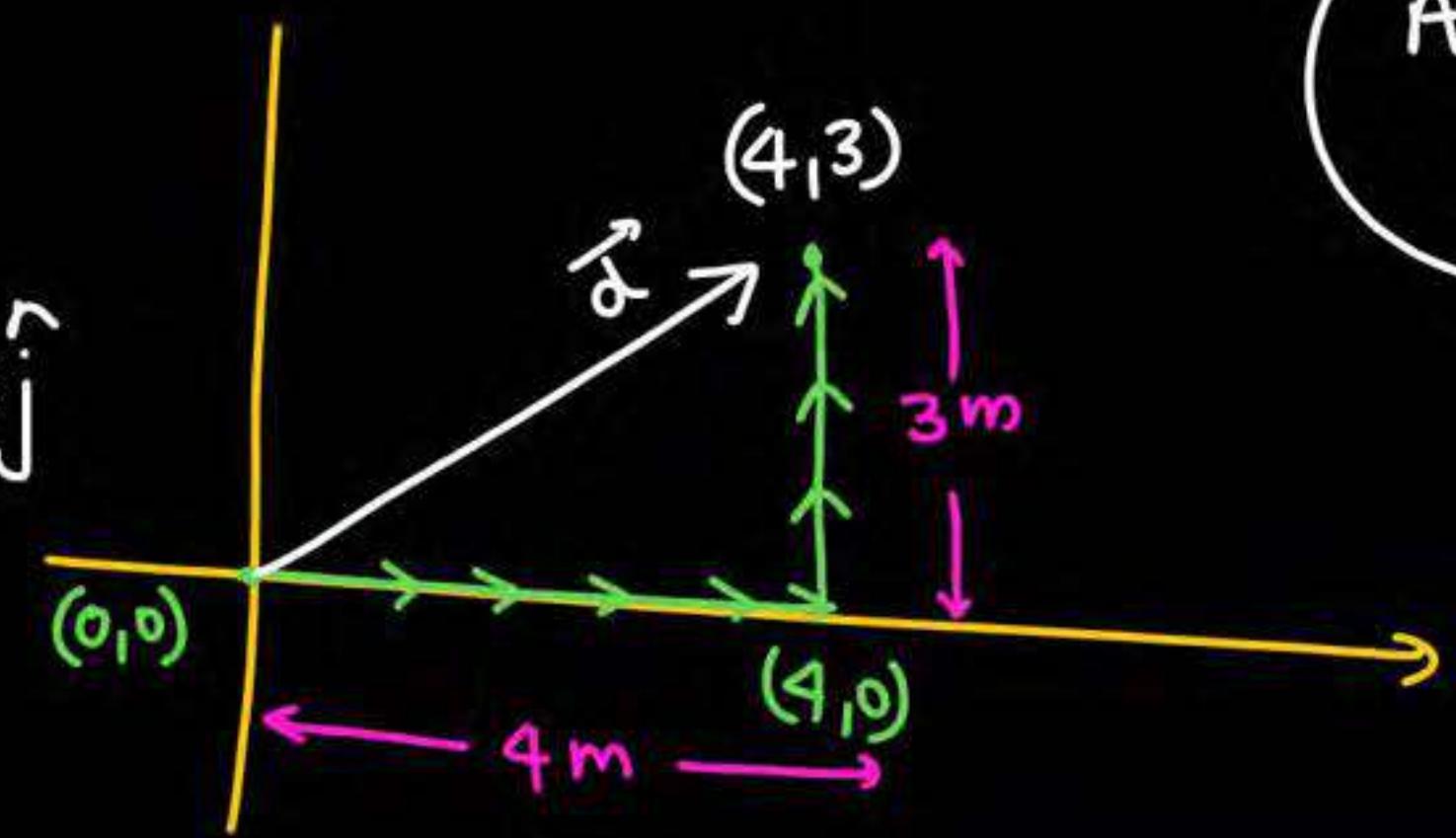
$$\text{Displacement} = \vec{d} = 4\hat{i} + 3\hat{j}$$

magnitude of

$$\begin{aligned}\text{displacement} &= \sqrt{4^2 + 3^2} \\ &= 5\end{aligned}$$

here

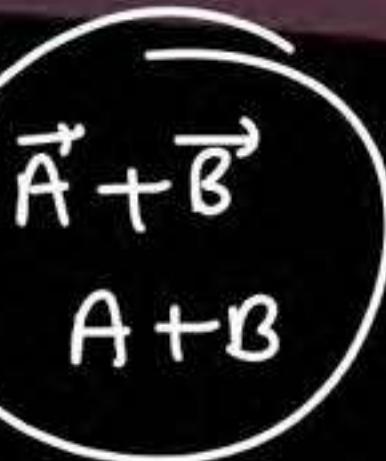
$$\text{Distance} > |\text{Displacement}|$$



$$\vec{d}_1 = 4\hat{i}$$

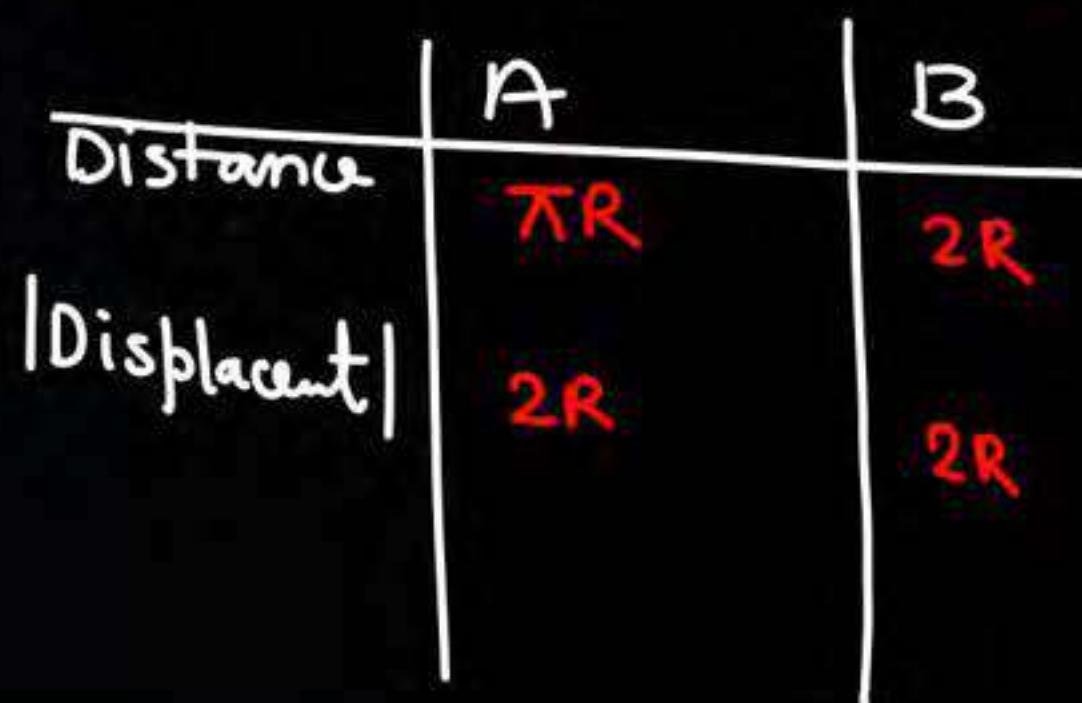
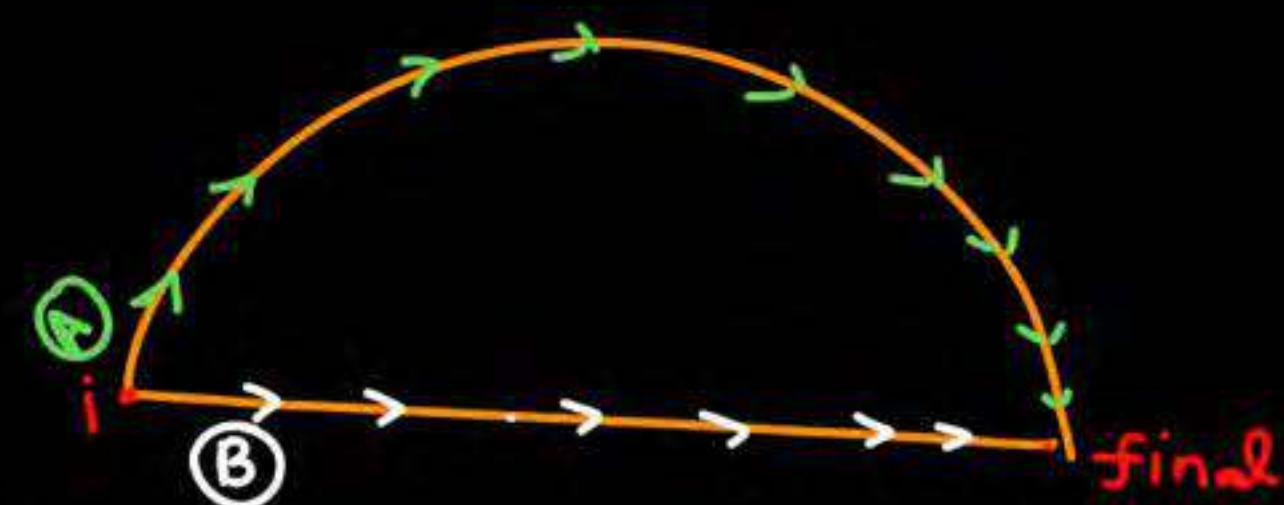
$$\vec{d}_2 = 3\hat{j}$$

$$\vec{d}_{\text{net}} = 4\hat{i} + 3\hat{j}$$



Ω

- (A) → semicircle
(B) → st. line



Q

A particle move 5m along east, then 6m along north and 10m in upward direction.

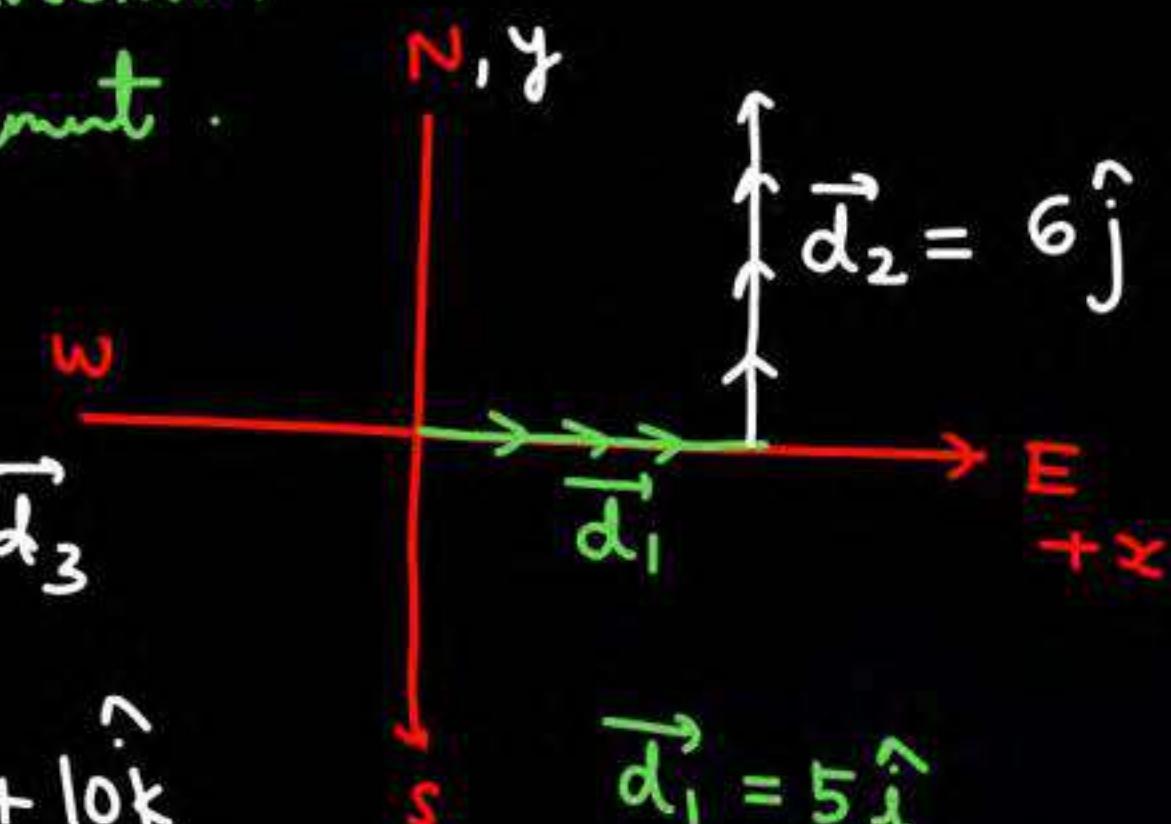
find distance & displacement.

$$\text{Distance} = 5 + 6 + 10 = 21$$

$$\text{Displacement} = \vec{d}_{\text{net}} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$$

$$= 5\hat{i} + 6\hat{j} + 10\hat{k}$$

$$\text{Magnitude} = \sqrt{5^2 + 6^2 + 10^2}$$



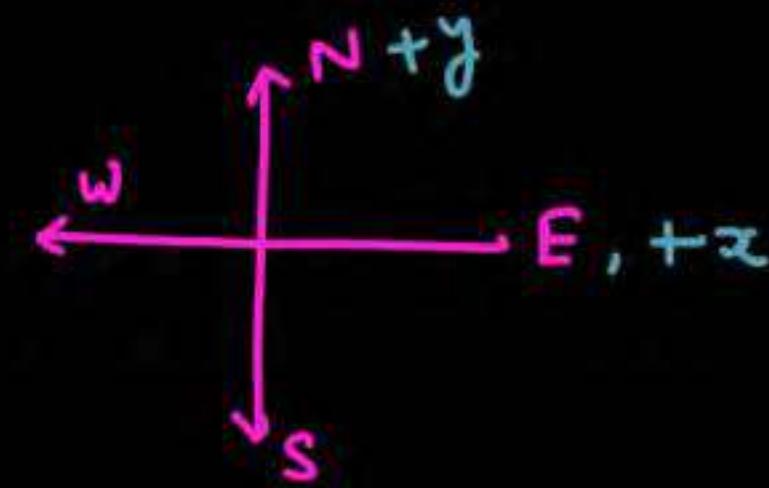
$$\vec{d}_1 = 5\hat{i}$$

$$\vec{d}_3 = 10\hat{k}$$

Q2 A particle moves

10m east $\vec{d}_1 = 10\hat{i}$
5m north $\vec{d}_2 = 5\hat{j}$
6m south $\vec{d}_3 = -6\hat{j}$
8m west $\vec{d}_4 = -8\hat{i}$
15m east $\vec{d}_5 = 15\hat{i}$

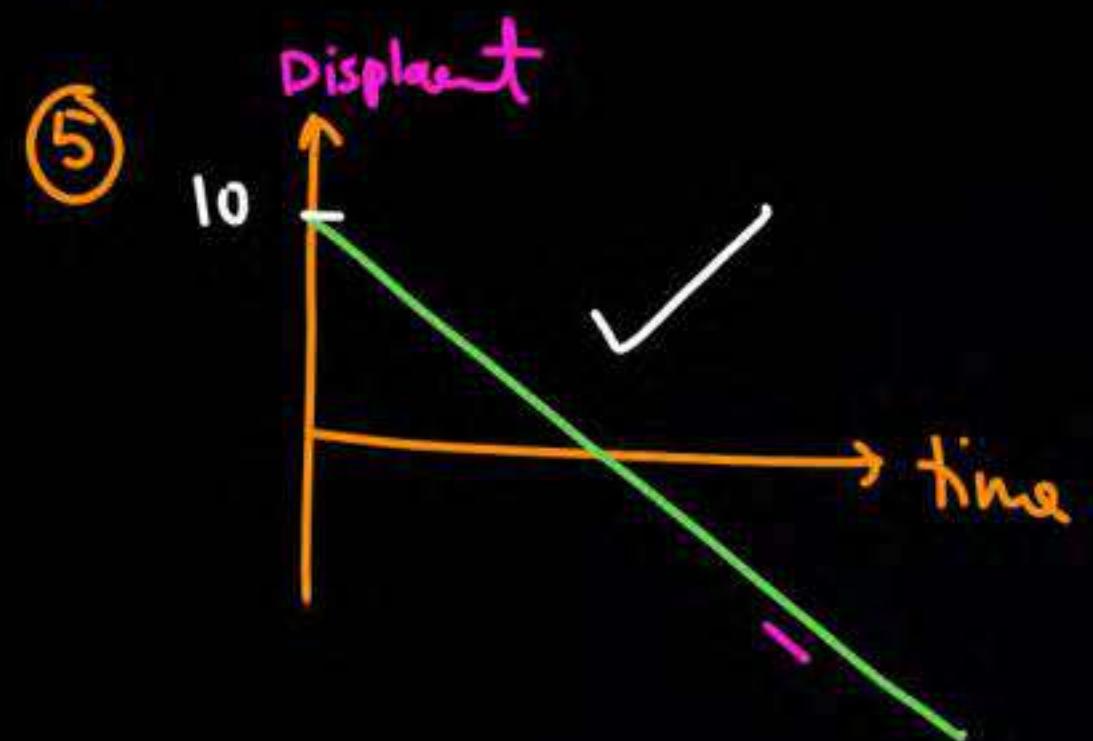
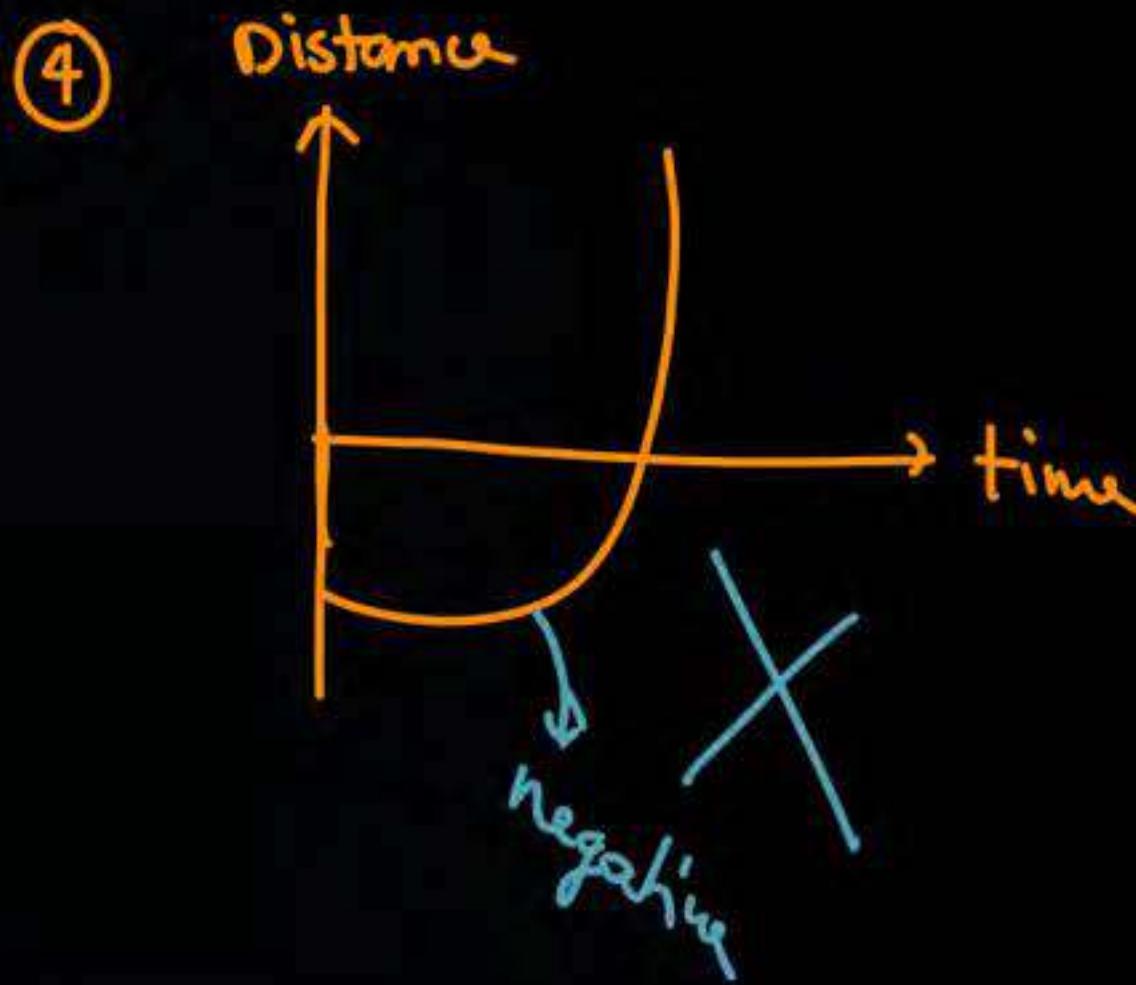
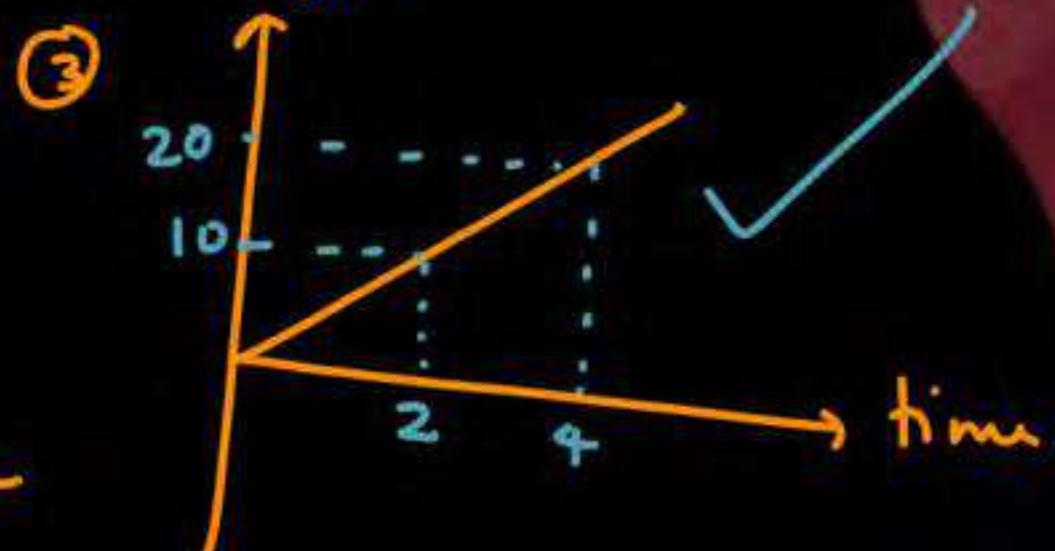
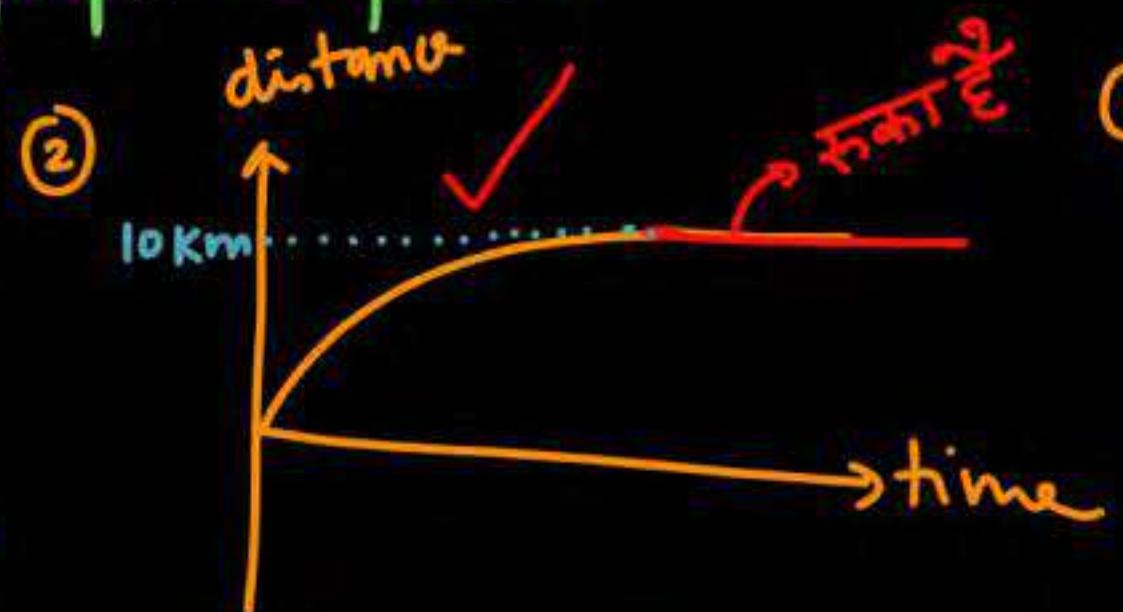
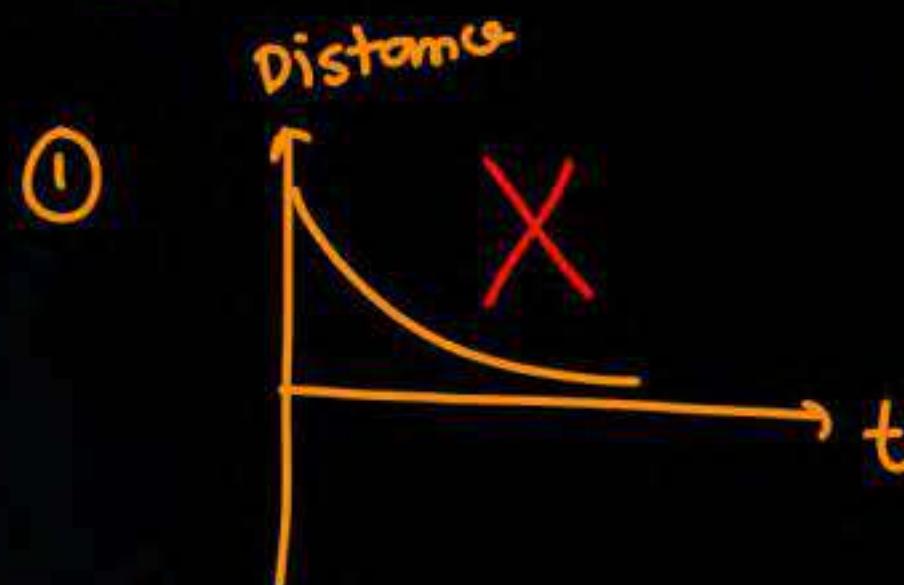
 $\vec{d}_6 = 20\hat{j}$

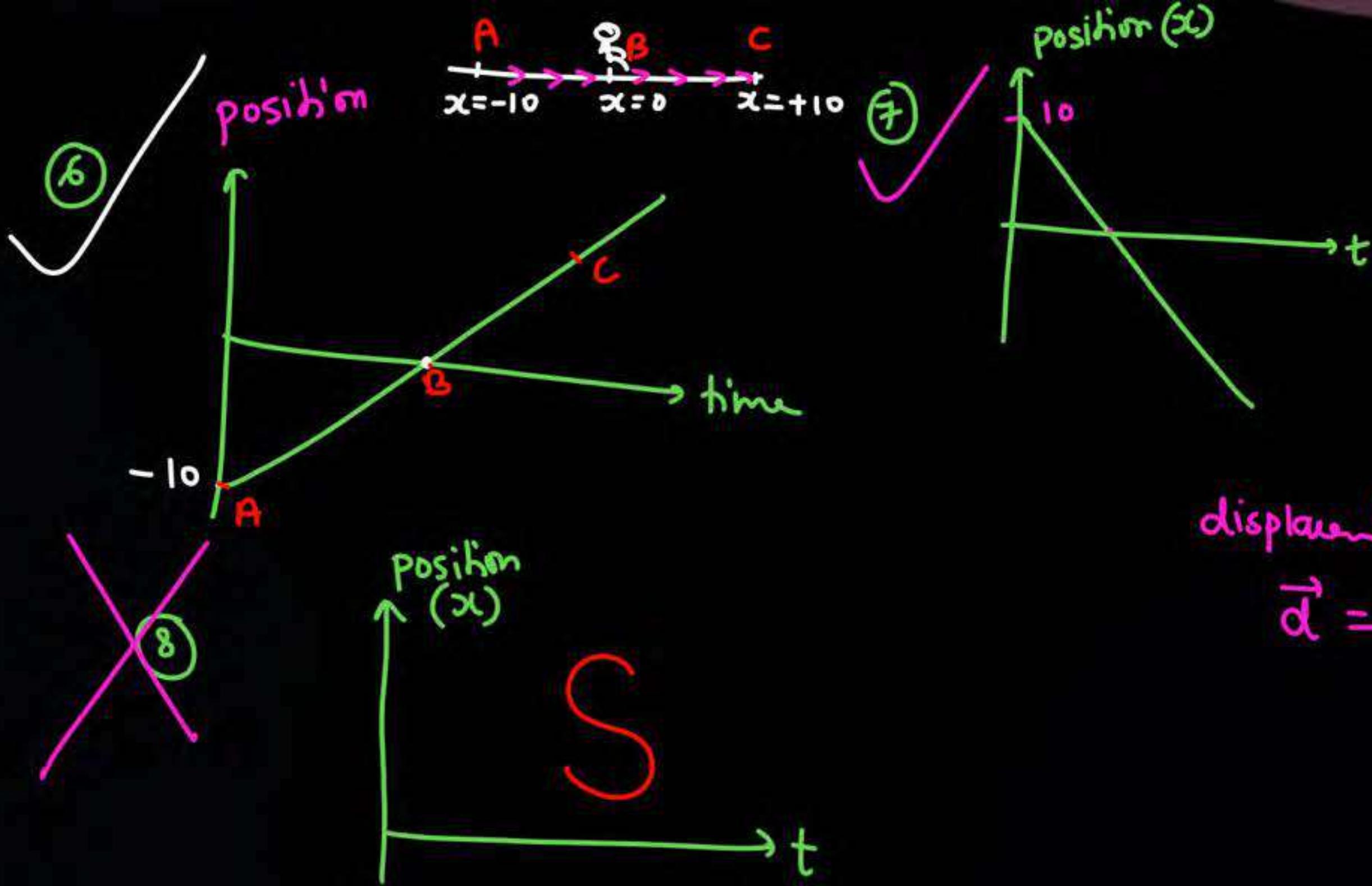


$$\begin{aligned}\vec{d}_{\text{net}} &= (\text{Add}) = (10 - 8 + 15)\hat{i} + (5 - 6 + 20)\hat{j} \\ &= 17\hat{i} + 19\hat{j}\end{aligned}$$

$$\text{distance} = 10 + 5 + 6 + 8 + 15 + 20$$

Q which of the graph is possible.

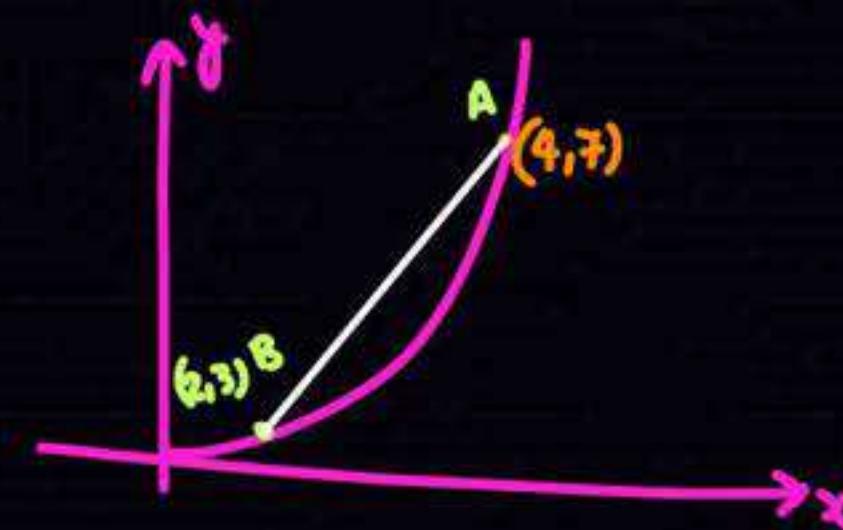




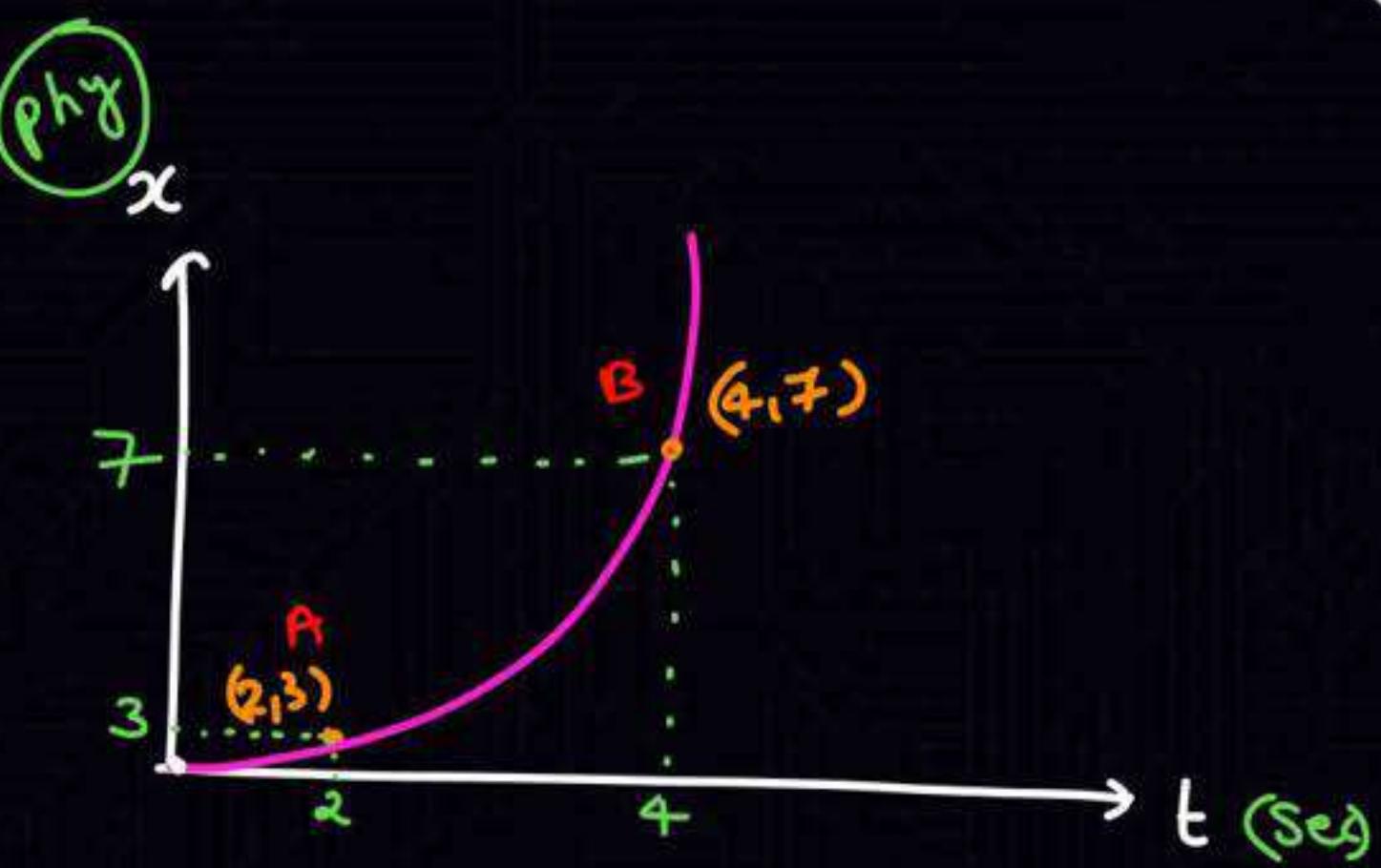
Slope

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

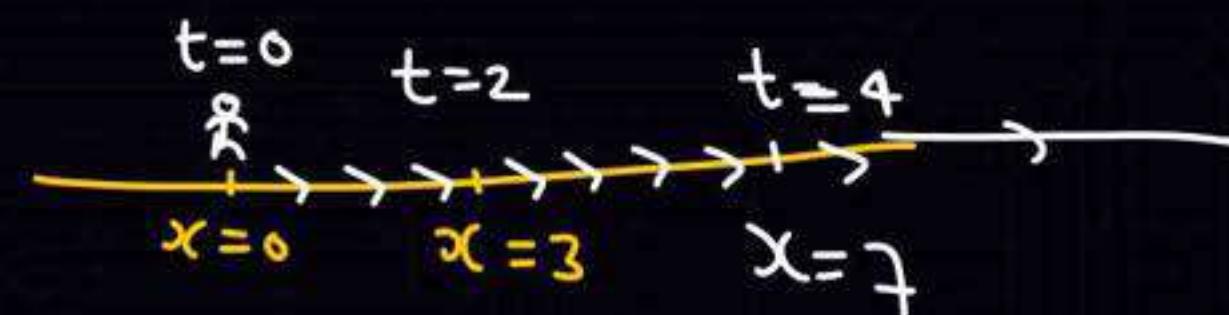
$$\text{Slope} = \frac{7-3}{4-2} = 2$$

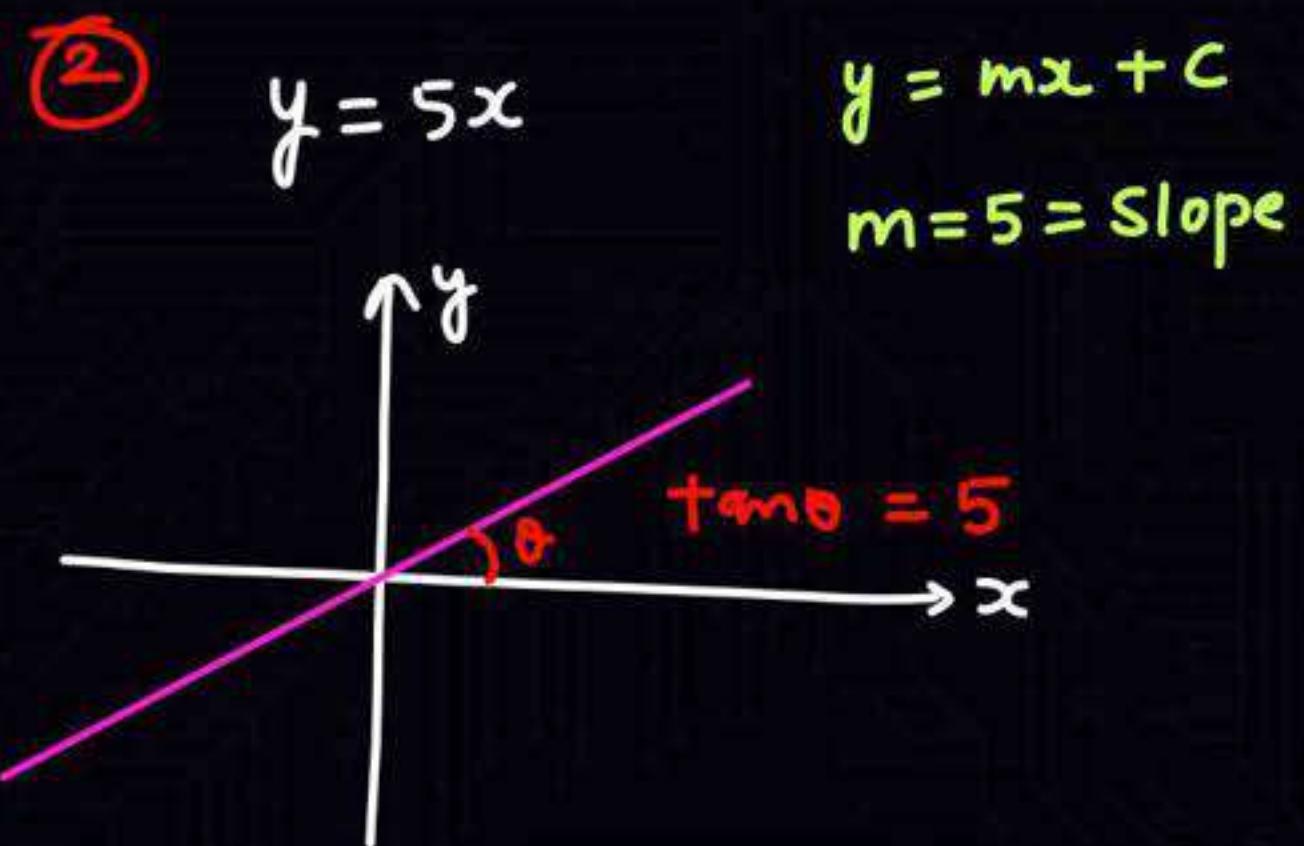
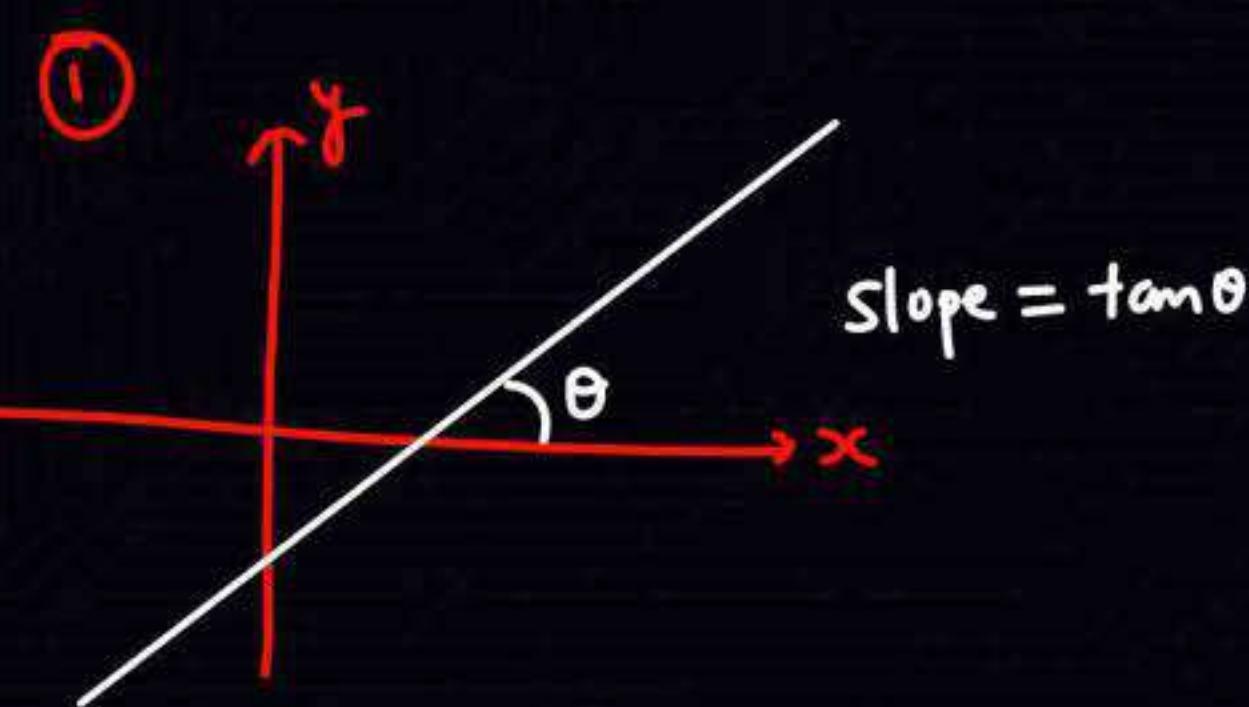


$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{change in } y}{\text{change in } x}$$



$$\text{Avg velocity } (A \rightarrow B) = \frac{x_f - x_i}{t_f - t_i} = \frac{7 - 3}{4 - 2} = 2$$





③

$$y = x\sqrt{3}$$



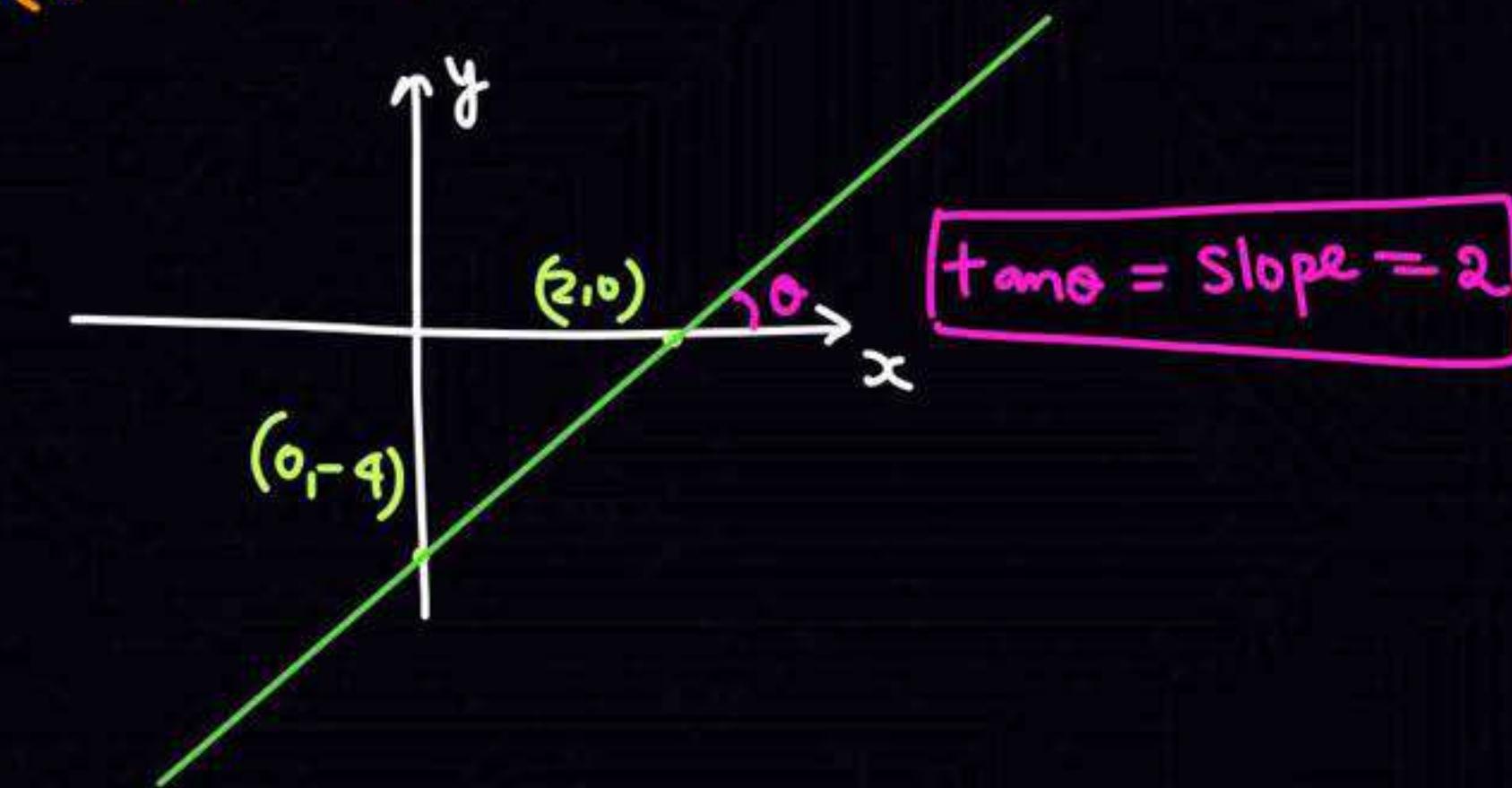
$$\text{Slope} = \sqrt{3} = \tan \theta$$

$$\theta = 60^\circ$$

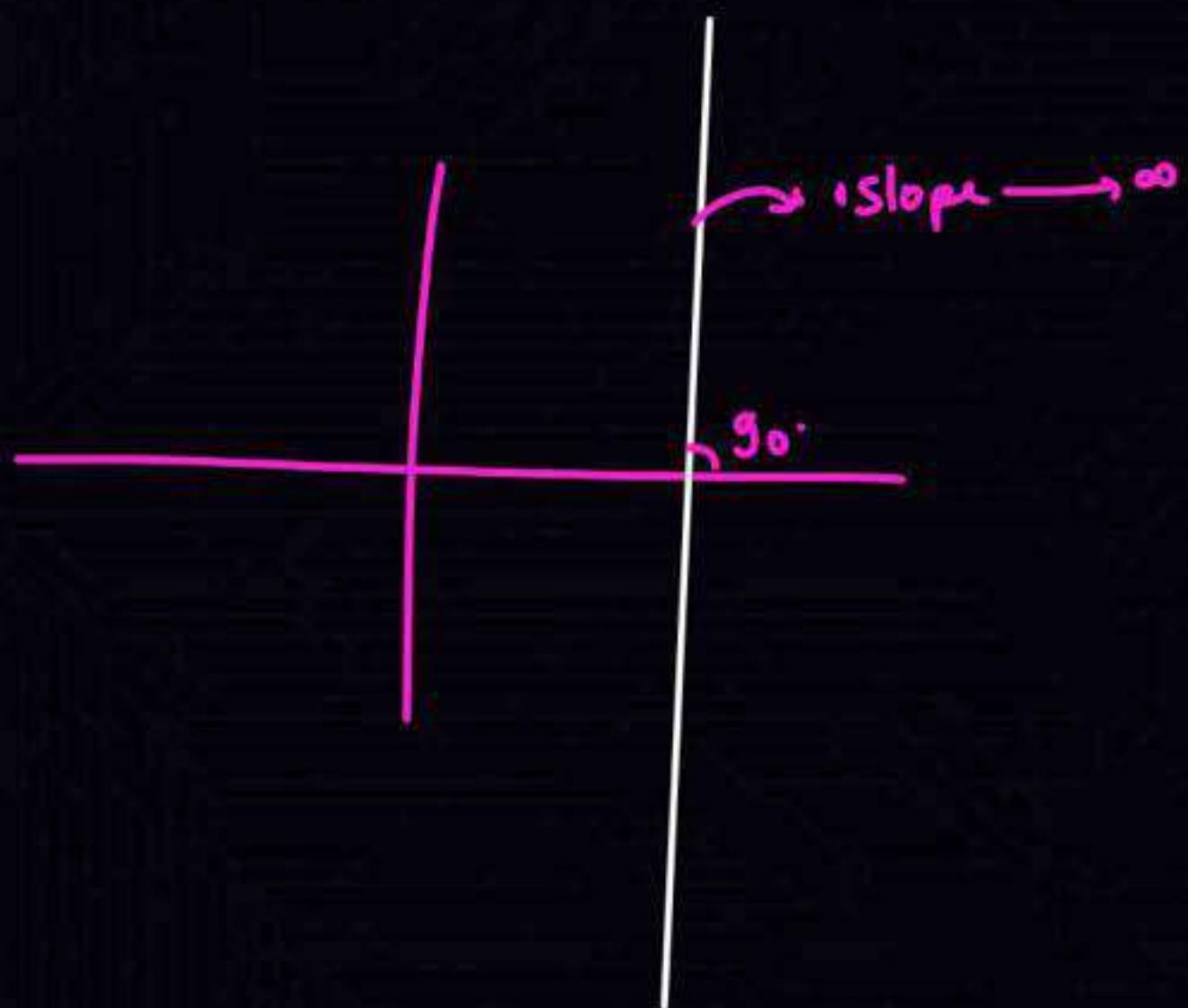
$$y = 2x - 4 \quad (\text{draw}) \rightarrow (\text{not imp in physics})$$

$$(x=0, y=-4) = (0_1, -4)$$
$$(y=0, x=2) = (2, 0)$$

Slope = 2 \Rightarrow +ve



$$\tan \theta = \text{Slope} = 2$$



$$y = -2x + 4$$

$$\begin{aligned}x=0, \quad y &= 4 \\y=0, \quad x &= 2\end{aligned}$$

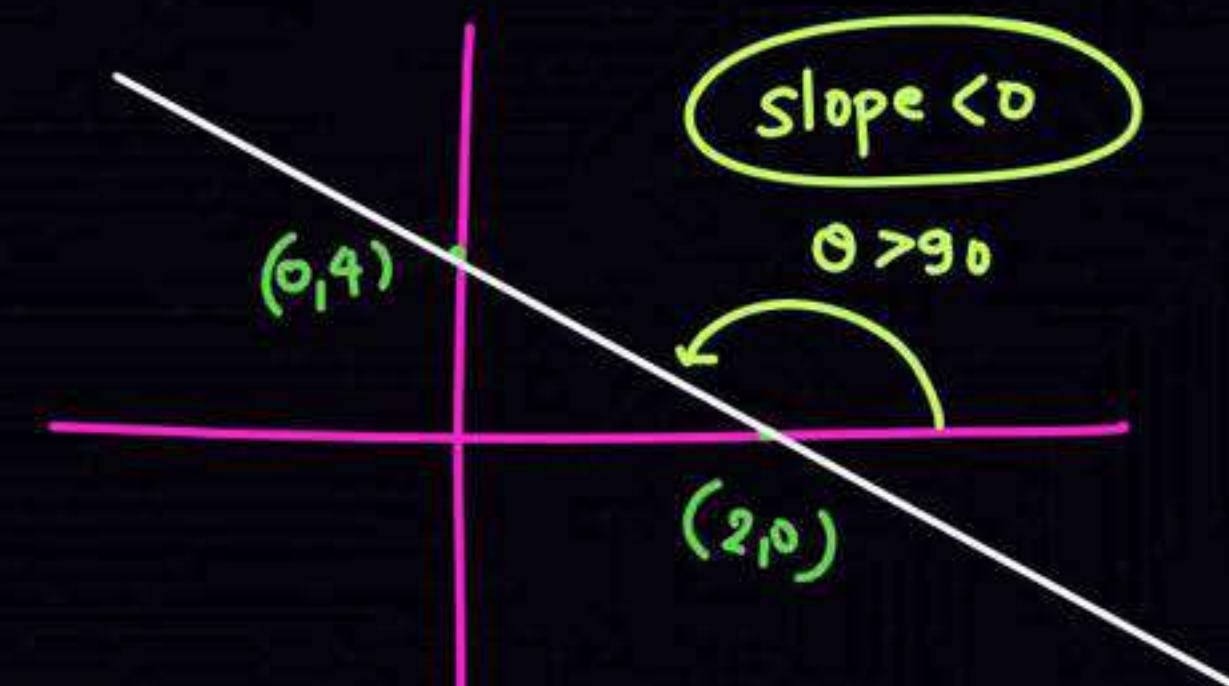
$$\text{Slope} = -2$$

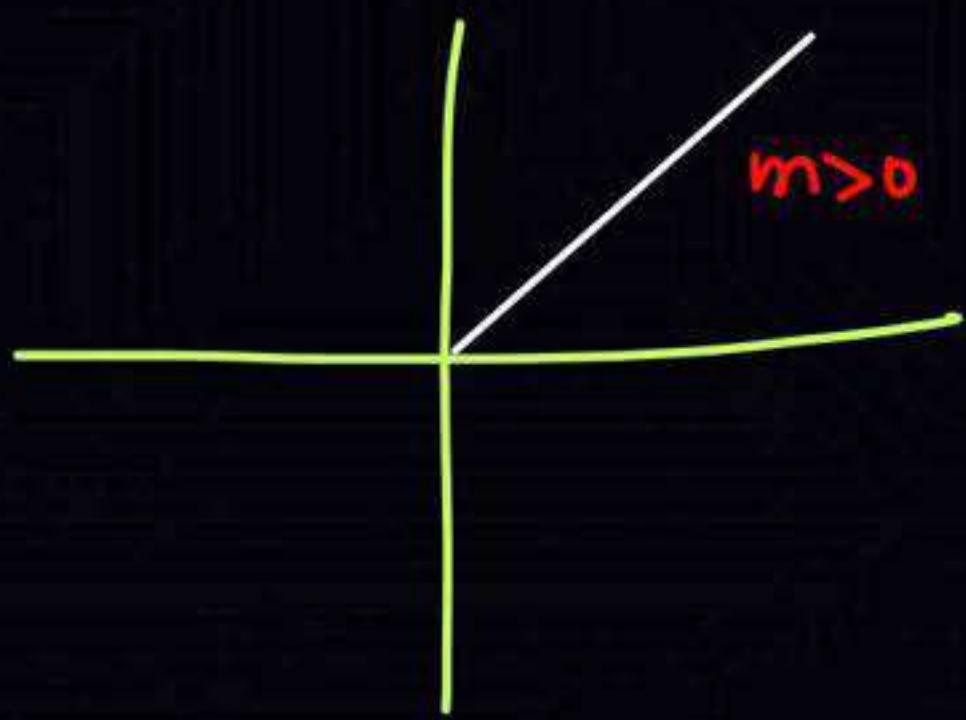
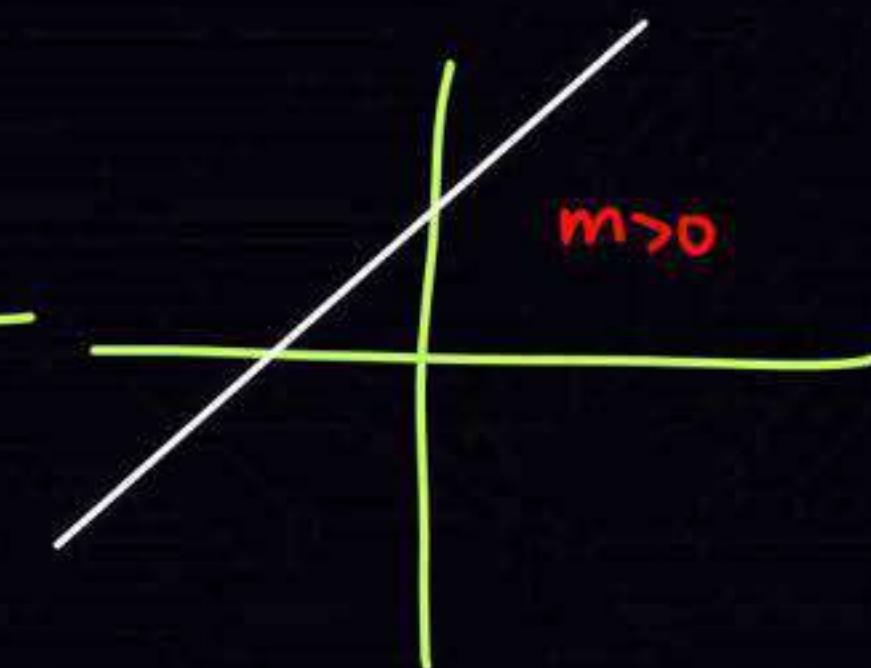
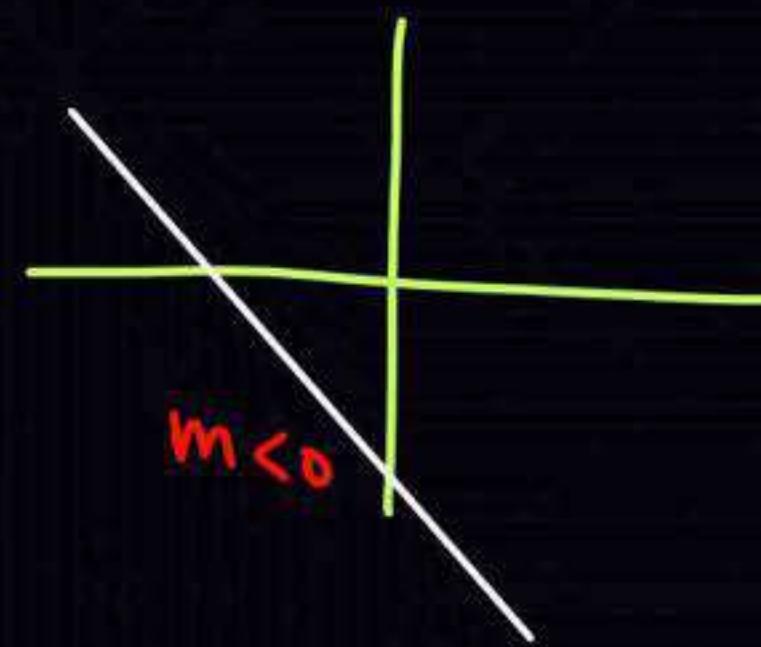
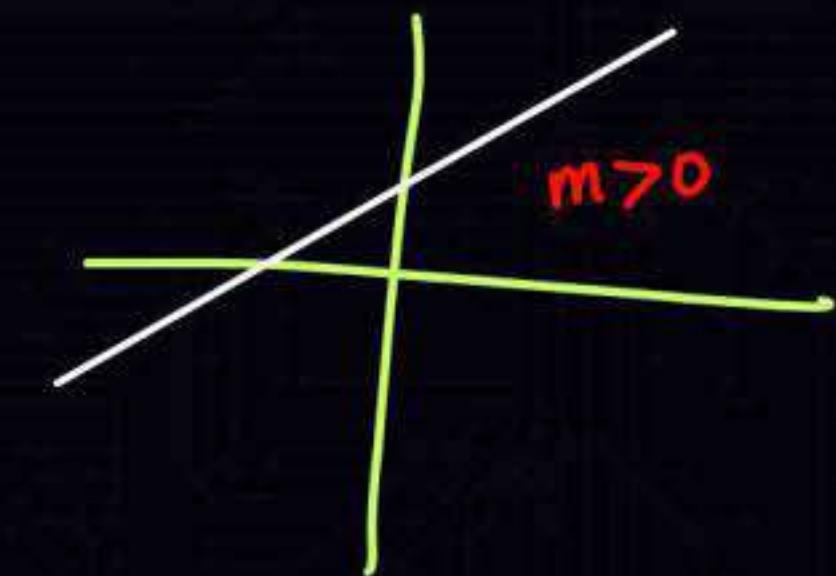
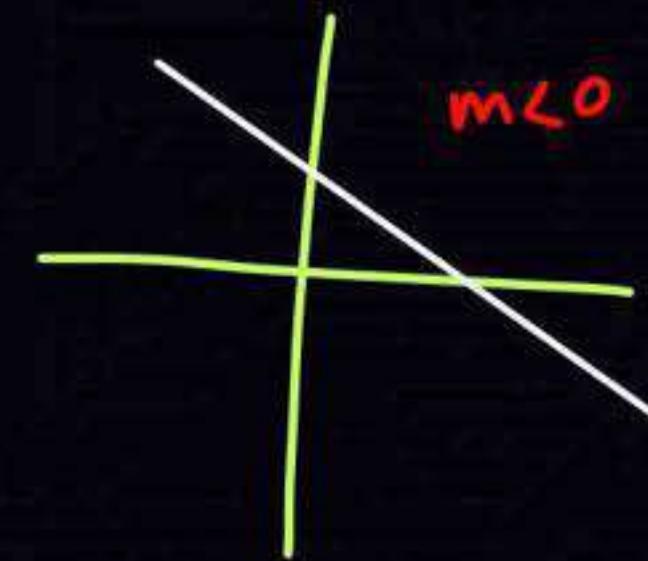
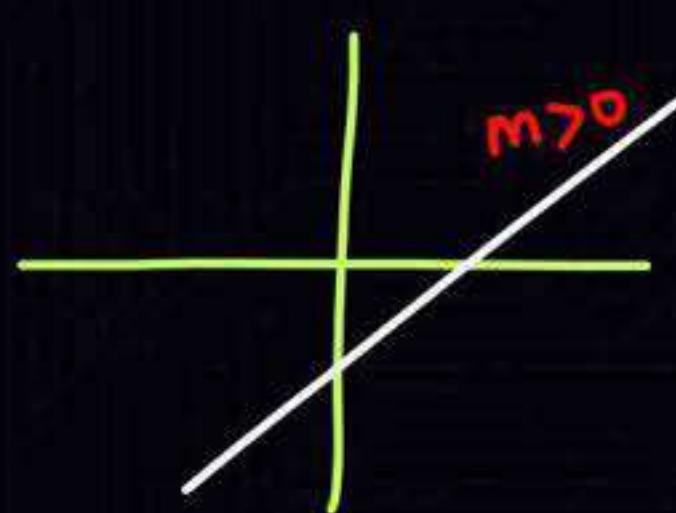
$$\tan \theta = -2$$

$$\begin{aligned}y &= mx + c \\2y &= 8x + 16\end{aligned}$$

$$\boxed{\text{Slope} = 8x}$$

$$\begin{aligned}y &= 4x + 8 \\ \text{Slope} &= 4\end{aligned}$$





$$y = x^n$$

$$\frac{dy}{dx} = nx^{n-1}$$

$$\textcircled{1} \quad y = x^3$$

$$\frac{dy}{dx} = 3x^{3-1} = 3x^2$$

$$\textcircled{2} \quad y = x^5$$

$$\frac{dy}{dx} = 5x^4$$

$$\textcircled{3} \quad y = x^7$$

$$\frac{dy}{dx} = 7x^6$$

$$\textcircled{4} \quad y = x^9$$

$$\frac{dy}{dx} = 9x^8$$

$$\textcircled{5} \quad y = 2x^5$$

$$\begin{aligned}\frac{dy}{dx} &= 2 \times 5x^4 \\ &= 10x^4\end{aligned}$$

$$\textcircled{6} \quad y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$\textcircled{7} \quad y = t^3$$

$$\frac{dy}{dt} = 3t^2$$

$$\textcircled{8} \quad x = t^3$$

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

$$\textcircled{9} \quad x = t^5$$

$$\frac{dx}{dt} = 5t^4$$

$$\textcircled{10} \quad x = t^7$$

$$\frac{dx}{dt} = 7t^6$$

$$\textcircled{1} \quad y = x^n$$

$$\frac{dy}{dx} = nx^{n-1}$$

$$\textcircled{2} \quad y = \sin x$$

$$\frac{dy}{dx} = \frac{d}{dx}(\sin x) = \cos x$$

↓
means
differentiation of $\sin x$ w.r.t. x
is $\cos x$

$$\textcircled{3} \quad y = \cos x$$

$$\frac{dy}{dx} = \frac{d}{dx} \cos x = -\sin x$$

$$\textcircled{4} \quad y = \tan x$$

$$\frac{dy}{dx} = \frac{d}{dx}(\tan x) = \sec^2 x$$

$$\textcircled{5} \quad y = \cot x$$

$$\frac{dy}{dx} = \frac{d(\cot x)}{dt} = -\operatorname{cosec}^2 x$$

$$* \frac{d}{dx}(\csc x) = -\csc x \cot x$$

$$* \frac{d}{dx}(x^n) = nx^{n-1}$$

$$* \frac{d}{dx} \cot x = -\operatorname{cosec}^2 x$$

$$* \frac{d}{dx} \sin x = \cos x$$

$$* \frac{d}{dx} e^x = e^x$$

$$* \frac{d}{dx}(\cos x) = -\sin x$$

$$* \frac{d}{dx}(\ln x) = \frac{1}{x}$$

$$* \frac{d}{dx}(\tan x) = \sec^2 x$$

$$* \frac{d}{dx}(\sec x) = \sec x \tan x$$

Q

$$x = \frac{t^3}{3} - 3t^2 + 9t + 21$$

$$v = t^2 - 6t + 9 + 0 = (t-3)^2$$

$$v = 0$$

$$t^2 - 6t + 9 = 0$$

$$t = 3 \text{ sec}$$

~~t = 3 is turning point~~

$$v = (t-3)^2 > 0$$

→ v → always +ve
No turning point



$$Q \quad x = 3t^2 - 12t + 10$$

$$\textcircled{1} \quad t=0, \quad t=2, \quad t=3,$$

$$\begin{cases} \rightarrow v = 6t - 12 \\ \rightarrow a = 6 = \text{const} \end{cases}$$

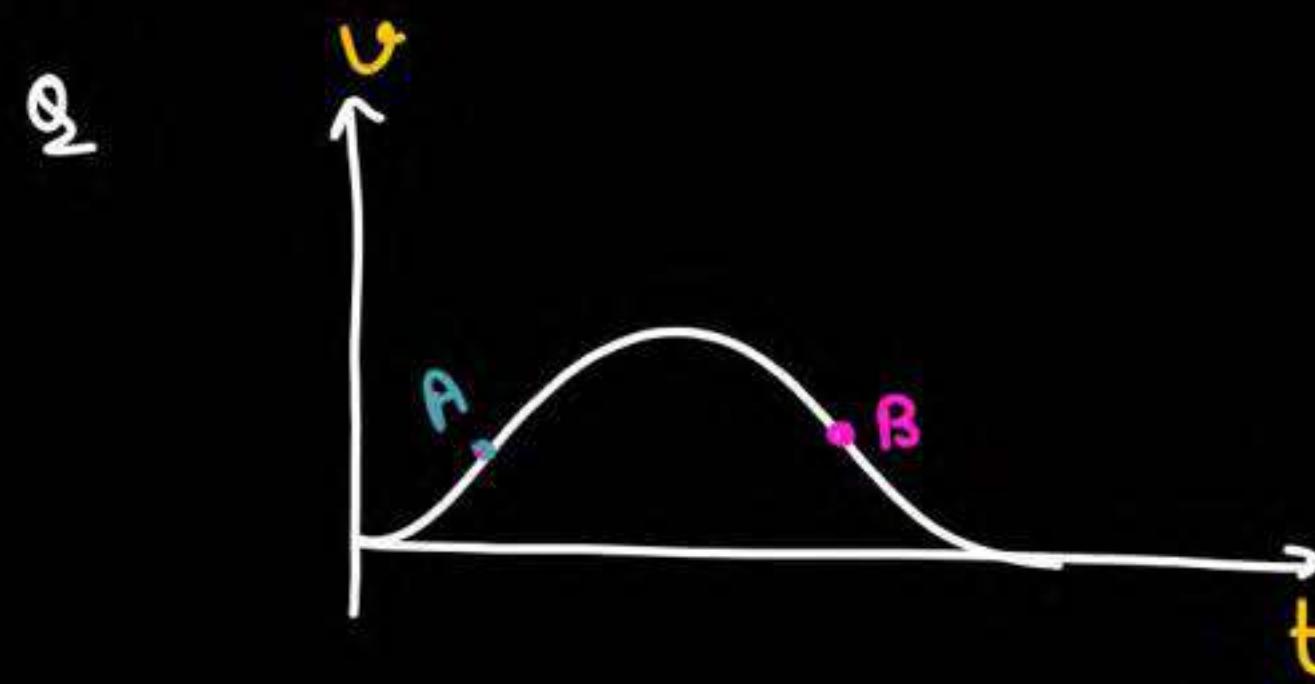
	x	v	a
$t=0$	10	-12	6
$t=2$	-2	0	6
$t=3$	+1	6	6

$\textcircled{2}$ find x & a when particle comes to at rest

$$v = 0, \quad v = 6t - 12 = 0$$

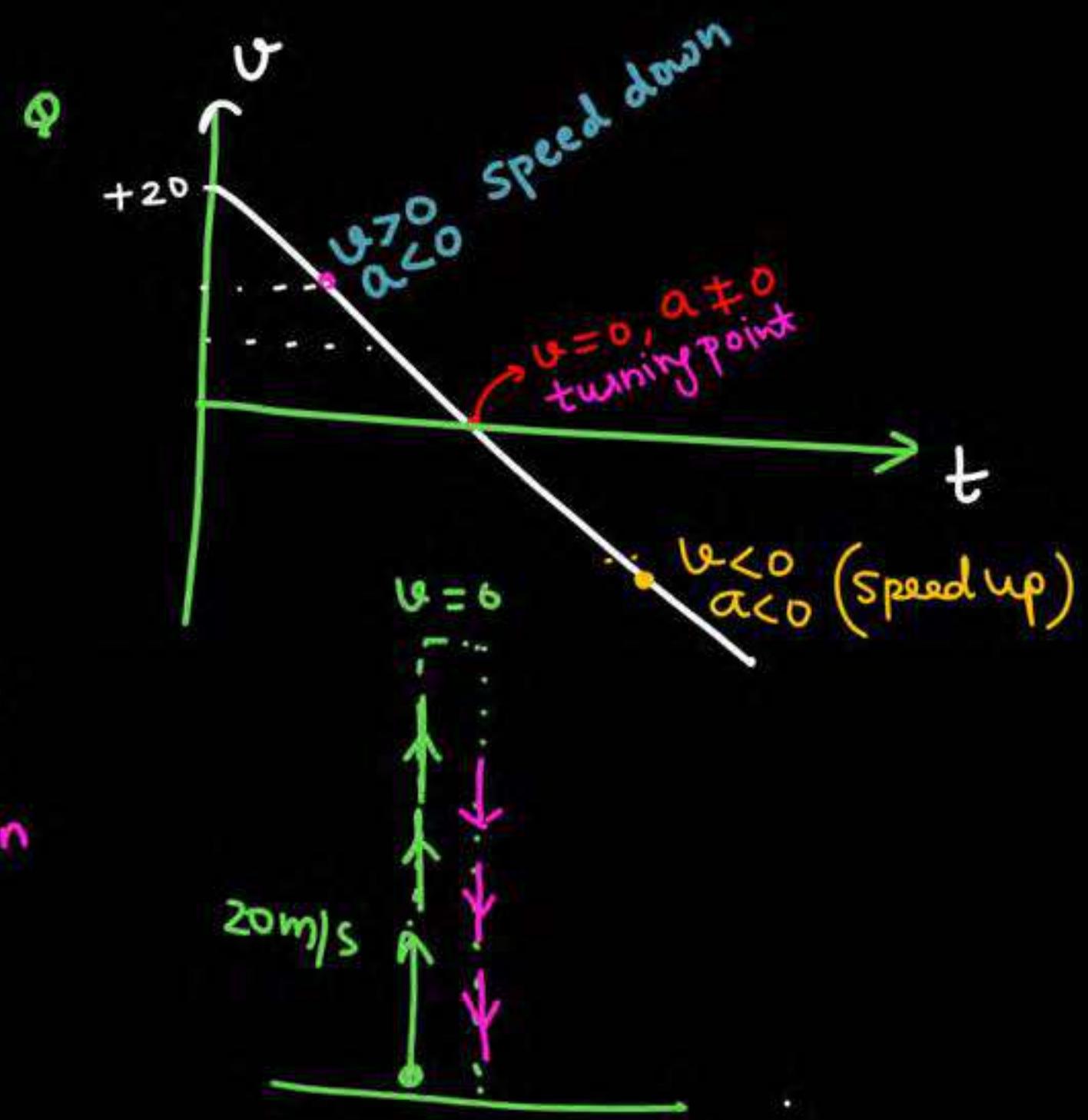
$$t = 2$$

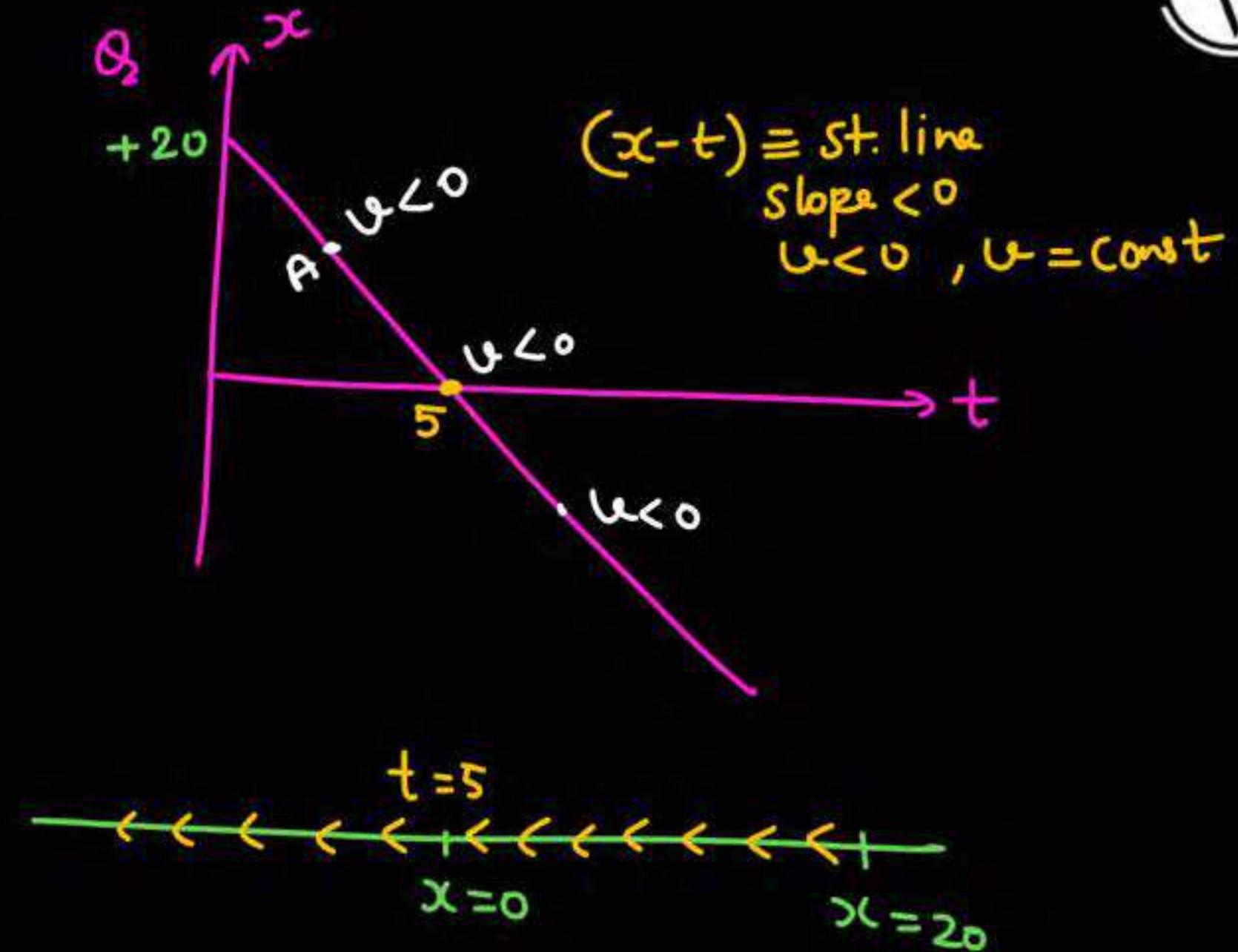
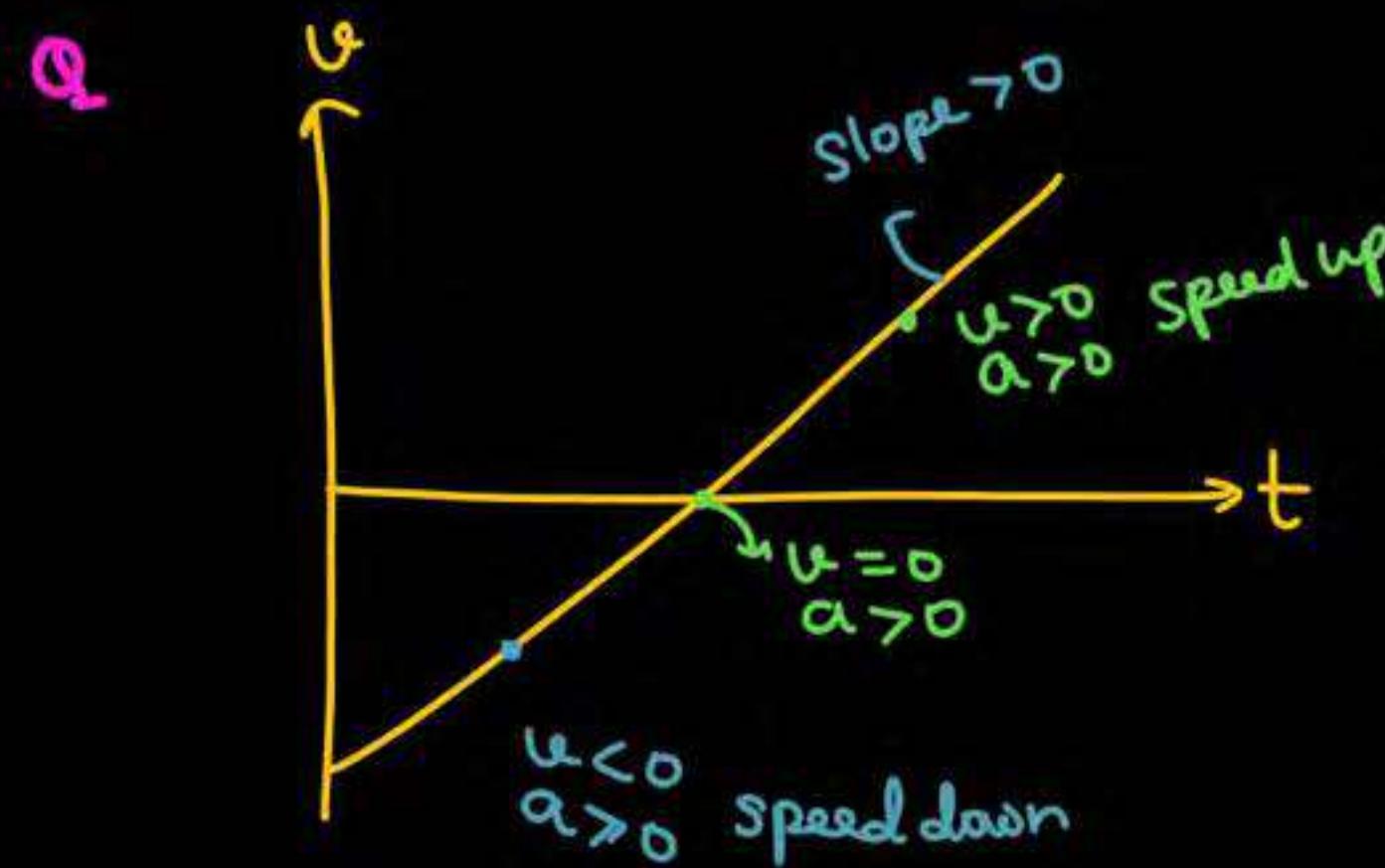
$$t = 2, \quad x = -2 \\ a = 6$$

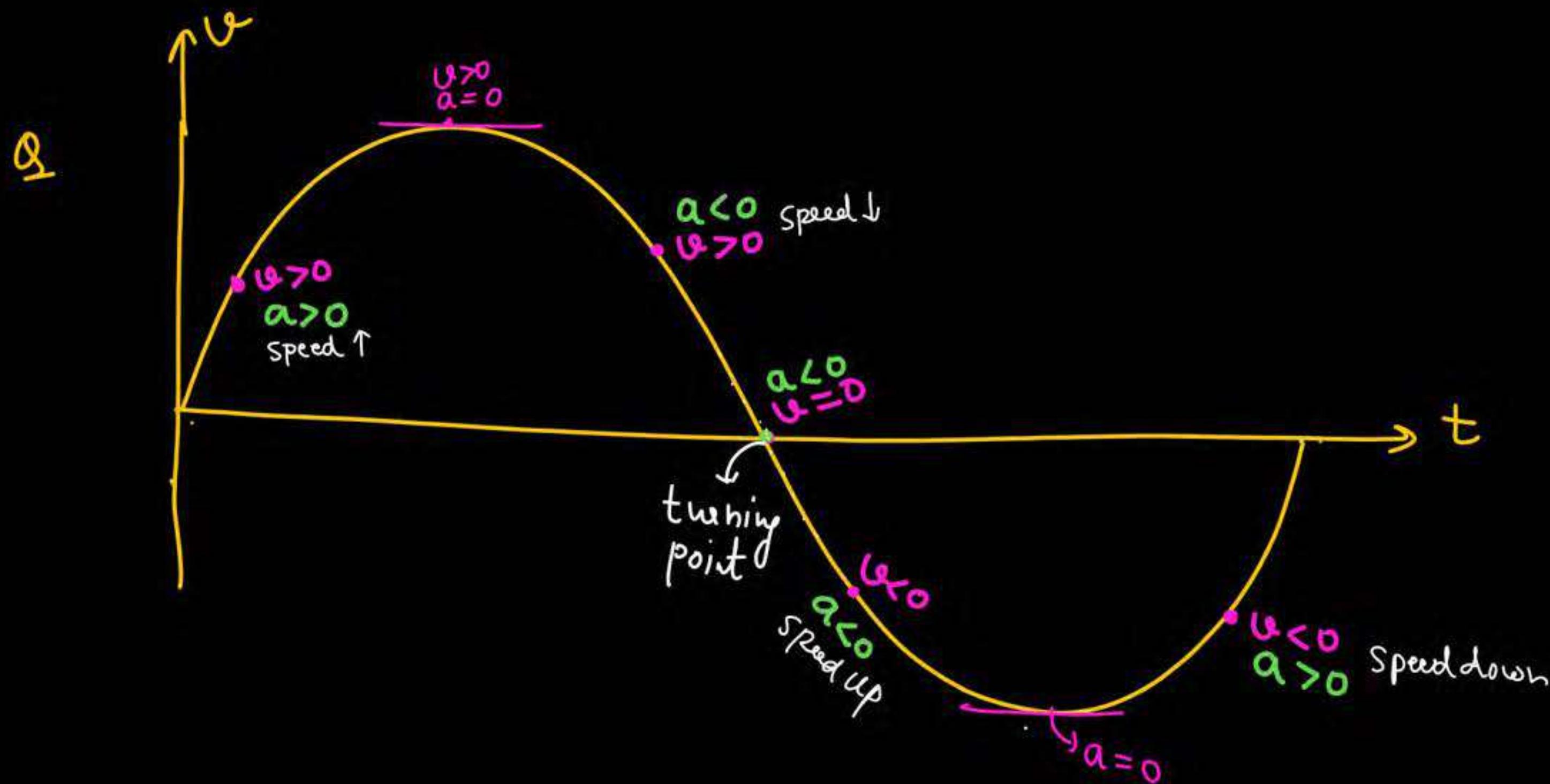


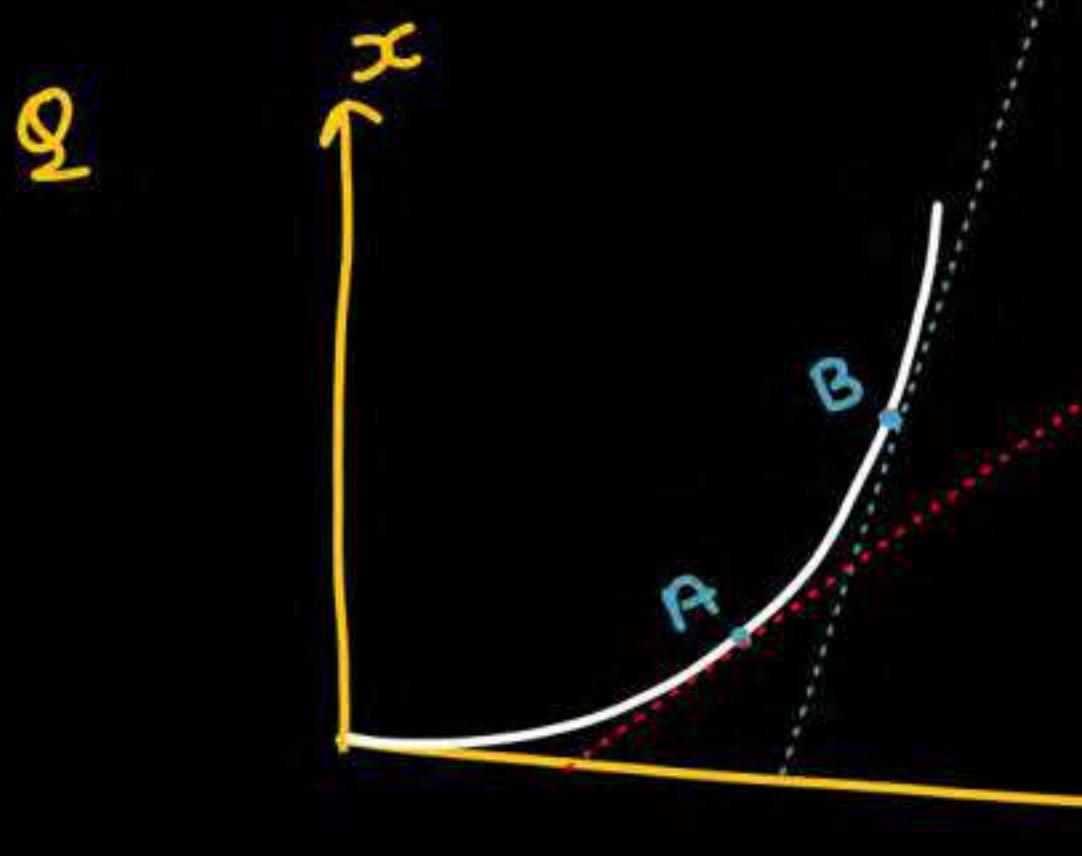
$v_A > 0, a_A > 0 \Rightarrow$ Speed up

$v_B > 0, a_B < 0 \Rightarrow$ Speed down









logical तरीका

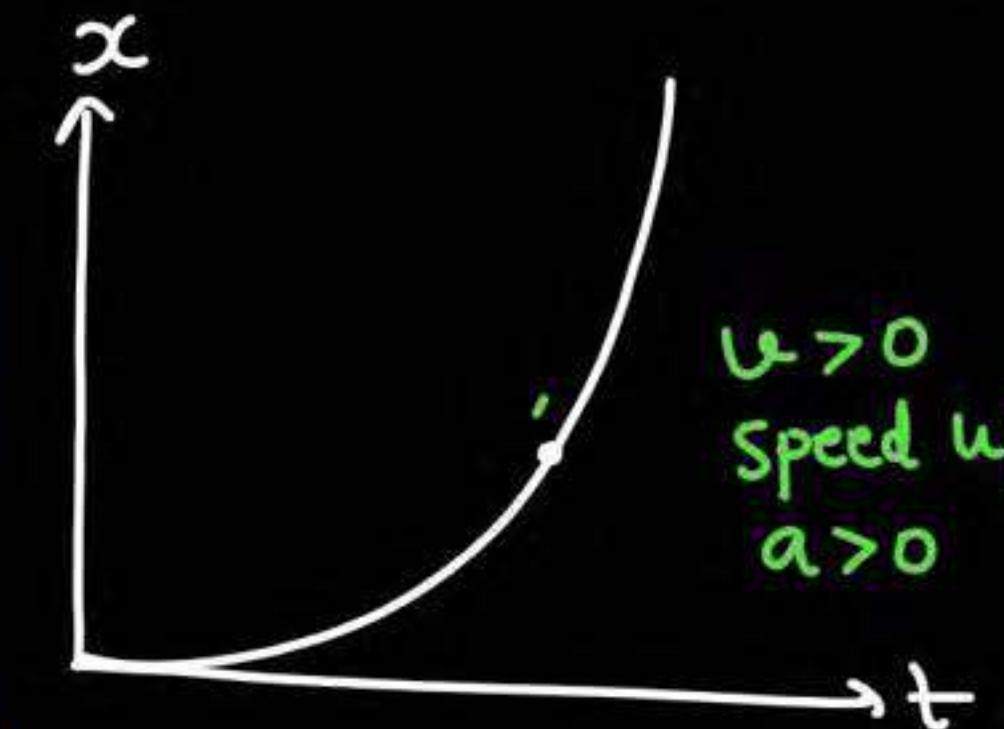
$$v_A > 0, v_B > 0$$

$(\text{slope})_{\text{at } B} > (\text{slope})_{\text{at } A}$

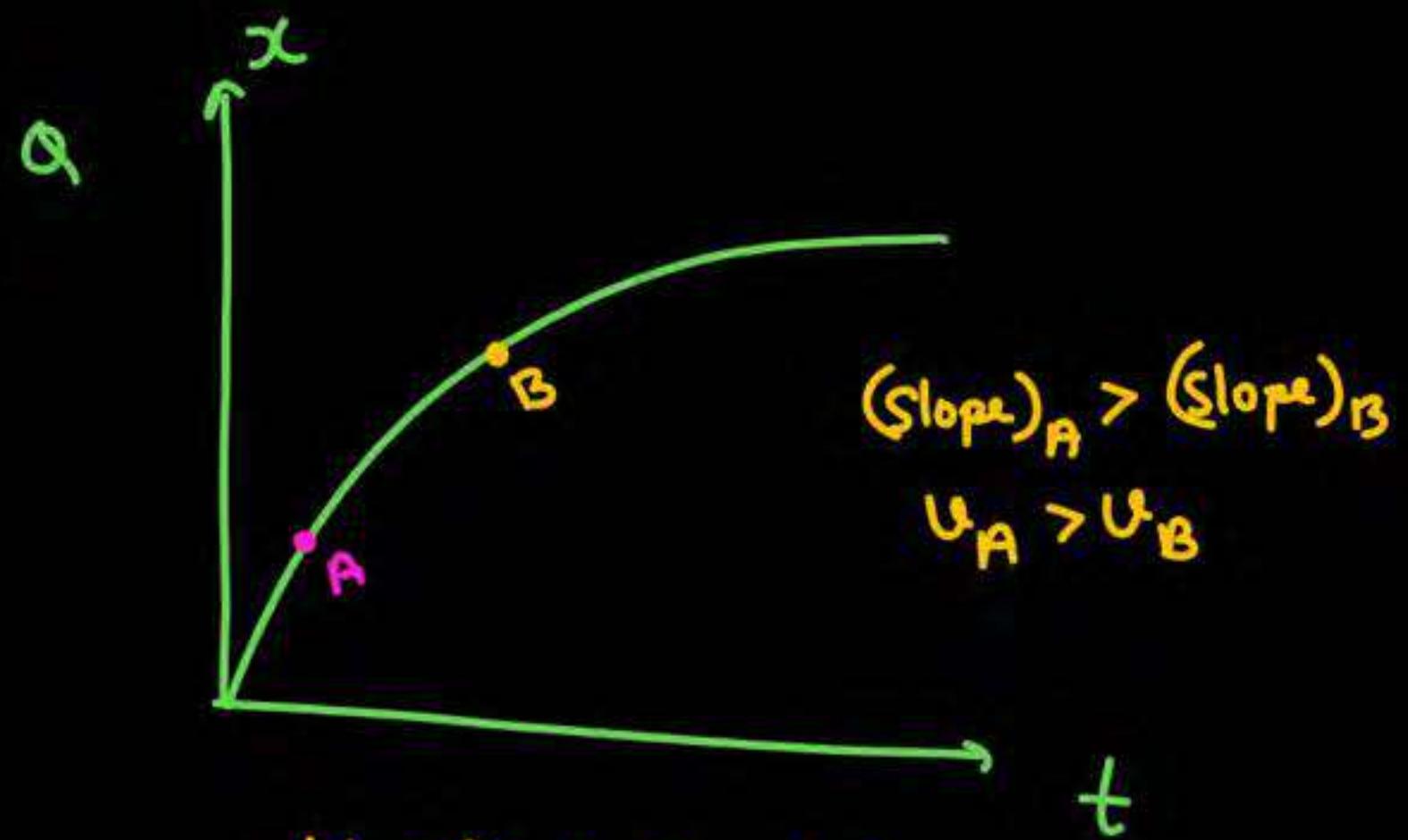
$$v_B > v_A$$

speed up

$$v > 0 \quad a > 0$$



$$v > 0 \\ \text{Speed up} \\ a > 0$$

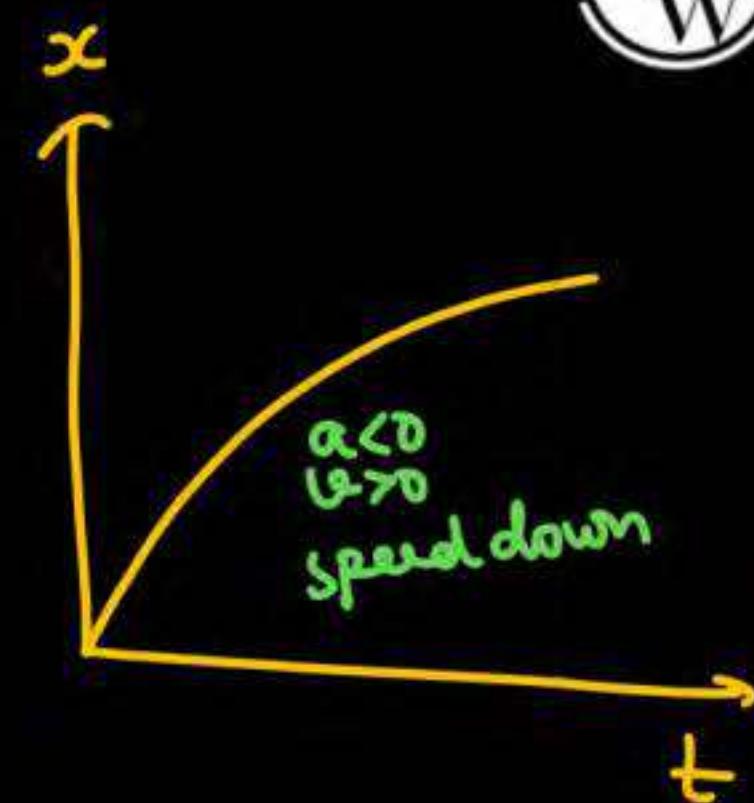
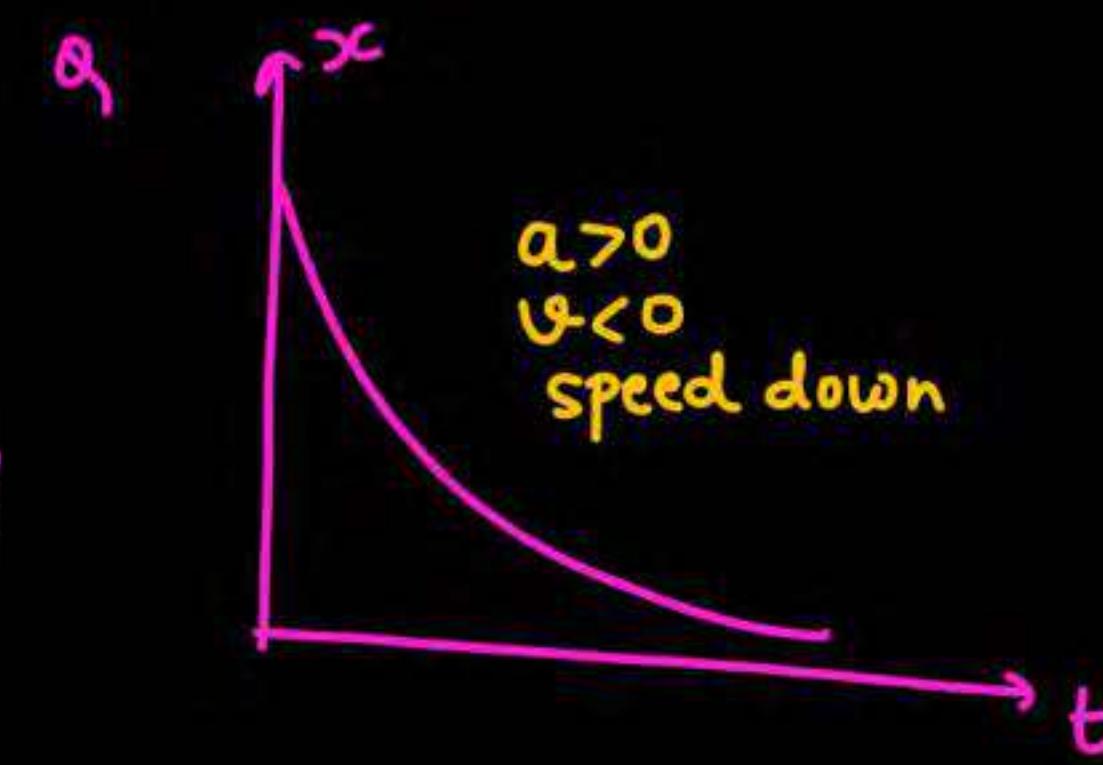
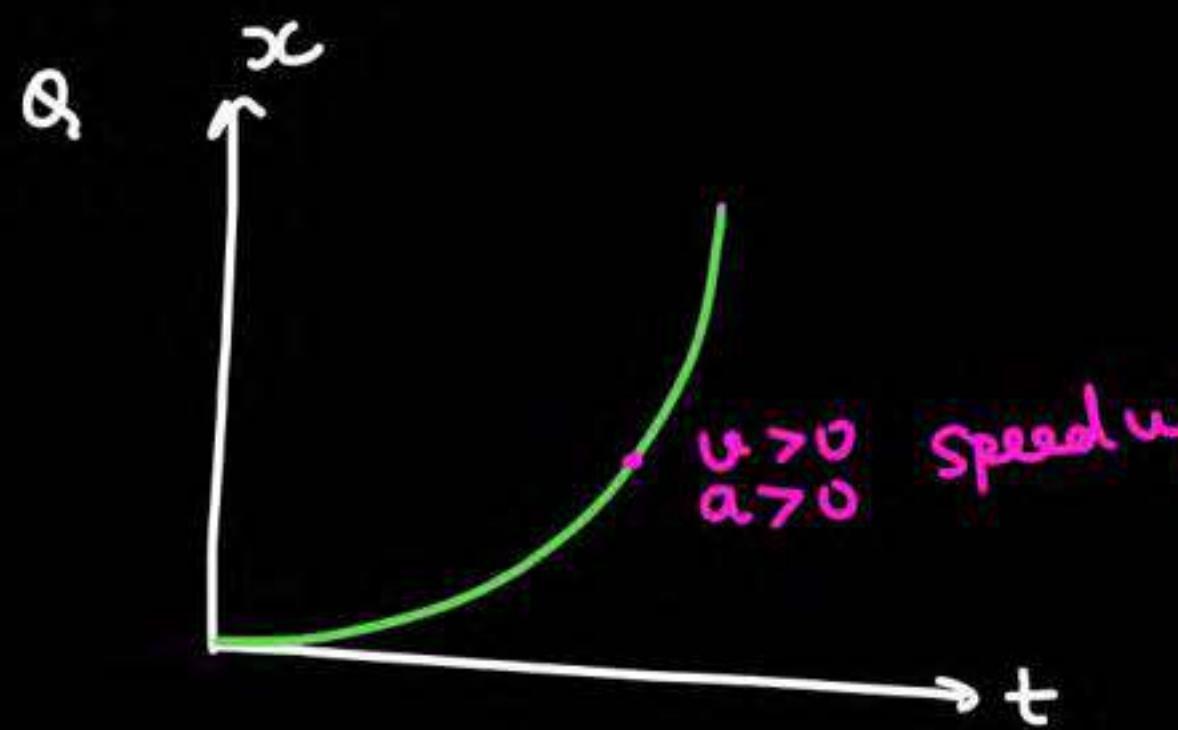


$$(\text{slope})_A > (\text{slope})_B$$

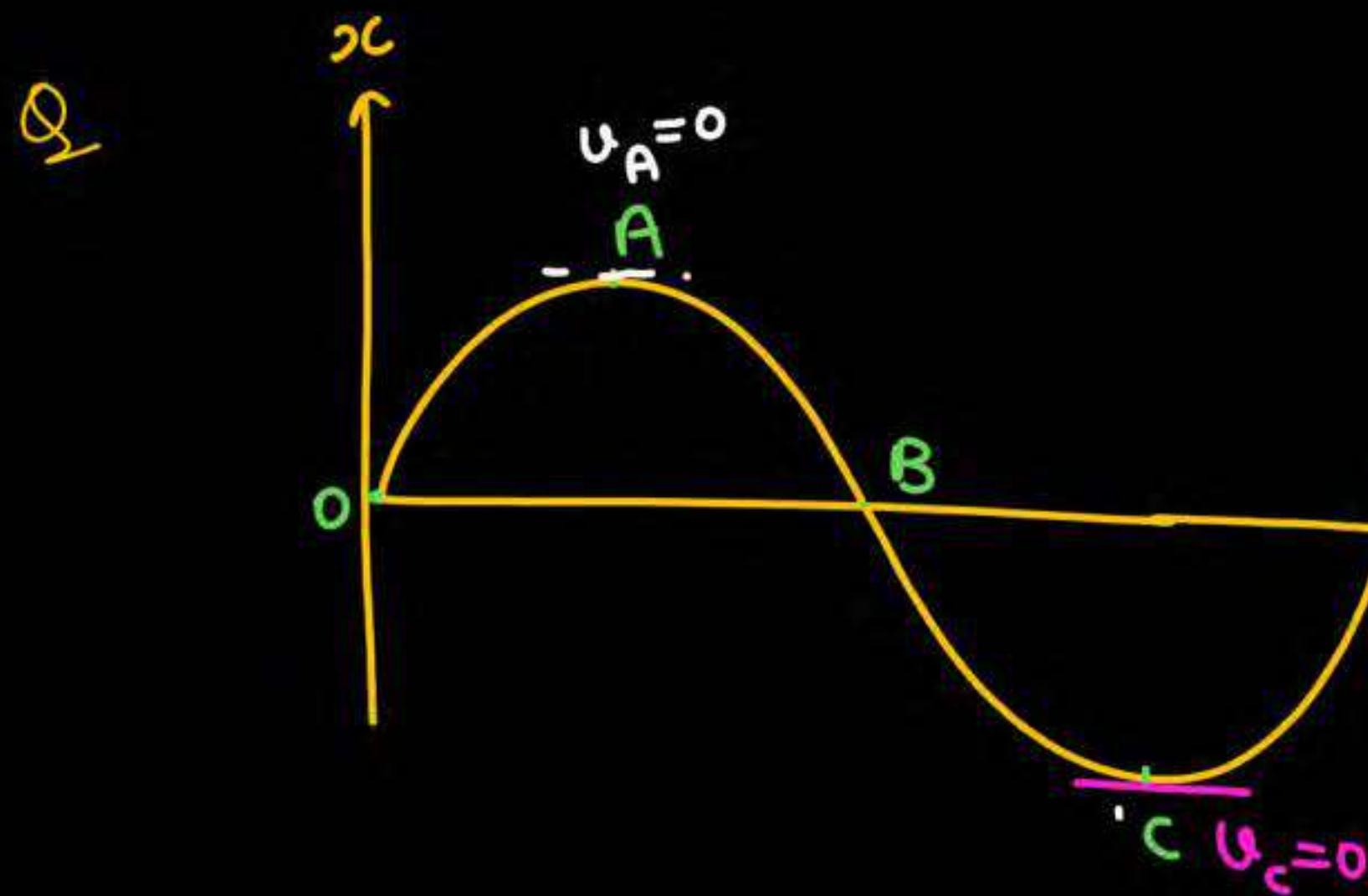
$$v_A > v_B$$

time $\uparrow \Rightarrow$ Speed \downarrow

$$v > 0, a < 0$$

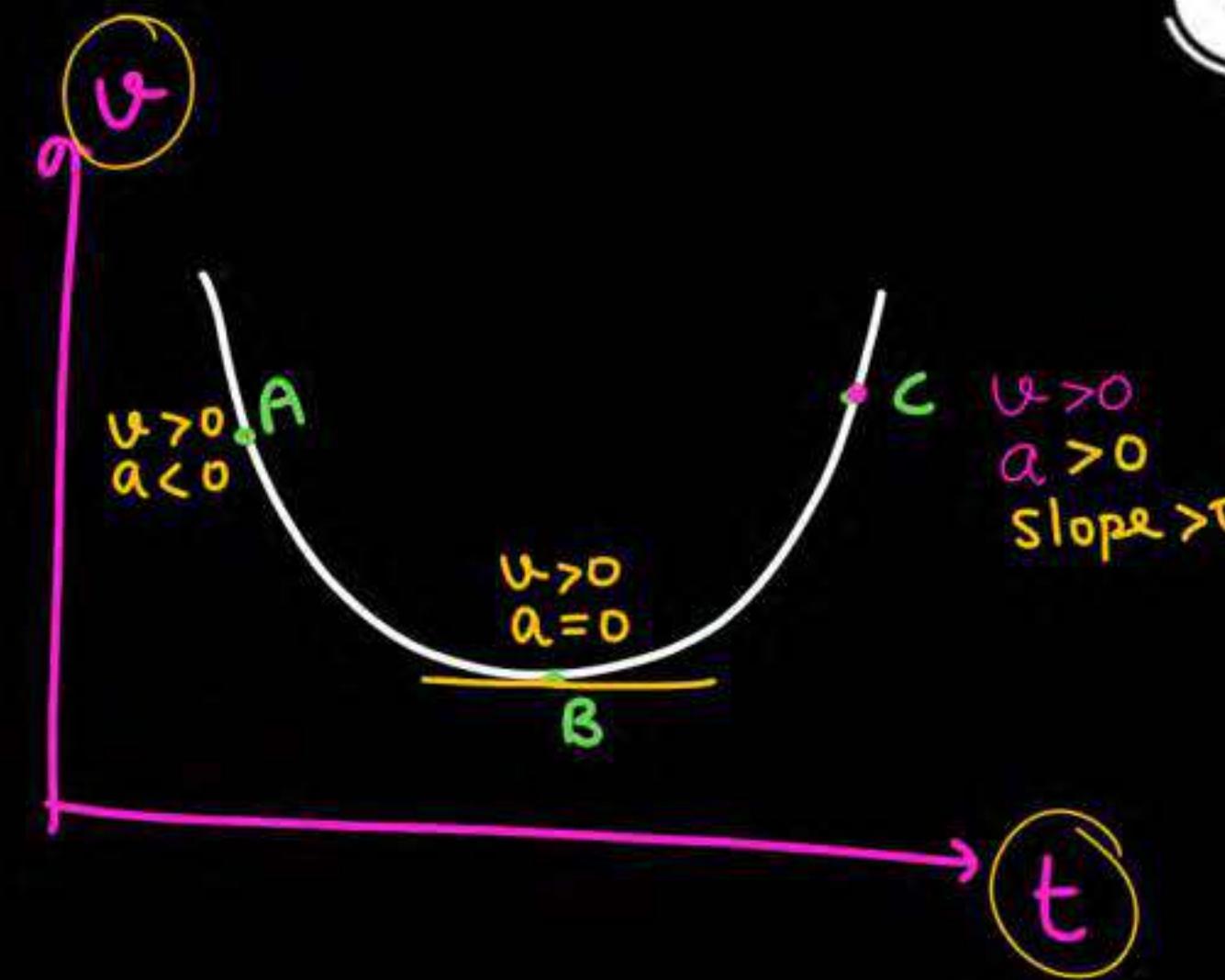
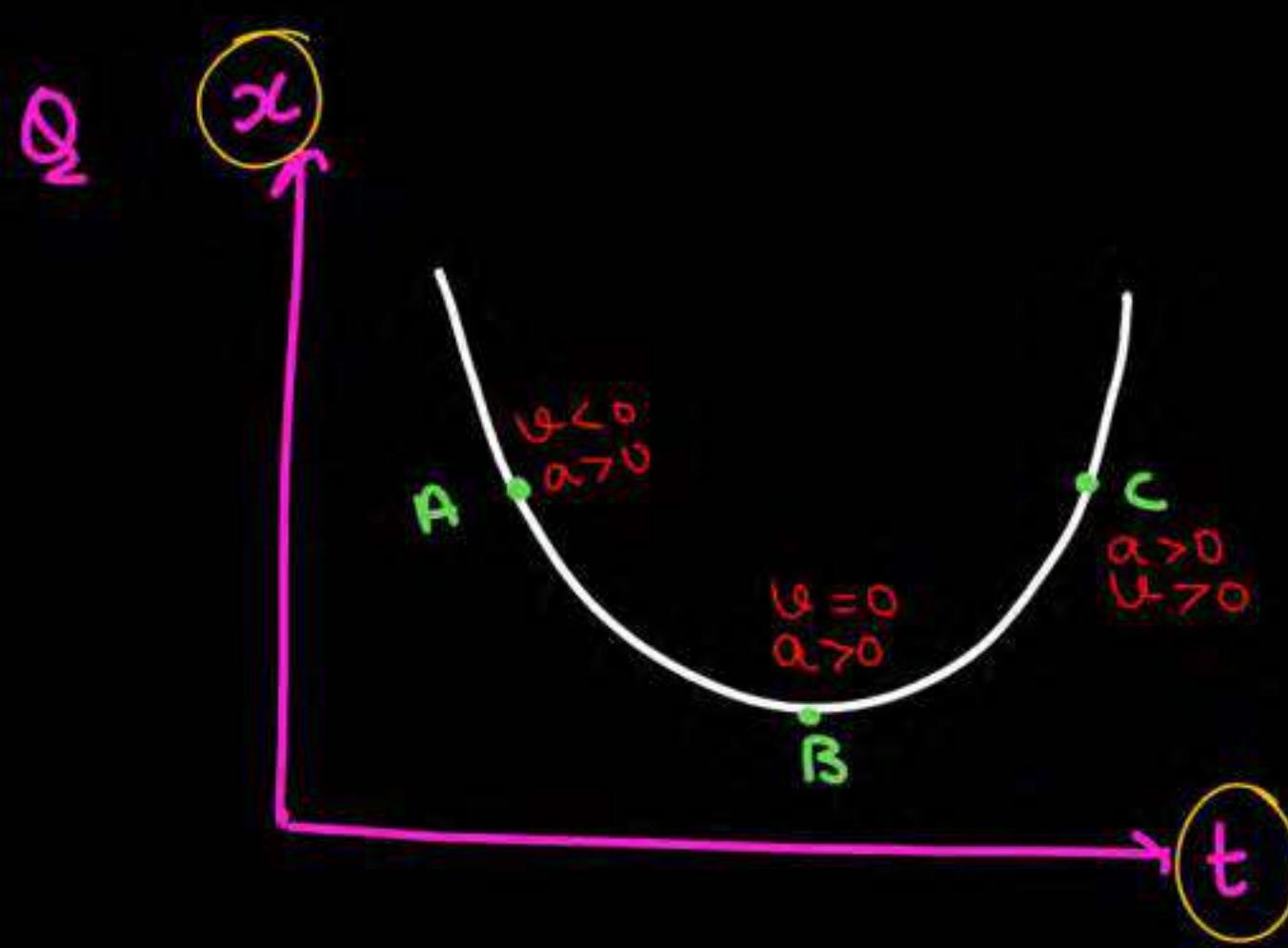


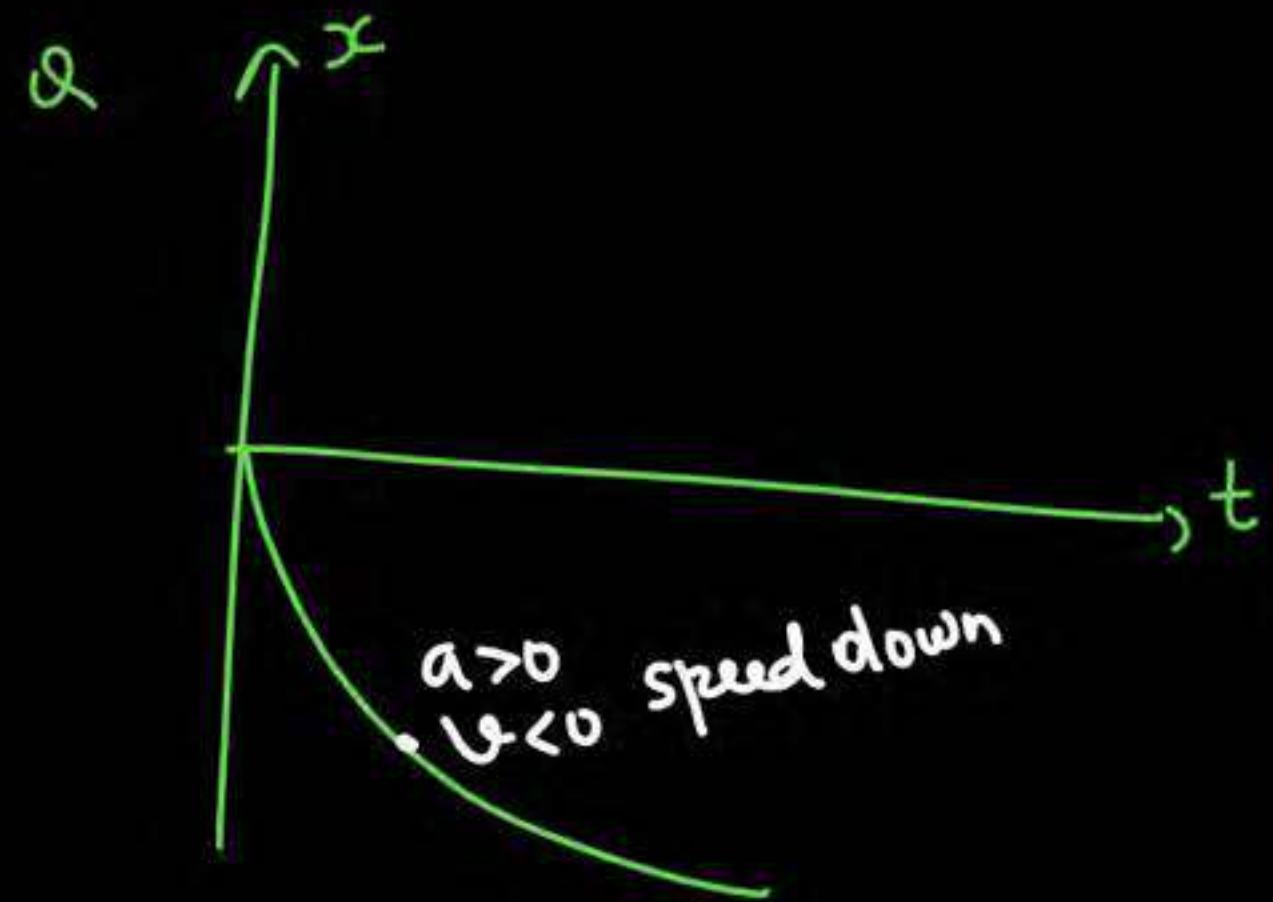
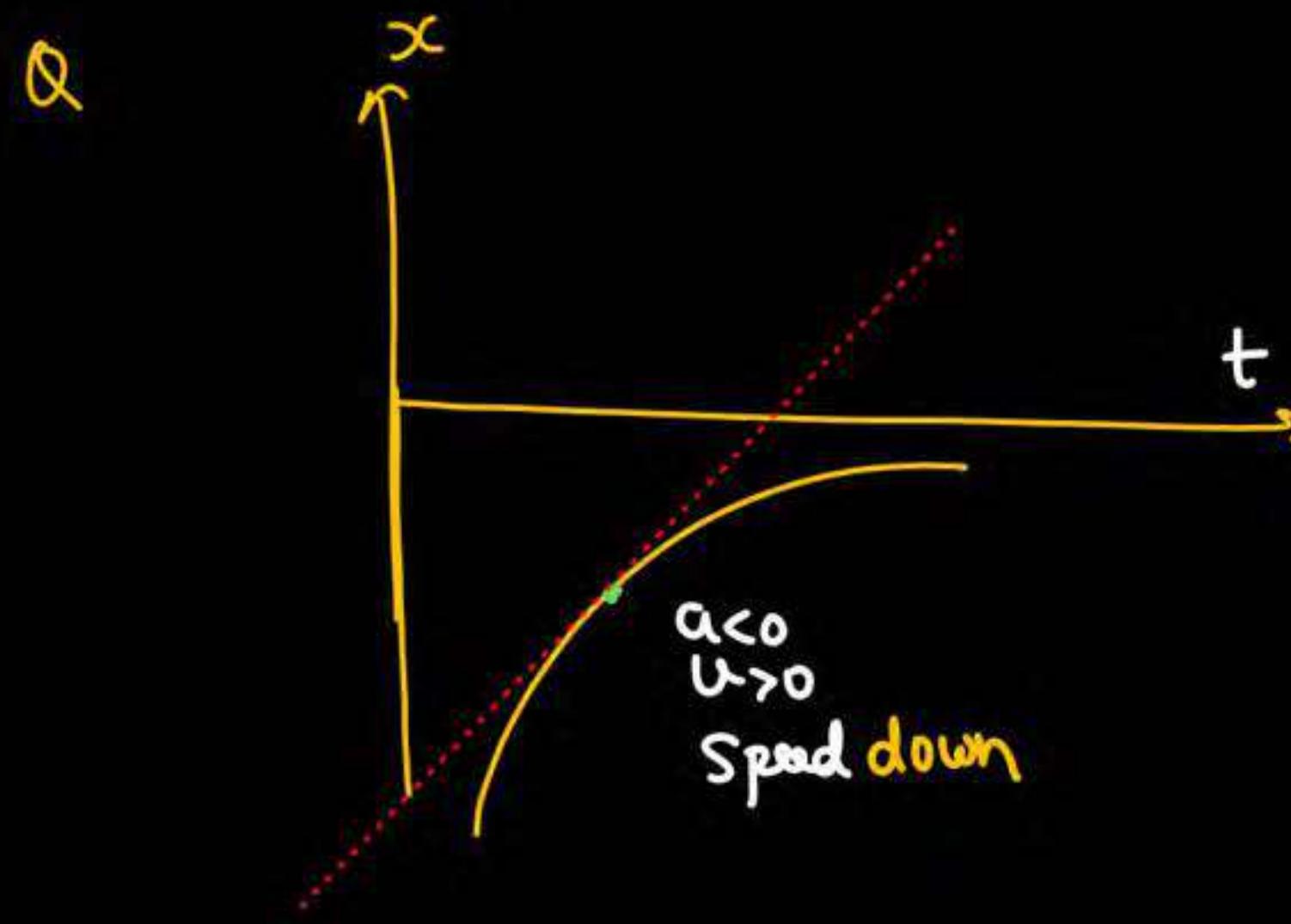
P
W

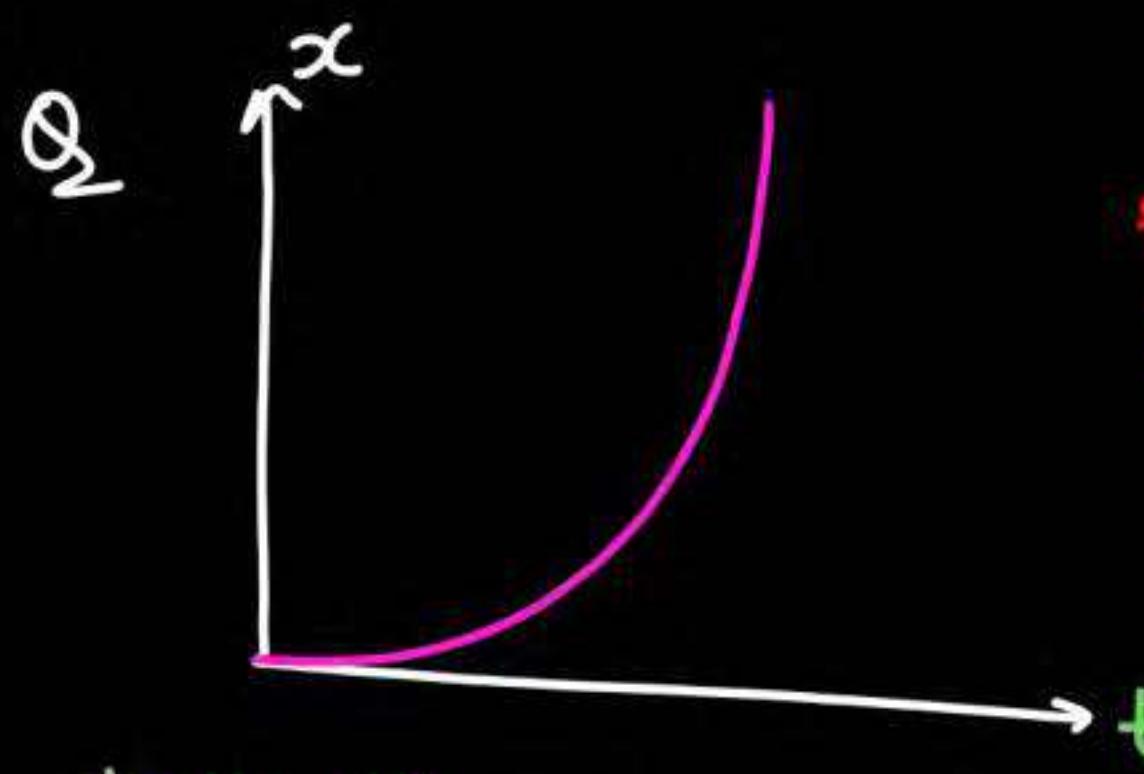


ω	a	
+	-	Speed $\uparrow \downarrow$
-	-	Speed \downarrow
-	+	Speed \uparrow
+	+	Speed \downarrow
+	+	Speed up

P
W



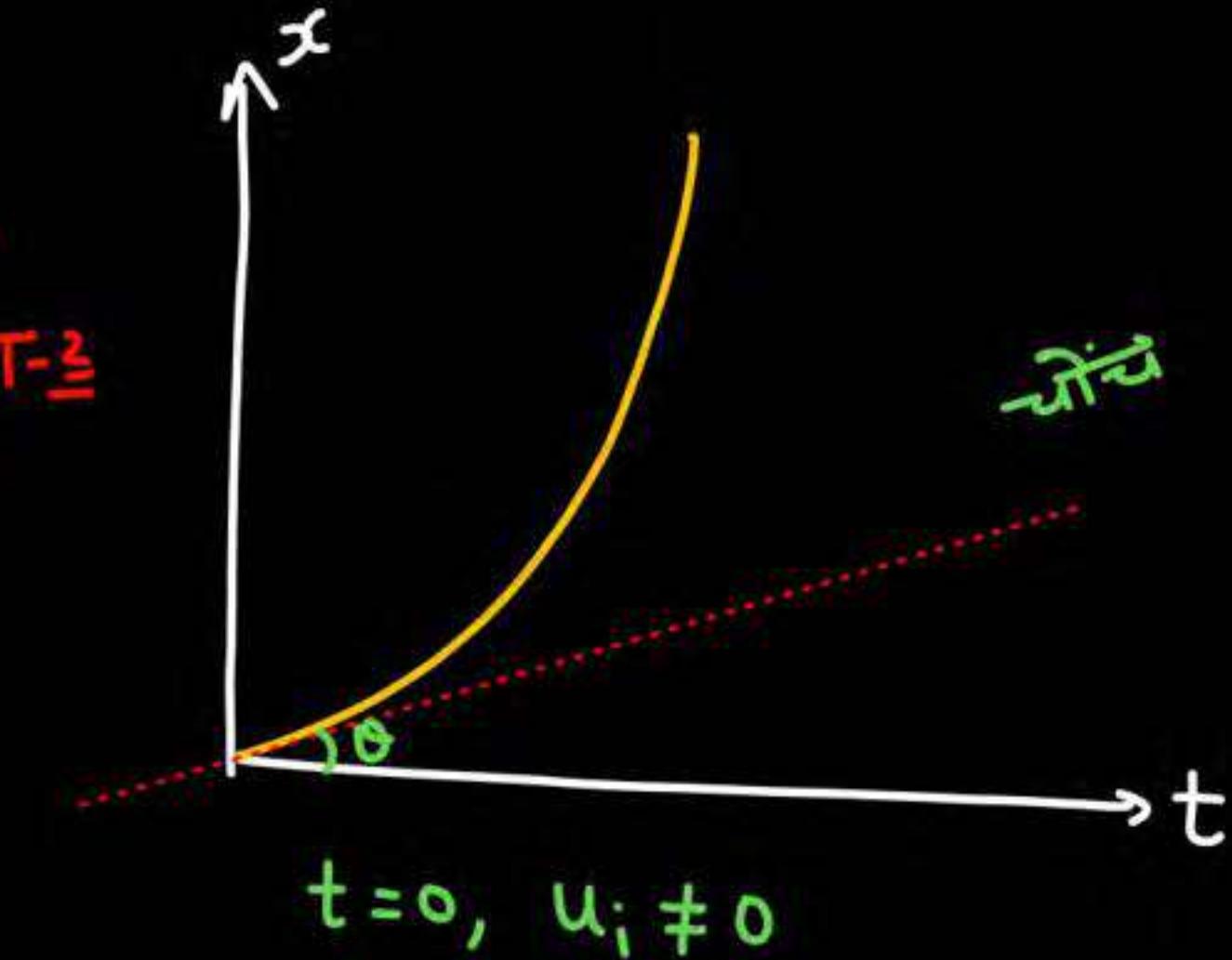




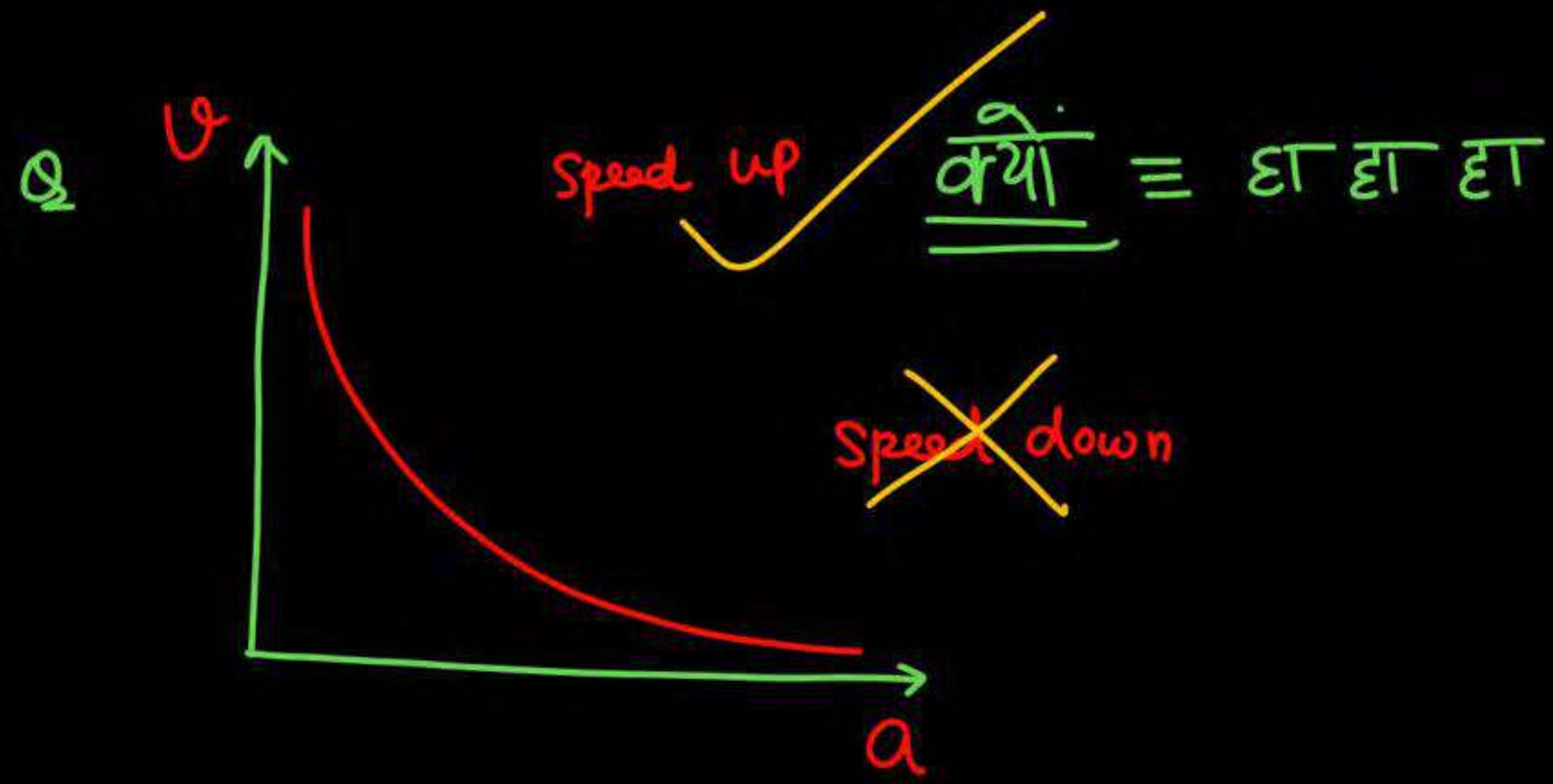
$$t=0, \text{ Slope}=0 \\ v=0$$

particle start motion from rest.

दिनी
अलग-2
है



$$t=0, u_i \neq 0$$



$$\text{Q} \quad x = t^2 - 4t + 5$$

find average speed from

Sol

$$\textcircled{1} \quad t=0, x_i = 5$$

$$t=4, x_f = 5$$

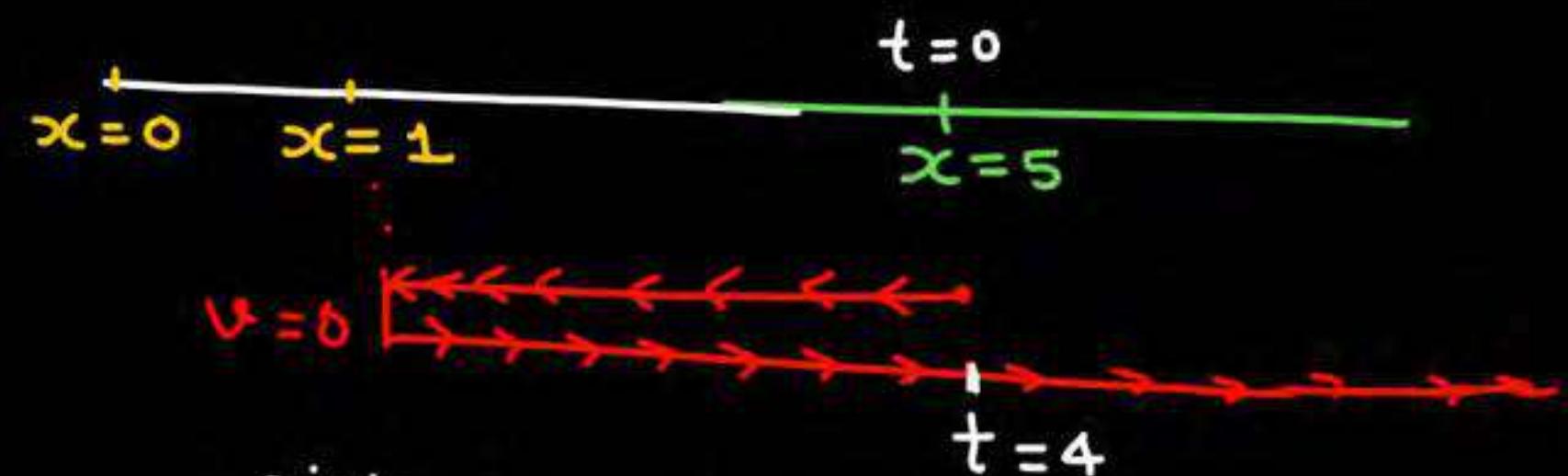
$$\textcircled{2} \quad \text{turning point} \equiv ?$$

$$v = 0$$

$$v = 2t - 4 = 0$$

$$\boxed{t = 2 \text{ sec}}$$

$$\begin{aligned} t = 2, x &= 2^2 - 4 \times 2 + 5 \\ &= 1 \end{aligned}$$



$$\text{Distance } t=0 \rightarrow t=4 = 4 + 4$$

$$\text{Average speed} = \frac{8}{4} = 2$$

Q $x = t^2 - 2t + 10$

find average speed from $t=0 \longrightarrow t=3$ sec

Soln $t=0, x_i = 10$

$$t=3, x_f = 9-6+10 = 13$$

$$v = 2t - 2 = 0$$

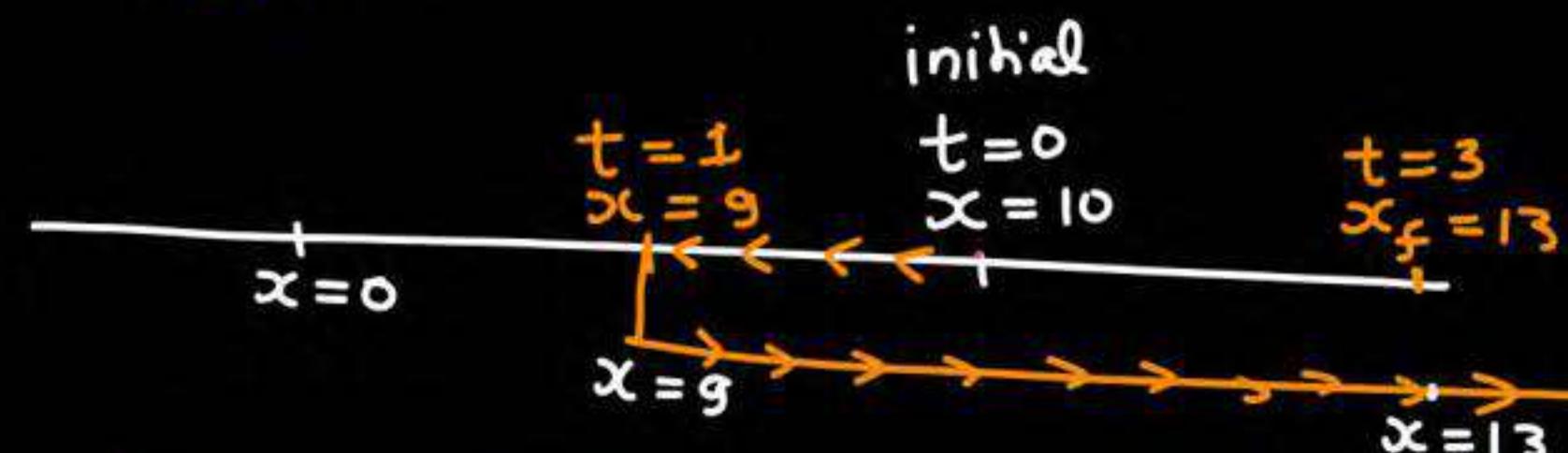
$$2t = 2$$

$$\boxed{t=1}$$

= turning point

$$t=1, x = 1^2 - 2 \times 1 + 10$$

$$x = 9$$



Average speed = $\frac{1+4}{3} = \frac{5}{3}$

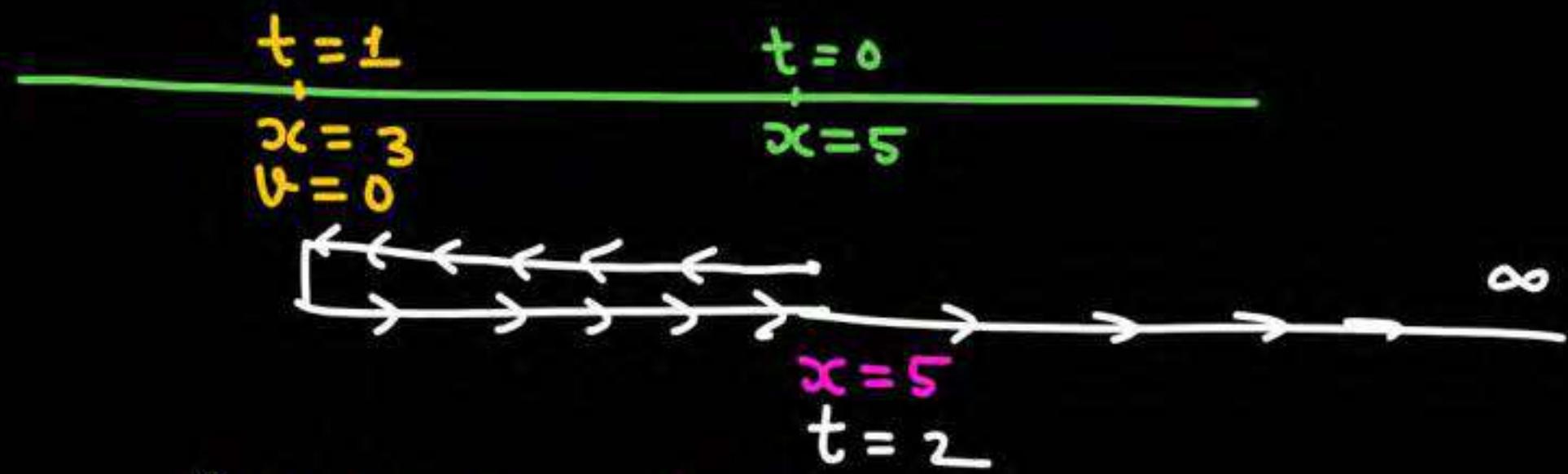
$$\text{Q. } x = 2t^2 - 4t + 5$$

$t=0 \longrightarrow t=2$ average speed = ?

(*) $t=2, x_f = 8 - 8 + 5 = 5$

(**) $v = 4t - 4 = 0$
 $t=1$

$t=1, x = 2 - 4 + 5 = 3$



Avg Speed = $\frac{2+2}{2} = 2$

Q

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

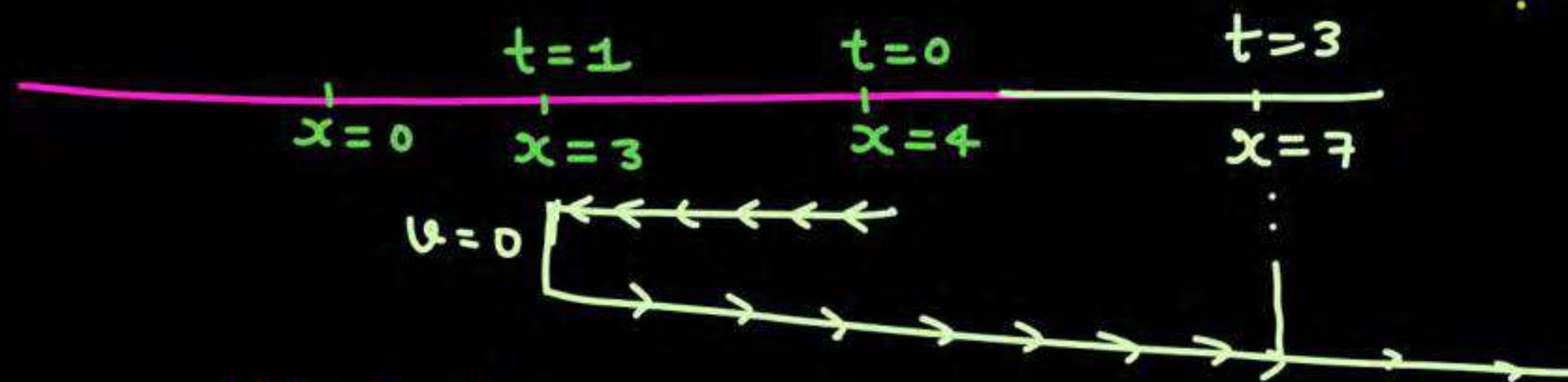
$$x = 9 - 6 + 4 = 7$$

find average speed $t=0 \longrightarrow t=3 \text{ sec}$.

$$v = 2t - 2 = 0$$

$$\boxed{t = 1 \text{ sec}}$$

$$x = 1 - 2 + 4 = 3$$



$$\text{Average velocity} = \frac{1+4}{3} = 5/3$$

P
W

$$v = 4t - 4$$

$$\underline{Q} \quad x = 2t^2 - 4t + 2$$

$$t=0 \longrightarrow t=3$$

$$\text{Average Speed} = \frac{2+8}{3} = \frac{10}{3}$$

$$t=0, x=2$$

$$v = 4t - 4 = 0$$

$$(t=1)$$

$$x = 2 - 4 + 2 = 0$$

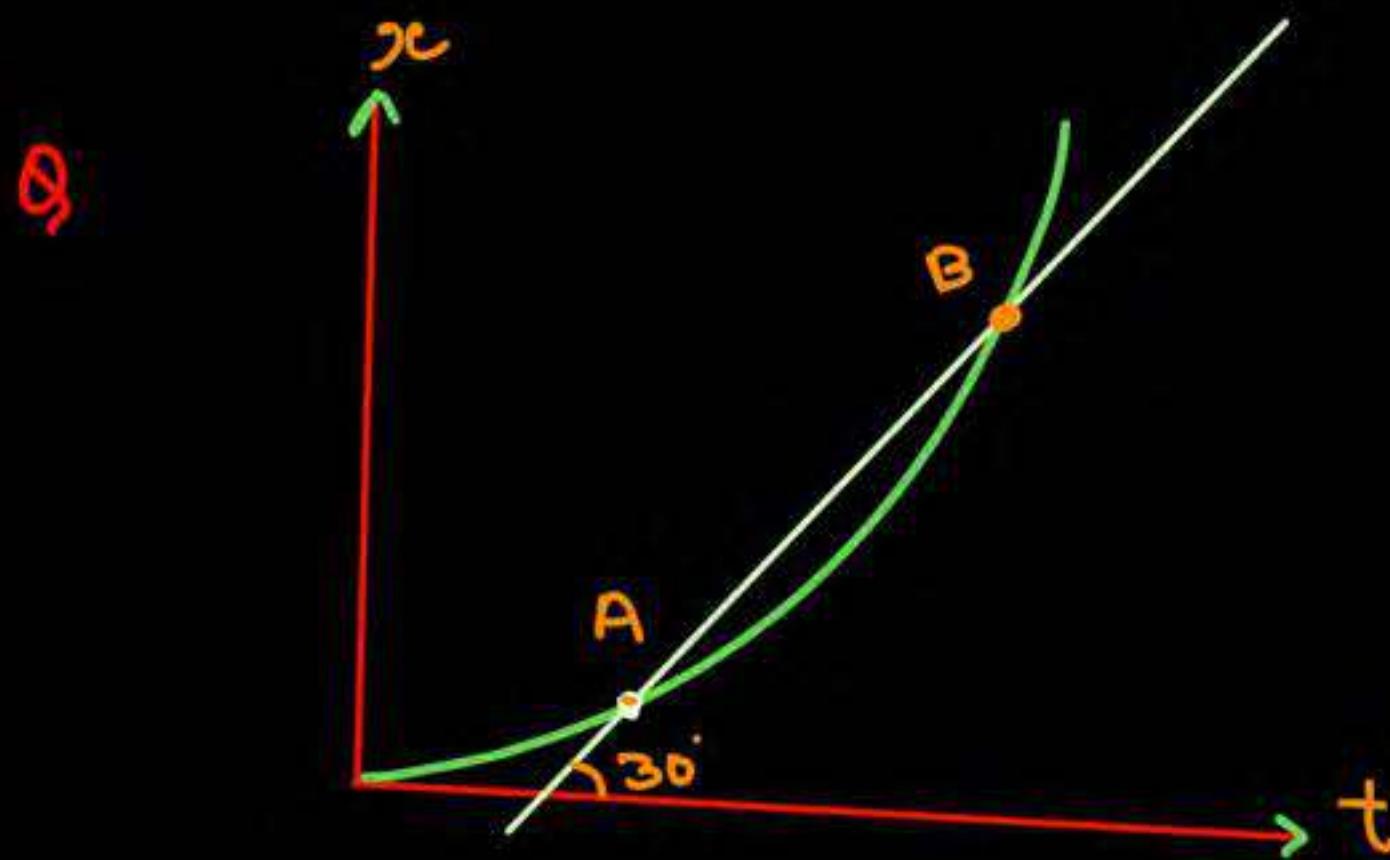
$$t=3 \quad x = 18 - 12 + 2 = 8$$

$$t=1 \\ x=0$$

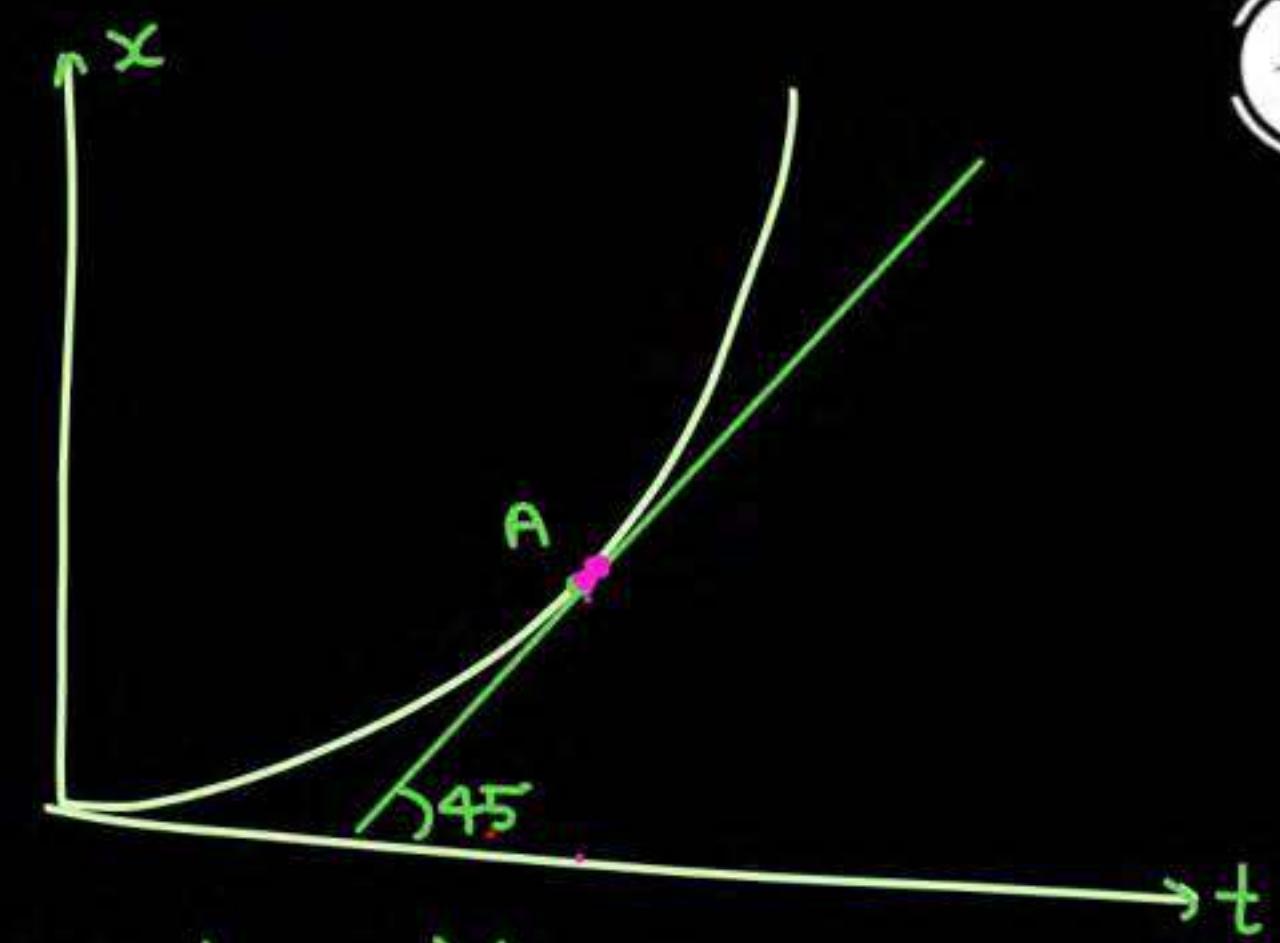
$$t=0 \\ x=2$$

$$t=3 \\ x=8$$

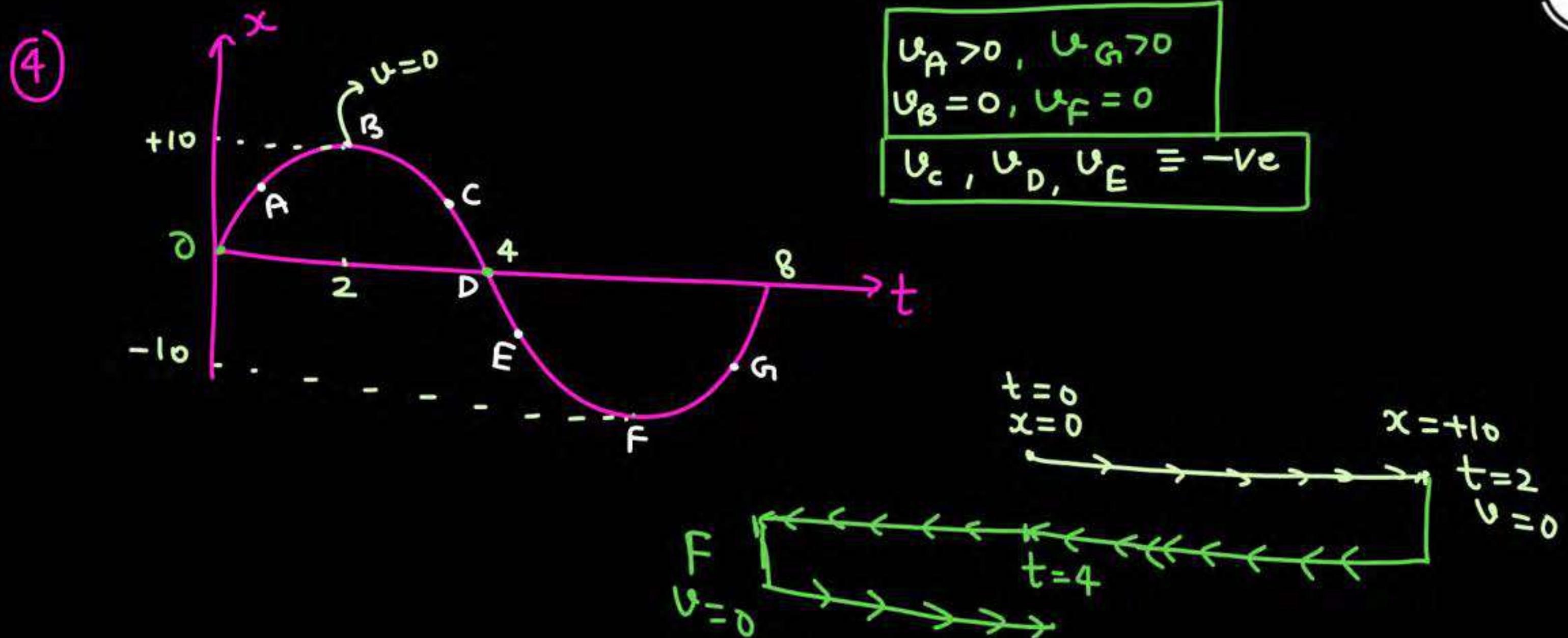




Average velocity = Slope of line AB
b/w $A \& B$ = $\tan 30^\circ$



Velocity at ' A' = $\tan 45^\circ$ = 1



Q

$$v = t^2 + 4t + 10$$

① find acc at $t = 1 \text{ sec}$

$$a = \frac{dv}{dt} = 2t + 4$$

$$t = 1, a = 2 + 4 = 6$$

② $t = 0 \longrightarrow t = 3$

$$\text{Average acc} = \frac{\vec{v}_f - \vec{v}_i}{\text{total time}}$$

$$t = 3, v_f = 9 + 12 + 10 = 31$$

$$t = 0, v_i = 10$$

$$\text{Avg acc} = \frac{31 - 10}{3 - 0} = 7$$

$$\text{Q2} \quad x = t^3 + 2t^2 + 5t$$

find velocity & acc at $t=2\text{sec}$

$$v = \frac{dx}{dt} = 3t^2 + 4t + 5, \quad t=2, v = 12 + 8 + 5 = 25$$

$$a = \frac{dv}{dt} = 6t + 4$$

$$t=2, a = 12 + 4 = 16$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{x}}{dt^2}$$

Q

$$x = 4t^2 - 16t + 20$$

find turning point

$$v = 0$$

$$v = \frac{dx}{dt} = 8t - 16$$

$$\boxed{v = 0, t = 2 \text{ sec}}$$

Unsolvable ques

Q2

$$x = \frac{t^3}{3} - 3t^2 + 9t + 21$$

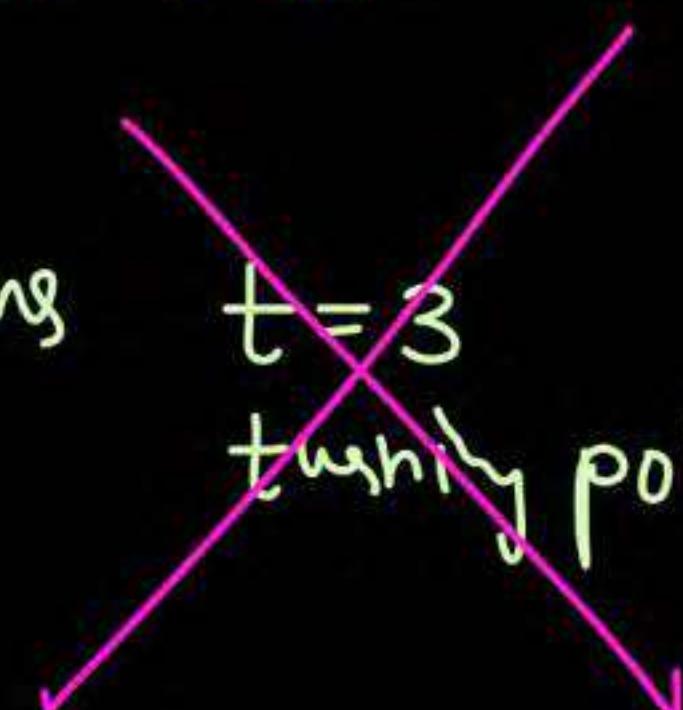
find turning point

Ans

$$t = 3$$

turning point

21



Q H.W 2 page exis. q7

P
W

Q $x = 3t^2 - 12t + 10$

- find
- ① x, v, a at $t=0, t=2, t=3$ sec
 - ② find value of $x \& a$ when particle comes to rest.
 - ③ find average velocity, average speed, average acc from $t=0$  $t=3$ sec

Homework

$$\underline{Q} \quad y = \pi x^2$$

$$\frac{dy}{dx} = \pi 2x$$

$$\underline{Q} \quad A = \pi r^2$$

$$\frac{dA}{dr} = \pi 2r$$

$$\underline{Q} \quad y = \pi x^3$$

$$\frac{dy}{dx} = \pi 3x^2$$

$$\underline{Q} \quad V = \left(\frac{4}{3}\pi\right) r^3$$

$$\frac{dV}{dr} = \frac{4\pi}{3} 3r^2$$

$$\underline{\text{Q}} \quad y = t^2 - 4t + 10$$

$$\frac{dy}{dt} = 2t - 4$$

$$\frac{d^2y}{dt^2} = 2 - 0$$

$$\underline{\text{Q}} \quad y = t^3 - 4t^2 + 10$$

$$\frac{dy}{dt} = 3t^2 - 8t + 0$$

$$\frac{d^2y}{dt^2} = 6t - 8$$

$$\underline{\text{Q}} \quad x = t^2 - 4t + 10$$

$$\frac{dx}{dt} = 2t - 4 + 0$$

$$\frac{d^2x}{dt^2} = 2 - 0$$

$$\underline{\text{Q}} \quad \textcircled{x} = t^3 - 4t^2 + 10$$

$$v = \frac{dx}{dt} = 3t^2 - 8t + 0$$

$$\textcircled{\frac{d^2x}{dt^2}} = 6t - 8 + 0$$

$$\text{Q } y = \sin x$$

$$\frac{dy}{dx} = \cos x$$

$$\frac{d^2y}{dx^2} = -\sin x$$

$$\text{Q } P = \ln t$$

find $\frac{dP}{dt}$ at $t = 10 \text{ sec}$

$$\begin{aligned}\frac{dP}{dt} &= \frac{1}{t} \\ &= \frac{1}{10}\end{aligned}$$



Q

$$y = x^2 + 3x$$

find

$$\frac{dy}{dx}$$

at $x=4$

~~$$y = 16 + 12 = 28$$~~
~~$$\frac{dy}{dx} = 0$$~~

$$\frac{dy}{dx} = 2x + 3$$

$x=4$

Put

$$\boxed{\frac{dy}{dx} = 2x + 3}$$
$$\frac{dy}{dx} = 11$$

$$Q \quad y = x^3$$

find $\frac{dy}{dx}$, at $x=2$

Solⁿ

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$\text{at } x=2, \quad \frac{dy}{dx} = 3 \times 2^2$$

$$= 12 \quad \text{Ans}$$

Similarly
find \Rightarrow

$$Q \quad y = t^2$$

find $\frac{dy}{dt}$ at $t=10 \text{ sec}$

$$\frac{dx}{dt} = 2t \Rightarrow \frac{dy}{dt} = 2 \times 10 = 20 \checkmark$$

~~*Ans~~

$$x = t^2 + 2t$$

find $\frac{dx}{dt}$ at $t=3 \text{ sec}$

$$\frac{dx}{dt} = 2t+2$$

$$\frac{dx}{dt} = 8$$

$$Q \quad x = t^3 - 2t^2 + 5$$

find $\frac{dx}{dt}$ and $\frac{d^2x}{dt^2}$ at $t=2 \text{ sec}$

d

$$x = t^3 - 2t^2 + 5$$

$$t=2, \frac{dx}{dt} = ?$$

$$\frac{dx}{dt} = 3t^2 - 4t + 0 \quad \text{put}$$

$$\frac{dx}{dt} = 3 \times 2^2 - 4 \times 2 = 12 - 8 = \underline{\underline{4}}$$

$$\frac{d^2x}{dt^2} = 6t - 4$$

$$t=2$$

$$\frac{d^2x}{dt^2} = 6 \times 2 - 4 = \underline{\underline{8}}$$

Put

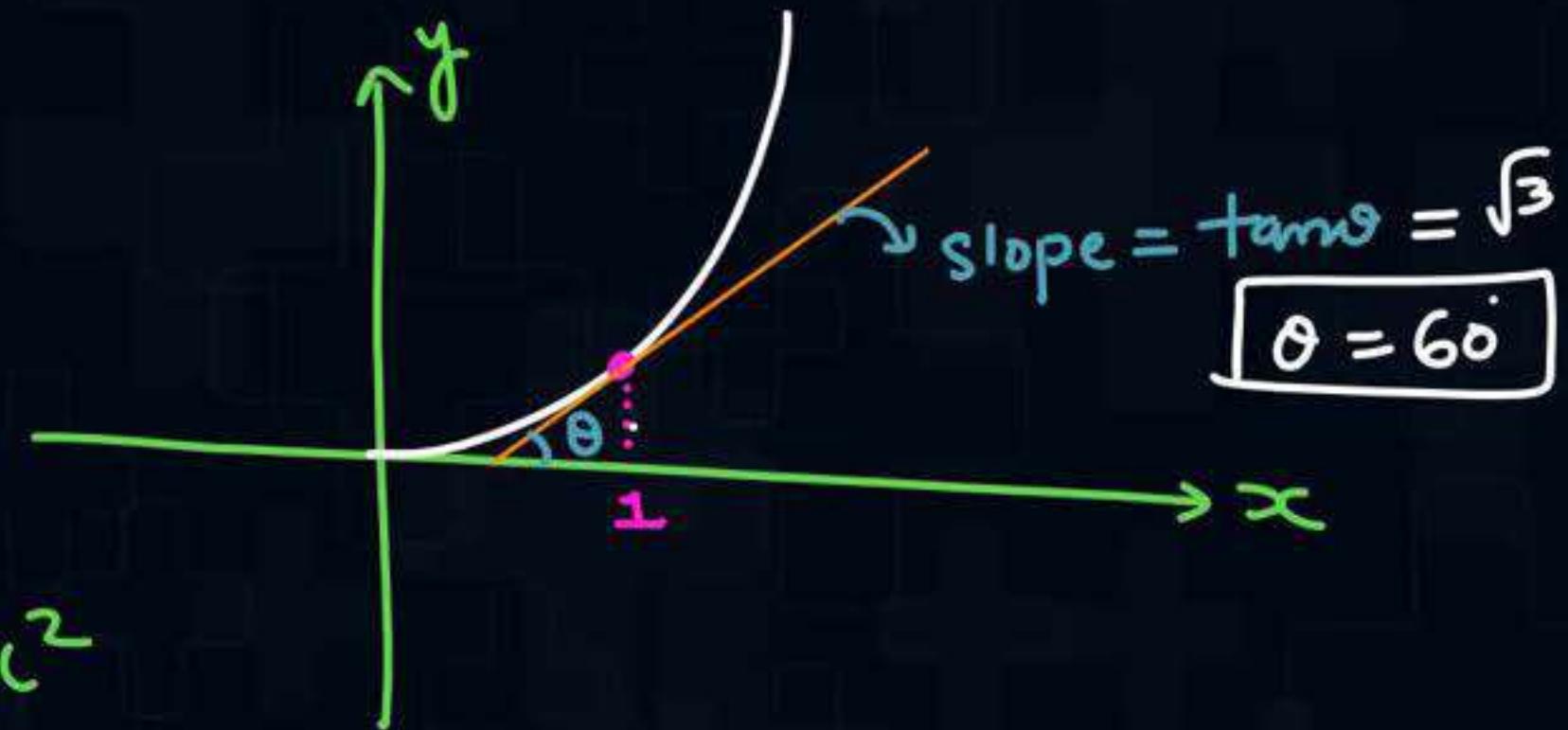
$$\text{Q} \quad y = \frac{x^3}{\sqrt{3}}$$

find $\frac{dy}{dx}$ at $x=1$

$$\frac{dy}{dx} = \frac{1}{\sqrt{3}} \cdot 3x^2 = \sqrt{3}x^2$$

$$\text{At } x=1 \Rightarrow \frac{dy}{dx} = \frac{3}{\sqrt{3}} \cdot 1^2 = \sqrt{3} = \text{slope}$$

$\frac{dy}{dx} = \text{slope of tangent at that point}$



Q

$$x = t^3 - 4t^2 + 5$$

$$\frac{dx}{dt} \text{ at } t=2 \text{ sec}$$

$$\frac{d^2x}{dt^2} \text{ at } t=2 \text{ sec.}$$

$$\frac{dx}{dt} = 3t^2 - 8t + 0$$

$$\frac{d^2x}{dt^2} = 6t - 8$$

Q

$$x = t^2 - 4t + 20$$

find value of $x, \frac{dx}{dt}, \frac{d^2x}{dt^2}$
at $t = 2 \text{ sec}$

$$\textcircled{1} \quad y = 5x^3$$

$$\begin{aligned}\frac{dy}{dx} &= 5\left(\frac{d}{dx}x^3\right) \\&= 5 \times 3x^2 \\&= 15x^2\end{aligned}$$

$$\textcircled{2} \quad y = Kx^3$$

Const

$$\begin{aligned}y &= K \frac{d(x^3)}{dx} \\y &= Kx(3x^2)\end{aligned}$$

$$\textcircled{3} \quad y = \pi x^3$$
$$\frac{dy}{dx} = \pi \cdot 3x^2$$
$$\textcircled{4} \quad y = \pi + x^3$$
$$\frac{dy}{dx} = 0 + 3x^2$$

$$Q \quad y = \frac{x^3}{\sqrt{3}}$$

do find $\frac{dy}{dx}$ at $x=1$



"
इस graph में $x=1$ पर tangent बनाओ
अस tangent का slope = $\frac{dy}{dx}$



#

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

differentiation of y wrt x

①

$$y = x^3$$

⇒

 $\frac{dy}{dt} \rightarrow \text{diff of } y \text{ wrt time}$

$$\frac{dy}{dt} = 3x^2 \cdot \frac{dx}{dt}$$

②

$$y = x^5$$

$$\frac{dy}{dt} = 5x^4 \frac{dx}{dt}$$

③

$$y = x^7$$

$$\frac{dy}{dt} = 7x^6 \frac{dx}{dt}$$

④

$$y = 5x^2$$

$$\frac{dy}{dt} = 10x \left(\frac{dx}{dt} \right)$$

$$\textcircled{5} \quad y = \pi x^2$$

$$\frac{dy}{dt} = \pi 2x \cdot \frac{dx}{dt}$$

$$\textcircled{6} \quad A = \pi r^2$$

$$\frac{dA}{dr} = \pi 2r$$

$$\textcircled{7} \quad A = \pi r^2$$

$$\frac{dA}{dt} = \pi 2r \cdot \frac{dr}{dt}$$

$$\textcircled{8} \quad y = \pi x^2$$

$$\frac{dy}{dx} = \pi 2x$$

$$\textcircled{9} \quad y = \frac{4}{3}\pi x^3$$

$$\frac{dy}{dx} = \frac{4}{3}\pi 3x^2$$

$$\frac{dy}{dt} = \frac{4}{3}\pi 3x^2 \left(\frac{dx}{dt} \right)$$

$$\textcircled{10} \quad y = \sin x$$

$$\frac{dy}{dx} = \cos x$$

$$\frac{dy}{dt} = \cos x \frac{dx}{dt}$$

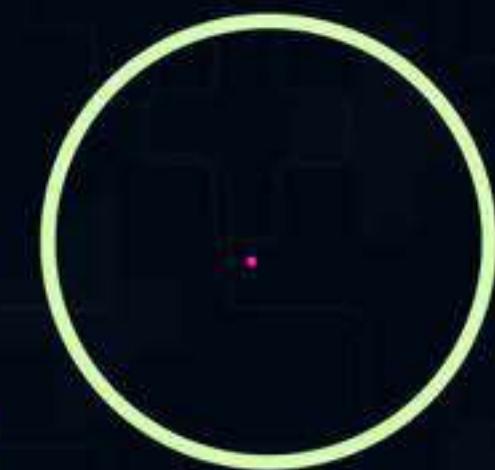
Q

Radius of a circle increases wrt time with the rate of +5 m/sec.
 find rate of change of area wrt time when radius is 10m.

$$A = \pi r^2$$

$$? = \frac{dA}{dt} = \pi 2r \frac{dr}{dt}$$

$$\frac{dr}{dt} = 5, r = 10$$



+5 m/sec

radius is 10m.

$\frac{dy}{dx} \rightarrow$ Rate of Change of y wrt x

$\frac{dA}{dt} \rightarrow$ Rate of Change of Area
wrt time

$\frac{dr}{dt} \rightarrow$ Rate of Change of radius
wrt time

$$\frac{dA}{dt} = \pi \cdot 2 \cdot 10 \cdot 5 = 100\pi$$

Q If radius of a sphere is increasing at the rate of 10 m/sec at what rate volⁿ of sphere will change, when radius is 3 m.

$$V = \frac{4}{3}\pi r^3$$

$$\frac{dV}{dt} = \frac{4\pi}{3} 3r^2 \frac{dr}{dt}$$

$$\frac{dV}{dt} = \frac{4\pi}{3} \cdot 3(3)^2 \times 10 = \underline{\underline{360\pi}}$$

Q A particle is moving on x-axis such that its x-co-ordinate w.r.t time changes as

$$x = t^2 - 4t + 10$$

① find velocity at $t = 3 \text{ sec}$

$$v = \frac{dx}{dt} = 2t - 4 + 0$$

$$t=3, v = 2 \times 3 - 4 = 2$$

$$v = 2 \text{ m/s}$$

② find velocity at $t = 4 \text{ sec}$

$$v = 2t - 4$$

← put

$$v = 2 \times 4 - 4$$

$$v = 4$$

③ find initial velocity = at $t = 0$

$$v = 2t - 4$$

$$t=0, v = 0 - 4 = -4$$

$$Q \quad x = t^2 - 6t + 10$$

① find velocity at $t=0, t=3, t=6$ sec = Inst. velocity

$$v = 2t - 6$$

$$t=0, v = -6$$

$$t=3, v = 0$$

$$t=6 \quad v = 2 \times 6 - 6$$

$$v = +6.$$

② find average velocity $t=0 \rightarrow t=3$

$$\text{Avg velocity} = \frac{x_f - x_i}{t_2 - t_1}$$

$$t=0, x_i = 0 - 0 + 10$$

|
 $\Rightarrow x_i = 10$

$$t=3, x_f = 3^2 - 6 \times 3 + 10 = 1$$

$$\text{Avg velocity} = \frac{1 - 10}{3 - 0} = -3$$

H1*

③ find average speed
from $t=0 \rightarrow t=4$

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

① find velocity at $t=0, t=2, t=4$ sec

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

$$v = 2t - 4$$

$$\boxed{t=0, v=-4}$$

$$\boxed{t=2, v=0}$$

$$\boxed{t=4, v=4}$$

② find average velocity from $t=0$ to $t=4$ sec

$$t=0, x_i = 5$$

$$t=4, x_f = \cancel{t^2} - 4 \times 4 + 5 = 5$$

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{duration}} = \frac{5-5}{4} = 0$$

⊕ $y = x^n$

$$\frac{dy}{dx} = \frac{d x^n}{dx} = n x^{n-1}$$

③ $y = x^{-5}$

$$\frac{dy}{dx} = -5 x^{-5-1} = -5 x^{-6}$$

$$\frac{dy}{dx} = \frac{-5}{x^6}$$

① $y = x^5$

$$\frac{dy}{dx} = 5 x^{5-1} = 5 x^4$$

② $y = x^7$

$$\frac{dy}{dx} = 7 x^6$$

$$\textcircled{4} \quad y = \frac{1}{x^2} = x^{-2}$$

$$\frac{dy}{dx} = -2x^{-2-1} = \frac{-2}{x^3}$$

$$f(x) = g(x) \pm h(x)$$

$$\frac{d}{dx} f(x) = \frac{d}{dx} g(x) \pm \frac{d}{dx} h(x)$$

$$\textcircled{5} \quad y = x^2 + x^5$$

$$\frac{dy}{dx} = 2x + 5x^4$$

$$\textcircled{6} \quad y = x^7 + x^8$$

$$\frac{dy}{dx} = 7x^6 + 8x^7$$

$$\textcircled{6} \quad y = x^3 - x^4$$

$$\frac{dy}{dx} = 3x^2 - 4x^3$$

$$\textcircled{1} \quad y = x^9 + \frac{1}{x^5}$$

$$\frac{dy}{dx} = 9x^8 - \frac{5}{x^6}$$

$y = x^6$

$\frac{dy}{dx} = 6x^5$

y' 

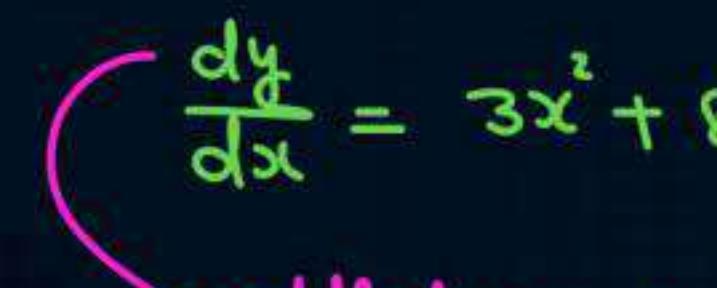
$$y = x^8$$

$$y' = \frac{dy}{dx} = 8x^7$$

$y = u \pm v$
$y' = u' \pm v'$

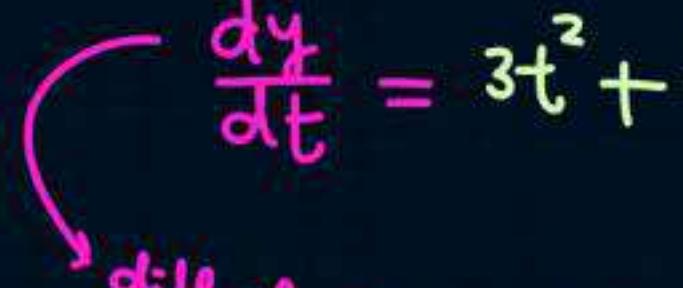
Q $y = x^3 + x^8$

$\frac{dy}{dx} = 3x^2 + 8x^7$

 diff of y wrt x

Q $y = t^3 + t^8$

$\frac{dy}{dt} = 3t^2 + 8t^7$

 diff of y wrt t

$$Q \quad y = 5x^3$$

$$\frac{dy}{dx} = 5 \times 3x^2 = 15x^2$$

$$Q \quad y = 4x^2$$

$$y' = 8x$$

$$Q \quad y = 3x^7$$

$$y' = \frac{dy}{dx} = 21x^6$$

$$Q \quad y = 2x^2 + 4x^3 + 6x^7$$

$$y' = 4x + 12x^2 + 42x^6$$

$$Q \quad y = x = x^1$$

$$\frac{dy}{dx} = 1 \cdot x^{1-1} = 1$$

$$y = x$$

$$\frac{dy}{dx} = 1$$

$$Q \quad y = 4x$$

$$\frac{dy}{dx} = 4x^1 = 4$$

#. $y = 5$

$$\frac{dy}{dx} = 0$$

$$y = C \xrightarrow{\text{const}}$$

$$\frac{dy}{dx} = 0, \quad \frac{d(\text{const})}{dx} = 0$$

. 8. $y = x^3 + 2x^5 + 7$

$$\frac{dy}{dx} = 3x^2 + 10x^4 + 0$$

. 9. $y = x^5 - x^4 + 2$

$$\frac{dy}{dx} = 5x^4 - 4x^3 + 0$$

* $\frac{d}{dx}(x^n) = n x^{n-1}$

* $\frac{d}{dx} \tan x = \sec^2 x$

* $\frac{d}{dx}(\ln x) = \frac{1}{x}$

* $\frac{d}{dx}(\text{const}) = 0$

* $\frac{d}{dx} \sec x = \sec x \tan x$

$\ln x = \log_e x$

* $\frac{d}{dx}(\sin x) = \cos x$

* $\frac{d}{dx} \cot x = -\operatorname{cosec}^2 x$

* $\frac{d}{dx}(\cos x) = -\sin x$

* $\frac{d}{dx} \operatorname{cosec} x = -\operatorname{cosec} x \cdot \cot x$

(*) $\frac{d}{dx} e^x = e^x$

$$Q \quad y = x^3 + \sin x$$

$$\frac{dy}{dx} = 3x^2 + \cos x$$

$$Q \quad y = x^7 + \tan x + 10$$

$$\frac{dy}{dx} = 7x^6 + \sec^2 x + 0$$

$$Q \quad y = \sin 30 = \frac{1}{2} = \text{const}$$

~~$$\frac{dy}{dx} = \cos 30 = \frac{\sqrt{3}}{2}$$~~

$$\frac{dy}{dx} = 0$$

$$Q \quad y = 3x^3 + \sin x + \tan x$$

$$\frac{dy}{dx} = 9x^2 + \cos x + \sec^2 x$$

$$Q \quad y = 2x^2 + \cos x + 5$$

$$\frac{dy}{dx} = 4x - \sin x + 0$$

$$y = \tan 45^\circ = 1$$

$$\frac{dy}{dx} = 0$$

$$Q \quad y = 3x^2 + \cos x + e^x - \sin x + 10$$

$$\frac{dy}{dx} = 6x - \sin x + e^x - \cos x + 0$$

$$Q \quad y = x^3 + \sin x$$

$$\frac{dy}{dx} = 3x^2 + \cos x$$

$$y = u \cdot v$$

$$y' = uv' + v u'$$

$$Q \quad y = x^3 \cdot \sin x$$

$$\frac{dy}{dx} = x^3 \left(\frac{d}{dx} \sin x \right) + \sin x \left(\frac{d}{dx} x^3 \right)$$

$$\frac{dy}{dx} = x^3 \cos x + [\sin x] \cdot 3x^2$$

$$Q \quad y = x^5 \tan x$$

$$\frac{dy}{dx} = x^5 \sec^2 x + [\tan x] (5x^4)$$

:

$$Q \quad y = x^3 e^x$$

$$\frac{dy}{dx} = x^3 e^x + e^x \cdot 3x^2$$

$$Q \quad y = e^x \cdot \sin x$$

$$\frac{dy}{dx} = e^x \cos x + \sin x \cdot e^x$$

$$Q \quad y = x^4 \ln x$$

$$\frac{dy}{dx} = x^4 \cdot \frac{1}{x} + (\ln x) (4x^3)$$

$$Q \quad y = e^x \cdot \cos x$$

$$\frac{dy}{dx} = e^x (-\sin x) + (\cos x) (e^x)$$

imp नहीं है phy के point of view से (skip) may ✓

$$\frac{10}{2} = 10 \times \left(\frac{1}{2}\right)$$

P
W

$$y = \frac{u}{v}$$

$$y' = \frac{vu' - uv'}{v^2}$$

Q $y = \frac{x^5}{\sin x}$

$$y' = \frac{(\sin x) \cdot 5x^4 - x^5 \cdot \cos x}{(\sin x)^2}$$

Q(m-z) product के form में ले जाकर diff कर दो

$$y = x^5 \cdot \csc x$$

$$y' = x^5 \cdot (-\csc x \cdot \cot x) + \csc x \cdot 5x^4$$

$$= \frac{\sin x}{\sin x} \frac{5x^4}{\sin x} - \frac{x^5}{\sin x} \frac{\cos x}{\sin x} = \frac{\sin x \cdot 5x^4 - x^5 \cos x}{\sin^2 x}$$

✓ Same

Chain rule

$$\text{Q} \quad y = \sin(x^2 + x^7)$$

$$\frac{dy}{dx} = \cos(x^2 + x^7) \times (2x + 7x^6)$$

$$\text{Q} \quad y = \cos(x^3)$$

$$\frac{dy}{dx} = -\sin(x^3) \cdot 3x^2$$

Book

$$y = f(g(x))$$

$$y' = f'(g(x)) \cdot g'(x)$$

$$y = f(\sqrt{x})$$

$$y' = f'(\sqrt{x}) \cdot (\sqrt{x})'$$

$$\text{Q} \quad y = \ln x^5$$

$$\frac{dy}{dx} = \frac{1}{x^5} \cdot 5x^4$$

$$\text{B} \quad y = \ln x^4$$

$$\frac{dy}{dx} = \frac{1}{x^4} \cdot 4x^3$$

$$\alpha \quad y = \ln(\sin x)$$

$$\frac{dy}{dx} = \frac{1}{\sin x} \cdot \cos x$$

$$\text{Q} \quad y = \tan^2 x = (\tan x)^2$$

$$y = (2 \tan x) \cdot \sec^2 x$$

$$\text{Q} \quad y = \cos^5 x$$

$$\frac{dy}{dx} = 5 \cos^4 x \times (-\sin x)$$

$$\textcircled{1} \quad y = \sin^3 x = (\sin x)^3$$

$$\frac{dy}{dx} = 3(\sin x)^2 \cdot \cos x.$$

$$\textcircled{2} \quad y = \sin^4 x = (\sin x)^4$$

$$\frac{dy}{dx} = 4(\sin x)^3 \cdot \cos x$$

$$\textcircled{3} \quad y = \ln(\sqrt{x})$$

$$\frac{dy}{dx} = \frac{1}{\sqrt{x}} \cdot (\text{कदर का differentiation})$$

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$y = f(g(x)) \Rightarrow y' = f'(g(x)) \cdot (g(x))'$$

पहले अंदर का वाले को कादू मानकर बाहर की तरफ differentiation करो।

Q $y = \ln(x^2 + x^3)$

$$\frac{dy}{dx} = \frac{1}{x^2 + x^3} \times [2x + 3x^2]$$

Q $y = \sin(x^2 + x^3)$

$$\frac{dy}{dx} = \cos(x^2 + x^3) (2x + 3x^2)$$

Q $y = \tan x^3$

$$\frac{dy}{dx} = \sec^2(x^3) \times 3x^2$$

$$\text{Q} \quad y = \ln(\sin x^3)$$

$$\frac{dy}{dx} = \frac{1}{\sin x^3} \times \cos(x^3) \times [3x^2]$$

$$\text{Q} \quad y = \sin(e^x)$$

$$y = \cos(e^x) \cdot e^x$$

$$\text{Q} \quad y = e^{x^3}$$

$$y = e^{x^3} \times 3x^2$$

Q Imp. for physio

$$y = \sin\left(5x + \frac{\pi}{3}\right)$$

$$\frac{dy}{dx} = \cos\left(5x + \frac{\pi}{3}\right) (5 + 0)$$

P
W

Q SHM \equiv (5-6) month waves

$$y = A \cdot \sin(\omega t + \phi)$$

$(A, \omega, \phi \rightarrow \text{const})$

$$\frac{dy}{dx} = A [\cos(\omega t + \phi)] [\omega + 0]$$

$$\text{Q} \quad y = 5 + x \quad ; \quad y = 5x$$

$$\frac{dy}{dx} = 0+1 \quad ; \quad \frac{dy}{dx} = 5 \times 1$$

$$\text{Q} \quad y = \underbrace{k+x}_{\text{const}} \quad ; \quad y = \underbrace{kx}_{\text{const}}$$
$$y' = 0+1 \quad ; \quad y' = k$$

Kinematik

$$\text{Q2 } y = x^2 + 4x + 10$$

$$\frac{dy}{dx} = 2x + 4 + 0$$

$$\text{Q3 } y = t^2 - 2t + 10$$

$$\frac{dy}{dt} = 2t - 2 + 0$$

$$\text{Q4 } y = x^2 - 6x + 5$$

$$\frac{dy}{dx} = 2x - 6 + 0$$

$$\text{Q5 } y = t^3 - t^2 + 10t + 5$$

$$\frac{dy}{dt} = 3t^2 - 2t + 10$$

$$Q \quad y = x^6$$

$$\frac{dy}{dx} = 6x^5$$

और differentiable करो

$$\text{double differentiation} \equiv \frac{d^2y}{dx^2} = y''$$

of y wrt x

$$\text{diff of } \left(\frac{dy}{dx} \right) \text{ wrt } x$$

$$y = x^6$$

$$\frac{dy}{dx} = y' = 6x^5$$

$$\frac{d^2y}{dx^2} = y'' = 30x^4$$

$$Q \quad y = x^3 + x^5 + x^4$$

$$y' = 3x^2 + 5x^4 + 4x^3$$

$$\frac{d^2y}{dx^2} = y'' = 6x + 20x^3 + 12x^2$$

Homework

$$\underline{Q} \quad y = \pi x^2$$
$$\frac{dy}{dx} =$$

$$\underline{Q} \quad A = \pi r^2$$
$$\frac{dA}{dr} =$$

$$\underline{Q} \quad y = \pi x^3$$
$$\frac{dy}{dx} =$$

$$\underline{Q} \quad V = \frac{4}{3}\pi r^3$$

$$\frac{dV}{dr} =$$

$$\underline{\text{Q}} \quad y = t^2 - 4t + 10$$

$$\frac{dy}{dt} =$$

$$\frac{d^2y}{dt^2} =$$

$$\underline{\text{Q}} \quad y = t^3 - 4t^2 + 10$$

$$\frac{dy}{dt} =$$

$$\frac{d^2y}{dt^2} =$$

$$\underline{\text{Q}} \quad x = t^2 - 4t + 10$$

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

$$\frac{d^2x}{dt^2} =$$

$$\underline{\text{Q}} \quad x = t^3 - 4t^2 + 10$$

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

$$\frac{d^2x}{dt^2} =$$

$$\text{Q} \quad y = \sin x$$

$$\frac{dy}{dx} =$$

$$\frac{d^2y}{dx^2} =$$

$$\text{Q} \quad P = \ln t$$

find $\frac{dP}{dt}$ at $t = 10 \text{ sec}$

$$\text{Q} \quad y = x^3$$

find $\frac{dy}{dx}$ at $x=2$

$$\text{Sol} \quad y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$\text{at } x=2, \quad \frac{dy}{dx} = 3x^2$$

$$= 12 \quad \text{Ans}$$

Similarly
find \Rightarrow

$$\text{Q} \quad y = t^2$$

find $\frac{dy}{dt}$ at $t=10 \text{ sec}$

$$\text{Q} \quad x = t^2 + 2t$$

find $\frac{dx}{dt}$ at $t=3 \text{ sec}$

$$\text{Q} \quad x = t^3 - 2t^2 + 5$$

find $\frac{dx}{dt}$ and $\frac{d^2x}{dt^2}$ at $t=2 \text{ sec}$

Q

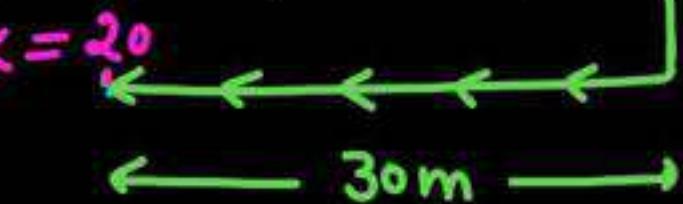
A particle is moving with velocity $+10 \text{ m/s}$ for 5 sec. along $+x$ -axis than it reversed its direction and move with velocity -10 m/s for three second.

find ① displacement

② Distance

Soln A particle is moving with velocity $+10 \text{ m/s}$ for 5 sec. along $+x$ -axis

$$\text{Displacement} = x = 0 \rightarrow x = 20 \rightarrow x = 50$$



$$\text{Displacement} = 20 - 0 \\ = 20$$

$$\text{Distance} = 50 + 30 = 80$$

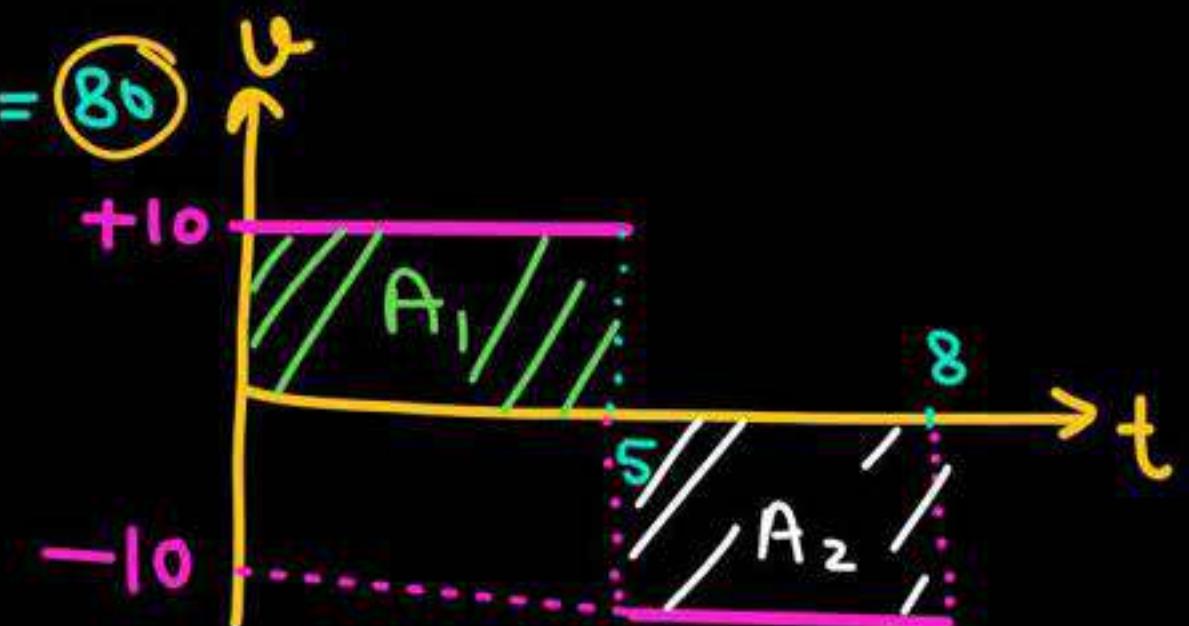
$$A_1 = 5 \times 10 = 50$$

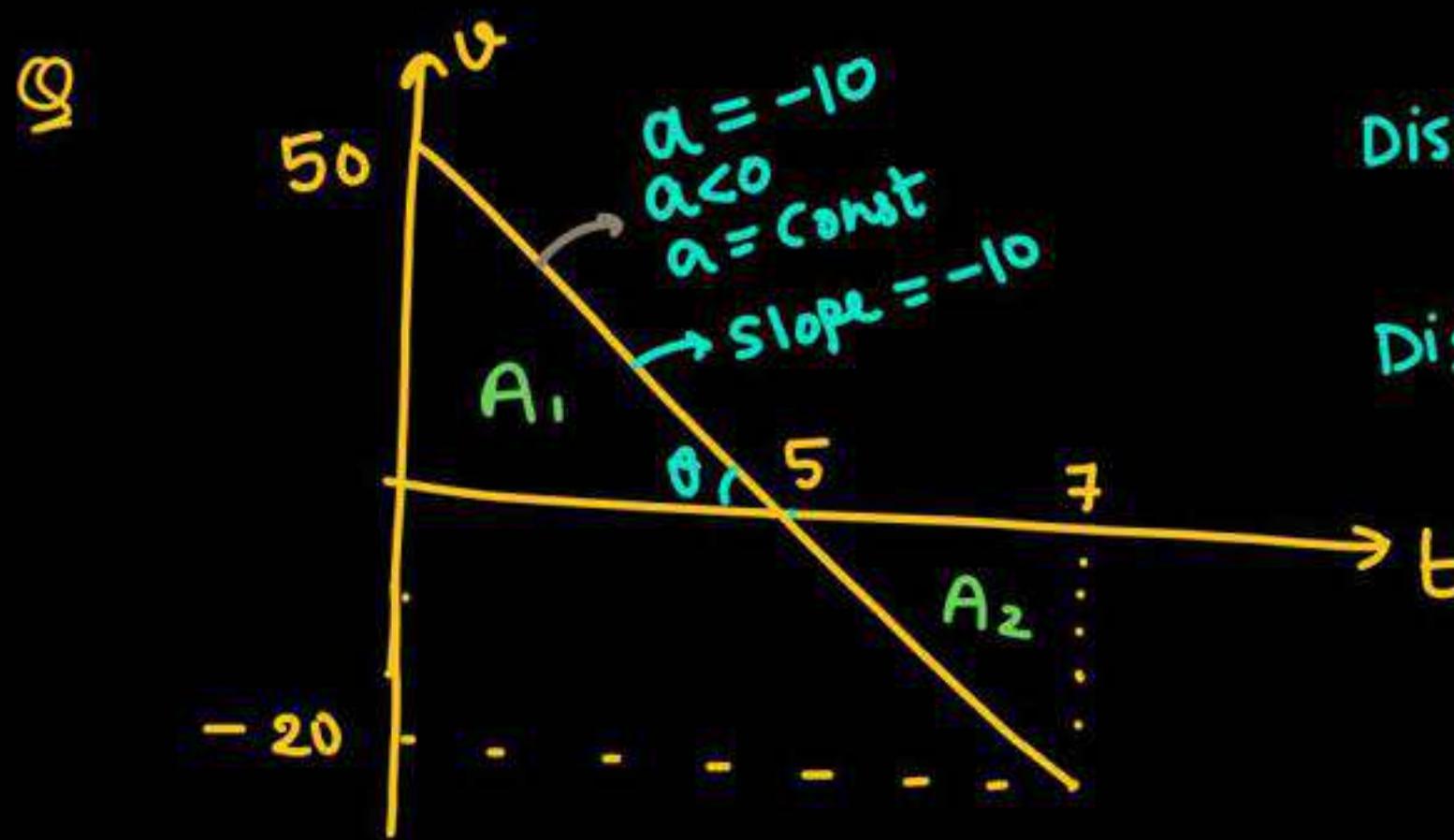
$$A_2 = 3 \times 10 = 30$$

$$\text{Displacement} = A_1 - A_2$$

$$= 50 - 30 = 20$$

$$\text{Distance} = A_1 + A_2 = 50 + 30 = 80$$





$$\text{Displacement} = 125 - 20 = 105$$

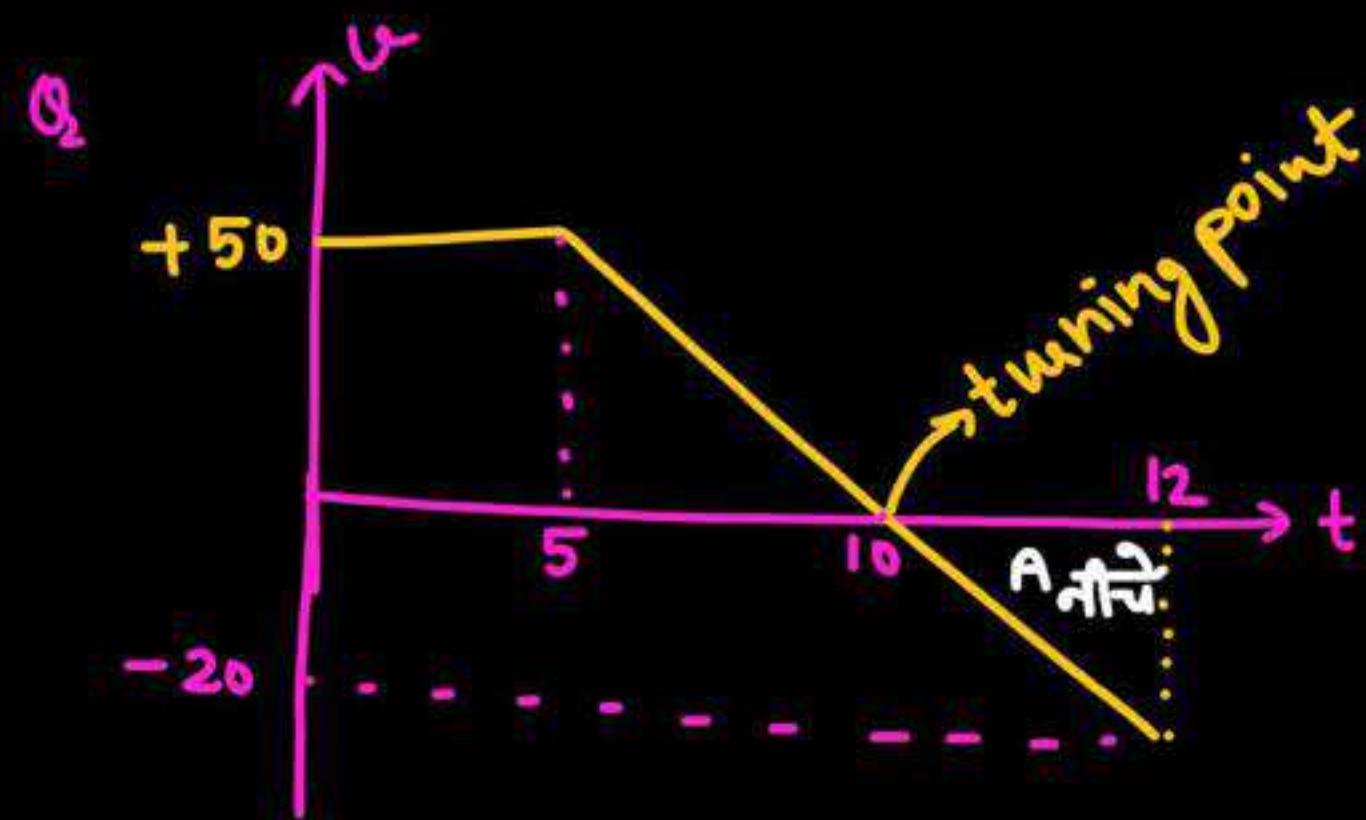
$$\text{Distance} = 125 + 20 = 145$$

$$\text{Average velocity} = \frac{105}{7}$$

$$\text{Avg. Speed} = \frac{145}{7}$$

$$A_1 = \frac{1}{2} \times 5 \times 50 = 125$$

$$A_2 = \frac{1}{2} \times 2 \times 20 = 20$$



$$\begin{aligned}
 \text{Displacement} &= A_{\text{upper}} - A_{\text{नीचे वाला}} \\
 &= \frac{1}{2} (5+10) \times 50 - \frac{1}{2} \times 2 \times 20 \\
 &= \frac{750}{2} - \frac{40}{2} = 375 - 20 = 355 \\
 \text{Distance} &= 375 + 20 = 395
 \end{aligned}$$

Q2

$$v = 10t + 20$$

Slope = 10 = const

$$a = 10$$

$$\rightarrow a = \frac{dv}{dt} = 10 + 0$$

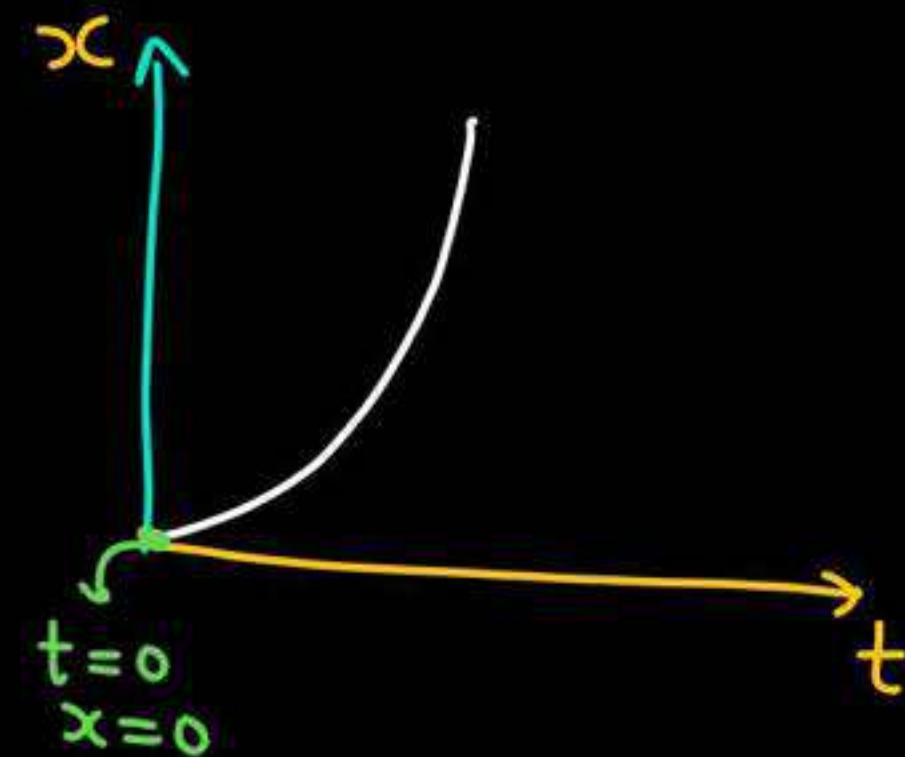
Q

Draw $x-t$ graph if at $t=0$ particle is at origin ($x=0$)

$$V = 10t + 20$$

$$a = +10 > 0$$

रुक्ती



QZ Q2 note करना

Q A particle starts motion from rest from origin such that its acc is +10. Draw v-t, x-t graph

$$a = +10$$

$$\frac{dv}{dt} = 10$$

$$\int dv = \int 10 dt$$

$$v = 10t + C$$

$$\text{at } t=0, 0 = 0 + C$$

$$\boxed{C=0}$$

$$t = 0, x = 0 \\ v = 0$$

$$v = 10t$$

$$\frac{dx}{dt} = 10t$$

$$\int dx = \int 10t dt$$

$$x = 10 \frac{t^2}{2} + C$$

$$x = 5t^2 + C$$

$$t = 0, x = 0 \Rightarrow 0 = 0 + C$$

$$\boxed{C=0}$$

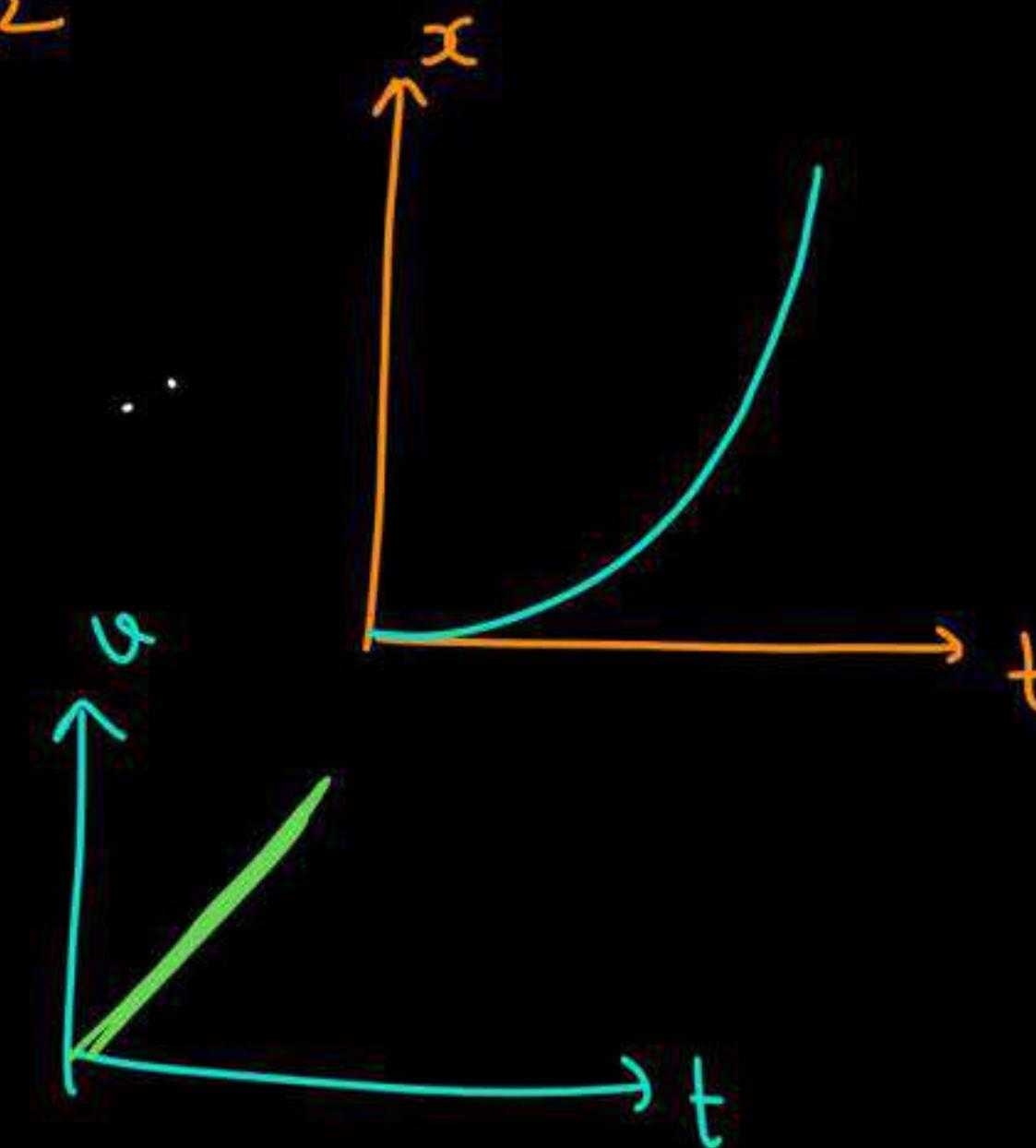
$$x = 5t^2$$

111
(Parabola)

~~Q&W~~

$$x = 5t^2$$

$$v = 10t$$

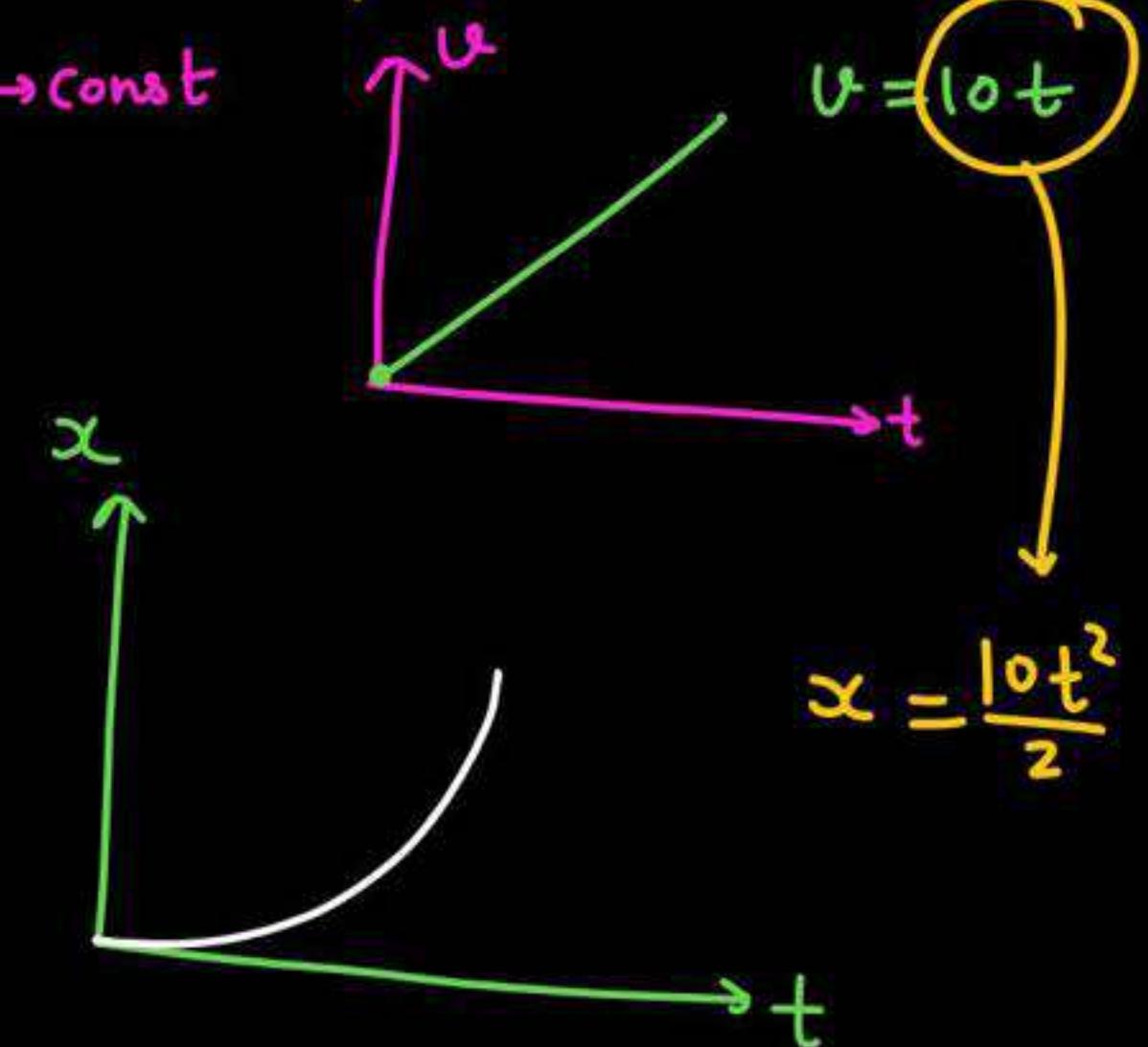


Q

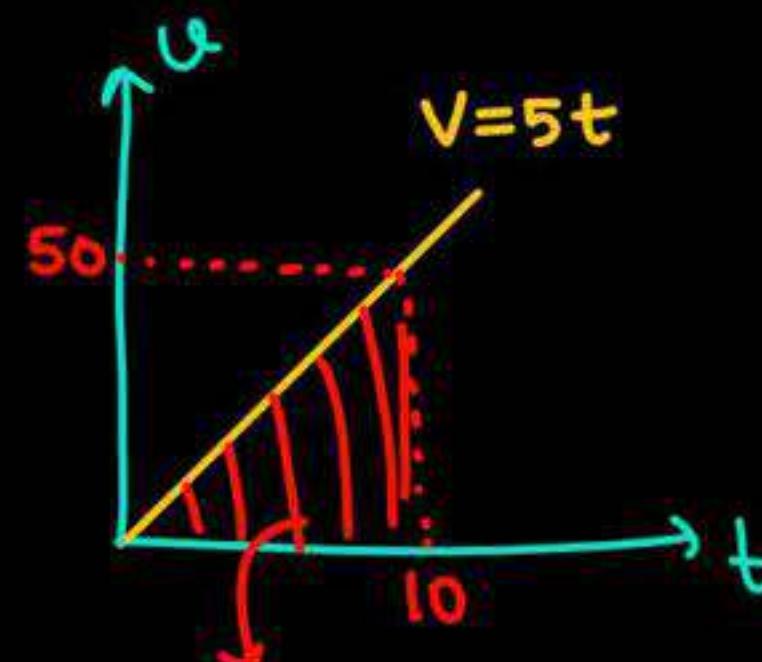
particle start from rest
from origin at $t=0$, having
acc $+10 \text{ m/s}^2$.

P
W

$a \rightarrow \text{const}$

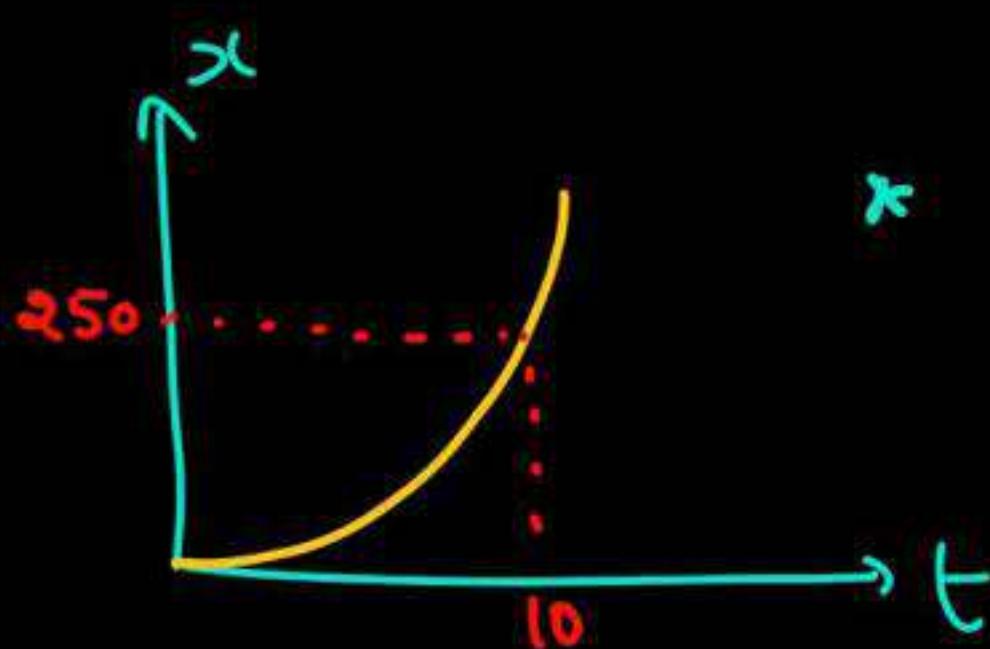


Q1 Particle start from rest from origin having acc $a = +5 = \text{const}$



$$\text{Area} = \frac{1}{2} \times 50 \times 10 = 250$$

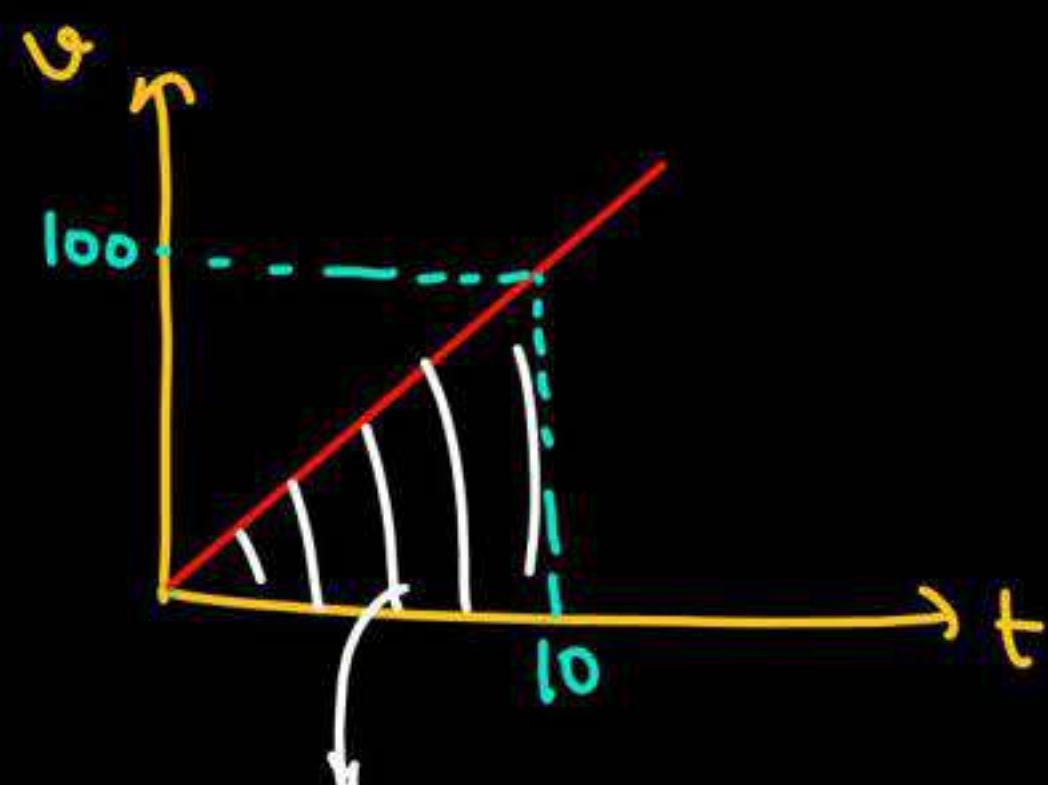
$$\begin{aligned} * & V = u + at \\ & = 0 + 5 \times 10 \\ & V = 50 \end{aligned}$$



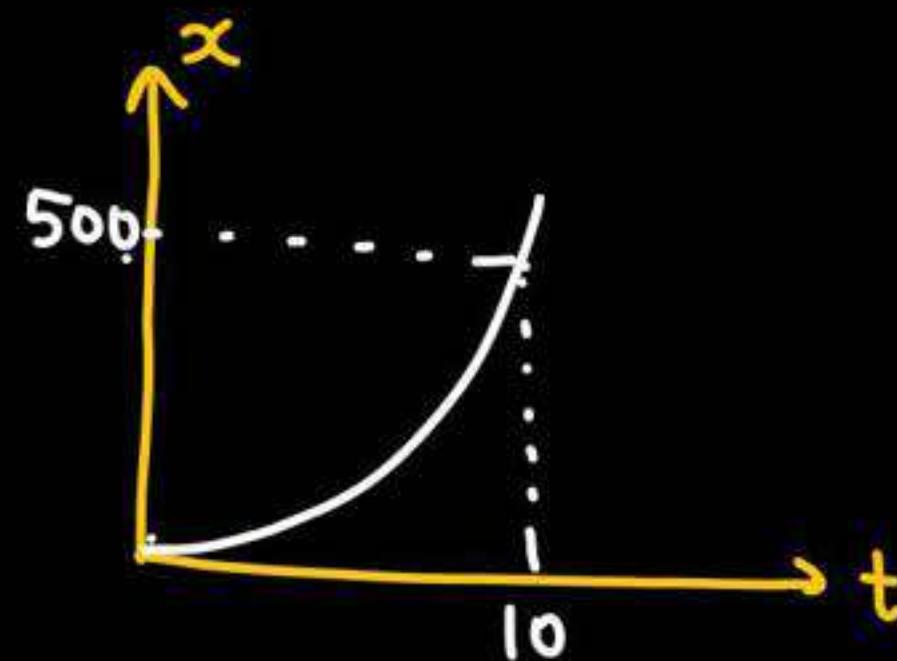
$$\begin{aligned} * & S = ut + \frac{1}{2}at^2 \\ & = 0 + \frac{1}{2} \times 5 \times 10^2 \\ & = 250 \end{aligned}$$

Q. Particle start from rest from origin having acc = +10m/s.

$t=0 \longrightarrow t=10$ तक $(v-t)$, $(x-t)$ draw



$$A_{\text{req}} = \frac{1}{2} \times 10 \times 100 = 500$$



$$u = 0$$

$$a = +10$$

$$v = u + at$$

$$v = 0 + 10 \times 10$$

$$v = 100$$

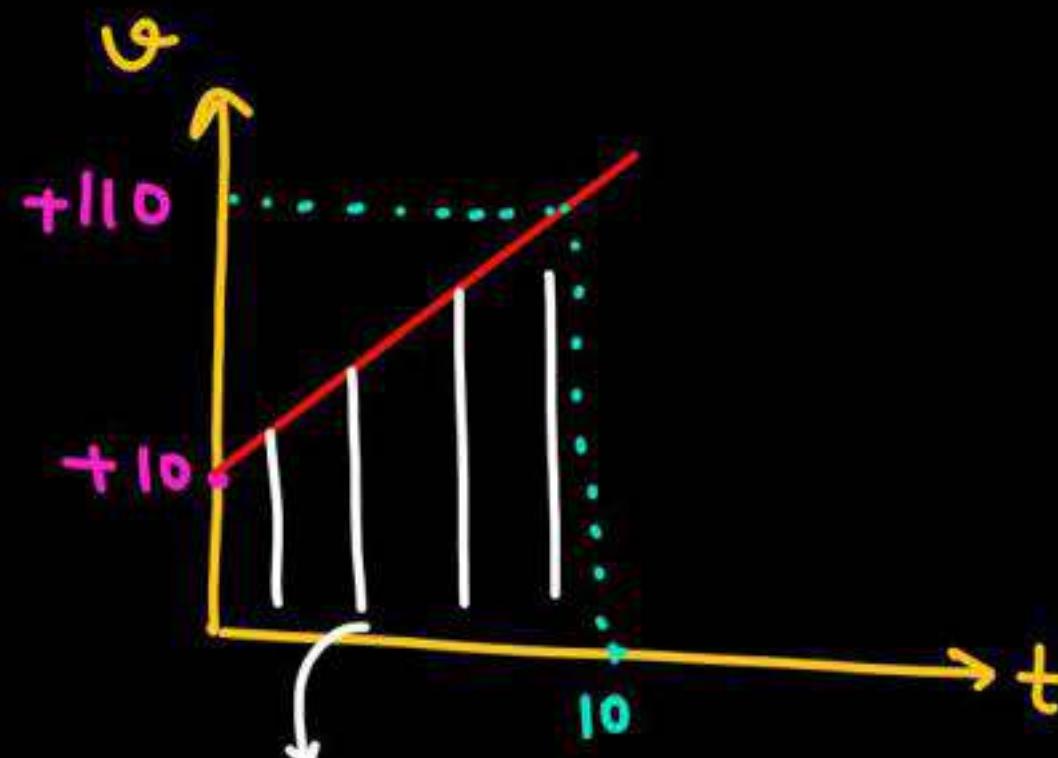
$$s = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2} \times 10 \times 10^2$$

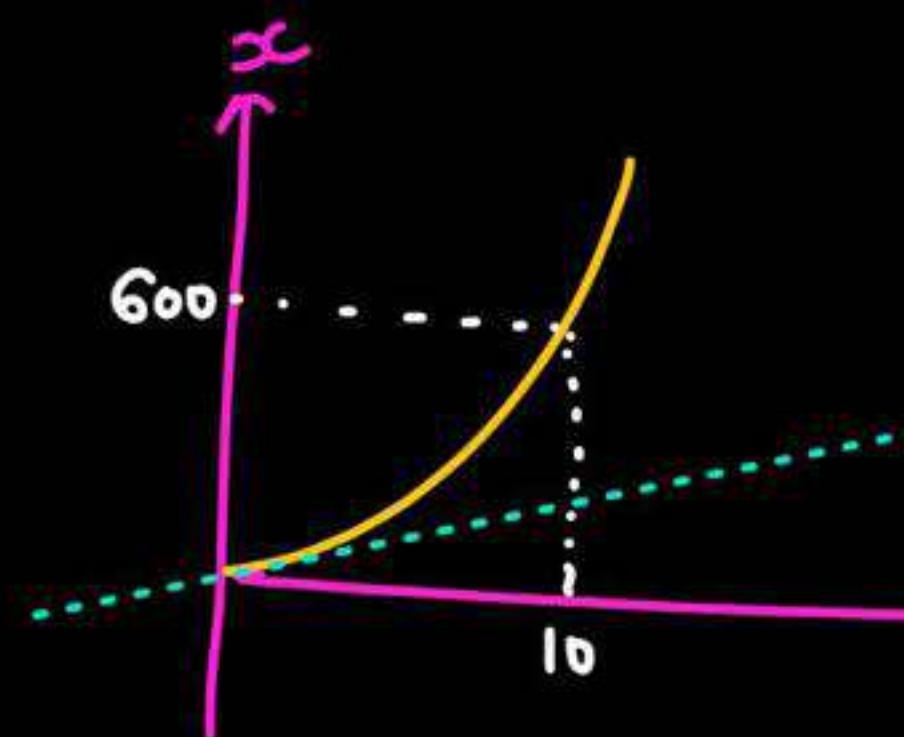
$$= 500$$

Q A particle starts motion having initial velocity +10m/s

and acc = +10m/s².



$$\text{Area} = \frac{1}{2} \times (10 + 110) \times 10 \\ = 600$$



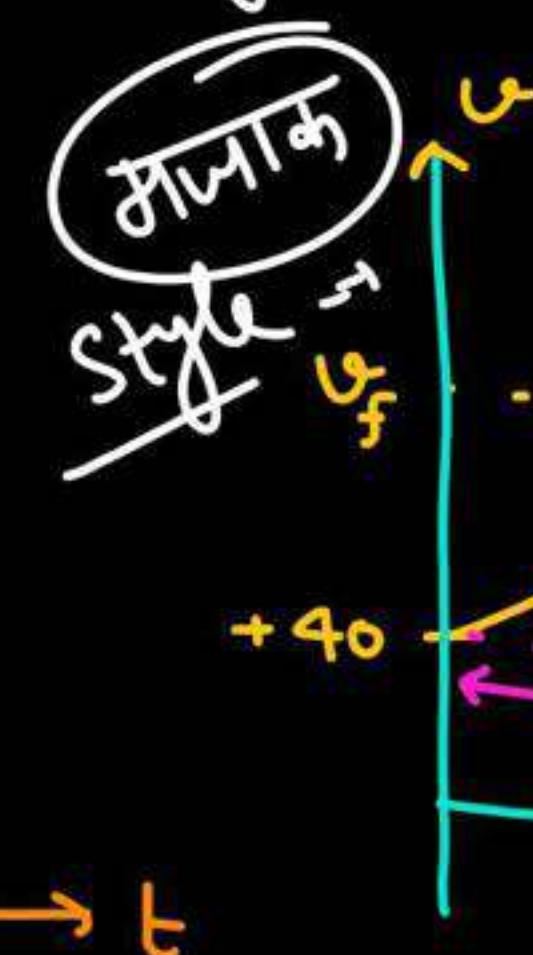
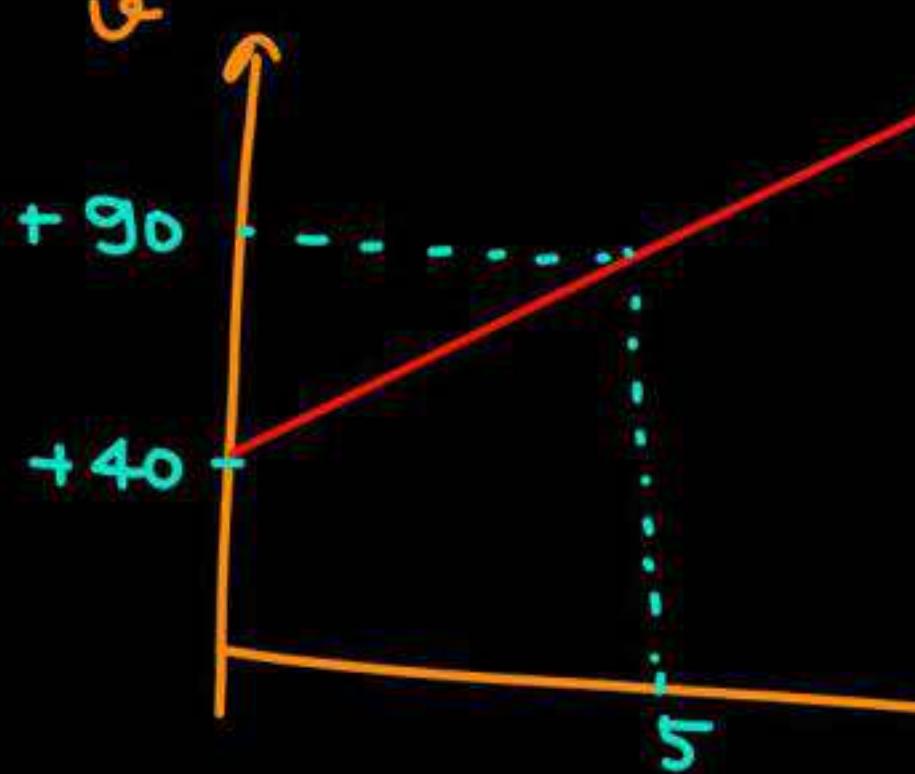
$$\begin{aligned} u &= +10 \\ a &= +10 \\ t &= 10 \text{ sec} \\ v &= u + at \\ &= 10 + 10 \times 10 \\ &= 10 + 100 \\ &\underline{\underline{v = 110}} \end{aligned}$$

$$\begin{aligned} S &= ut + \frac{1}{2}at^2 \\ &= 10 \times 10 + \frac{1}{2} \times 10 \times 10^2 \\ &= 100 + 500 = 600 \end{aligned}$$

Q A particle starts motion having initial velocity $+40 \text{ m/s}^2$

and $\text{acc} = +10 \text{ m/s}^2$.

*



$$\tan \theta = \text{Slope} = \frac{v_f - 40}{5} = 10$$

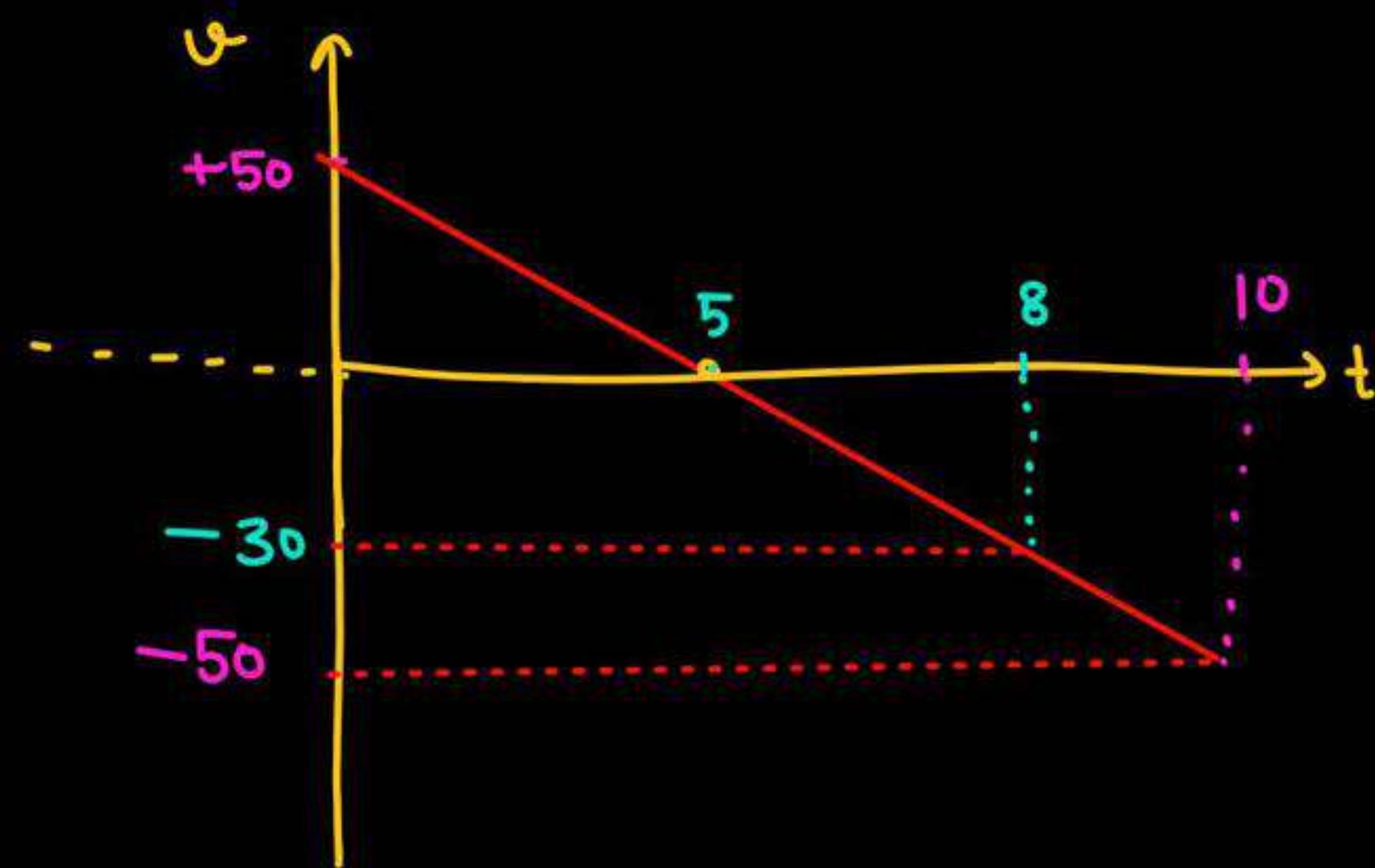
$$v_f - 40 = 50$$

$$v_f = 90$$

Q A particle starts motion having initial velocity +50 m/s and acc = -10 m/s². $a < 0$

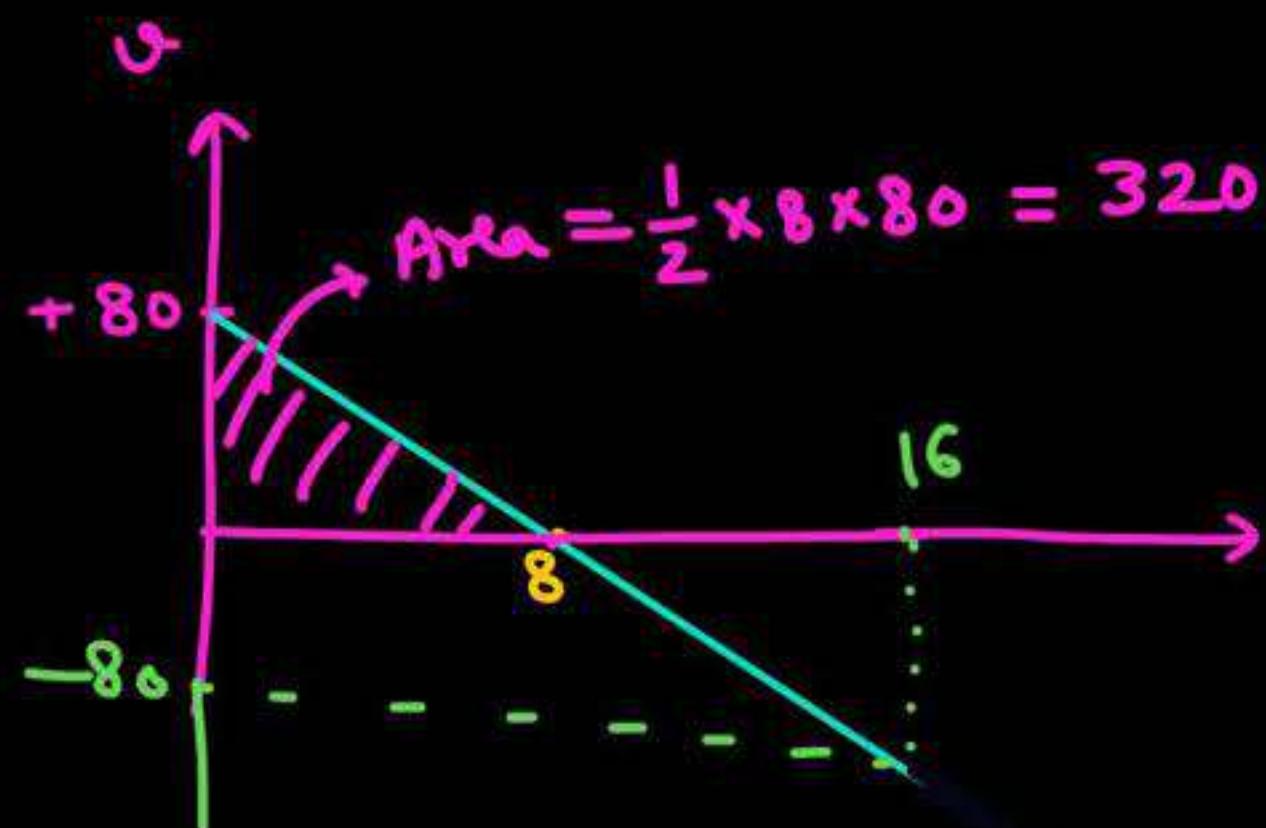
$$50 - 80 = -30$$

10



Q A particle starts motion having initial velocity +80 m/s

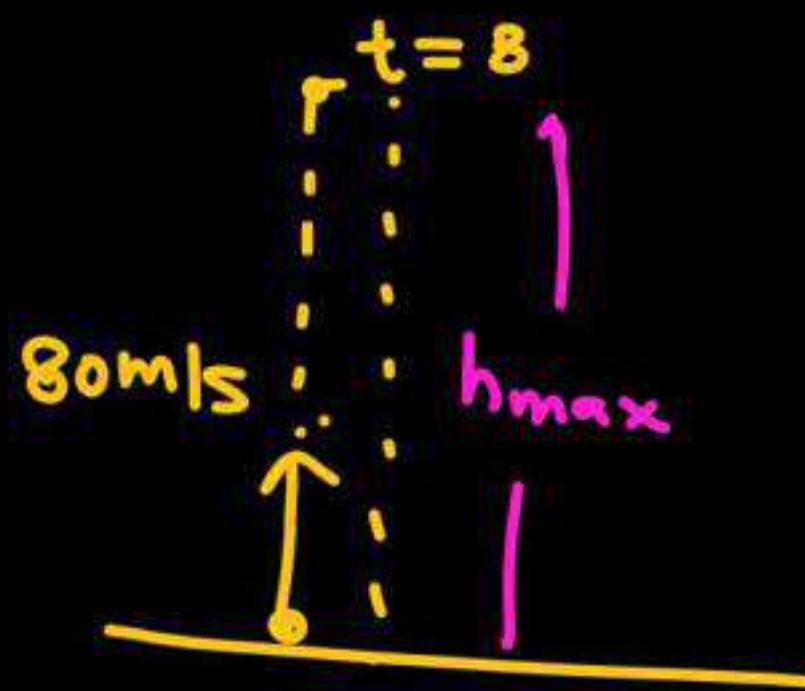
and acc = -10 m/s²



$$t = 10 \text{ sec}$$

$$v = 80 - 100 = -20 \text{ m/s}$$

$$\begin{aligned} v &= u + at = 80 + (-10) 10 \\ &= -20 \end{aligned}$$

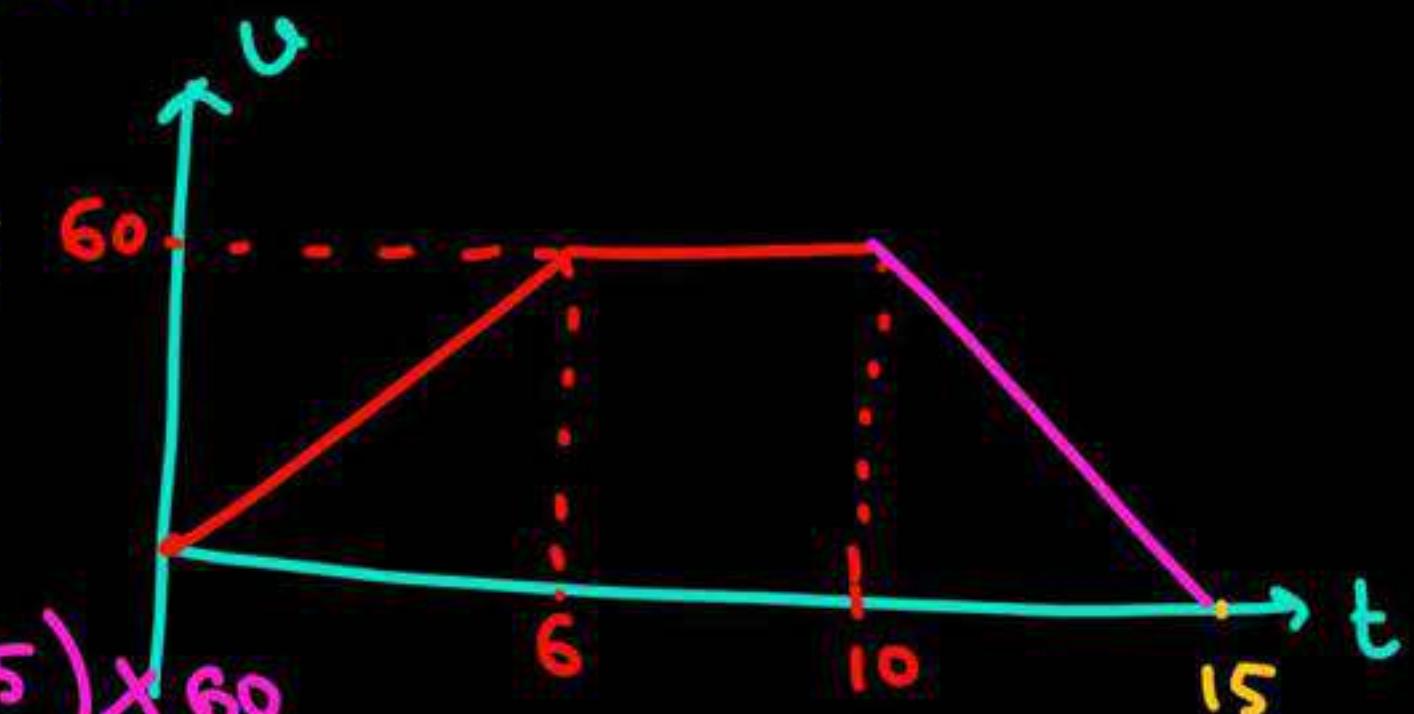


Q A particle starts motion from rest, having acc $+10 \text{ m/s}^2$ for 6 sec. after that it moves with constant velocity for next four second. In last part of journey particle comes to rest & took 5 sec. having const acc.

① find acc in last part of journey

② Distance travelled, Displacement

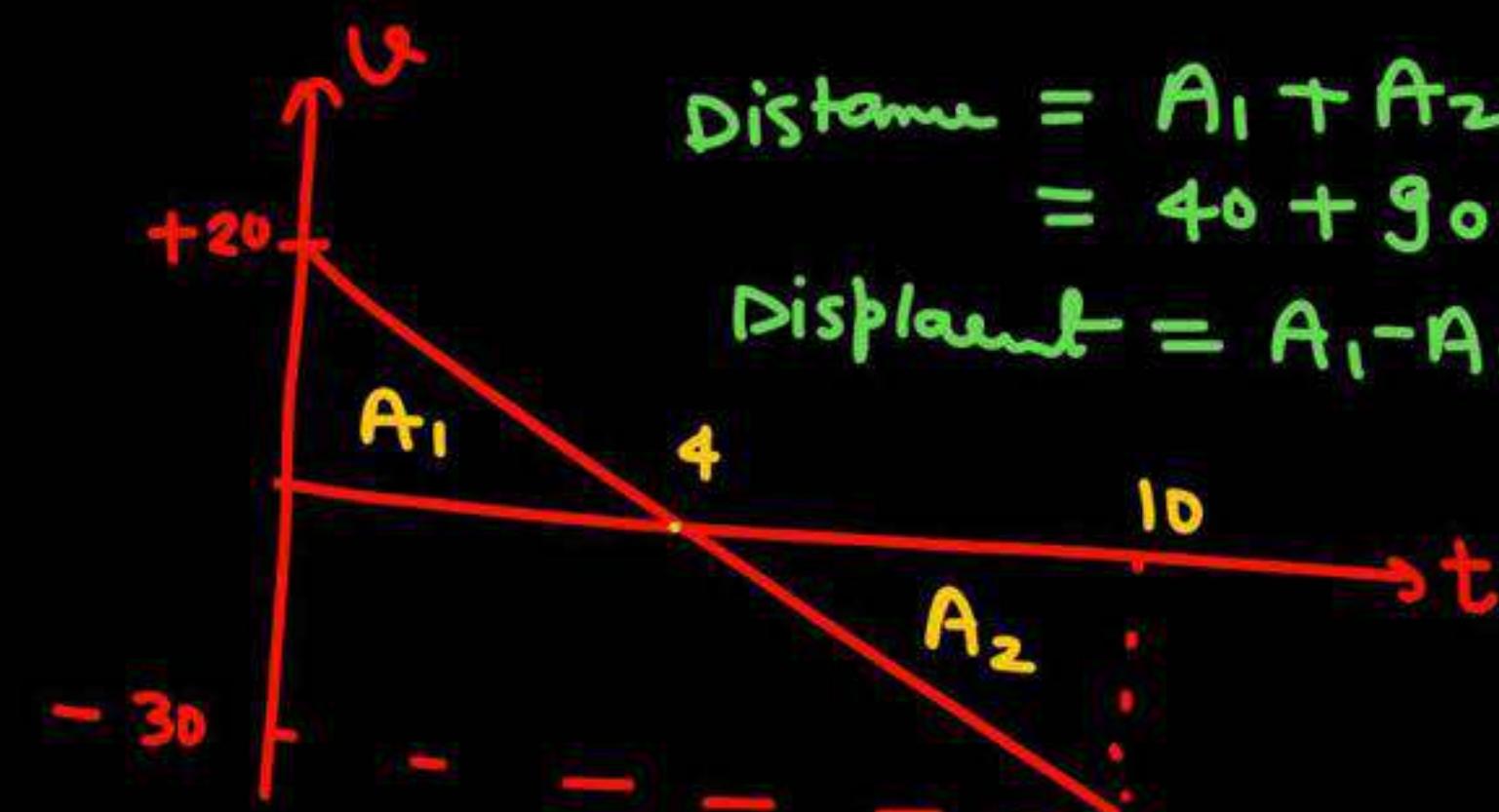
$$\therefore \text{Displ.} = \text{Area} = \frac{1}{2} \times (4 + 15) \times 60$$



Question

Q particle is moving with initial velocity +20 m/s having acceleration -5 m/s². Find distance travelled by particle in 10 sec.

~~$u = +20$
 $a = -5$
 $s = ut + \frac{1}{2}at^2$
 Displ. = $20 \times 10 - \frac{1}{2} \times 5 \times 10^2$
 $= 200 - 250$
 $= -50$~~



$$\text{Distance} = A_1 + A_2 \\ = 40 + 90 = 130$$

$$\text{Displacement} = A_1 - A_2 = 40 - 90 \\ = -50$$

~~H/W~~

P
W

Q A particle starts motion from rest, having acc + 10 m/s^2 for 6 sec. after that it moves with constant velocity for next four second. After that particle moves with const acc of -20 m/s^2 for five second. find

Distance travelled.

$$\int \sin(ax+b) dx = -\frac{1}{a} \cos(ax+b) + C$$

$$\int e^x dx = e^x + C$$

$$\int e^{ax+b} dx = \frac{1}{a} e^{ax+b} + C$$

$$* \int \frac{1}{x} dx = \ln x + C$$

$$\begin{aligned} * \int \frac{1}{3x} dx &= \frac{1}{3} \int \frac{1}{x} dx \\ &= \frac{1}{3} \ln x + C \end{aligned}$$

$$* \int \frac{1}{3x+4} dx = \frac{1}{3} \ln(3x+4) + C$$

मनकेर लिखी करता पढ़ालिए



प्राक्ति का दृष्टि

$$\int \frac{1}{ax+b} dx = \frac{1}{a} \ln(ax+b) + C$$

$$\int \frac{1}{4x+5} dx = \frac{1}{4} \ln(4x+5) + C$$

$$\int \frac{1}{4x+5} dx = ?$$

$$4x+5 = t \quad (\text{let})$$

differentiate

$$4 dx = 1 dt$$

$$dx = \frac{1}{4} dt$$

$$\int \frac{1}{4x+5} dx = \int \frac{1}{t} \frac{1}{4} dt$$

$$= \frac{1}{4} \int \frac{1}{t} dt = \frac{1}{4} \ln t$$

$$= \frac{1}{4} \ln(4x+5)$$

Definite Integration

$$\int f(x) \cdot dx = g(x) \Big|_{x_i=a}^{x_f=b}$$

upper limit of x
 $x_f = b$
 $x_i = a$
 lower limit of x

Q

$$\int_{x_i=0}^{x_f=3} x^2 dx = \int_0^3 x^2 dx = \frac{x^3}{3} \Big|_0^3 = \left(\frac{3^3}{3}\right) - \left(\frac{0^3}{3}\right)$$

$$= 9$$

Any

$$Q \int_2^3 9x^3 dx = 4 \cdot \frac{x^4}{4} \Big|_2^{x=3} = x^4 \Big|_{x=2}^{x=3} = 3^4 - 2^4 = 81 - 16 = \checkmark$$

P
W

$$Q \int_0^{\pi/2} \cos x dx = \sin x \Big|_0^{\pi/2} = (\sin \pi/2) - \sin 0 = 1 - 0 = 1$$

Q

$$\int_{x=1}^{x=4} 2x \, dx = 2 \cdot \frac{x^2}{2} \Big|_1^4 = x^2 \Big|_1^4 = 4^2 - 1^2 = 15$$

Q

$$\int_0^1 7x^6 \, dx = x^7 \Big|_0^1 = 1^7 - 0^7 = 1$$

Q

$$\int_2^3 e^x \, dx = e^x \Big|_2^3 = e^3 - e^2$$

X

$$\int_0^{10} 2x \, dx = x^2 \Big|_{x=0}^{x=10} = 100 - 0 = 100$$

Q

$$\int_0^1 (3x^2 + 2x) \, dx = \left(3\frac{x^3}{3} + 2\frac{x^2}{2} \right) \Big|_{x=0}^{x=1} = (x^3 + x^2) \Big|_{x=0}^{x=1} = (1^3 + 1^2) - (0^3 + 0^2) = 2$$

Q $y = x^3$

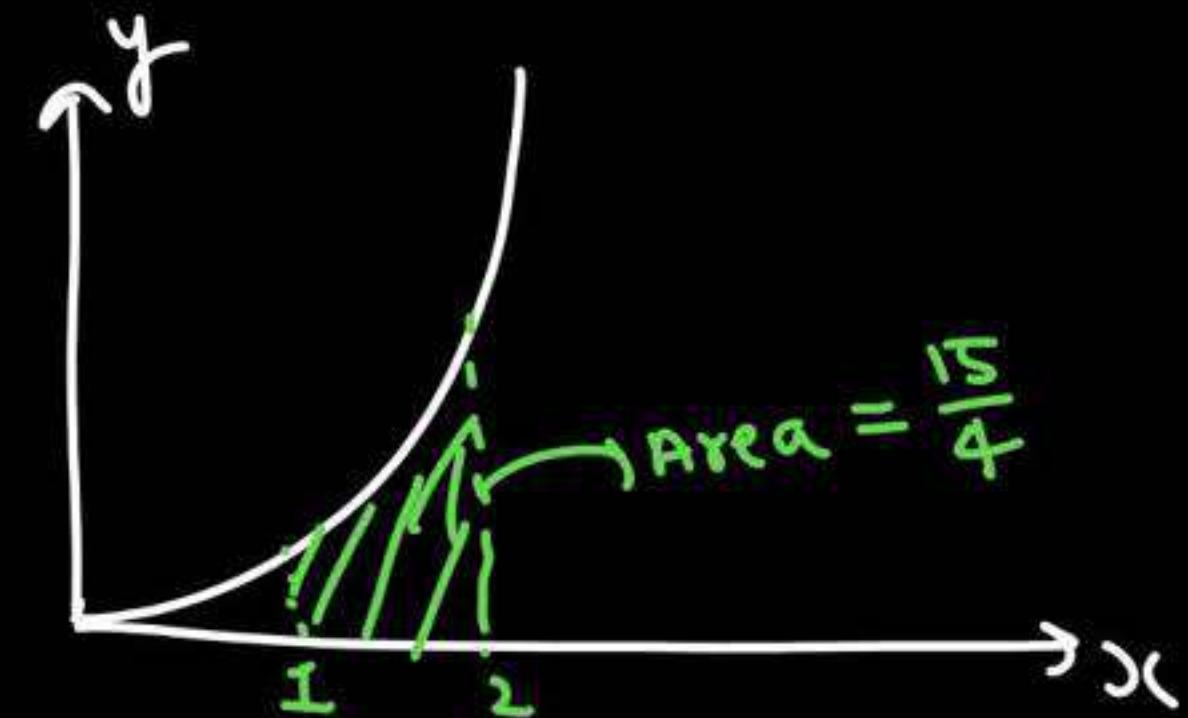
find area under curve (blw curve & x-axis)
from $x = 1$ to $x = 2$

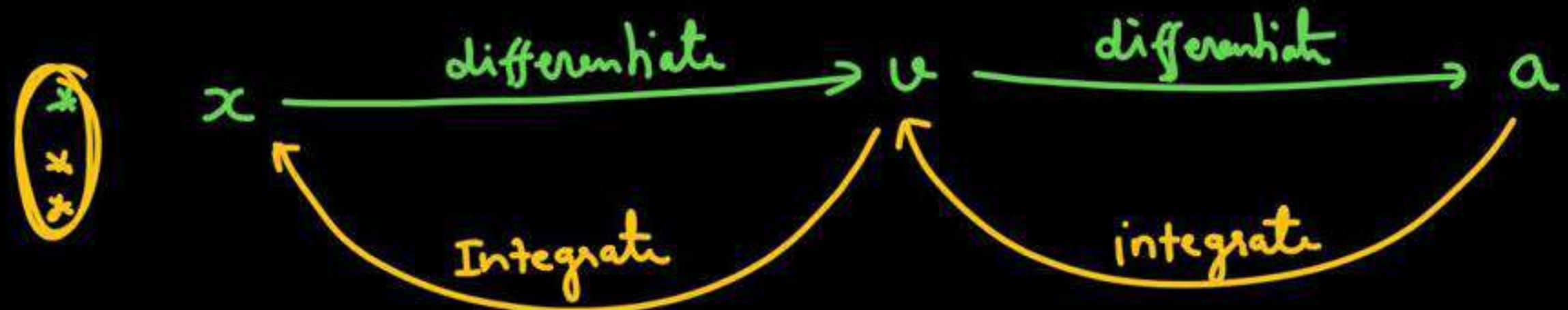
Sol

$$\text{Area} = \int y \, dx = \int x^3 \, dx$$

$$\text{Area} = \frac{x^4}{4} \Big|_{x=1}^{x=2}$$

$$= \frac{1}{4} [2^4 - 1] = \frac{15}{4}$$





Q at $t=0$, particle is at $x=10$
 particle is moving such that its v vs time relation is given as

$$v = 3t^2 + 2t$$

find ① location of particle at $t=1$ sec

$$\textcircled{2} \quad x = f(t)$$

$$x = \int v dt = \int (3t^2 + 2t) dt = t^3 + t^2 + C$$

$$\text{at } t=0, x=10$$

$$10 = 0 + 0 + C \Rightarrow \textcircled{C=10}$$

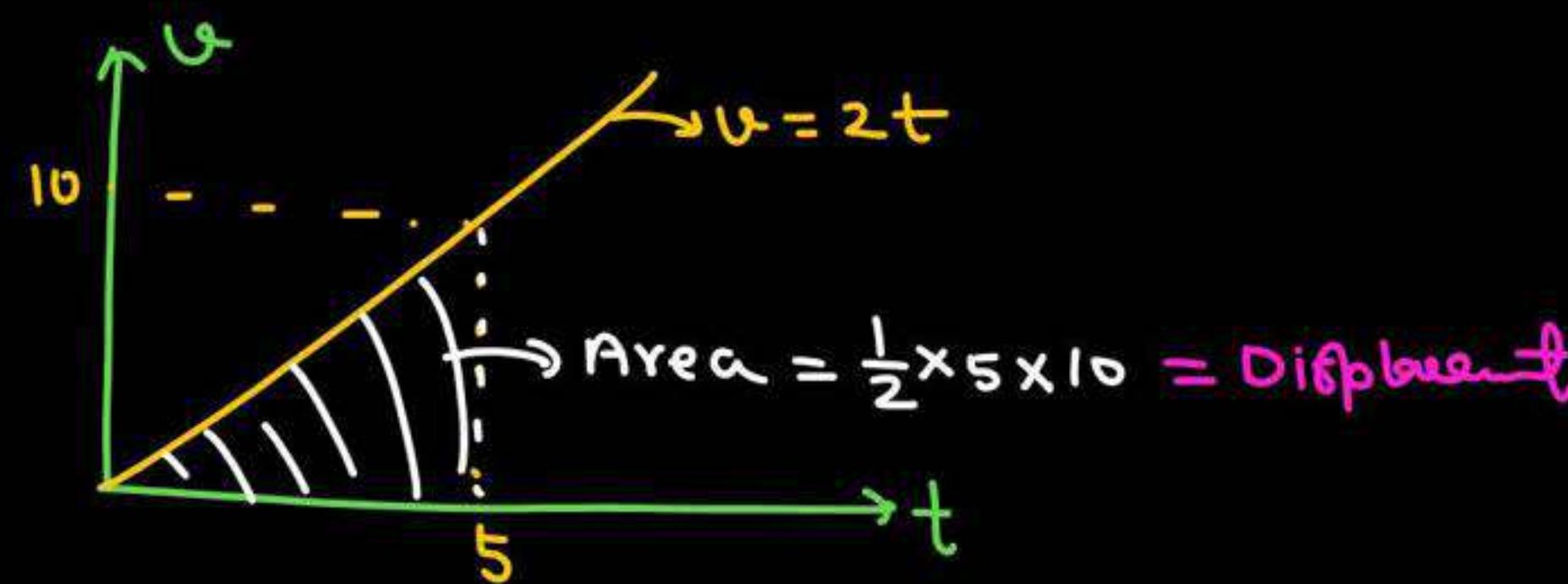
$$x = t^3 + t^2 + C$$

$$x = t^3 + t^2 + 10$$

Q A particle is moving along x-axis s.t its velocity vs time relation is given as

Displacement
from $t=0 \rightarrow t=5$

Solⁿ Area = $\frac{1}{2} \times 5 \times 10$
= 25



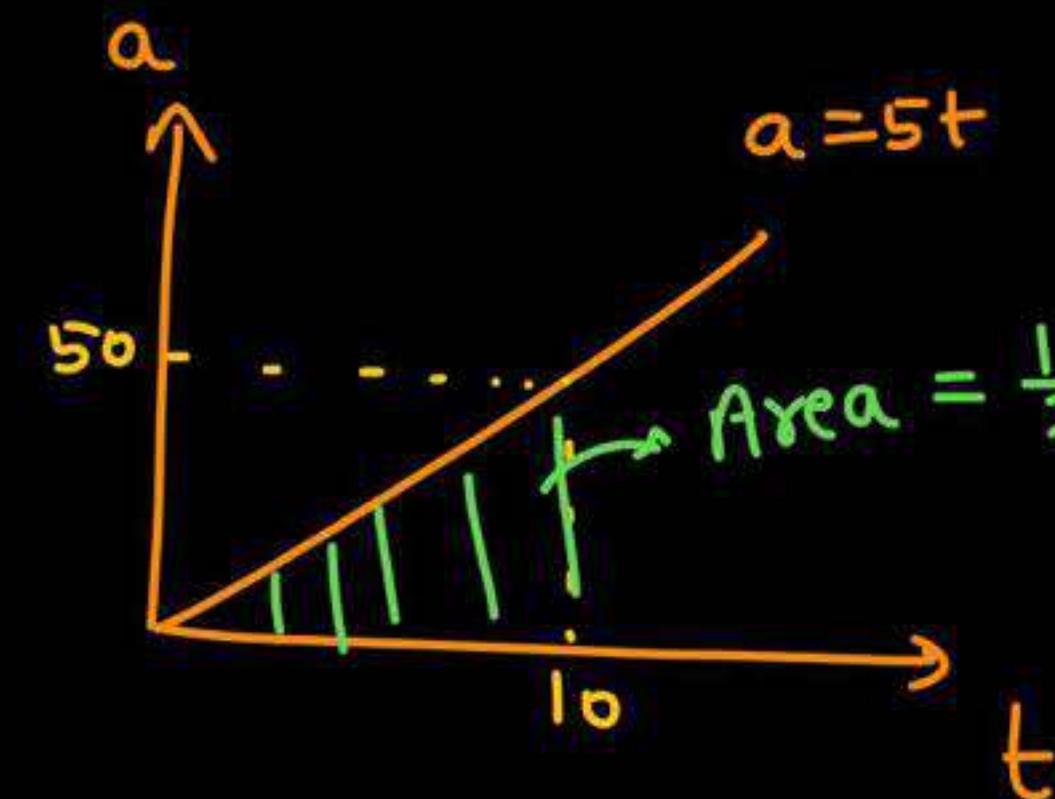
Q A particle starts motion from rest such that its $a-t$ graph is given as

find velocity at $t=10\text{ sec}$,

$$\text{Area} = \vec{V}_f - \vec{V}_i$$

$$\frac{1}{2} \times 10 \times 50 = V_f - 0$$

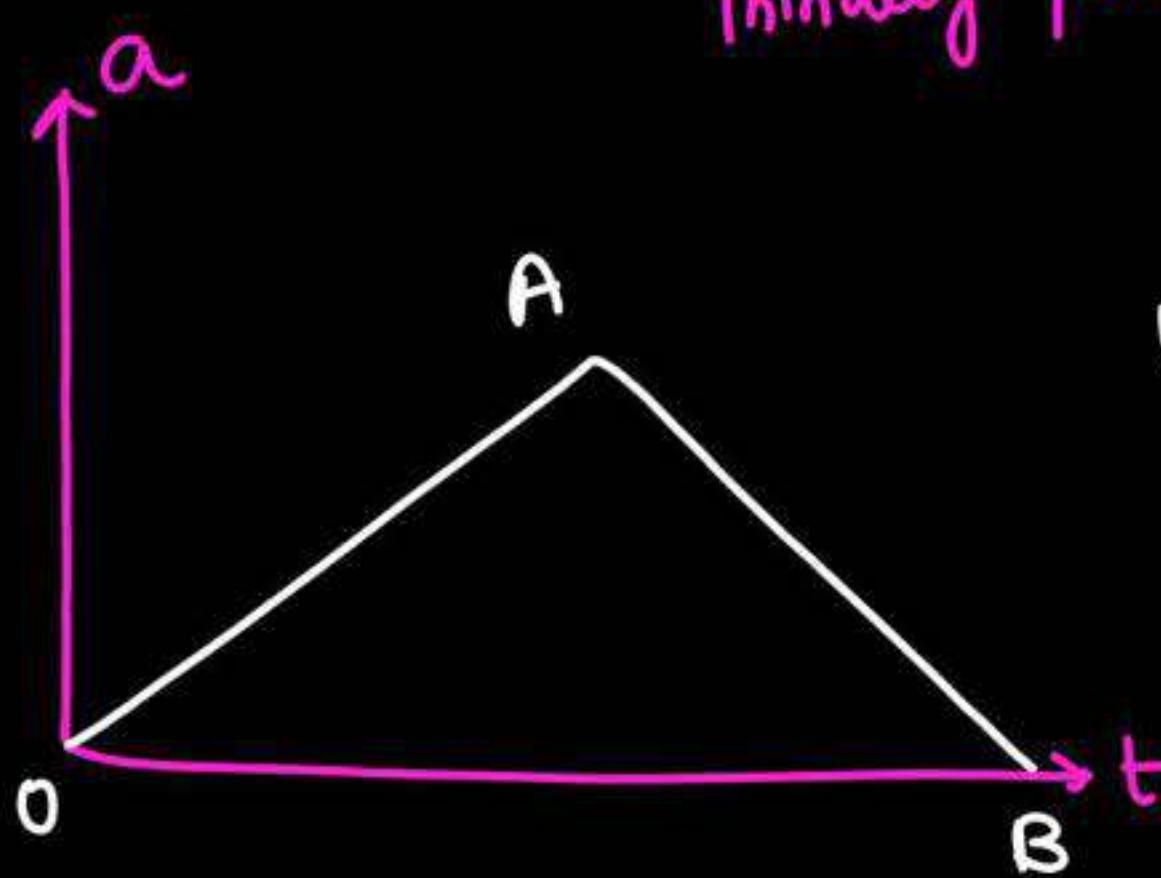
$$V_f = 250$$



$$a = 5t$$

$$\text{Area} = \frac{1}{2} \times 10 \times 50 = V_f - V_i$$

change in velocity
 $= V_f - V_i$



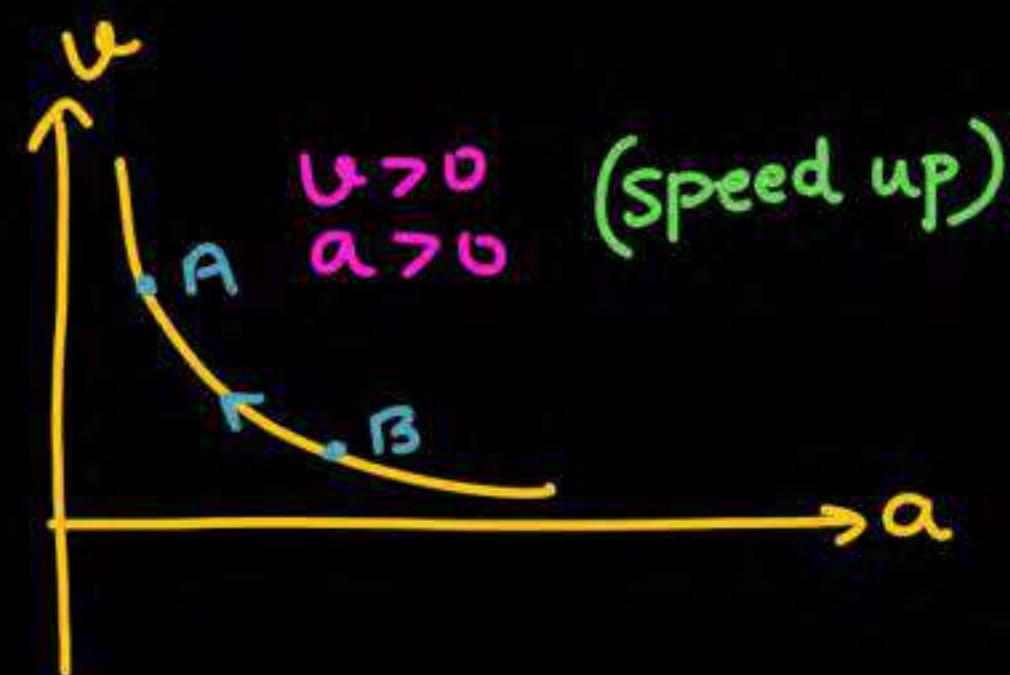
v_{max} ~~on ET~~ ~~ET~~ A

~~A~~ $\equiv 35\%$.

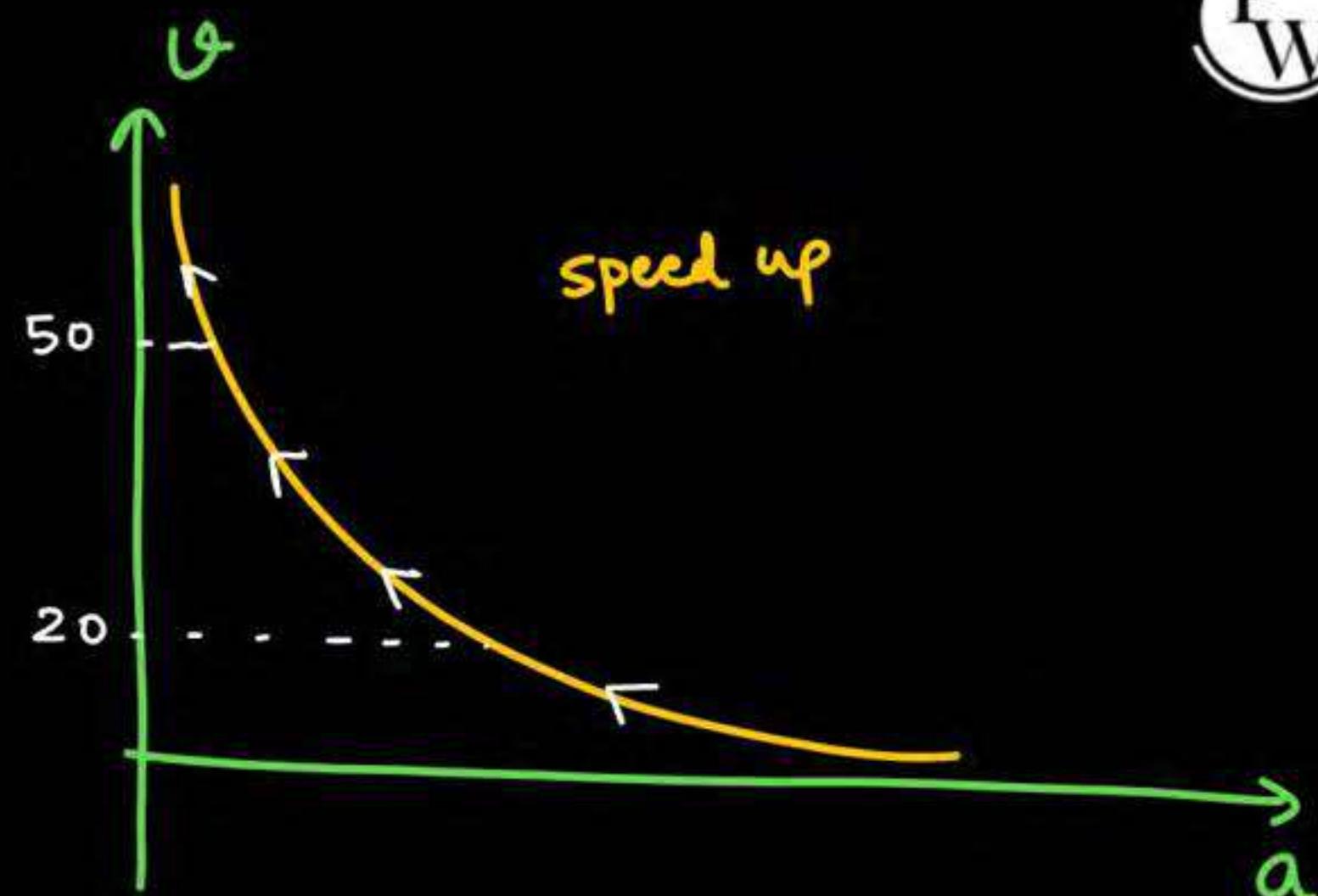
B $\equiv 45\%$.

C $\equiv 0\%$.

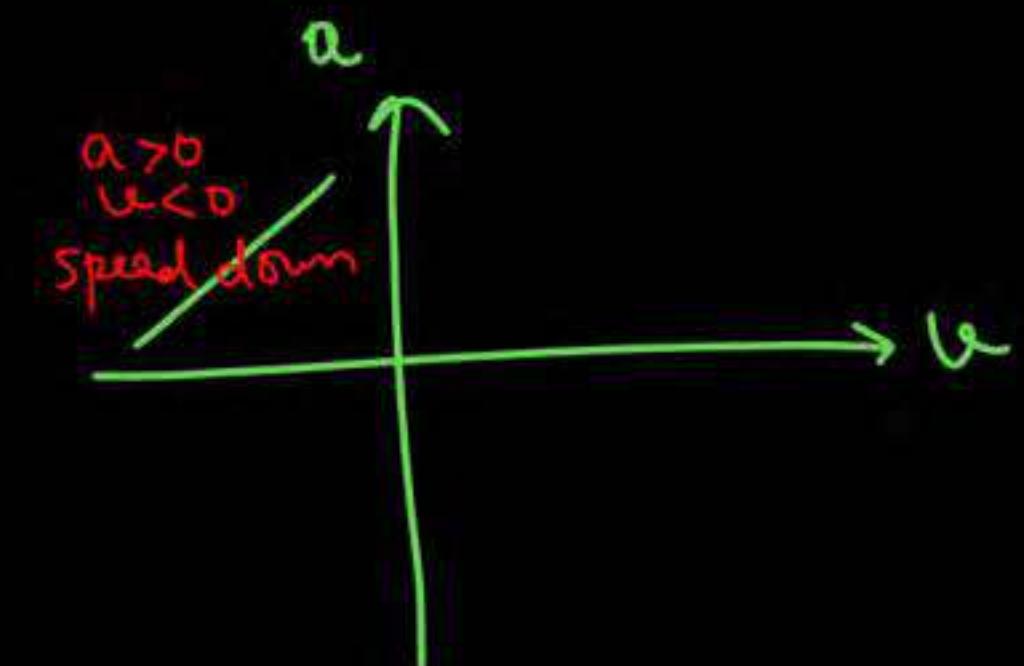
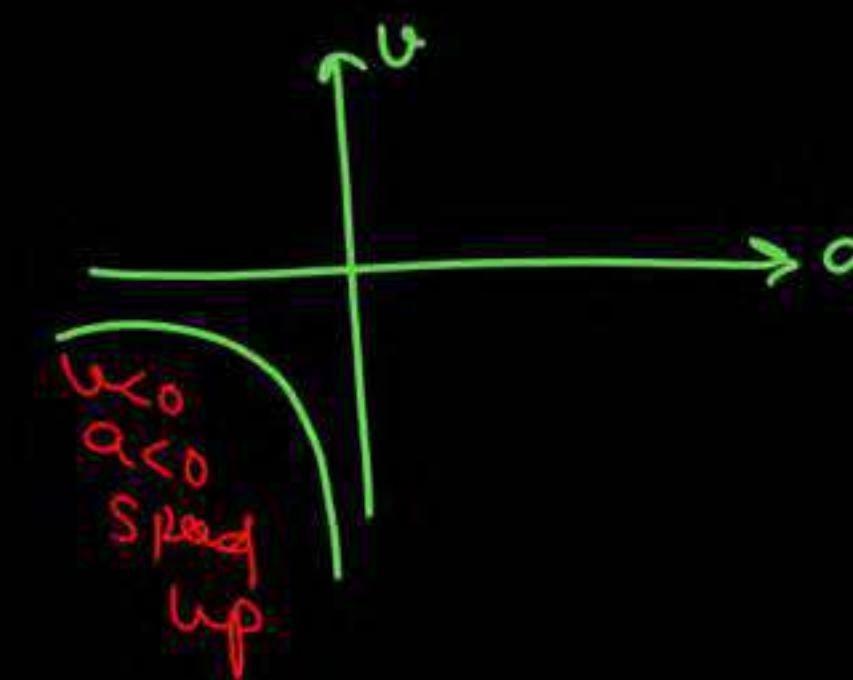
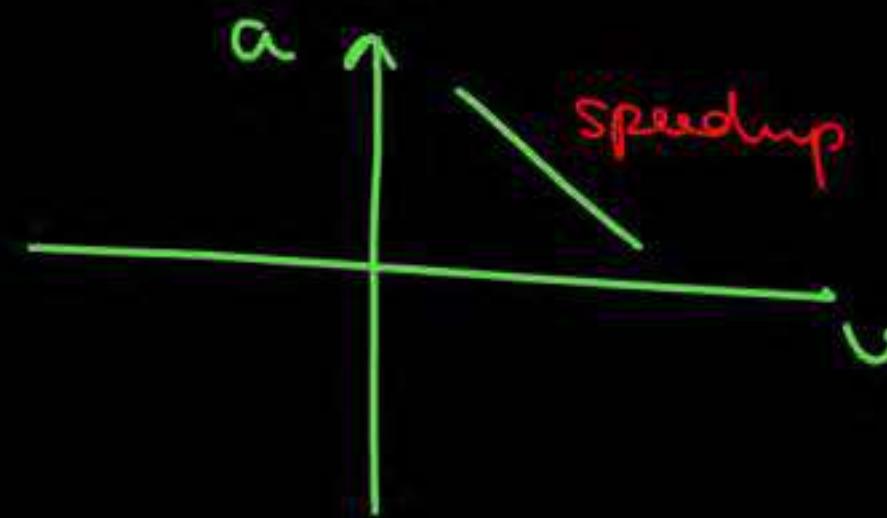
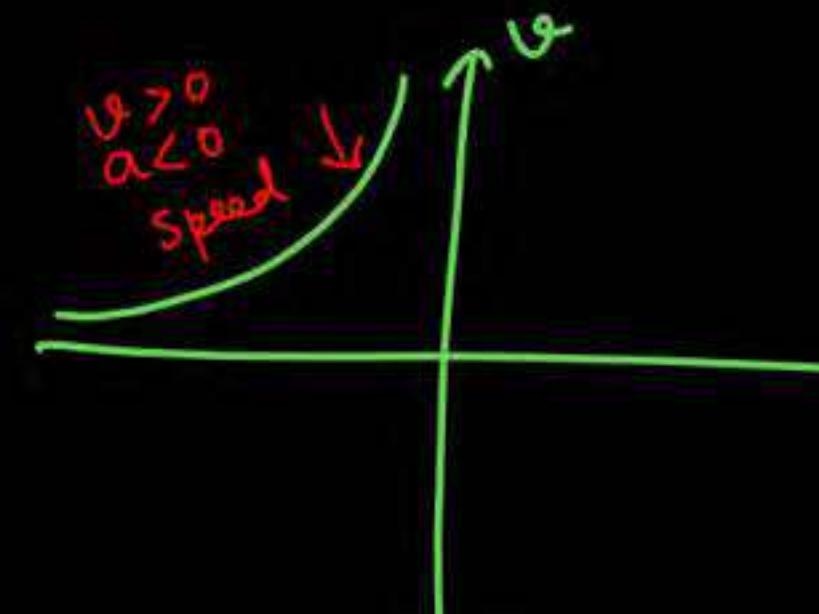
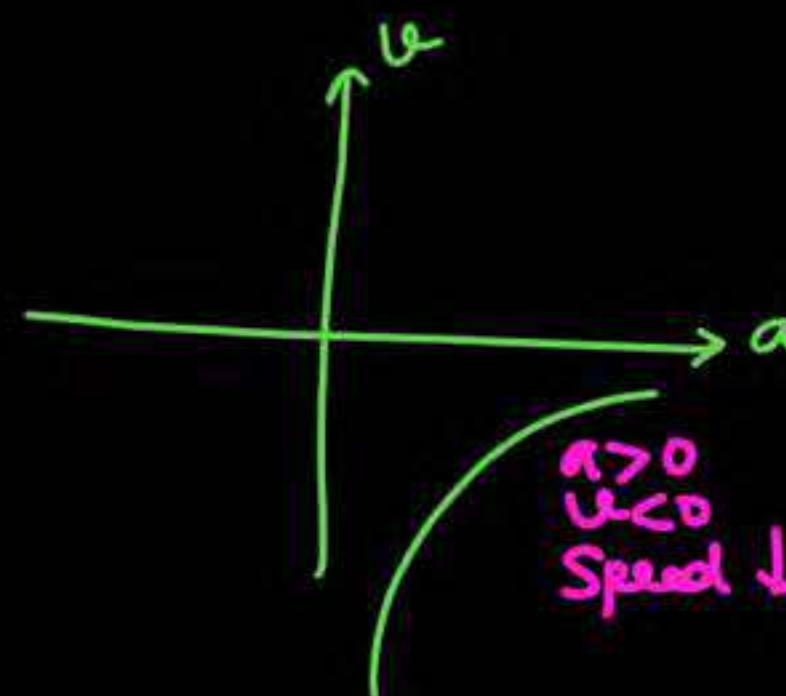
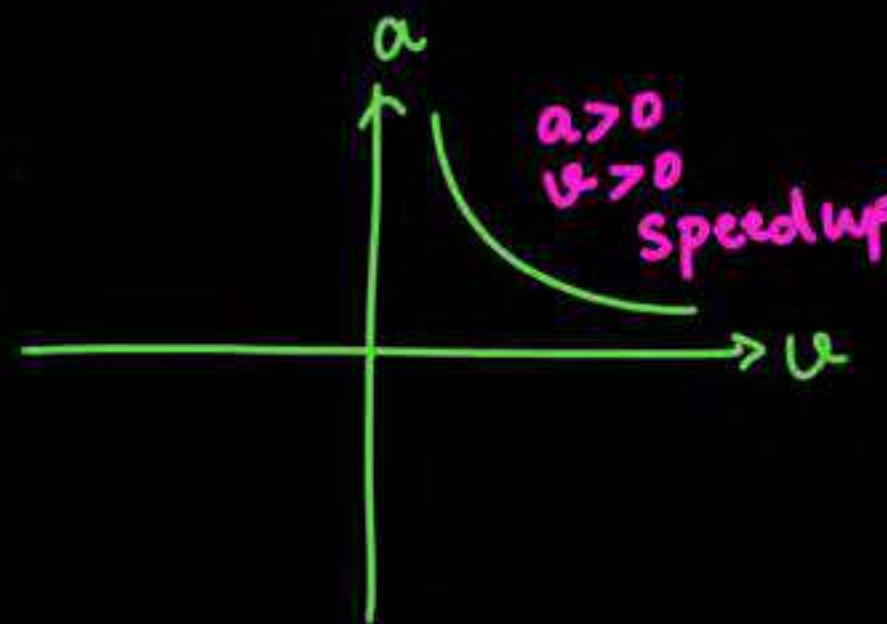
D \equiv ~~ET~~ ~~ET~~ 7% .



- ① Velocity is decreasing X
- ② " " increasing ✓
- ③ acc is increasing X
- * ④ acc is decreasing ✓

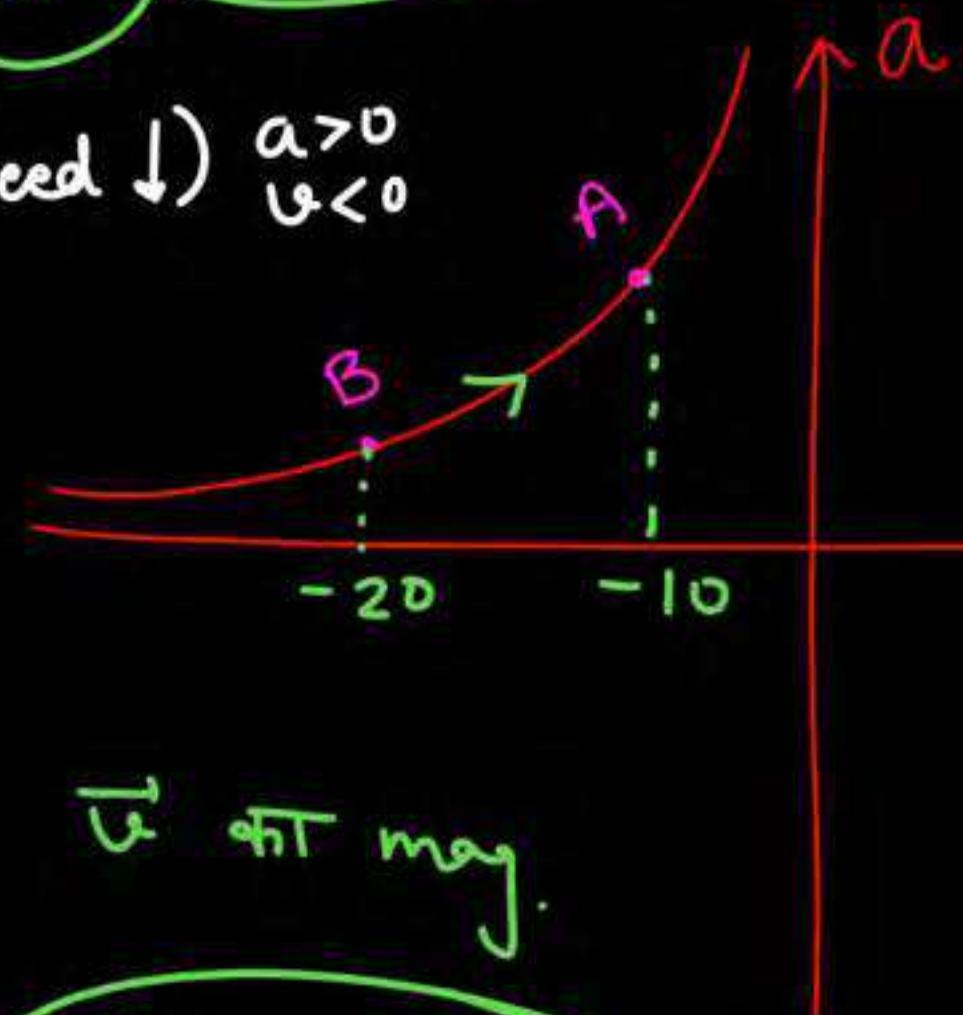


α



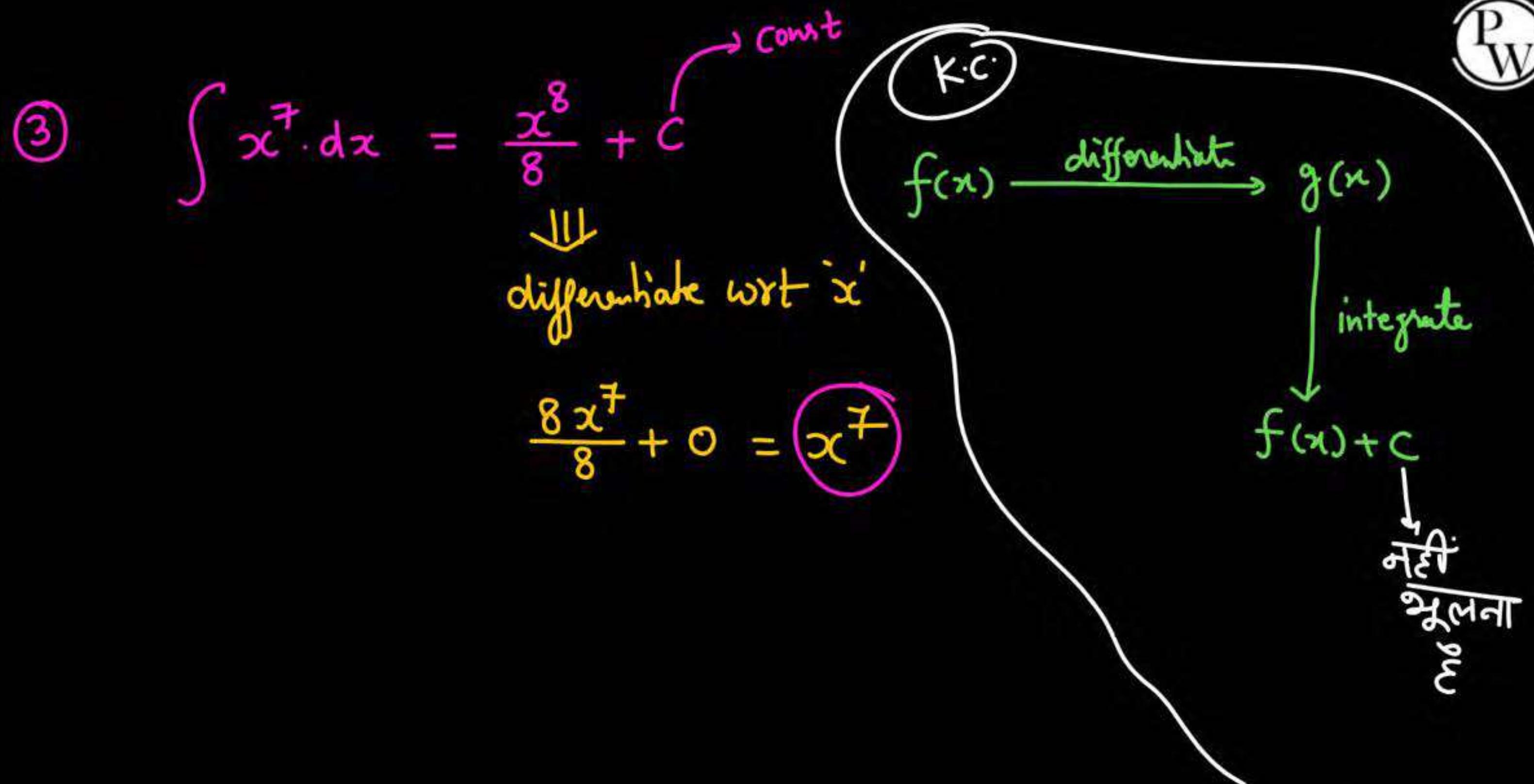
Q HW next dn = Dis

(Speed ↓) $a > 0$
 $v < 0$



B → A

- ① acc is increasing
- ② " " decreasing $\equiv ?$
- ③ v " increasing
- ④ v is decreasing



Q

$$\textcircled{1} \quad x^3 \text{ का diff. wrt } x \Rightarrow 3x^2 \Rightarrow \int 3x^2 dx = 3 \int x^2 dx \\ = 3 \frac{x^3}{3} + C \\ = x^3 + C$$

$$\textcircled{2} \quad x^3 + 5 \text{ का differeniation wrt } x \Rightarrow 3x^2 + 0$$

$$\int 3x^2 \cdot dx = x^3 + C$$

$$\textcircled{3} \quad x^3 + 25 \text{ का diff. लेता हूं } \Rightarrow 3x^2 + 0$$

$$\int 3x^2 dx = x^3 + C$$

④

$$\int x^{10} dx = \frac{x^{11}}{11} + C$$

⑤

$$\int x^{50} dx = \frac{x^{51}}{51} + C$$

⑥

$$\int x^{25} dx = \frac{x^{26}}{26} + C$$

⑦

$$\int x^{-5} dx = \frac{x^{-5+1}}{-5+1} + C$$

$$\textcircled{8} \quad \int x^2 dx = \frac{x^3}{3} + C$$

$$\textcircled{9} \quad \int x^7 dx = \frac{x^8}{8} + C$$

$$\textcircled{10} \quad \int (x^2 + x^3) dx = \frac{x^3}{3} + \frac{x^4}{4} + C$$

$$= \int x^2 dx + \int x^3 dx$$

$$\textcircled{11} \quad \begin{aligned} \int 5x^4 dx &= 5 \int x^4 dx \\ &= 5 \frac{x^5}{5} + C \\ &= x^5 + C \end{aligned}$$

$$\textcircled{12} \quad \int 6x^5 dx = x^6 + C$$

$$\textcircled{13} \quad \int (3x^2 + 7x^6) dx$$

$$= 3\frac{x^3}{3} + 7\frac{x^7}{7} + C = x^3 + x^7 + C$$

$$\textcircled{14} \quad \int x^{-3} dx = \frac{x^{-3+1}}{-3+1} + C$$

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

देखाया गया लिएगा।

$$\textcircled{15} \quad \int \frac{1}{x^3} dx = \int x^{-3} dx$$

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

$$\textcircled{16} \quad \int \left(\frac{1}{x^2} + \frac{1}{x^3} \right) dx = \int (x^{-2} + x^{-3}) dx$$

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

$$\textcircled{17} \quad \int \left(\frac{1}{x^9} + \frac{1}{x^{10}} \right) dx = \int (x^{-9} + x^{-10}) dx$$

$$= \frac{x^{-9+1}}{-9+1} + \frac{x^{-10+1}}{-10+1} + C = \boxed{-\frac{x^{-8}}{8} - \frac{x^9}{9} + C}$$

$$\textcircled{18} \quad \int (3x^2 - 4x^3) dx = x^3 - x^4 + C$$

$$\textcircled{19} \quad \star \star \star$$

$$\int dx = \int 1 dx = \int x^0 dx = \frac{x^{0+1}}{0+1} + C$$

$$= x$$

$$\boxed{\int dx = x + C}$$

$$\int 5dx = 5\int dx = 5x + C$$

$$\int 7dx = 7x + C$$

$$\begin{aligned} & \int (3x^2 + 4x^3 + 5)dx \\ &= 3 \cdot \frac{x^3}{3} + 4 \cdot \frac{x^4}{4} + 5x + C \\ &= x^3 + x^4 + 5x + C \end{aligned}$$

सतीष देव✓

Q

$$\int (2x + 7x^6 + 10) dx = x^2 + x^7 + 10x + C$$

III

differentiate wrt x

same

$$2x + 7x^6 + 10 + 0$$

$$\int (2t + 7t^6 + 10) dt = t^2 + t^7 + 10t + C$$

** very very imp



$$Q \quad \frac{d}{dx} \sin(2x+3) = \cos(2x+3) \cdot [2+0] = 2\cos(2x+3)$$

$$\frac{d}{dx} \sin(ax+b) = a\cos(ax+b)$$

$$\frac{d}{dx} e^{2x+3} = e^{2x+3} \cdot (2+0) = 2e^{2x+3}$$

$$\frac{d}{dx} \sin(2x+3) = 2\cos(2x+3)$$

$$\int 2\cos(2x+3) dx = \sin(2x+3) + C$$

$$\int \cos(2x+3) dx = \frac{1}{2} \sin(2x+3) + C'$$

$$\int \cos x dx = \sin x + C$$

$$\int \cos(ax+b) dx = \frac{1}{a} \sin(ax+b) + C$$

$$\int e^{2x} dx = \frac{1}{2} e^{2x} + C$$

$$\frac{d}{dx} \sin(2x) = 2 \cdot \cos 2x$$

diff → ← integ.

$$\int 2 \cos 2x \cdot dx = \sin 2x + C$$

$$\int \cos 2x \cdot dx = \frac{1}{2} \sin 2x + \frac{C}{2}$$

$$\sin x \xrightarrow{\text{diff}} \cos x$$

$$\int \cos x \cdot dx = \sin x + C$$

$$\int \boxed{\cos 2x} \cdot dx = \sin 2x + C \times$$

III
differentielle

$$\boxed{2(\cos 2x)} + 0$$

$$\int \cos 2x \cdot dx = \boxed{\frac{1}{2} \sin 2x + C}$$

III
differentielle

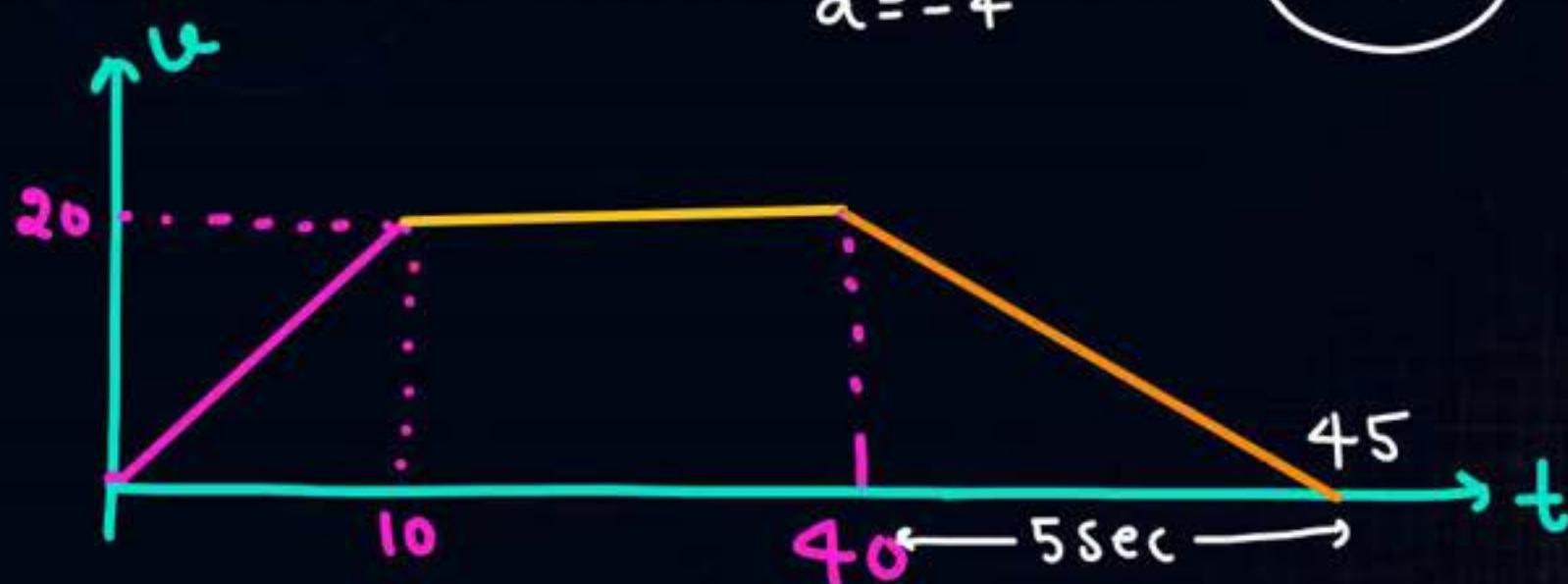
$$\cos 2x = \frac{1}{2} (\cos 2x) \times 2$$

Question

Note ✓

A particle starts from rest, accelerates at 2 m/s^2 for 10 s and then goes at constant speed for 30 s and then decelerates at 4 m/s^2 till it stops. What is the distance travelled by it:

- A 750 m
- B 800 m
- C 700 m
- D 850 m



$$\text{Area} = \frac{1}{2} \times (30 + 45) \times 20 = \underline{\underline{750}}$$

Ans : (A)

Question

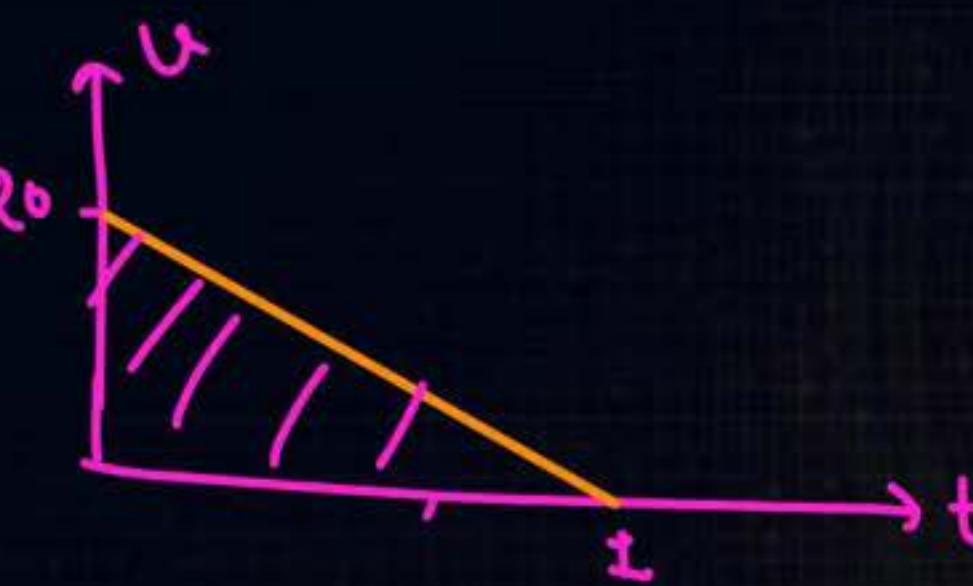
note X

The driver of a car which is moving on a straight horizontal road with a speed of 72 kmh^{-1} applies brakes. If the retardation produced is 20 ms^{-2} , the distance moved by the car before coming to rest will be

- A 10 m
- B 8 m
- C 6 m
- D 2 m

$$u = 72 \frac{\text{km}}{\text{hr}} = 72 \times \frac{5}{18} \text{ m/s} = 20 \text{ m/s}$$

$$\text{Area} = \frac{1}{2} \times 20 \times 1 \\ = 10$$



Ans : (A)

Q A particle starts motion having initial velocity 20 m/s and it moves with const acc of 10 m/s².

① find velocity at t = 4 sec

② find displacement of particle from t = 0 \longrightarrow t = 4 sec

③ find displacement in 4th sec

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

$$S_n = 20 + \frac{1}{2} \cdot (2 \times 4 - 1) \times 10$$

$$= 20 + 35 = 55$$

$$u = 20$$

$$a = 10$$

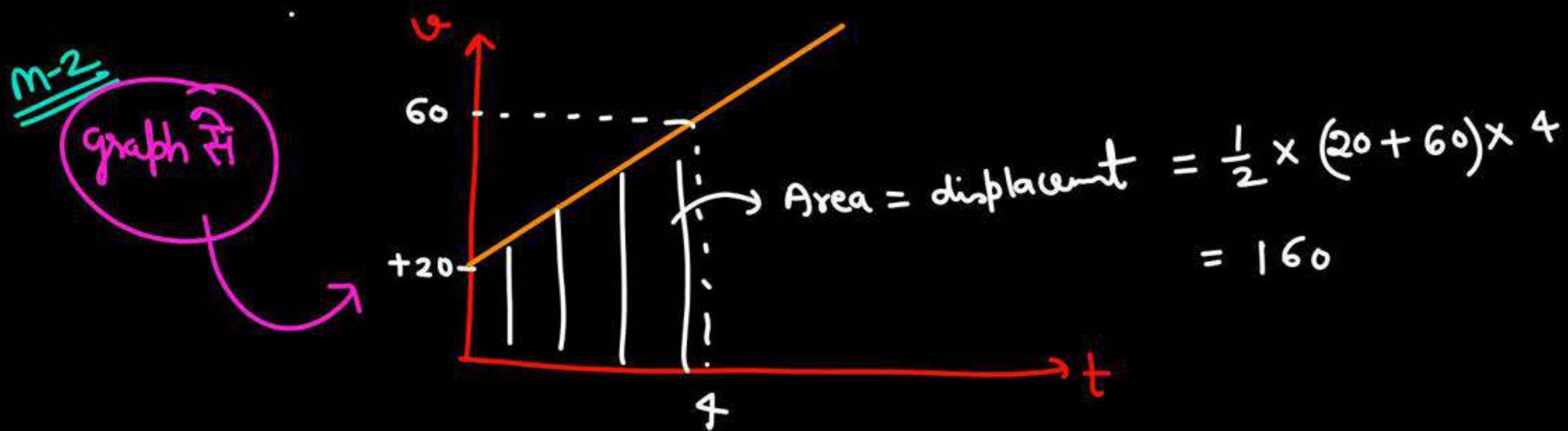
$$\textcircled{1} \quad t = 4, \Rightarrow v = u + at \\ = 20 + 10 \times 4$$

$$v = 60$$

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

$$= 20 \times 4 + \frac{1}{2} \times 10 \times 4^2 = 160$$

Q A particle starts motion having initial velocity 20 m/s and it moves with const acc of 10 m/s^2 .

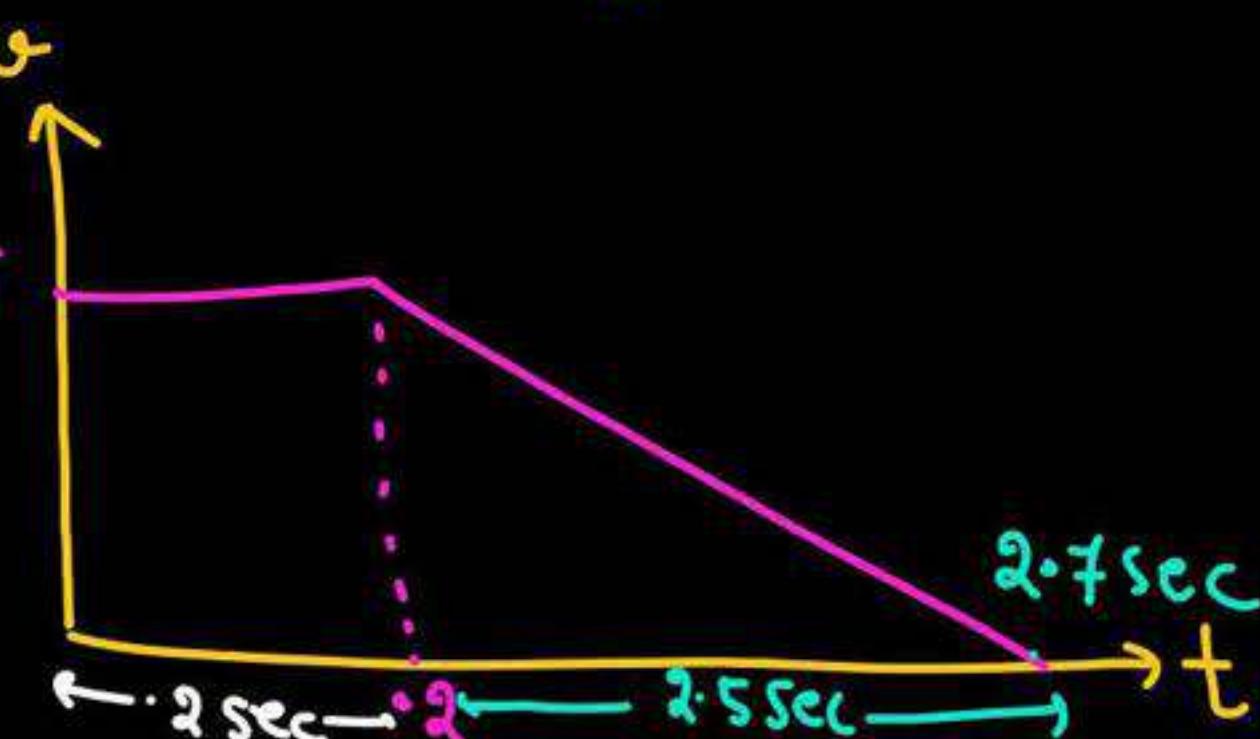


19. A driver takes 0.20 s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of 6.0 m/s^2 , find the distance travelled by the car after he sees the need to put the brakes on.

HCV
note
find stopping distance.

$$54 \text{ km/hr} = 54 \times \frac{5}{18} = 15 \text{ m/s}$$

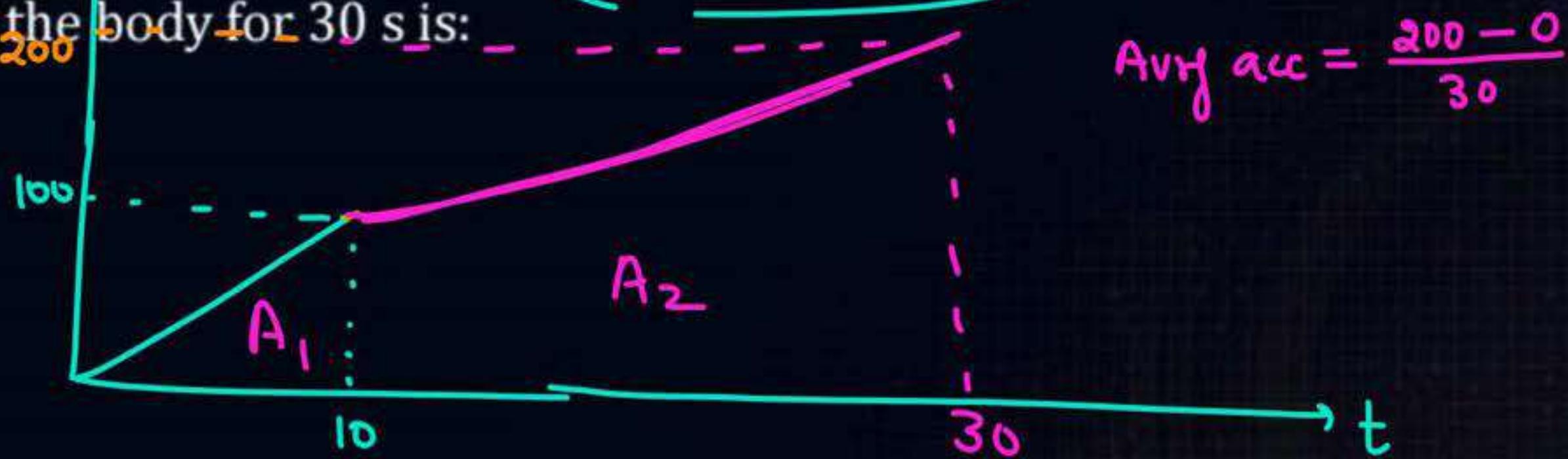
$$\begin{aligned}\text{Area} &= \frac{1}{2} \times (2 + 2.7) \times 15 \\ &= 21.75\end{aligned}$$



Question

Note X

If a body starting from the rest travels with a uniform acceleration of 10 ms^{-2} for first 10 second and with uniform acceleration 5 ms^{-2} for next 20 seconds, then average acceleration of the body for 30 s is:



- A 15 ms^{-2}
- B 10 ms^{-2}
- C 20 ms^{-2}
- D $20/3 \text{ ms}^{-2}$

$$\text{Displac} = A_1 + A_2$$

Ans : (D)

Question

notex

Rough copy

P
W

A car is moving with a velocity of 30 m/s. The driver applied brake for 5 seconds to bring it down to zero. What is the average acceleration?

$$= \frac{v_f - v_i}{\text{total time}} = \frac{0 - 30}{5}$$

$$= -6 \checkmark$$

- A -5 m/s^2
- B 6 m/s^2
- C -6 m/s^2
- D ZERO

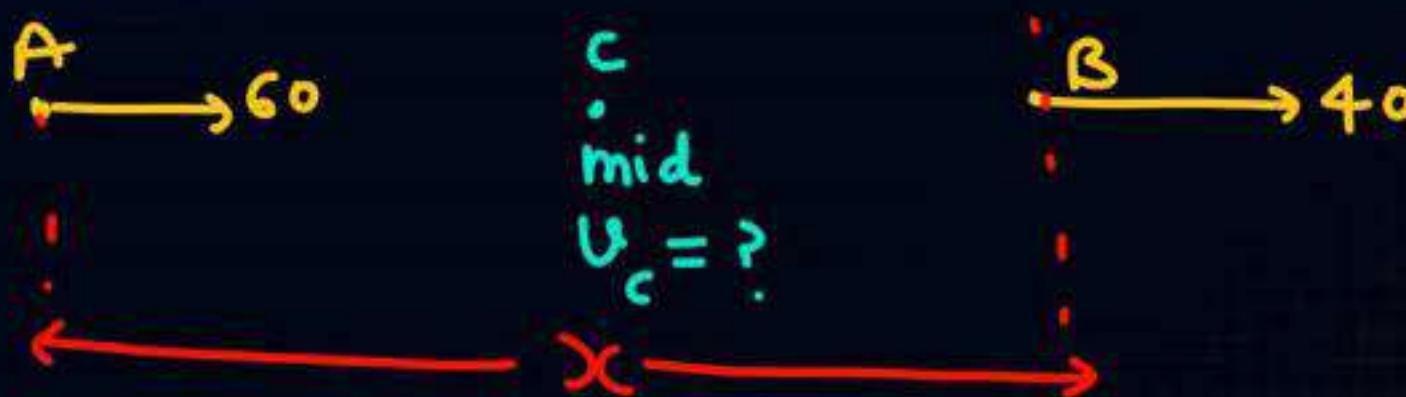
Ans : (C)

Question

Notes ✓

A truck travelling with uniform acceleration crosses two points A and B with velocities 60 m/s and 40 m/s respectively. The speed of the body at the midpoint of A and B is nearest to:

- A 17 m/s
- B 20 m/s
- C 19.49 m/s
- D 50.9 m/s



$\textcircled{A \rightarrow B}$

$\textcircled{(A \rightarrow C)}$

$$40^2 = 60^2 + 2ax \Rightarrow 2ax = -2000$$

$$ax = -1000$$

$$v_c^2 = 60^2 + 2ax \cancel{\frac{x}{2}}$$

$$v_c^2 = 3600 - 1000 = 2600$$

$$v_c = 10\sqrt{26}$$

$$\begin{aligned} 40^2 &= 1600 \\ 60^2 &= \underline{3600} \\ &\quad -2000 \end{aligned}$$

Ans : **(A)**

Question

Notes ✓

Both

P
W

A particle having initial velocity 10 m/s moves with a constant acceleration 5 ms^{-2} , for a time 15 second along a straight line, what is the displacement of the particle in the last 2 second?

A 160 m

$t = 0 \rightarrow t = 15$

B 200 m

$$S_{15} = 10 \times 15 + \frac{1}{2} \times 5 \times (15)^2$$

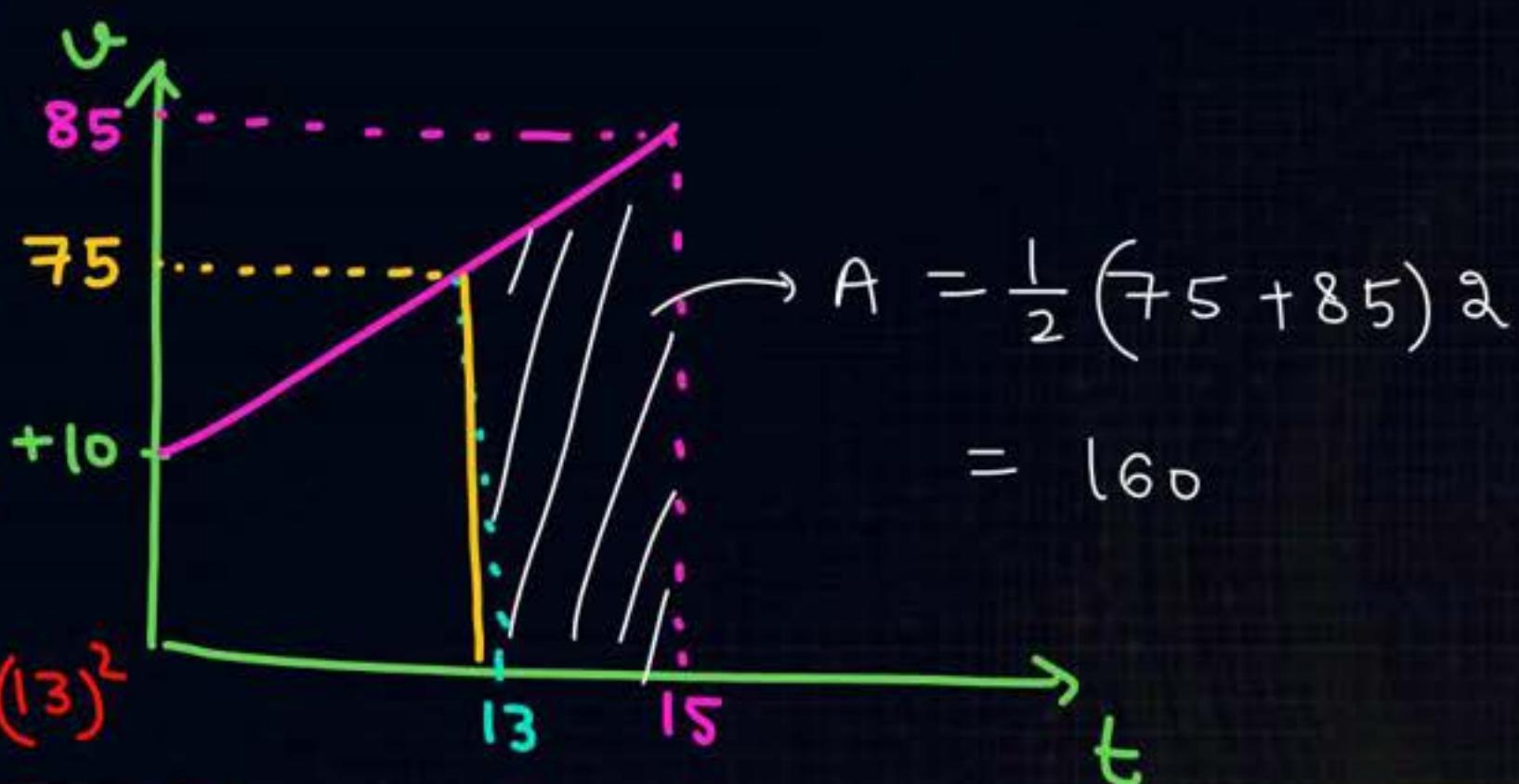
C 210 m

$$S_{13} = 10 \times 13 + \frac{1}{2} \times 5 \times (13)^2$$

D 230 m

$$\text{Ans } S_{15} - S_{13} = 20 + \frac{5}{2} [15^2 - 13^2]$$

$$= 20 + \frac{5}{2} \times 28 \times 2 = 20 + 140 = 160$$



Ans : (A)

Question

Class notes ✓

2 m/s

A bullet moving with a velocity of 200 cm/s penetrates a wooden block and comes to rest after travelling 4 cm inside it. What velocity is needed for travelling distance of 9 cm in same block?

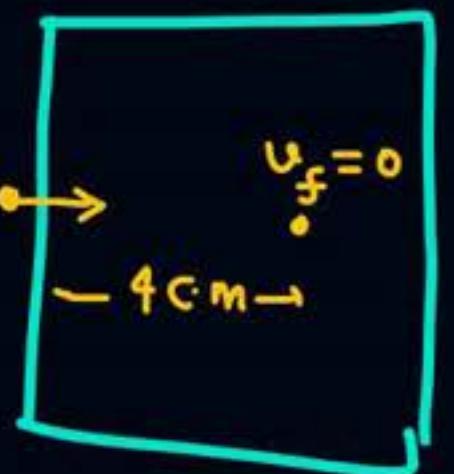
A 100 cm/s

B 136.2 cm/s

C 300 cm/s

D 250 cm/s

$u = 2$



$0^2 = 2^2 + 2a \times \frac{4}{100}$

$-4 = \frac{8}{100} a$

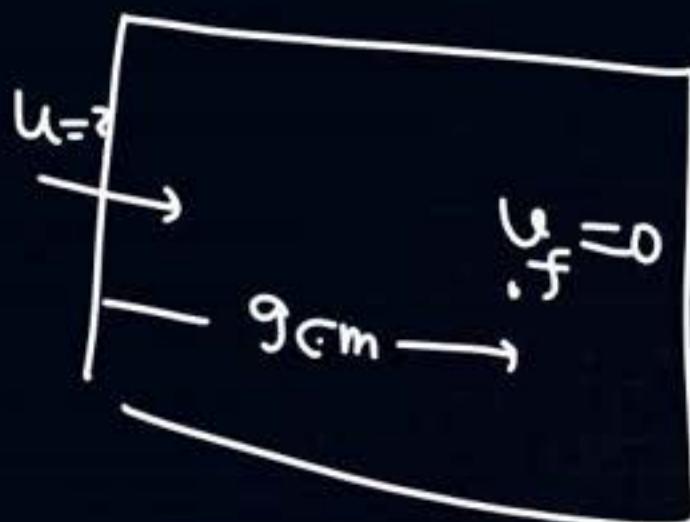
$a = -50$

$0^2 = u^2 + 2as$

$0 = u^2 + 2 \times (-50) \left(\frac{9}{100} \right)$

$u^2 = 9$

$u = 3$



Ans : (C)

Question

note X

$F=ma$

$u = 10$

$v_f = 0$

A car moving with a velocity of 10 m/s can be stopped by the application of a constant force F in a distance of 20m. If the velocity of the car is 30 m/s. It can be stopped by this force in $\alpha = \text{Const}$ $S = 20$

A $20/3$ m

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

$0 = 10^2 + 2a \cdot 20$

$a = -\frac{100}{40} = -\frac{5}{2}$

$0^2 = 30^2 + 2 \times a \times x$

$0 = 900 + 2 \left(-\frac{5}{2} \right) x$

$5x = 900$

$x = 180$

B 20 m

C 60 m

D 180 m

Ans : (D)

Note $u =$

17. A bullet going with speed 350 m/s enters a concrete wall and penetrates a distance of 5.0 cm before coming to rest. Find the deceleration.

Rough

$$v_f = 0 \quad a = ?$$

 $\frac{1}{2} \text{ min}$

$$\begin{array}{r} 35 \\ 35 \\ \hline 1225 \end{array}$$

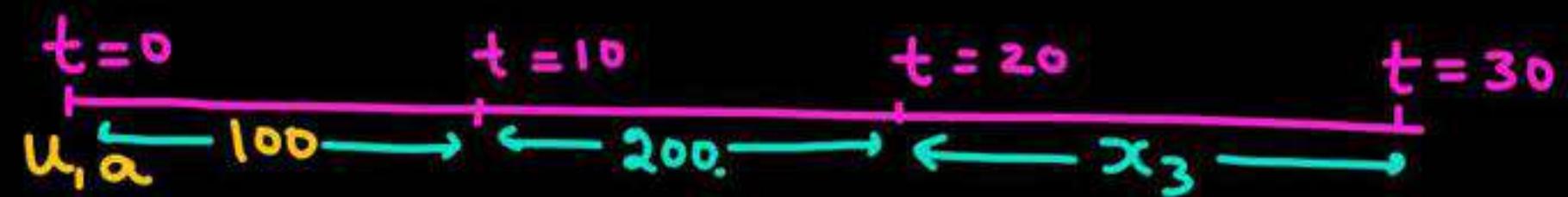
$$0^2 = (350)^2 + 2 \times a \times \frac{5}{100}$$

$$a = -(350)^2 \times 10$$

$$a = -1225000$$

Q A particle covered 100m distance in first 10 sec. and in next 10 sec it travel 200m. find distance travel in next 10 sec. (acc is const)

300 X
400 X



$$t=0 \rightarrow t=10 \Rightarrow 100 = u \times 10 + \frac{1}{2} a \cdot 10^2$$

$$100 = 10u + 50a \quad \text{--- (1)}$$

$$\textcircled{1} - \textcircled{2}$$

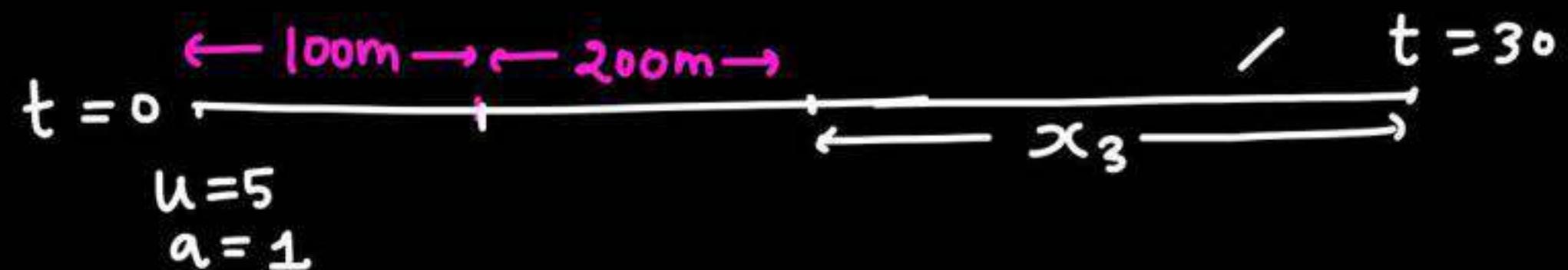
$$-50 = -50a$$

$$t=0 \rightarrow t=20 \Rightarrow 300 = u \cdot 20 + \frac{1}{2} \cdot a \cdot (20)^2$$

$$300 = 20u + 200a$$

$$150 = 10u + 100a \quad \text{--- (2)}$$

$a = 1$
$u = 5$



$$t = 0 \longrightarrow t = 30$$

$$300 + x_3 = ut + \frac{1}{2}at^2$$

$$300 + x_3 = 5 \times 30 + \frac{1}{2} \times 1 \times (30)^2$$

$$300 + x_3 = 150 + 450$$

$$x_3 = 300$$

A particle, after starting from rest, experiences, constant acceleration for 20 seconds. If it covers a distance of S_1 , in first 10 seconds and distance S_2 in next 10 sec, then

(a) $S_2 = S_1/2$

(b) $S_2 = S_1$

(c) $S_2 = 2S_1$

~~(d)~~ $S_2 = 3S_1$

$$S_1 = 0 + \frac{1}{2} \cdot a \cdot 10^2$$

$$\frac{S_1 + S_2}{S_1} = \frac{400}{100}$$

$$S_1 + S_2 = 0 + \frac{1}{2} \cdot a \cdot (20)^2$$

$$1 + \frac{S_2}{S_1} = 4$$

$$\frac{S_2}{S_1} = 3$$

$S_2 = 3S_1$

Q A particle travels x_1 in 1st 10 sec & x_2 in next 10 sec
find distance travelled in next 10 sec. ($a \rightarrow \text{const}$)

$$x_1 = u \times 10 + \frac{1}{2} \cdot a \cdot 10^2$$

$$x_1 + x_2 = u \times 20 + \frac{1}{2} \cdot a \cdot 20^2$$

$$x_1 + x_2 + x_3 = u \times 30 + \frac{1}{2} \cdot a \cdot 30^2$$

$$\begin{aligned} a &= \checkmark \\ u &= \checkmark \end{aligned}$$

Q A particle starts motion from origin towards $+x$ -axis with initial velocity 60 m/s and $\text{const acc} = -10\text{ m/s}^2$

① When particle will come to at rest

$$t = 6$$

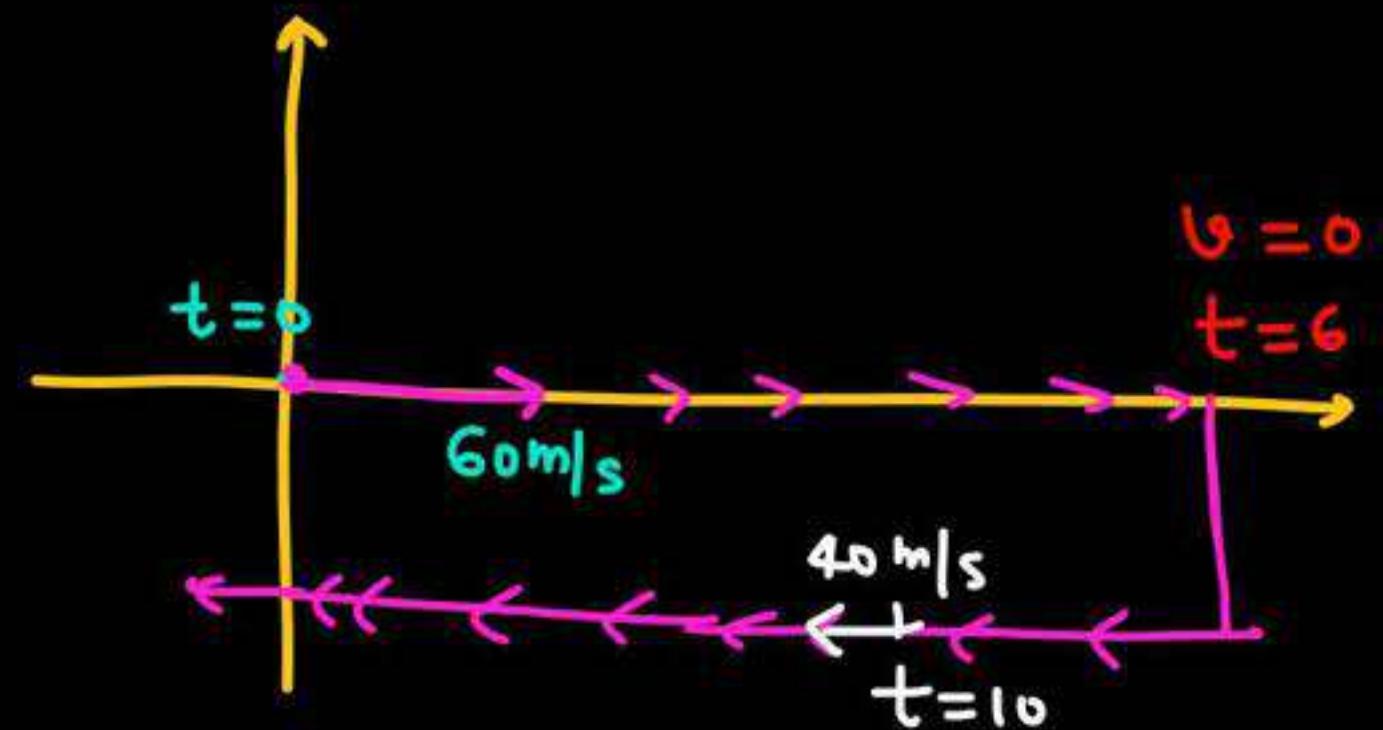
② find v at $t = 2$, $v = 40$

" v at $t = 10\text{ sec}$

$$v = -40$$

③ Displacement in 10 sec

$$S = 60 \times 10 + \frac{1}{2} \times (-10) \times 10^2 = 600 - 500 = 100$$



A particle starts from rest at $t = 0$ and $x = 0$ to move with a constant acceleration $= +2 \text{ m/s}^2$, for 20 seconds. After that, it moves with -4 m/s^2 for the next 20 seconds. Finally, it moves with positive acceleration for 10 seconds until its velocity becomes zero.

- (a) What is the value of the acceleration in the last phase of motion?
- (b) What is the final x-coordinate of the particle?
- (c) Find the total distance covered by the particle during the whole motion.



Ans

- (a) 4 m/s^2
- (b) 200 m
- (c) 1000 m

A car accelerates with uniform rate from rest on a straight road. The distance travelled in the last second of a three second interval from the start is 15 m then find the distance travelled in first second in m.

HW

Ans → 3

A particle moving in one-dimension with constant acceleration of 10 m/s^2 is observed to cover a distance of 100 m during a 4s interval. How far will the particle move in the next 4s?

HW

Ans 260

Q2

$$\begin{array}{c} u = 45 \text{ m/s} \\ \text{---} \\ a = -10 \end{array}$$

distance travelled in 5th sec.

$$\text{Displacement} = A_{\text{अपर}} - A_{\text{तीव्र}} = 0$$

$$\begin{aligned} \text{Distance} &= A_{\text{अपर}} + A_{\text{तीव्र}} \\ &= \frac{25}{20} + \frac{25}{20} = \frac{50}{20} = \underline{2.5} \end{aligned}$$



$$A_{\text{अपर}} = \frac{1}{2} \times 5 \times 5 = \frac{25}{20}$$

$$A_{\text{तीव्र}} = \frac{1}{2} \times 5 \times 5 = \frac{25}{20}$$



$$\textcircled{1} \quad t = 4, v = 20$$

$$\textcircled{2} \quad t = 6, v = 0$$

$$\textcircled{3} \quad t = 8, v = -20$$

$$\textcircled{4} \quad t = 10, v = -40$$

$$\textcircled{5} \quad t = 12, v = -60$$

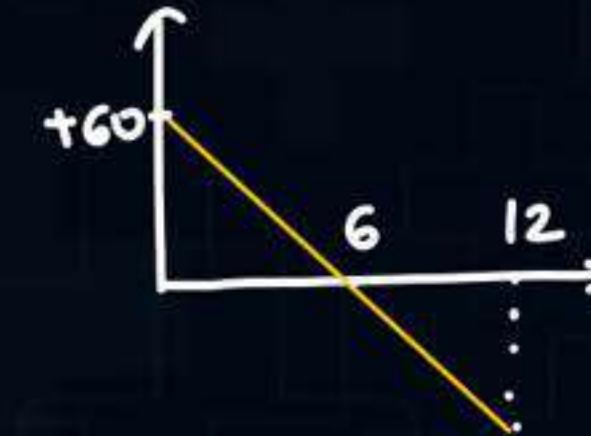
⑥ find location of particle at $t = 4 \text{ sec}$

$$u = +60, \alpha = -10$$

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

$$x = 60 \times 4 - \frac{1}{2} \times 10 \times 4^2$$

$$x = 240 - 80 = \underline{\underline{160}}$$



⑦ find location of particle at $t = 8 \text{ sec}$

$$x = 60 \times 8 - \frac{1}{2} \times 10 \times 8^2$$

$$x = 480 - 320 = 160$$

③ find where particle comes to rest

$$x_{\max} = ?$$

$$v_f = 0$$

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

$$0 = (60)^2 + 2(-10)x_{\max}$$

$$\boxed{x_{\max} = 180}$$

Q A particle is projected from ground vertically upward with Velocity 60 m/s. find

① find velocity at $t = 10$

Sign Convention

Consider Upward dir^h (+ve)

$$u = 60 \text{ ऊपर} = +60$$

$$a = 10 \text{ नीचे} = -10$$

$$\textcircled{1} \quad t = 10, \quad v = u + at = 60 + (-10)(10)$$

$$v = -40$$

location

$$t = 10$$

$$y = 60 \times 10 + \frac{1}{2}(-10)(10)^2 = +100$$



$$t=6 \rightarrow v_f = 0$$

Q.

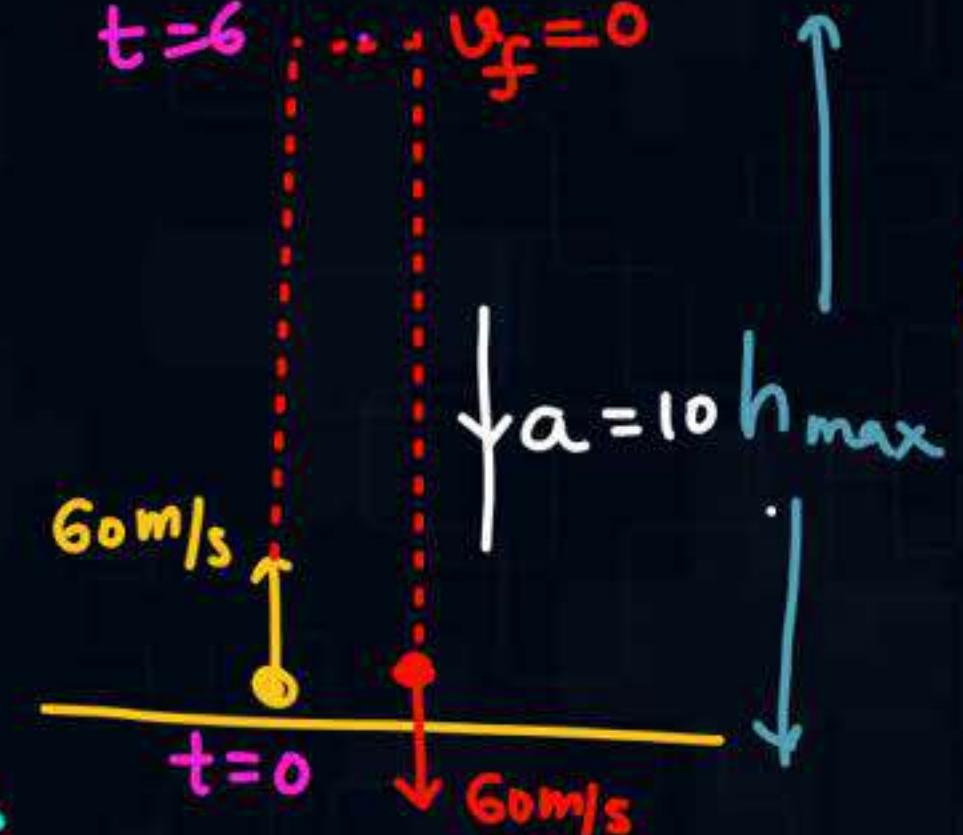
① find v at

$$t=4, v = 20$$

$$t=11, v = -50$$

② when particle will comes to at rest $t=6$

③ find time of flight $\Rightarrow 6+6 = 12 \text{ sec}$

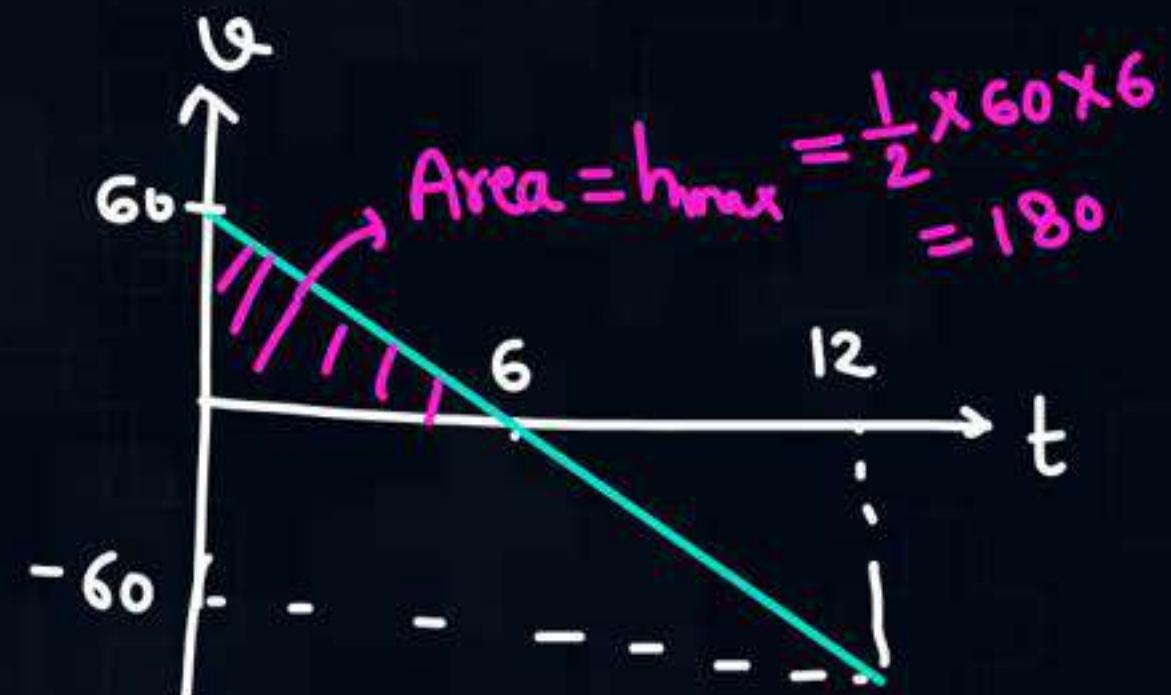


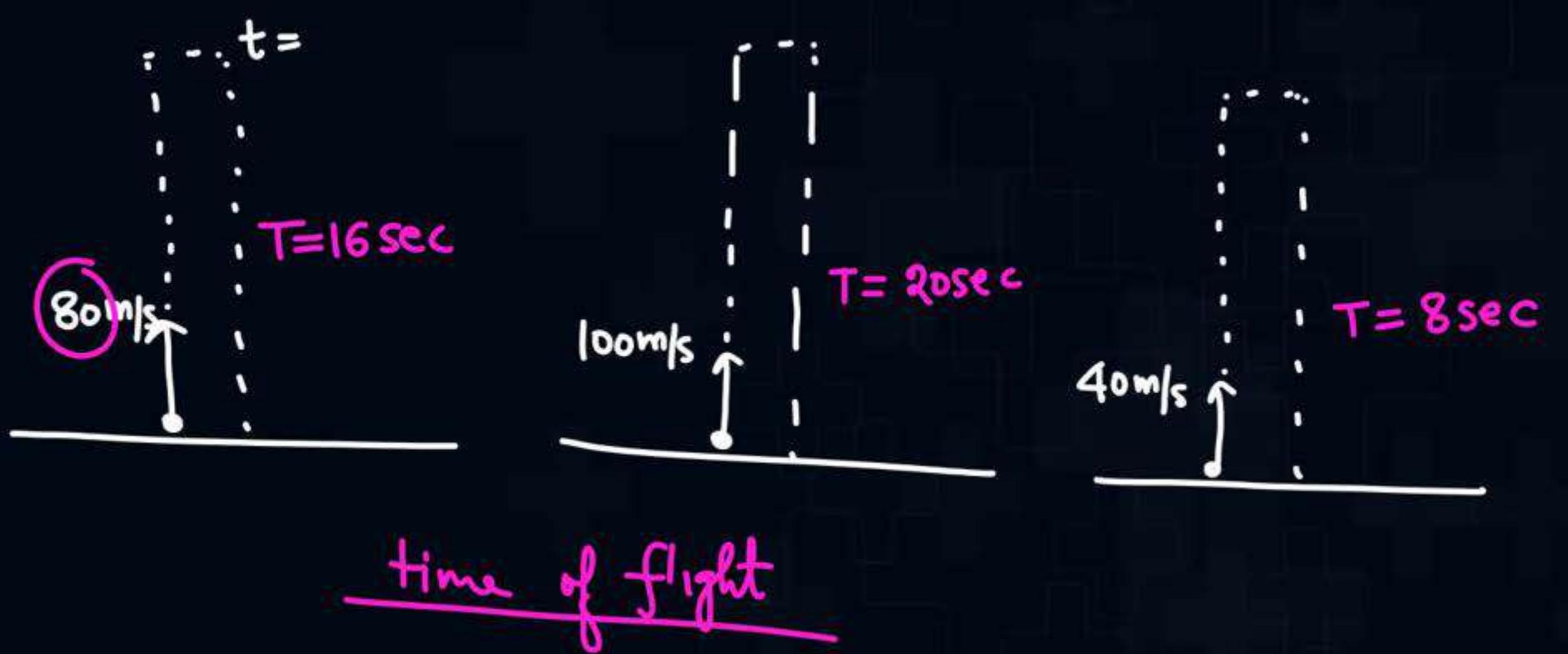
④

max height

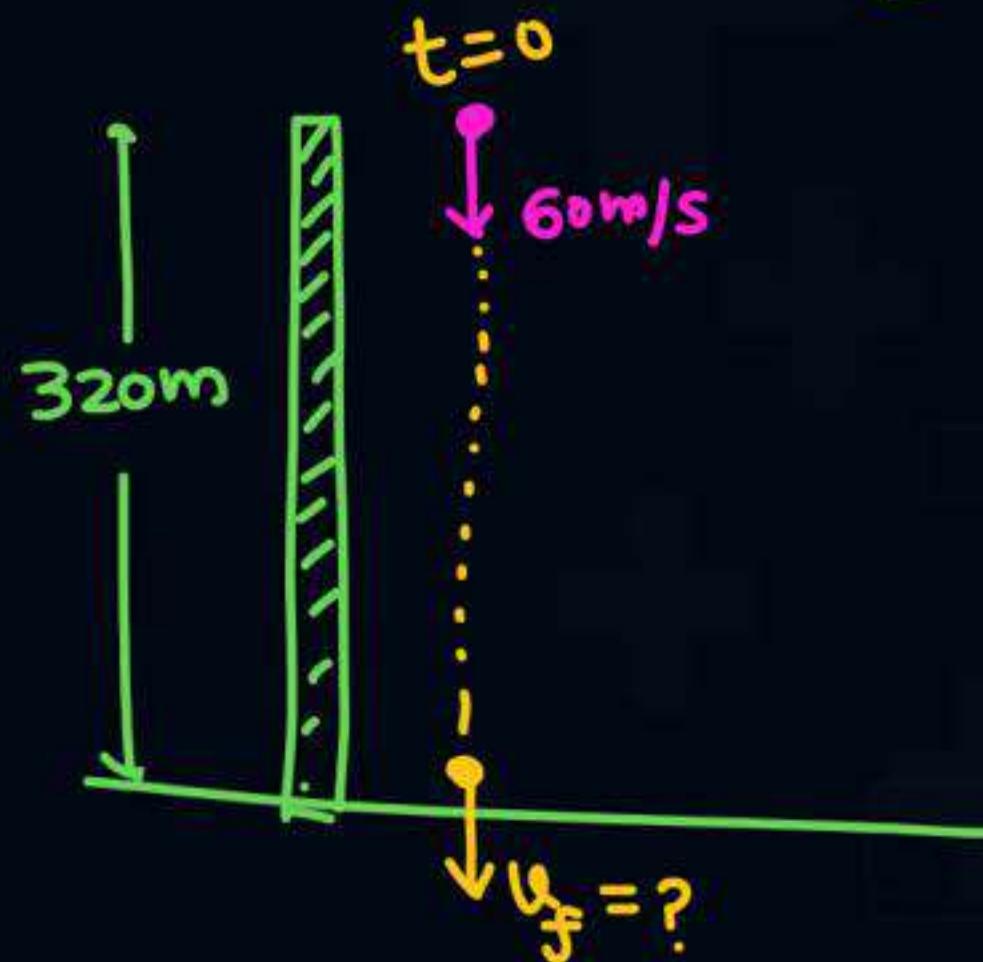
$$0^2 = 60^2 + 2 \times (-10) h_{\max}$$

$$h_{\max} = 180$$





Q



Q when particle will hit the ground
& with what velocity.

नीचे \Rightarrow +ve (downward)

$$u = +60 \quad a = +10$$

$$\text{displacement} = s = \text{नीचे } 320 \\ s = +320$$

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

$$+320 = 60t + \frac{1}{2} \times 10 \times t^2$$

$$t^2 + 12t - 64 = 0$$

$$(t+16)(t-4) = 0$$

$$t = 4 \text{ sec}$$

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

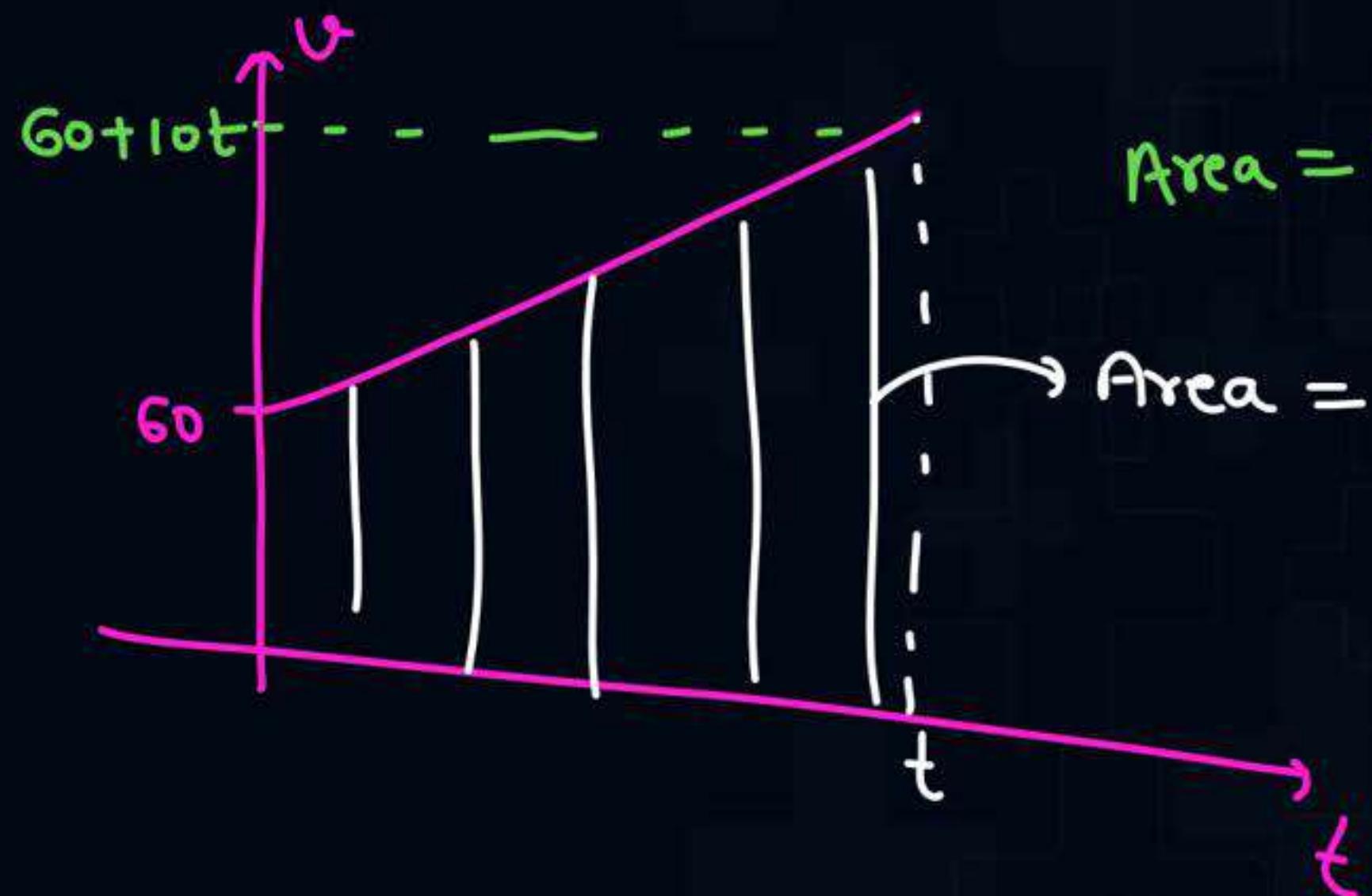
$$v^2 = 60^2 + 2 \times 10 \times 320$$

$$v^2 = 3600 + 6400$$

$$v^2 = 10000$$

$$v = 100 \text{ (नीचे)}$$

III
(Common Sense)



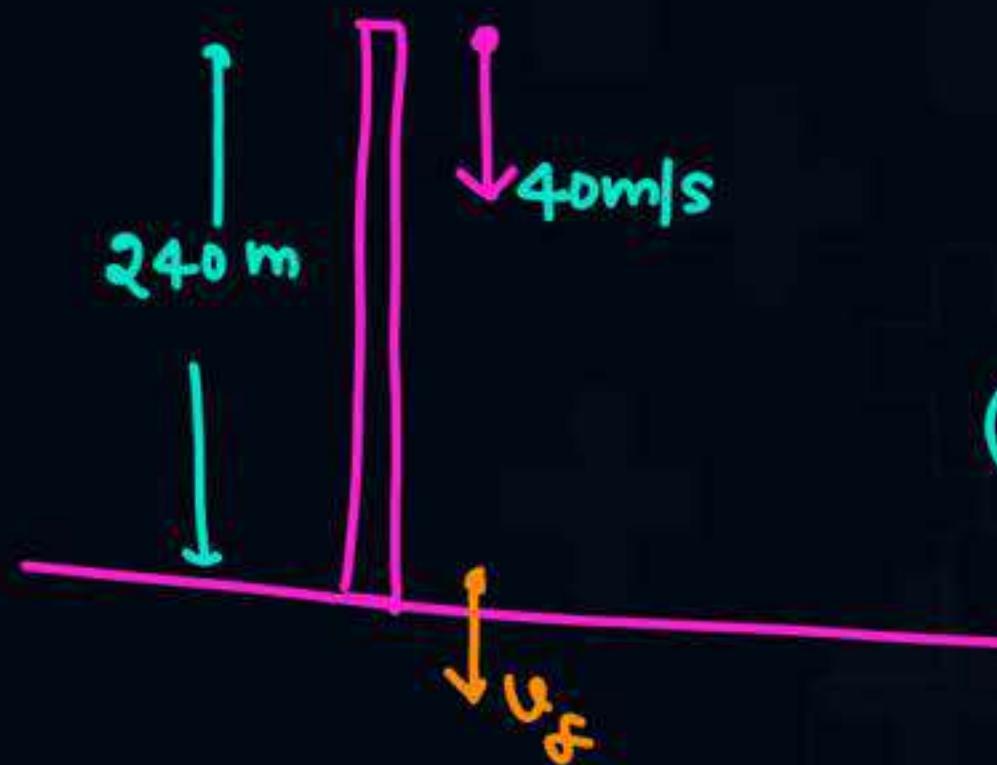
$$\text{Area} = \frac{1}{2}(60 + 60 + 10t) \times t = 320$$

$$(120 + 10t)t = 640$$

$$10t^2 + 120t = 640$$

$$t^2 + 12t - 64 = 0$$

Q



downward = +ve

$$u = +40$$

$$a = +10$$

$$s = +240$$

① velocity of particle before it hit the ground

$$u^2 = (40)^2 + 2 \times 10 \times 240$$

$$u = 80 \text{ (Ans)}$$

② when particle will hit the ground.

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

$$240 = 40t + \frac{1}{2} \times 10 \times t^2$$

$$5t^2 + 40t - 240 = 0$$

$$t^2 + 8t - 48 = 0$$

$$(t+12)(t-4) = 0$$

$t=4$ ✓

Q note ✓



when it will hit the ground

$$u = 0$$

$$a = +10$$

$$S = +500$$

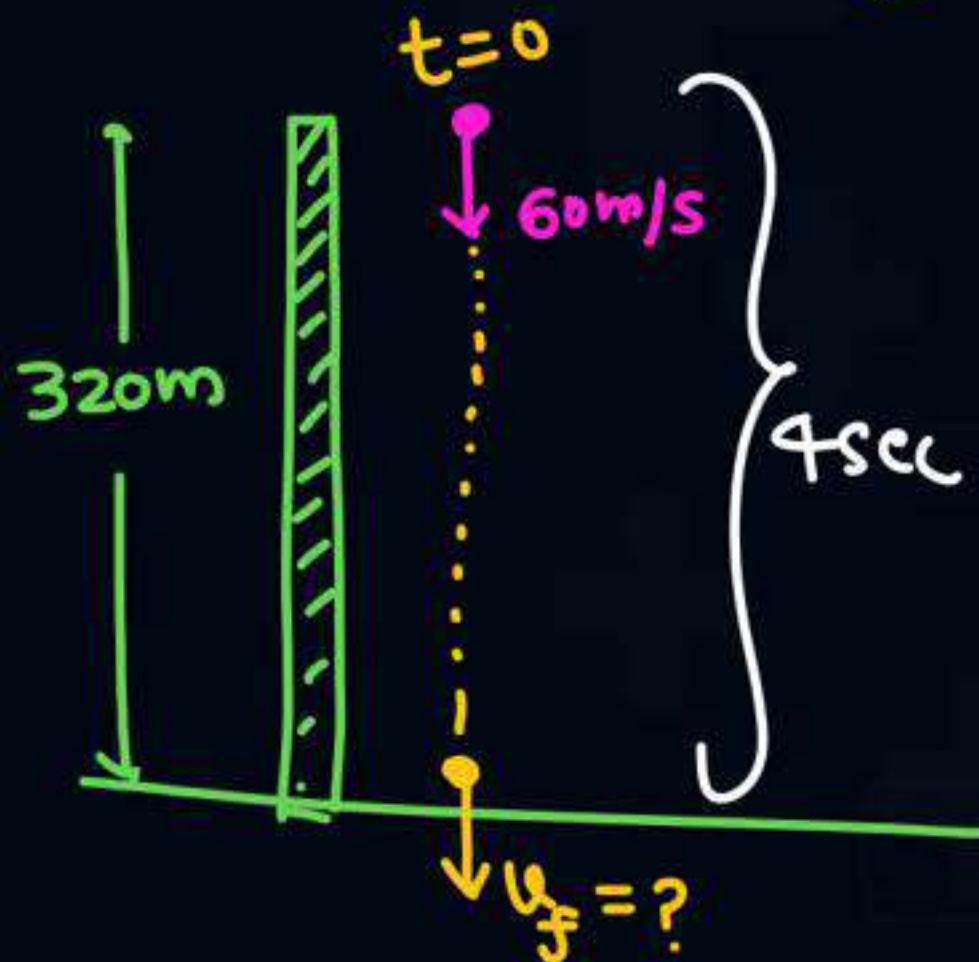
$$500 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$t = \sqrt{\frac{1000}{10}} = 10 \text{ sec}$$

$$v_f^2 = 0^2 + 2 \times 10 \times 500$$

$$v_f = 100$$

Q



Q when particle will hit the ground & with what velocity.

नीचे \Rightarrow +ve (downward)

$$u = +60 \quad a = +10$$

$$\text{displacement} = s = \text{नीचे } 320 \\ s = +320$$

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

$$+320 = 60t + \frac{1}{2} \times 10 \times t^2$$

$$t^2 + 12t - 64 = 0$$

$$(t+16)(t-4) = 0$$

$$t = 4 \text{ sec}$$

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

$$v^2 = 60^2 + 2 \times 10 \times 320$$

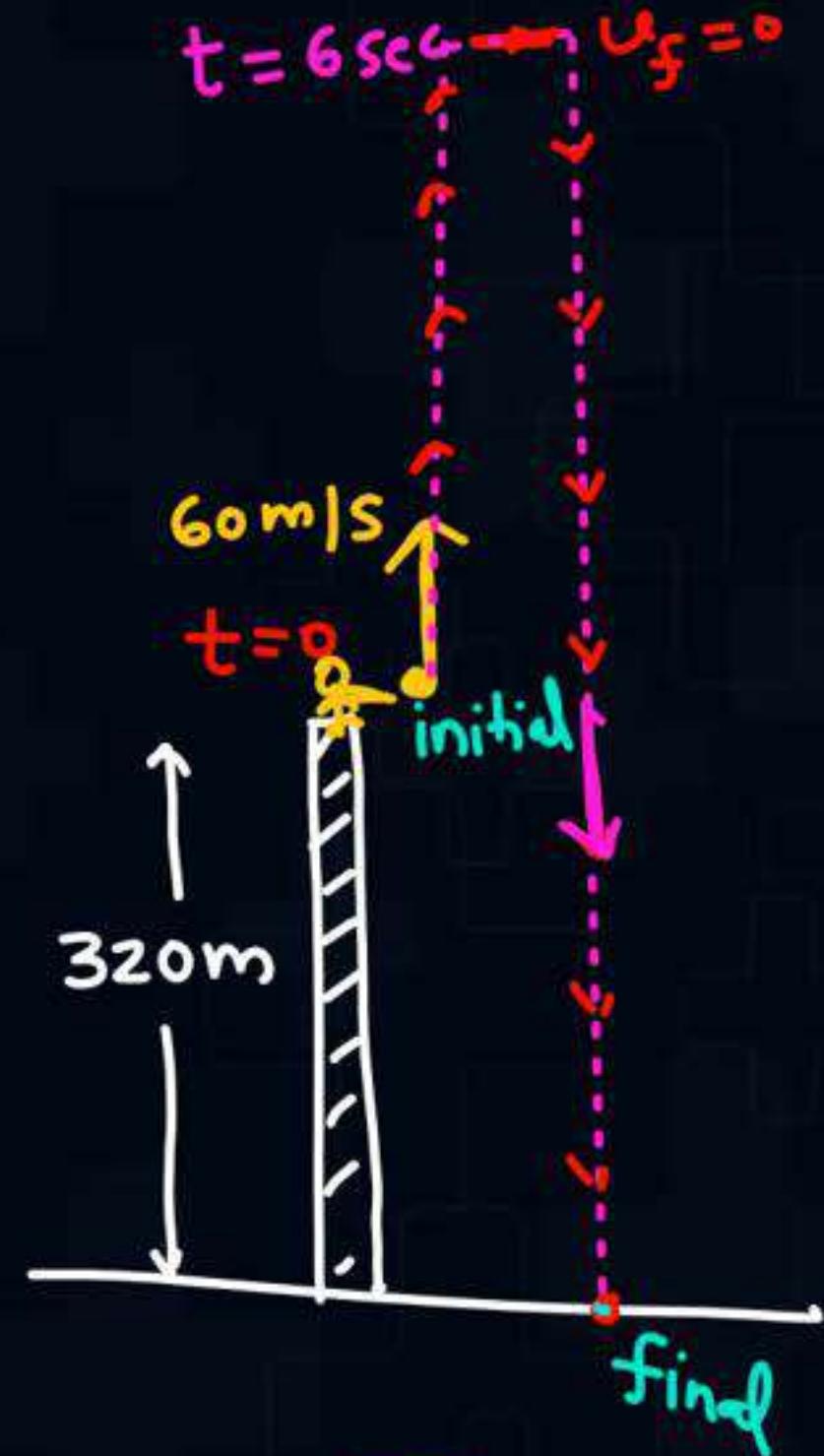
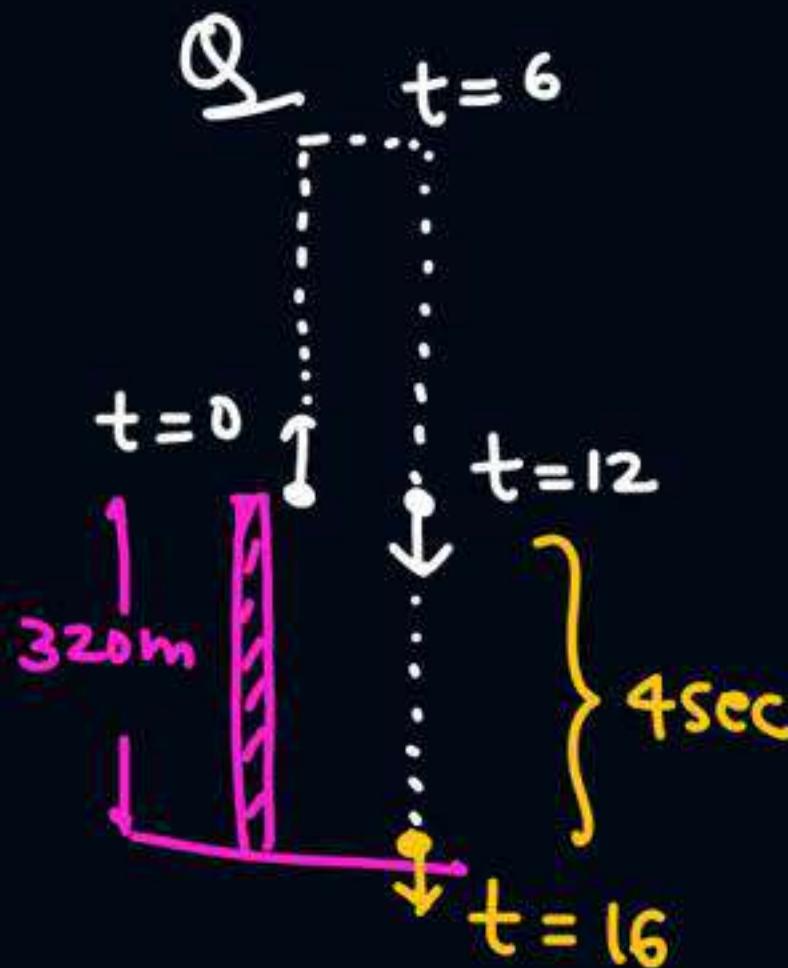
$$v^2 = 3600 + 6400$$

$$v^2 = 10000$$

$$v = 100 \text{ (नीचे)}$$

III
(Common Sense)

$$t = 6 \text{ sec} \rightarrow v_f = 0$$



$$t = 16 \text{ sec}$$

when it will hit the ground.

उपर $\rightarrow +ve$

$$u = \text{उपर } 60 = +60$$

$$a = \text{नीचे } g = -10$$

$$S = \text{नीचे } 320 = -320$$

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

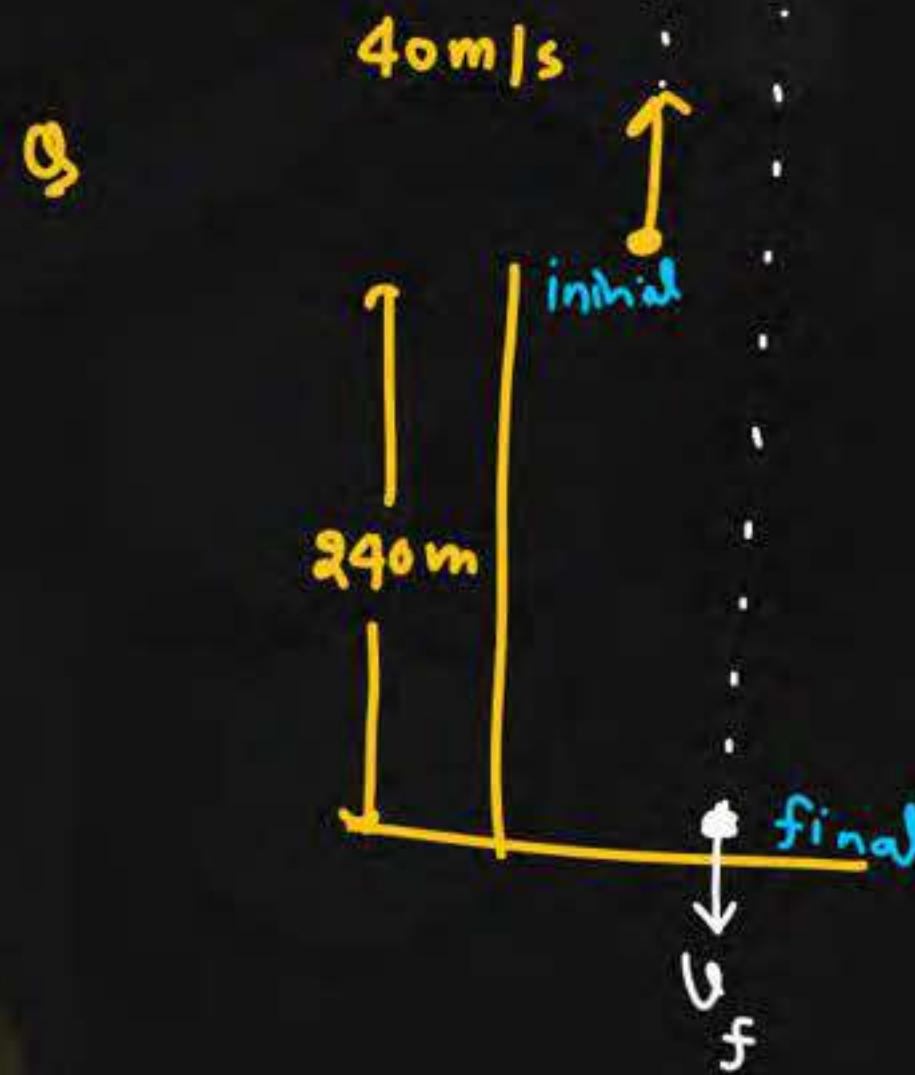
$$-320 = 60t - \frac{1}{2} \times 10 \times t^2$$

$$5t^2 - 60t - 320 = 0$$

$$t^2 - 12t - 64 = 0$$

$$(t-16)(t+4) = 0$$

on M practice



- ① find the time when particle will hit the ground
- ② " " velocity just before particle hit the ground

Upward (positive) \rightarrow +ve

$$u = +40$$

$$a = -10$$

$$s = -240$$

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

$$-240 = 40t + \frac{1}{2}(-10)t^2$$

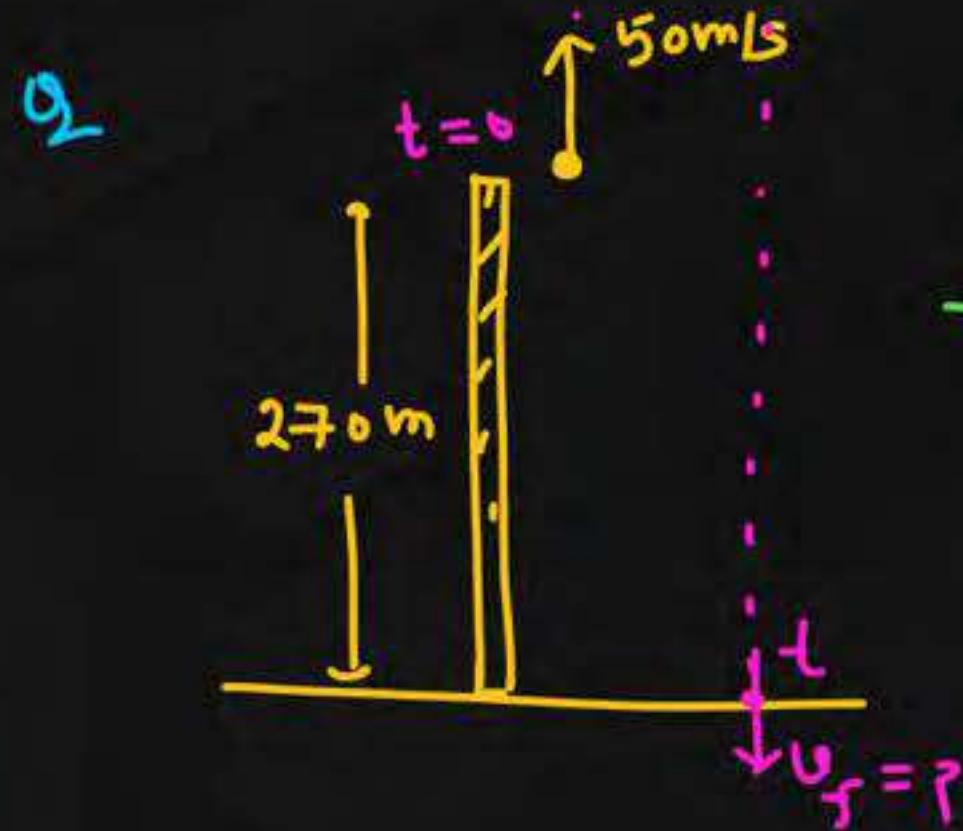
$$5t^2 - 40t - 240 = 0$$

$$t^2 - 8t - 48 = 0$$

$$(t-12)(t+4) = 0$$

$t = 12 \text{ Ans}$

$$\begin{aligned} v^2 &= u^2 + 2as \\ &= (40)^2 + 2 \times (-10)(-240) \\ \boxed{v &\approx 80} \end{aligned}$$

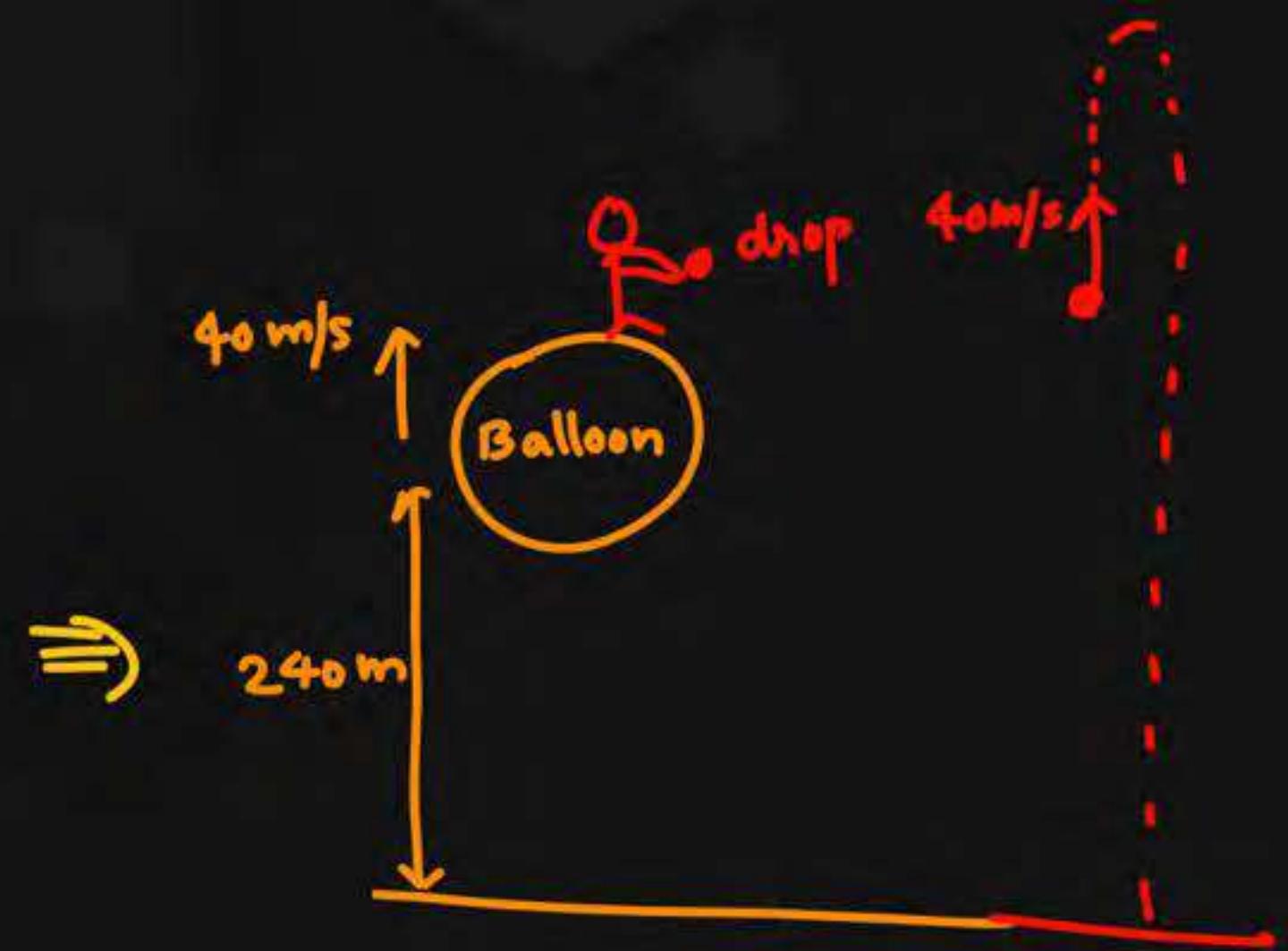
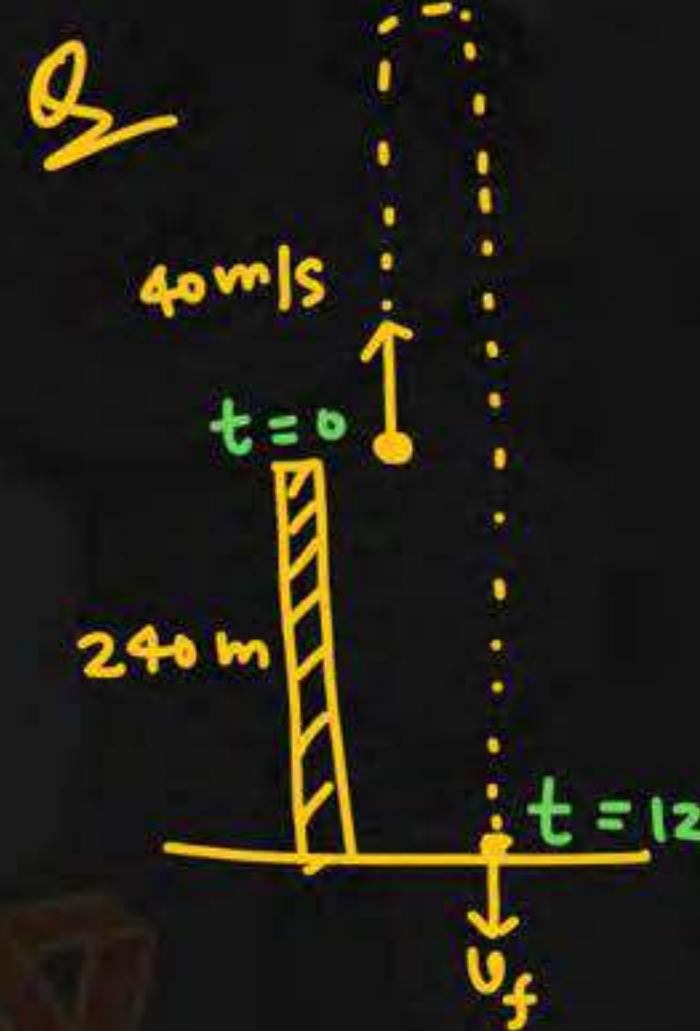


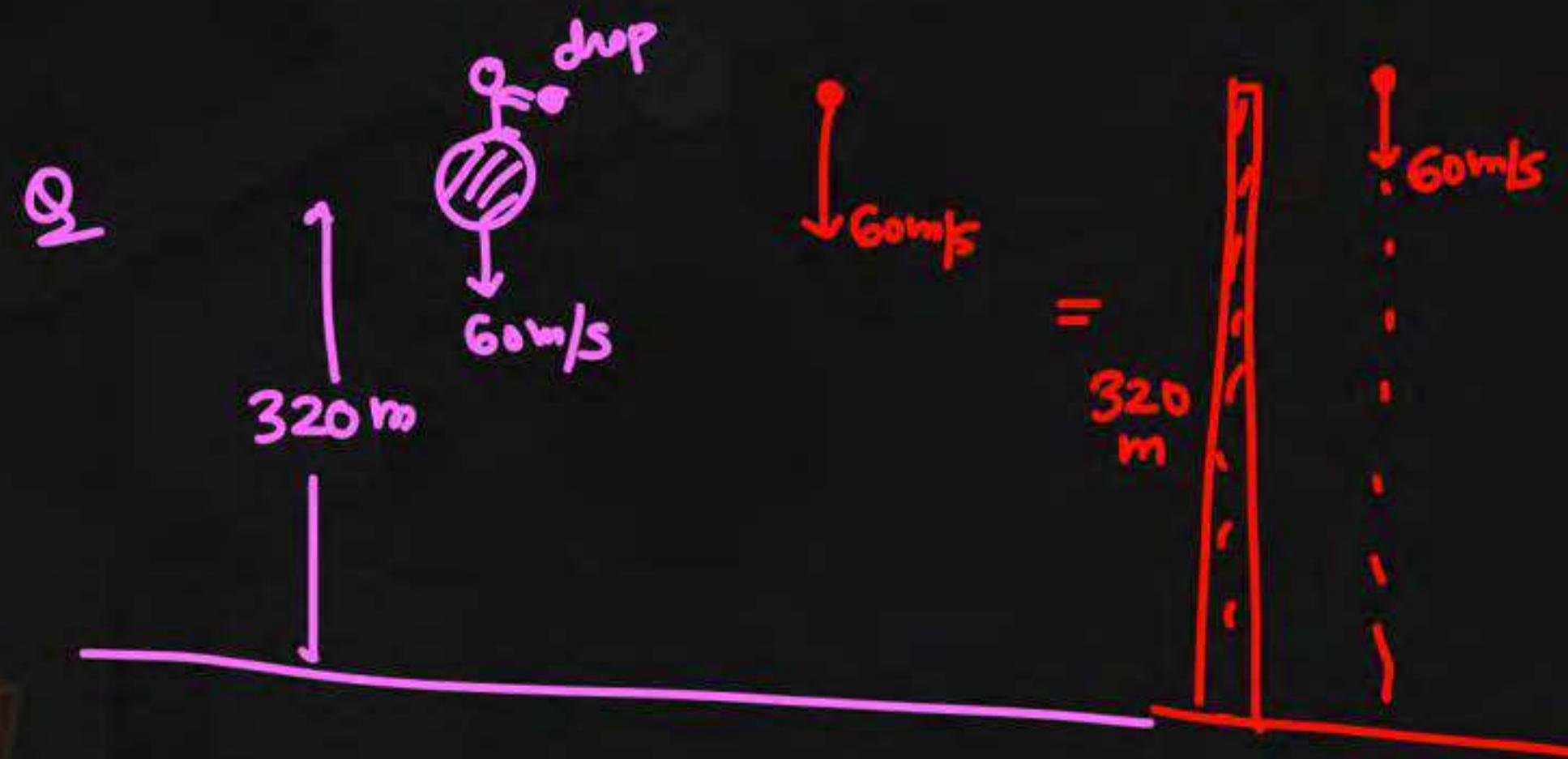
$$S = ut + \frac{1}{2}at^2$$

$$-270 = 50t - \frac{1}{2} \times 10 \times t^2$$

Solve quadratic ✓

$$U_f^2 = (50)^2 + 2(-10)(-270)$$



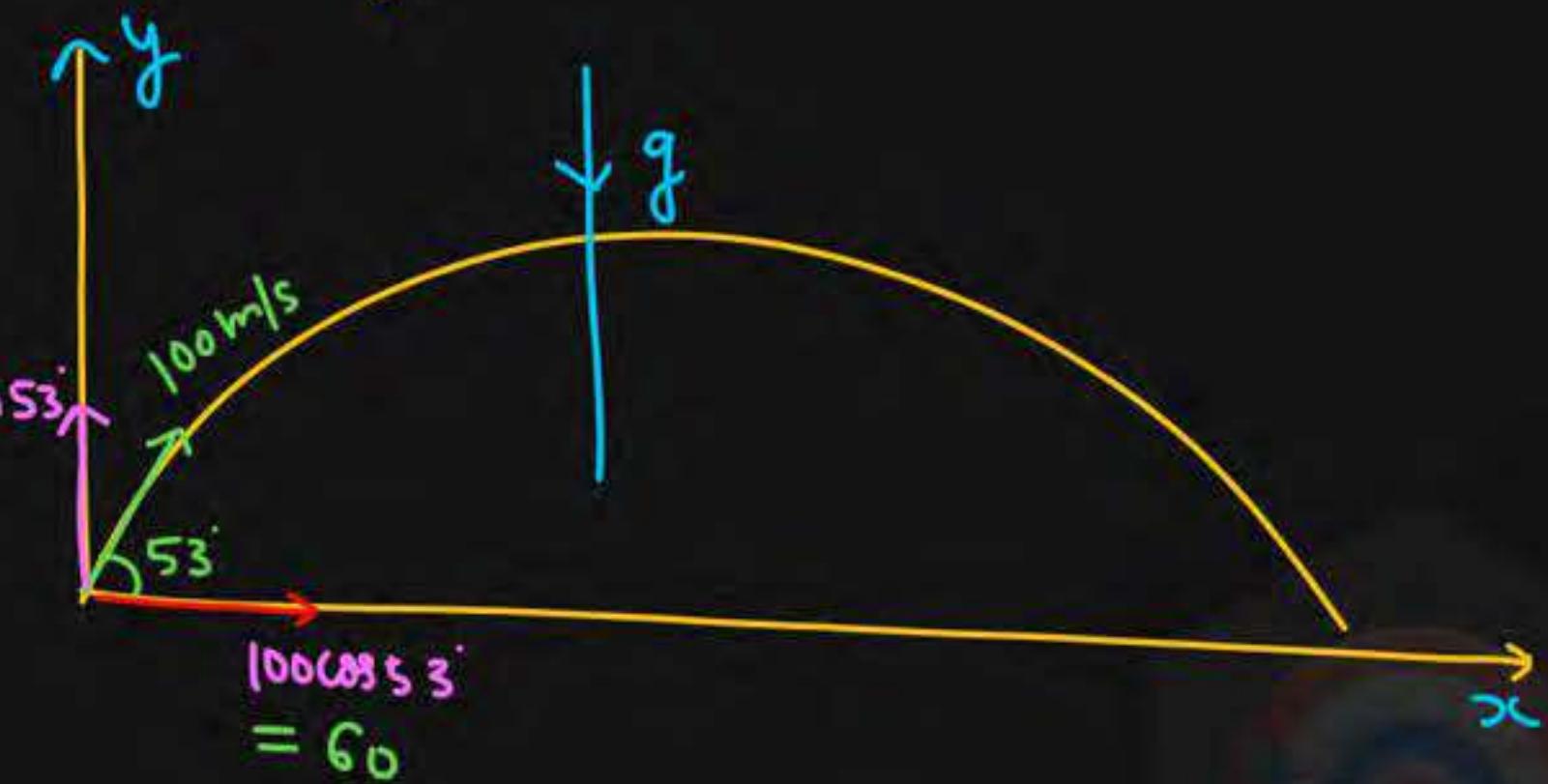


Q A particle is projected with velocity 100 m/s at angle of 53° with the horizontal.

(a) Find initial velocity

$$\vec{v} = 60\hat{i} + 80\hat{j}$$

$$v_0 = 100 \sin 53^\circ$$



(b) $\vec{a} = g$ नीचे

$$\vec{a} = -g\hat{j} = -10\hat{j}$$

$$\vec{a} = 0\hat{i} - 10\hat{j}$$

$$\vec{a}_x = 0$$

(c) Find time of flight

$$T = 8 + 8 = 16 \text{ sec}$$

(d) Range = $60 \times 16 = 960$

(e) find velocity at

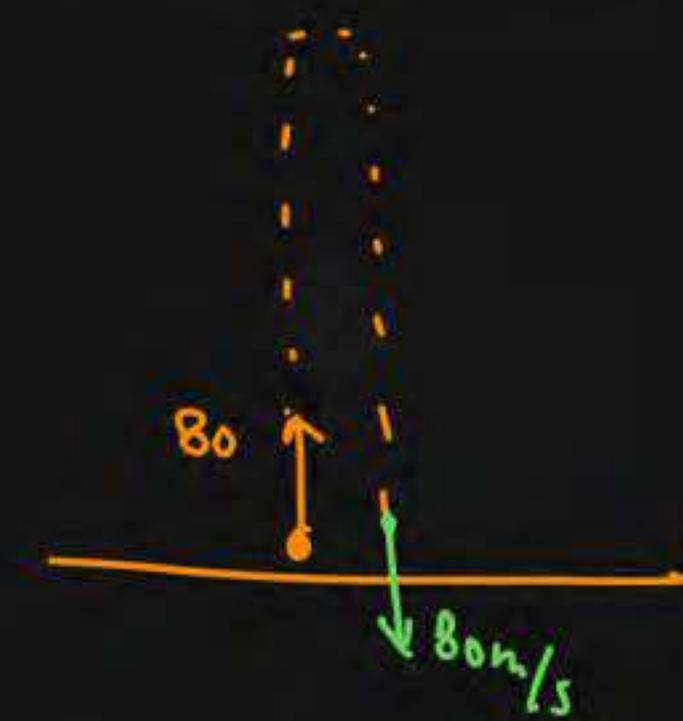
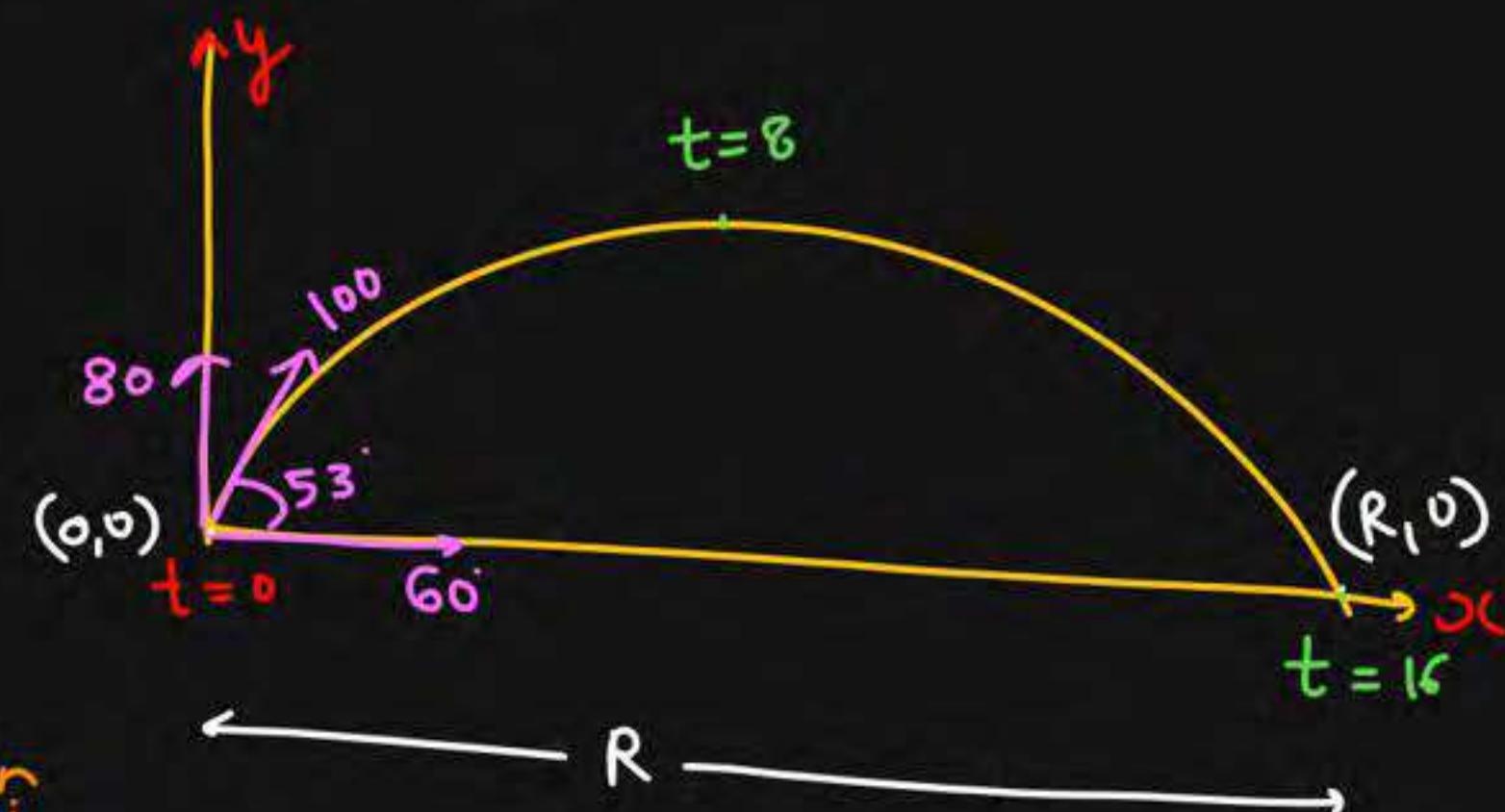
$$t = 2 \quad \vec{v} = 60\hat{i} + 60\hat{j}$$

$$t = 8 \quad \vec{v} = 60\hat{i} + 0\hat{j}$$

$$t = 10 \quad \vec{v} = 60\hat{i} - 20\hat{j}$$

~~$t = 16$~~ $\vec{v} = 60\hat{i} - 80\hat{j}$

just before it hit the ground



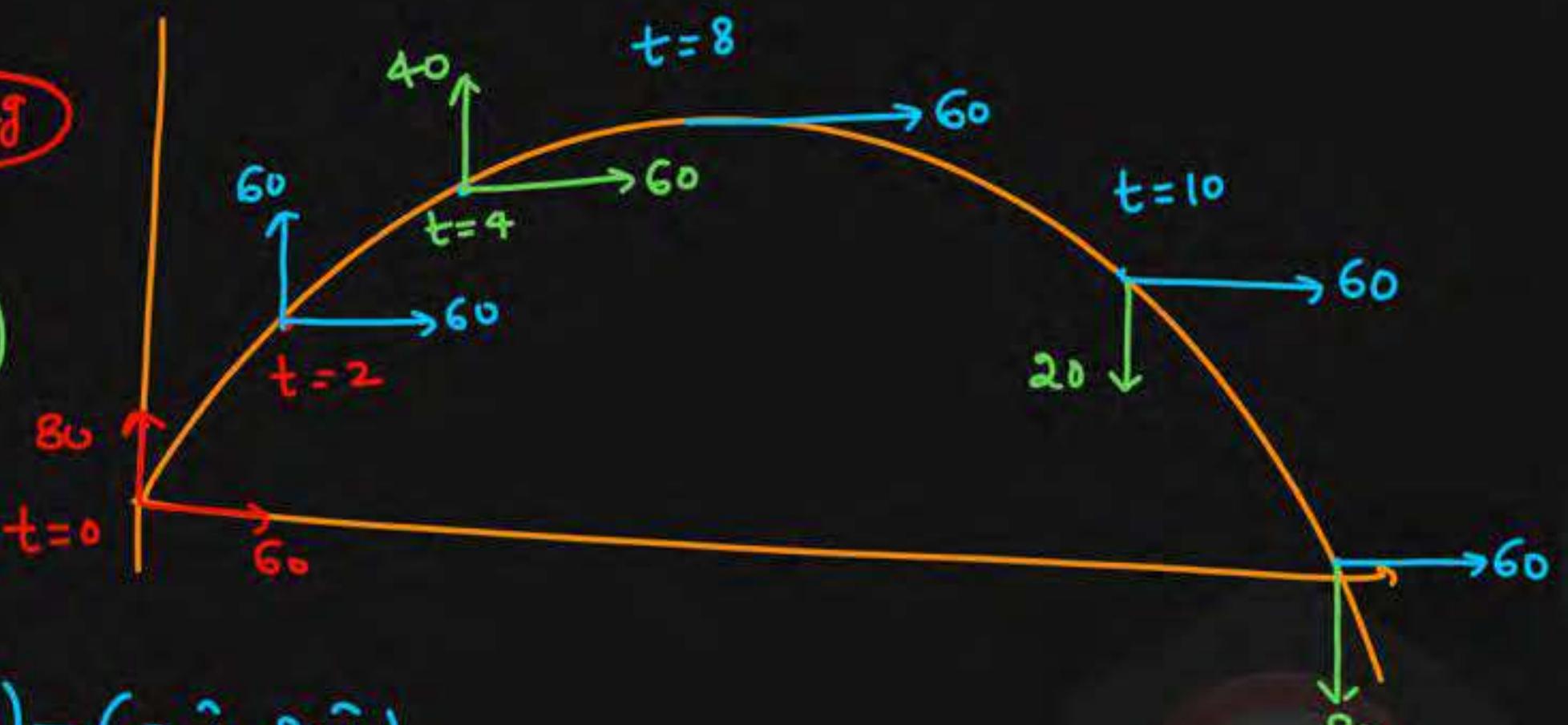
$$\vec{P} = \text{momentum} = m \vec{v}$$

f) find change in momentum
for entire motion $m = 1 \text{ kg}$

$$\Delta \vec{P} = \vec{P}_f - \vec{P}_i$$

$$\begin{aligned}\vec{P}_i &= m \vec{v}_i = 1(60\hat{i} + 80\hat{j}) \\ &= 60\hat{i} + 80\hat{j} \\ \vec{P}_f &= 60\hat{i} - 80\hat{j}\end{aligned}$$

$$\begin{aligned}\Delta \vec{P} &= \vec{P}_f - \vec{P}_i = (60\hat{i} - 80\hat{j}) - (60\hat{i} + 80\hat{j}) \\ &= -160\hat{j}\end{aligned}$$

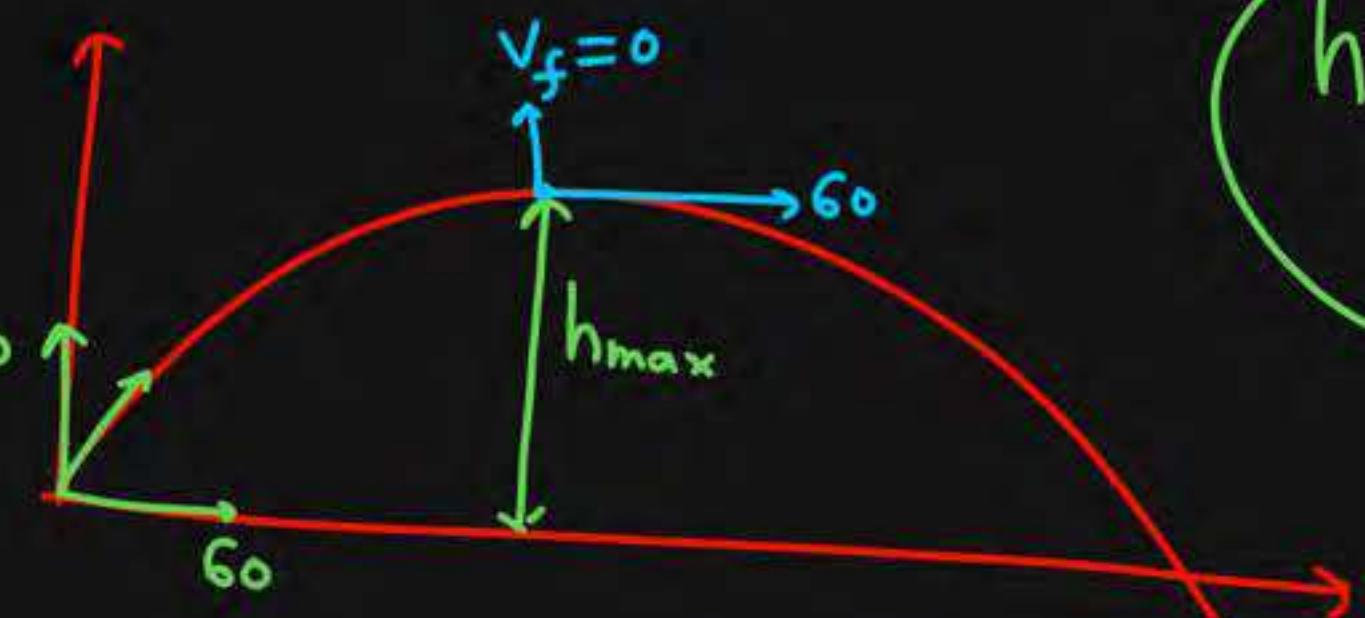


(g) find h_{\max}

$$(y) v^2 = u^2 + 2as$$

$$0^2 = (80)^2 + 2(-10)(h_{\max})$$

$$h_{\max} = 320$$



h_{\max} का तरीके
3rd eqn of motion
देखें

(h) find \vec{v} at any time t

$$\vec{v} = 60\hat{i} + (80 - 10t)\hat{j}$$

(i) find when \vec{v} become perpendicular to \vec{a}

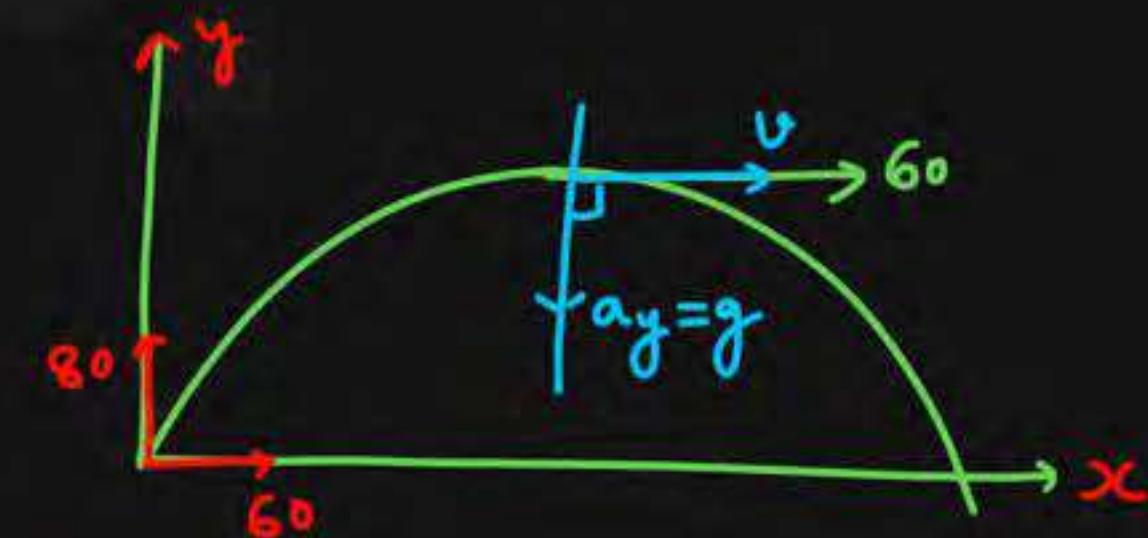
$$\vec{v} \cdot \vec{a} = 0$$

$$\vec{v} = 60\hat{i} + (80 - 10t)\hat{j}$$

$$\vec{a} = -10\hat{j}$$

$$\vec{v} \cdot \vec{a} = -10(80 - 10t) = 0$$

$$t = 8 \text{ sec}$$



(j) $v = u + at$
 $\vec{v}_y = 80 - 10t$

(j) find the time when velocity of particle become perpendicular to initial velocity.

$$\vec{u} = 60\hat{i} + 80\hat{j}$$

$$\vec{v}_f = 60\hat{i} + (80 - 10t)\hat{j}$$

$$\underline{\vec{v} \cdot \vec{u} = 0}$$

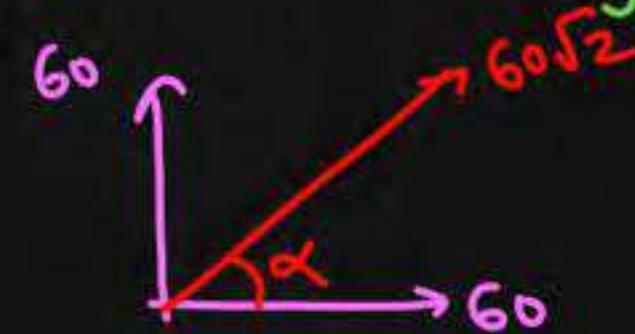
$$60 \times 60 + 80(80 - 10t) = 0$$

$$3600 + 6400 - 800t = 0$$

$$t = \frac{10000}{800} = \frac{100}{8} = 12.5$$

*^k find the angle made by velocity with horizontal at t=2 sec

$$t=2, \vec{v} = 60\hat{i} + 60\hat{j}$$



$$\tan \alpha = \frac{60}{60} = 1$$

$$\alpha = 45^\circ$$



Direction Cosine $\cos \alpha = \frac{Ax}{A} = \frac{60}{60\sqrt{2}} = \frac{1}{\sqrt{2}}$

$$\alpha = 45^\circ$$

(Q) find location of particle at $t=2$, $t=8$ sec

$$x = 60 \times 2 = 120$$

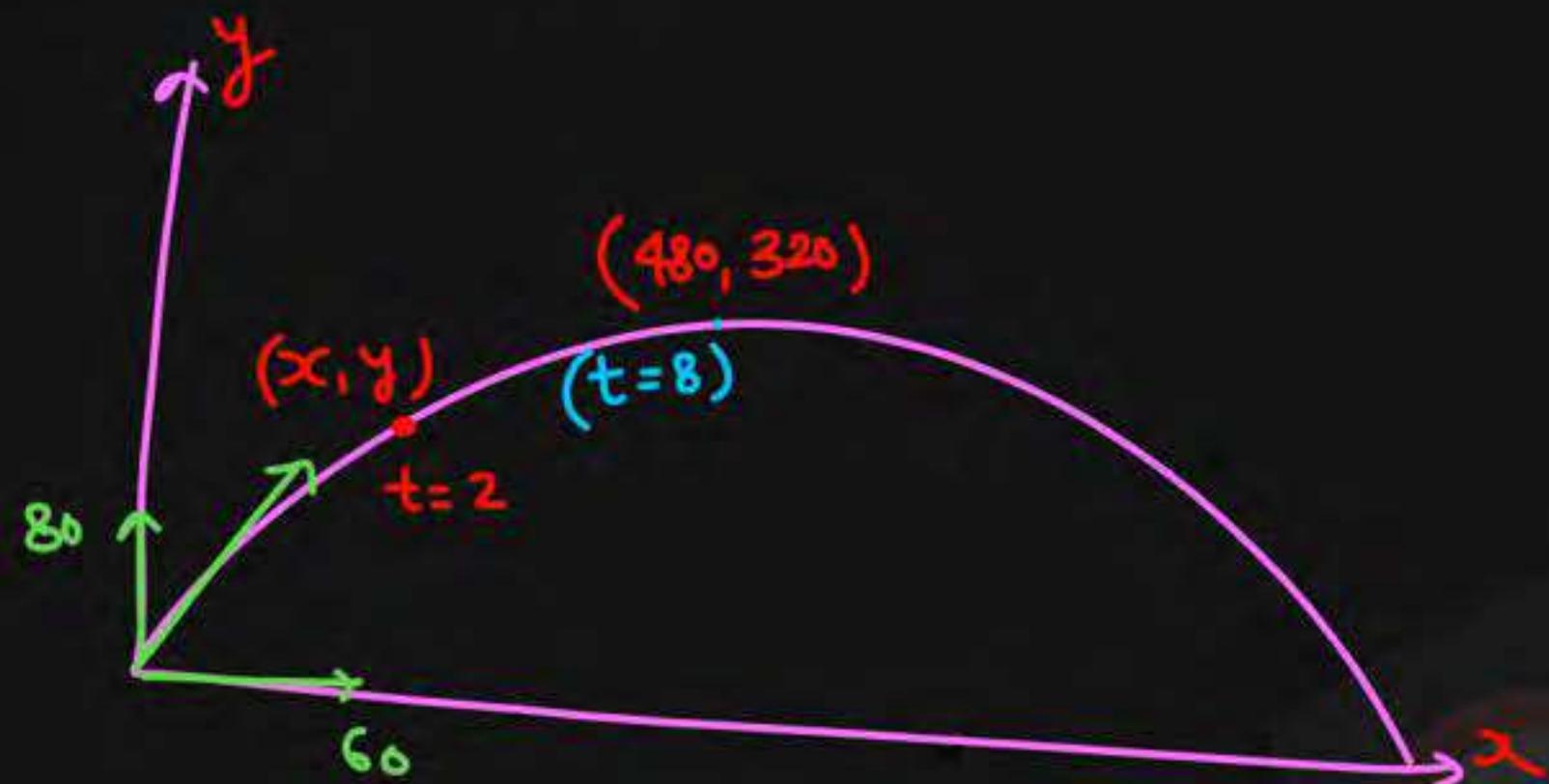
$$y = 80 \times 2 - \frac{1}{2} \times 10 \times 2^2 \\ = 160 - 20 = 140$$

$$(x, y) \Rightarrow (120, 140)$$

$$t = 8, \quad x = 60 \times 8 = 480$$

$$y = 80 \times 8 - \frac{1}{2} \times 10 \times 8^2 \\ = 640 - 320 = 320$$

$$(480, 320)$$



$$(480, 320)$$

(m) If air start flowing such that it given horizontal acc of $+5 \text{ m/s}^2$ to the particle (No air resistance) find

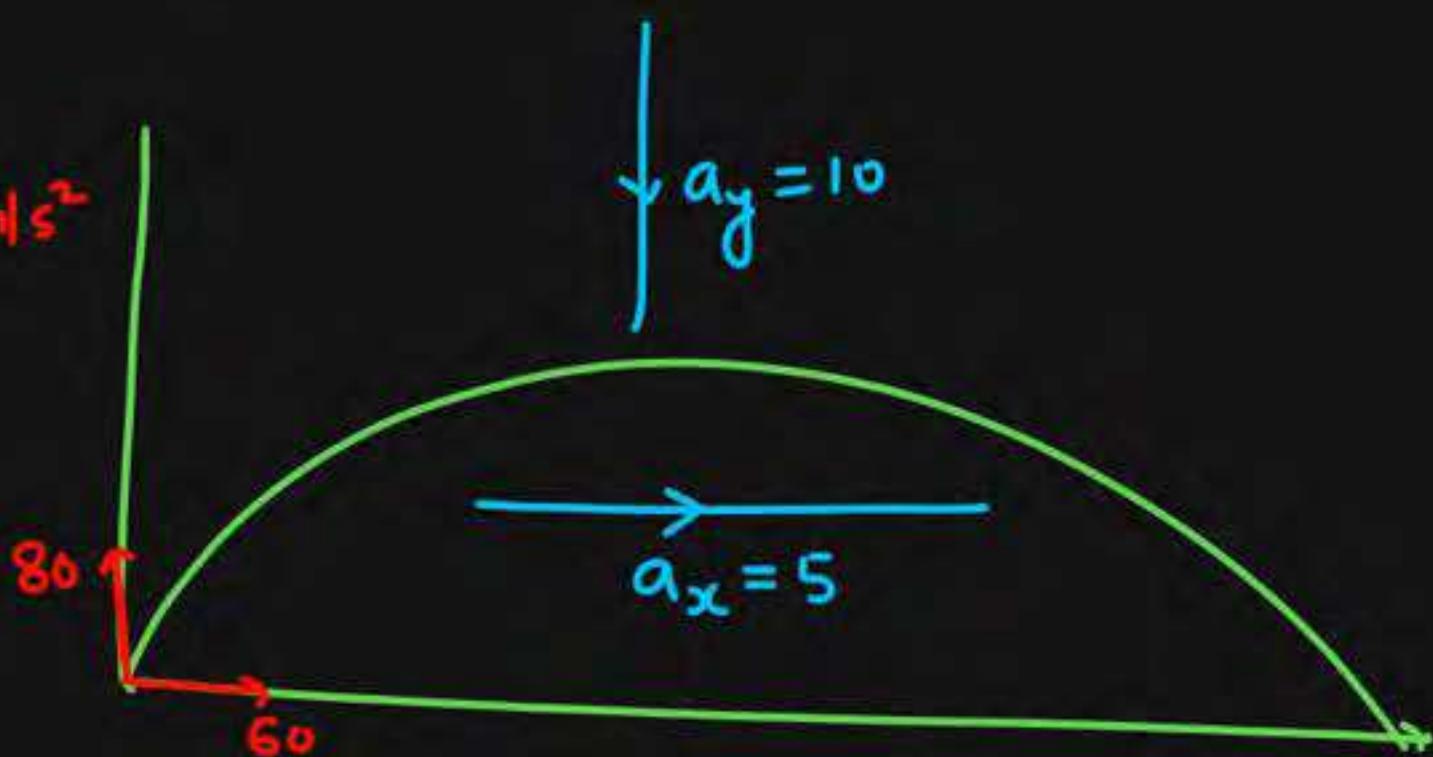
$$\textcircled{1} \quad T = 8 + 8 = 16 \text{ (Same)}$$

T, H_{\max} \longrightarrow Same.

$$\text{Range} = R = Ut + \frac{1}{2} a t^2 \quad (\text{x dir } \vec{i})$$

$$R = 60 \times 16 + \frac{1}{2} \times 5 \times (16)^2$$

$$\begin{aligned} t &= 2, \vec{v} = (60 + 5 \times 2) \hat{i} + (80 - 10 \times 2) \hat{j} \\ &= 70 \hat{i} + 60 \hat{j} \end{aligned}$$



Q

$$\vec{u}_i = 40\hat{i} + 60\hat{j}$$

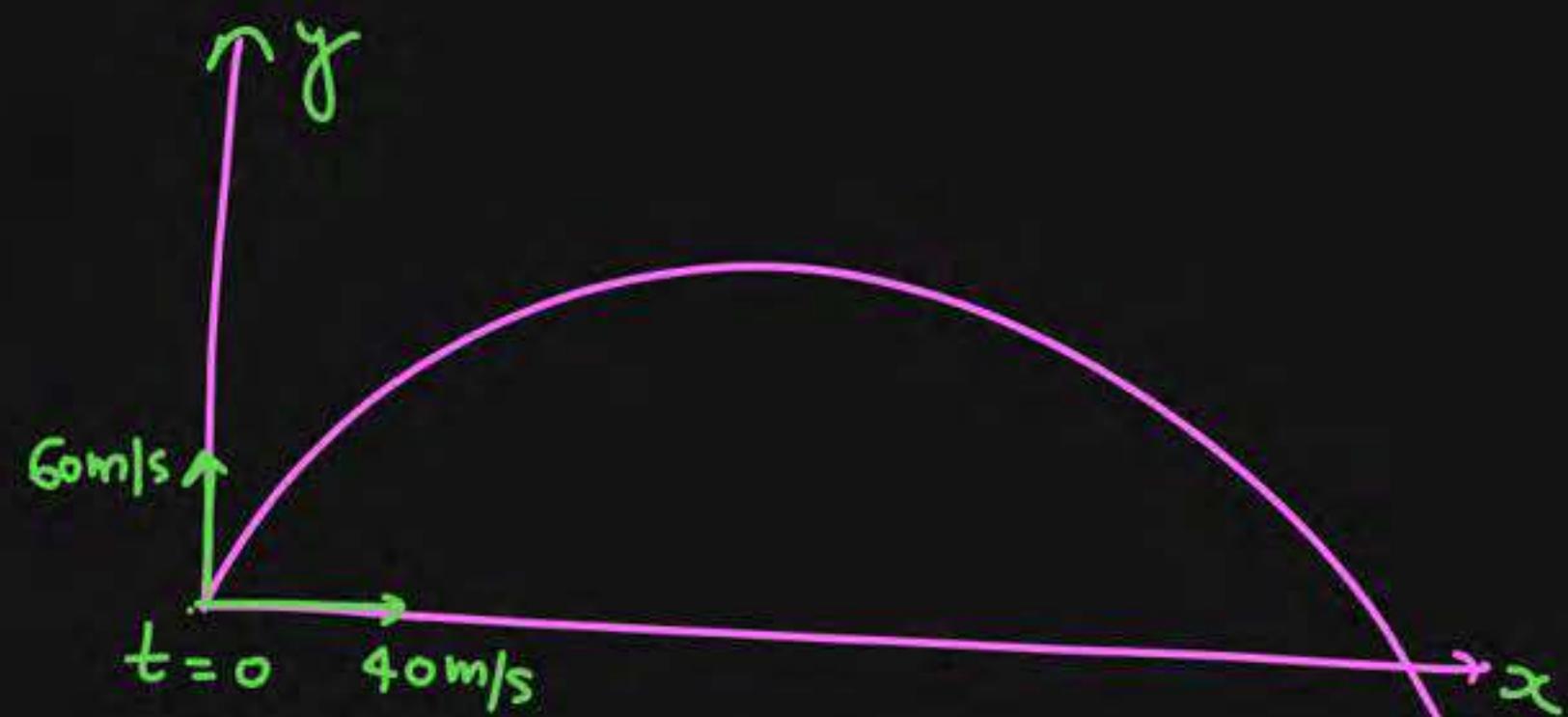
find

$$\textcircled{1} \quad T = 6 + 6 = 12$$

$$\textcircled{2} \quad R = 40 \times 12 = 480$$

$$\textcircled{3} \quad h_{max} = 180$$

$$\textcircled{4} \quad t=2, \vec{v} = 40\hat{i} + 40\hat{j}$$



$$\textcircled{3} \quad 0^2 = c_0^2 + 2 \times (-10) h_{max}$$

$$h_{max} = \frac{3600}{20}$$

Q2 find equation of trajectory

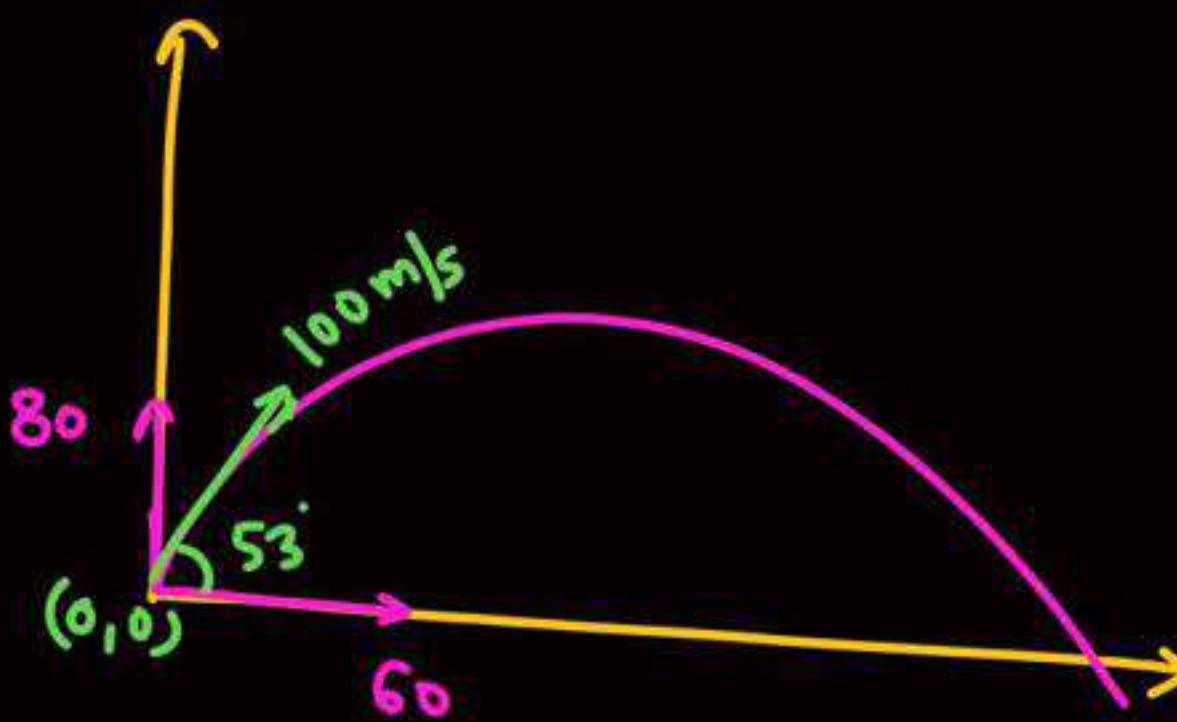
$$x = 60t \Rightarrow t = \frac{x}{60}$$

$$y = 80t - \frac{1}{2} \times 10 \times t^2$$

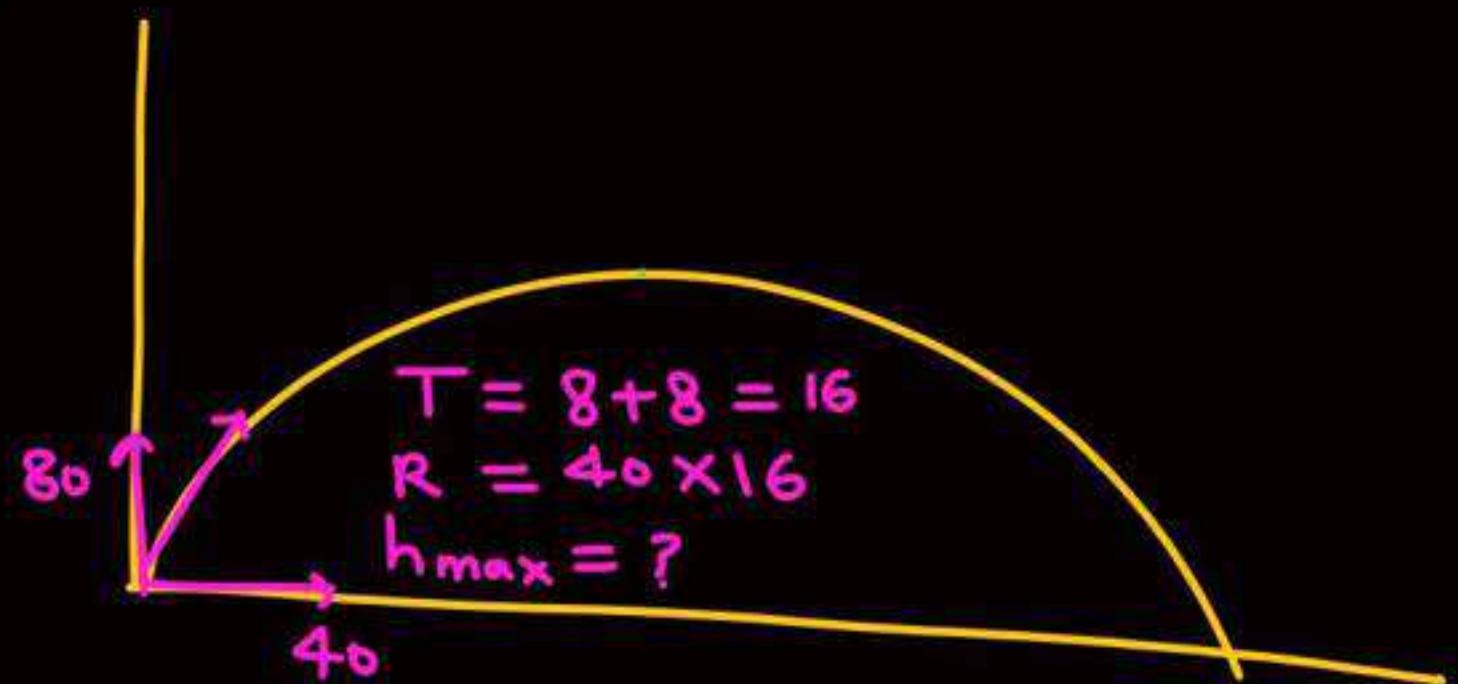
$$y = 80 \frac{x}{60} - \frac{1}{2} \times 10 \times \left(\frac{x}{60}\right)^2$$

$$\boxed{y = \frac{4x}{3} - \frac{x^2}{720}}$$

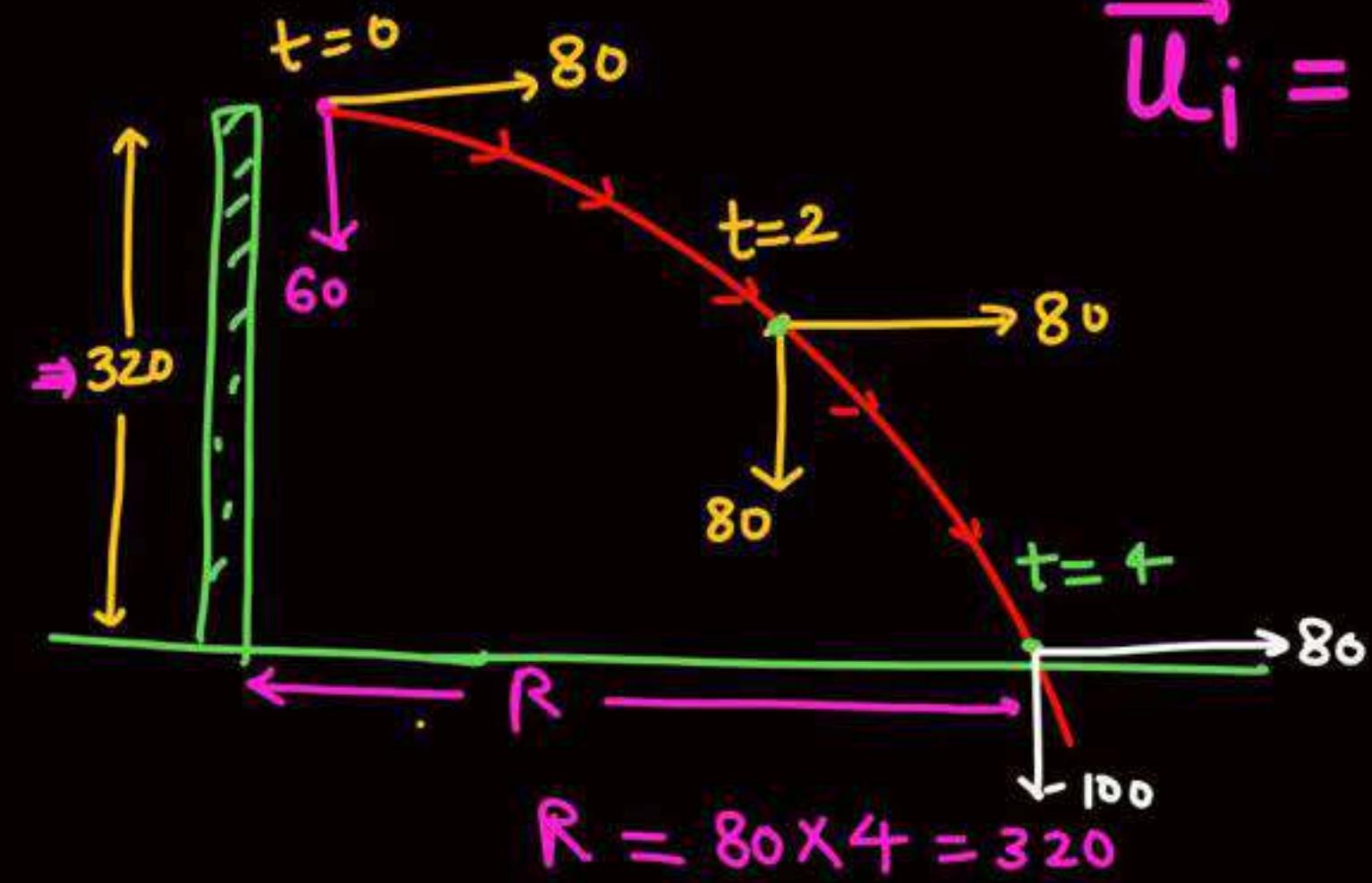
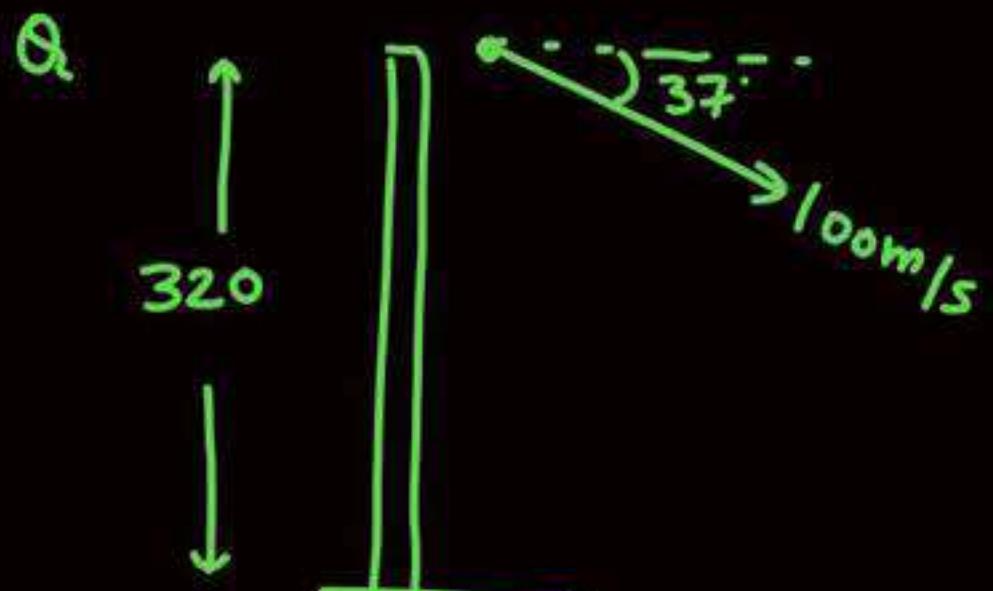
parabola



Q



$$0^2 = 80^2 - 2 \times 10 \times h_{\max}$$



$$\vec{U}_i = 80\hat{i} - 60\hat{j}$$

① When & where particle will strike the ground.

$$y = \downarrow +ve \quad s = ut + \frac{1}{2}at^2$$

$$+320 = +60t + \frac{1}{2} \times 10 \times t^2$$

$$\boxed{t = 4 \text{ sec}}$$

Q2

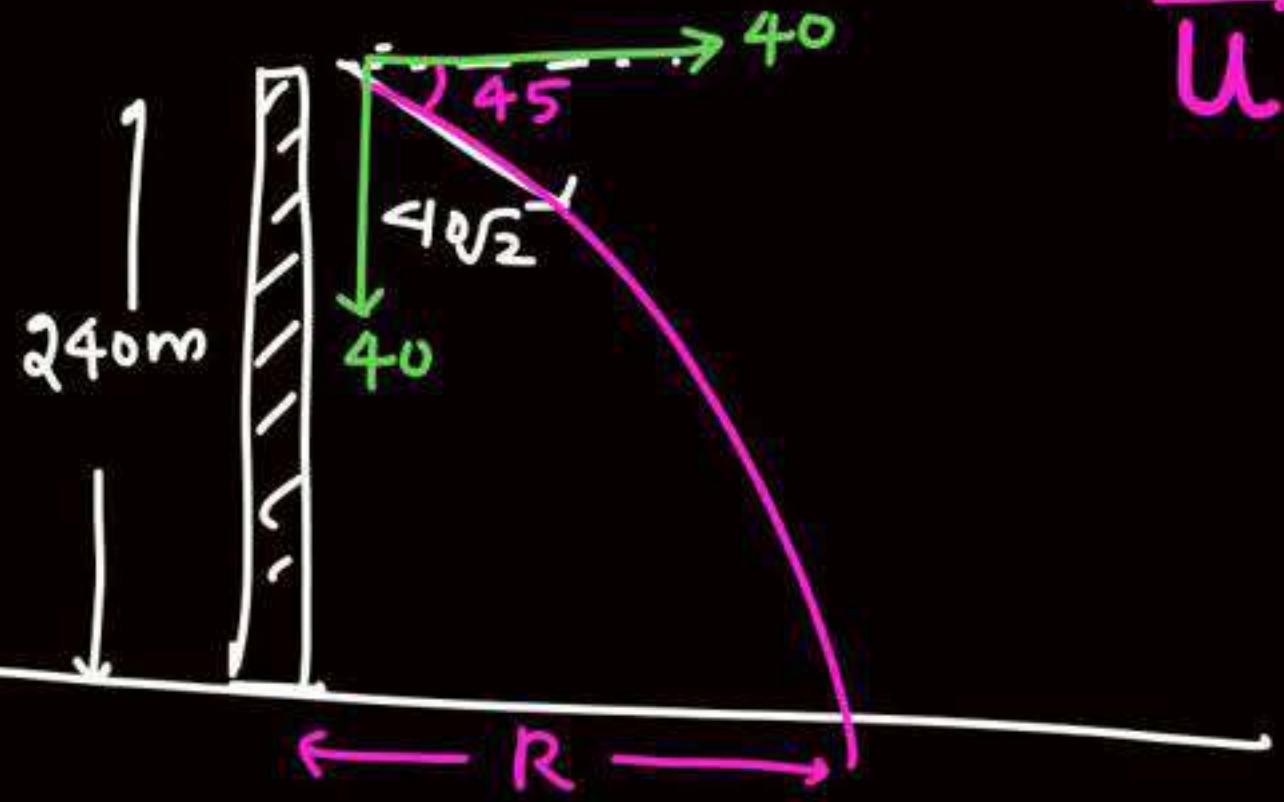
When particle will strike the ground & where

(y)

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

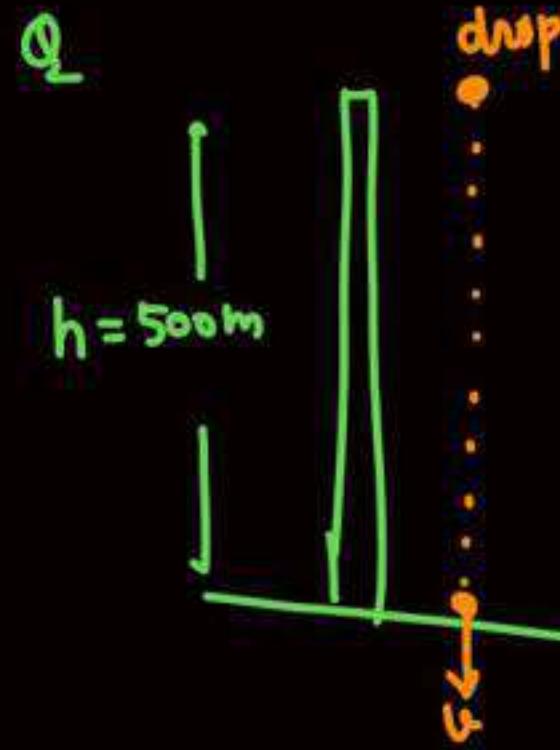
$$240 = 40t + \frac{1}{2} \times 10 \times t^2$$

$$\boxed{t = 4}$$



$$\vec{u}_i = 40\hat{i} - 40\hat{j}$$

$$\boxed{R = 40 \times 4 = 160}$$



$$h = 0 + \frac{1}{2}gt^2$$

$$500 = \frac{1}{2} \times 10 \times t^2$$

$$t^2 = 100$$

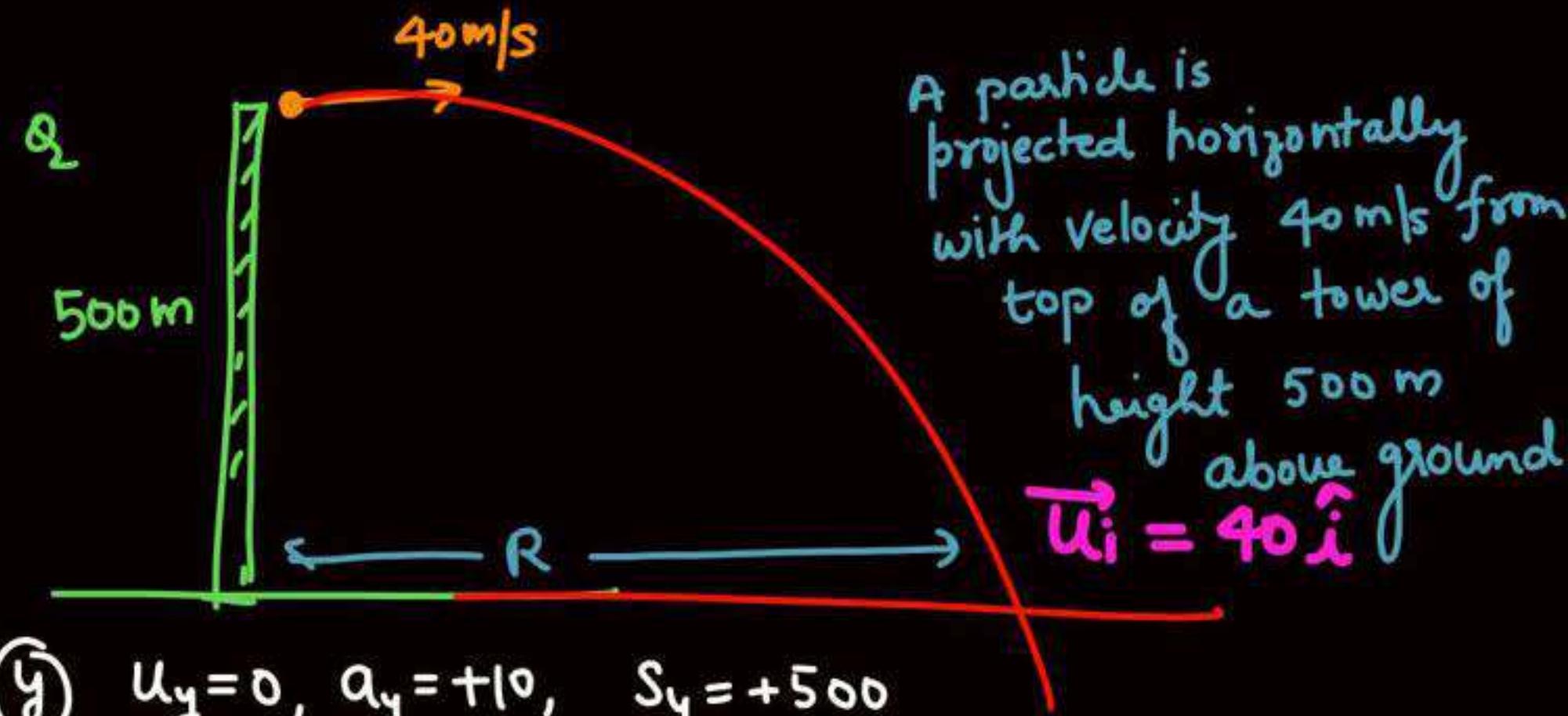
$$\boxed{t = 10 \text{ sec}}$$

$$v^2 = 0^2 + 2gh$$

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

$$= \sqrt{2 \times 10 \times 500}$$

$$= 100$$

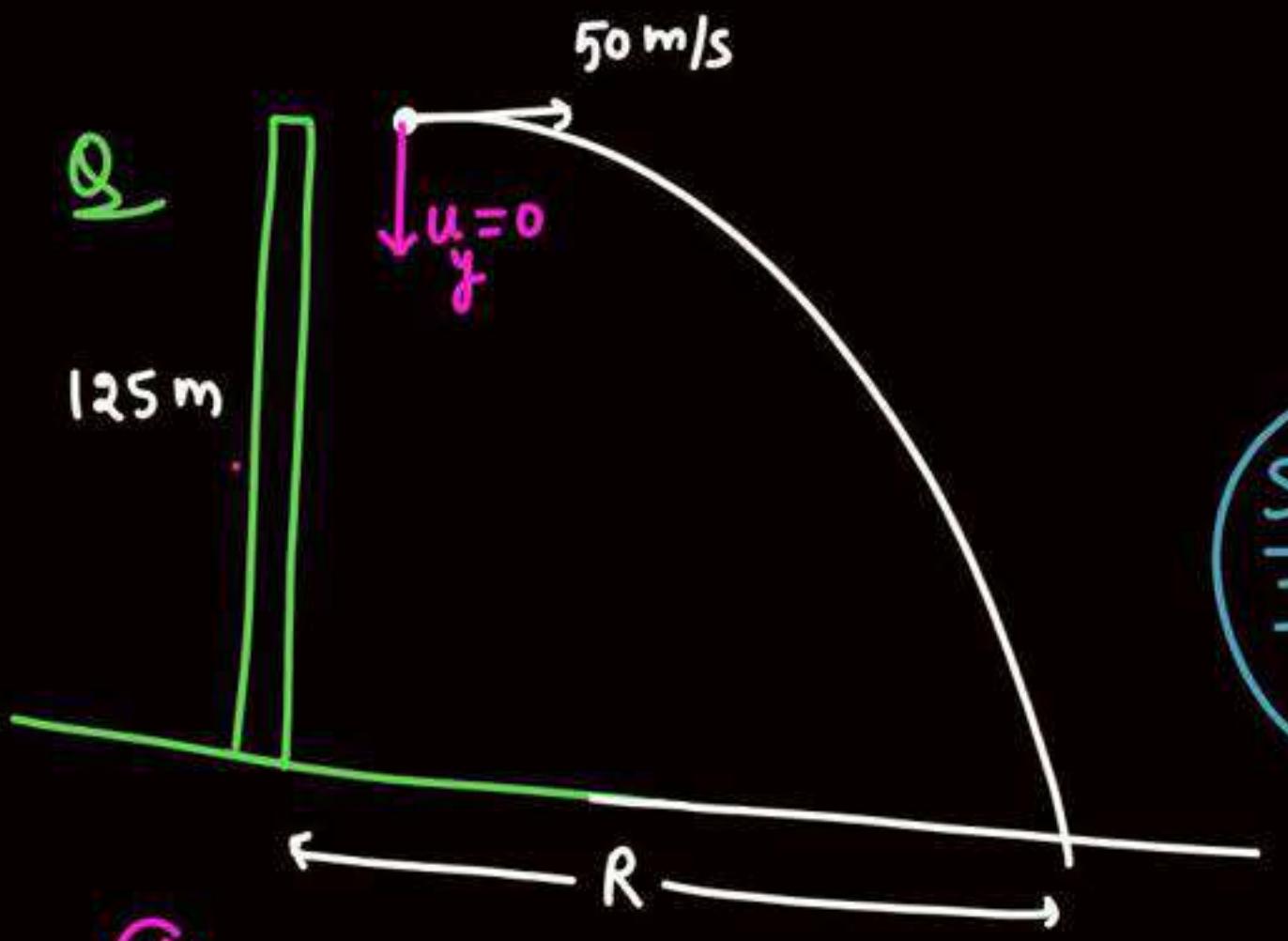


④ $U_y = 0, a_y = +10, S_y = +500$

$$500 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$\boxed{t = 10 \text{ sec}}$$

$$R = 40 \times 10 = 400 \text{ m}$$



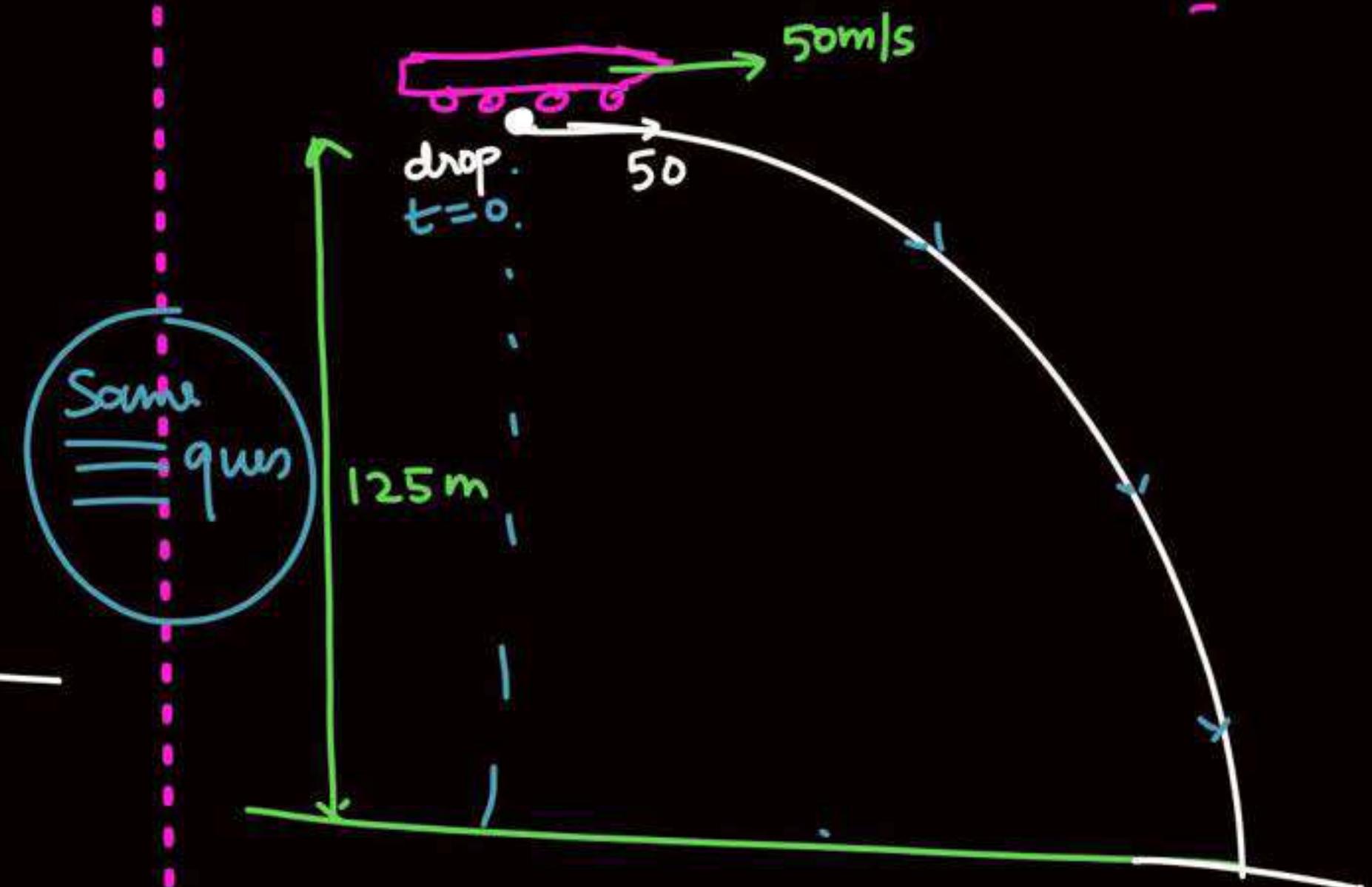
(y)

$$125 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$t = \sqrt{\frac{250}{10}} = 5$$

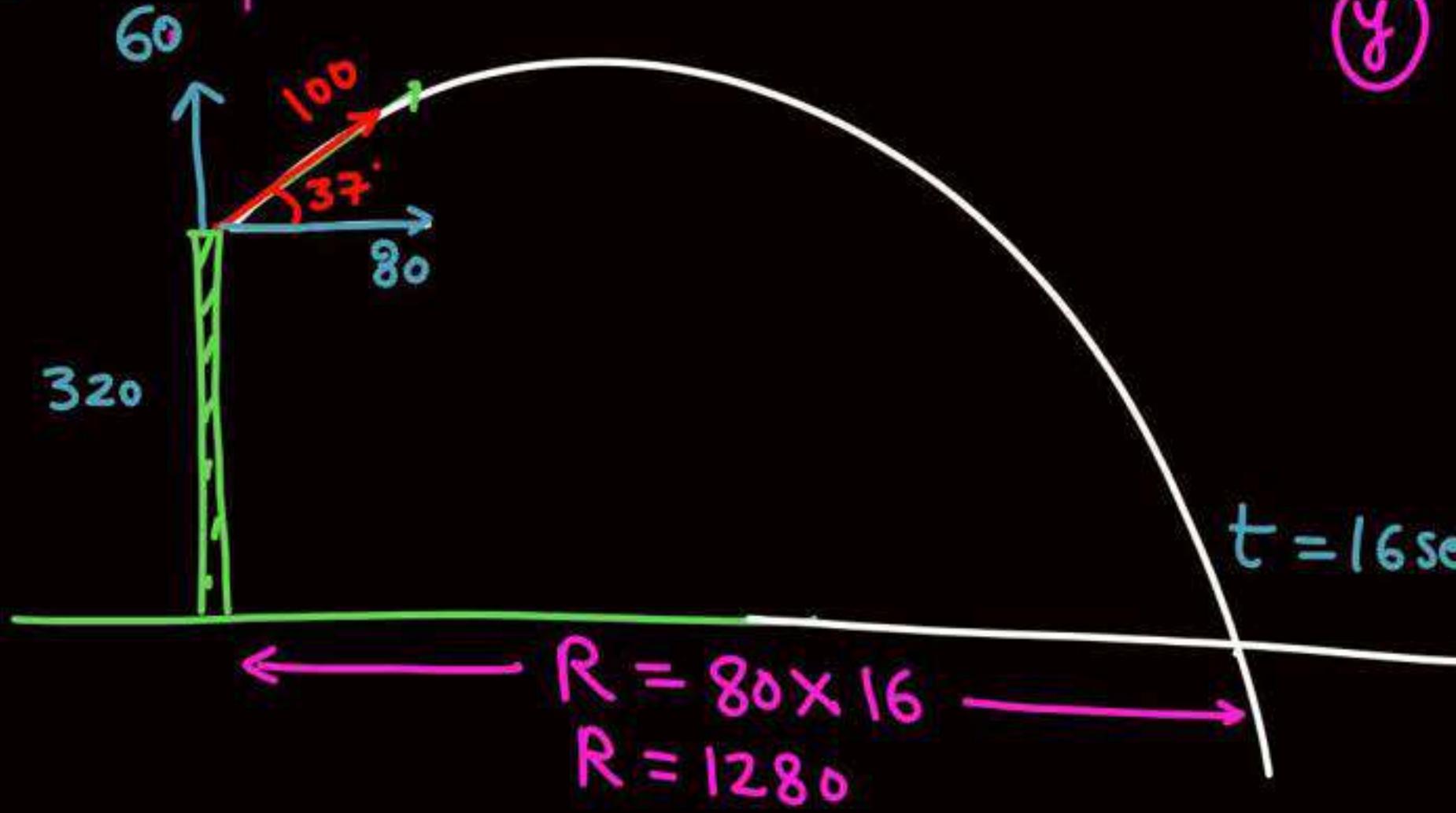
(x)

$$\begin{aligned} R &= 50 \times 5 \\ &= 250 \text{ m} \end{aligned}$$



$$\begin{aligned} t &= 5 \\ R &= 250 \text{ m} \end{aligned}$$

Q



Y
↑ +ve

$$U_y = +60$$

$$a_y = -10$$

$$S_y = -320$$

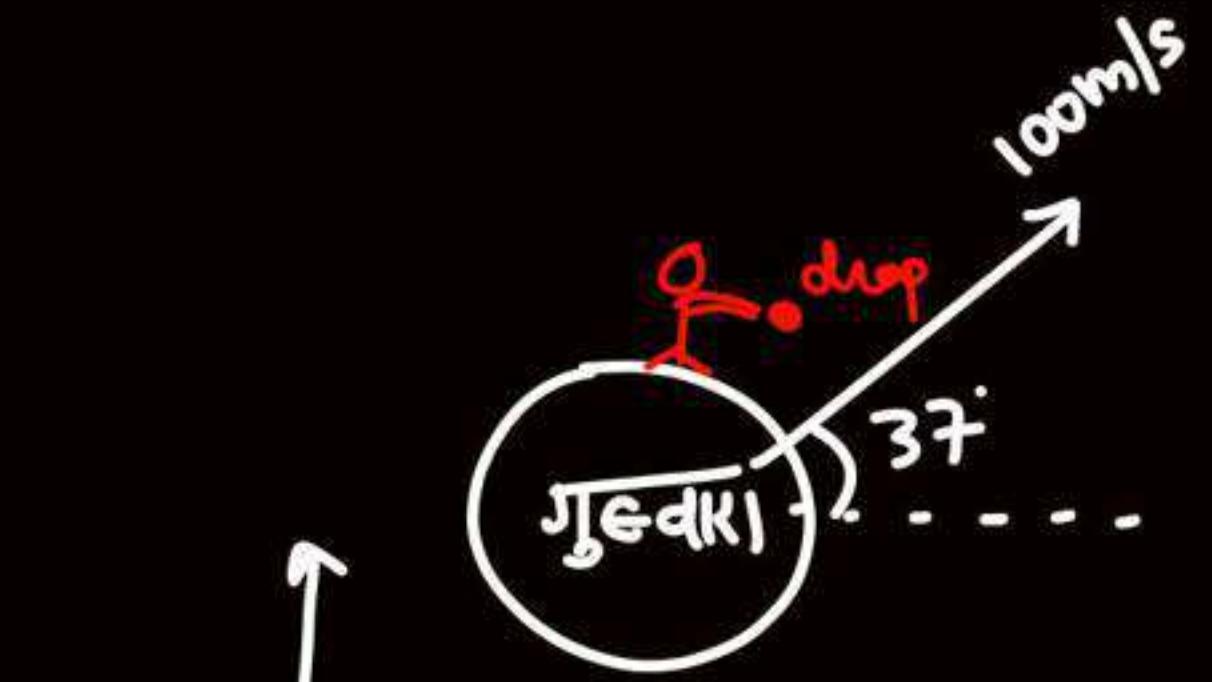
Already ✓

$$-320 = 60t - \frac{1}{2} \times 10 \times t^2$$

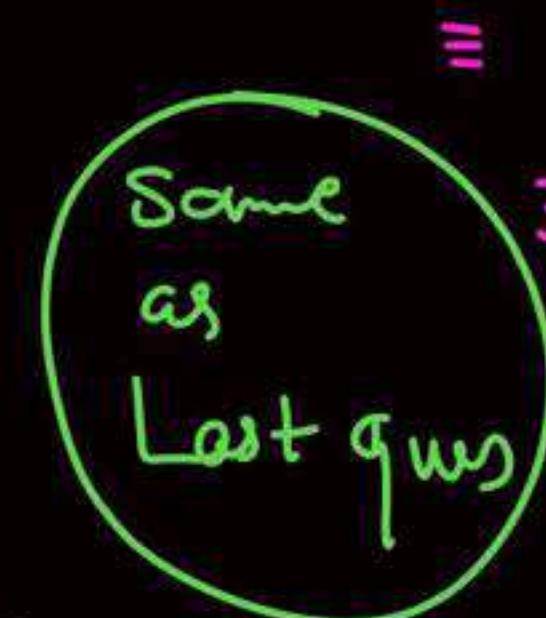
$$\boxed{t = 16 \text{ sec}}$$

w find T & R

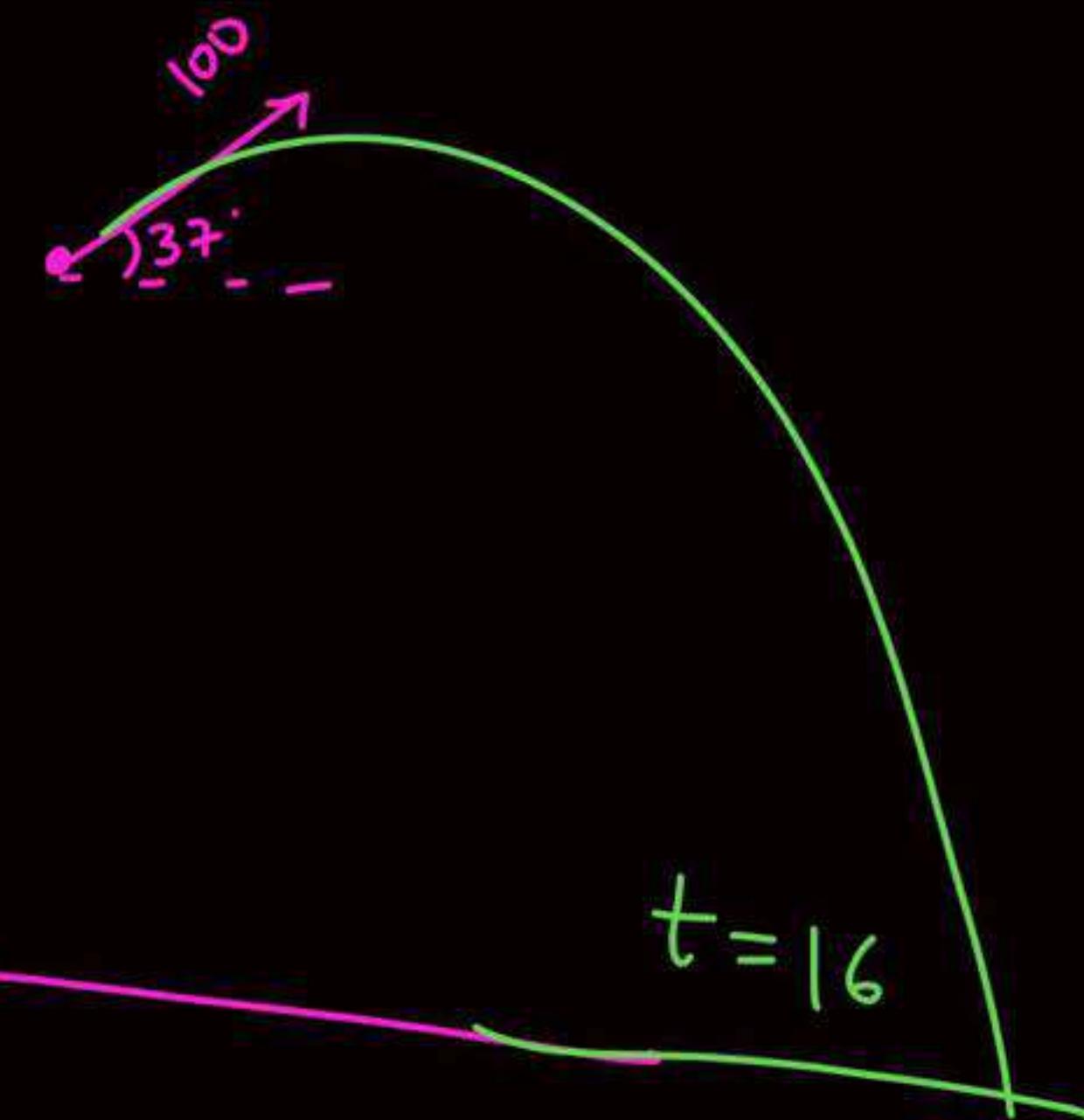
θ_1

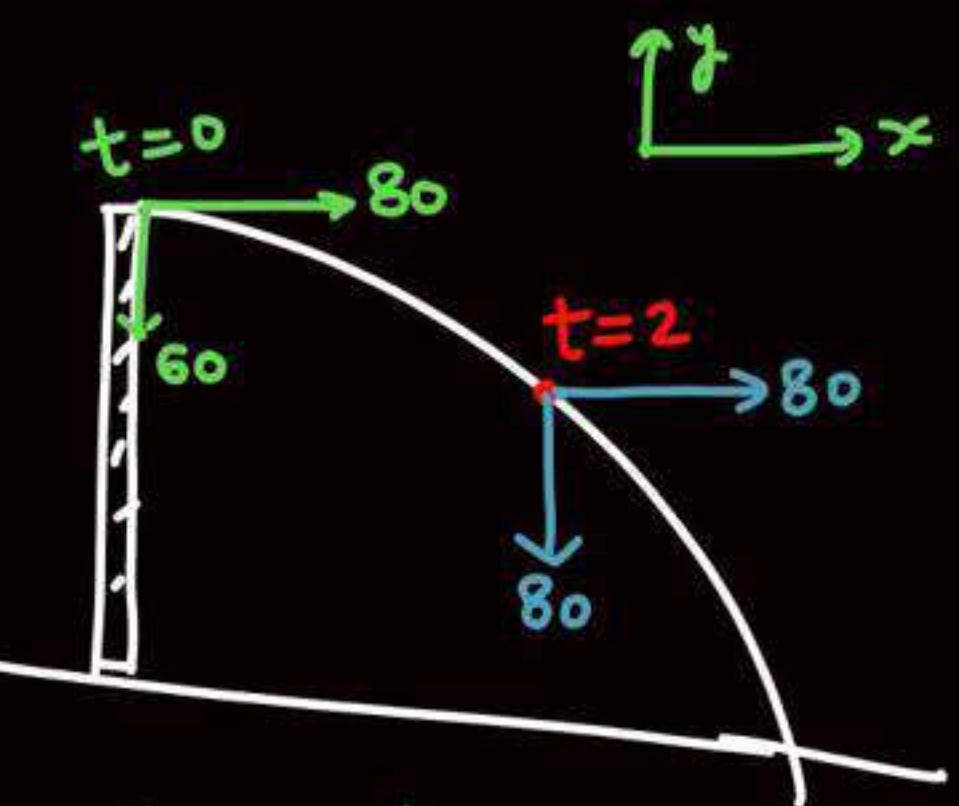


320m



320m





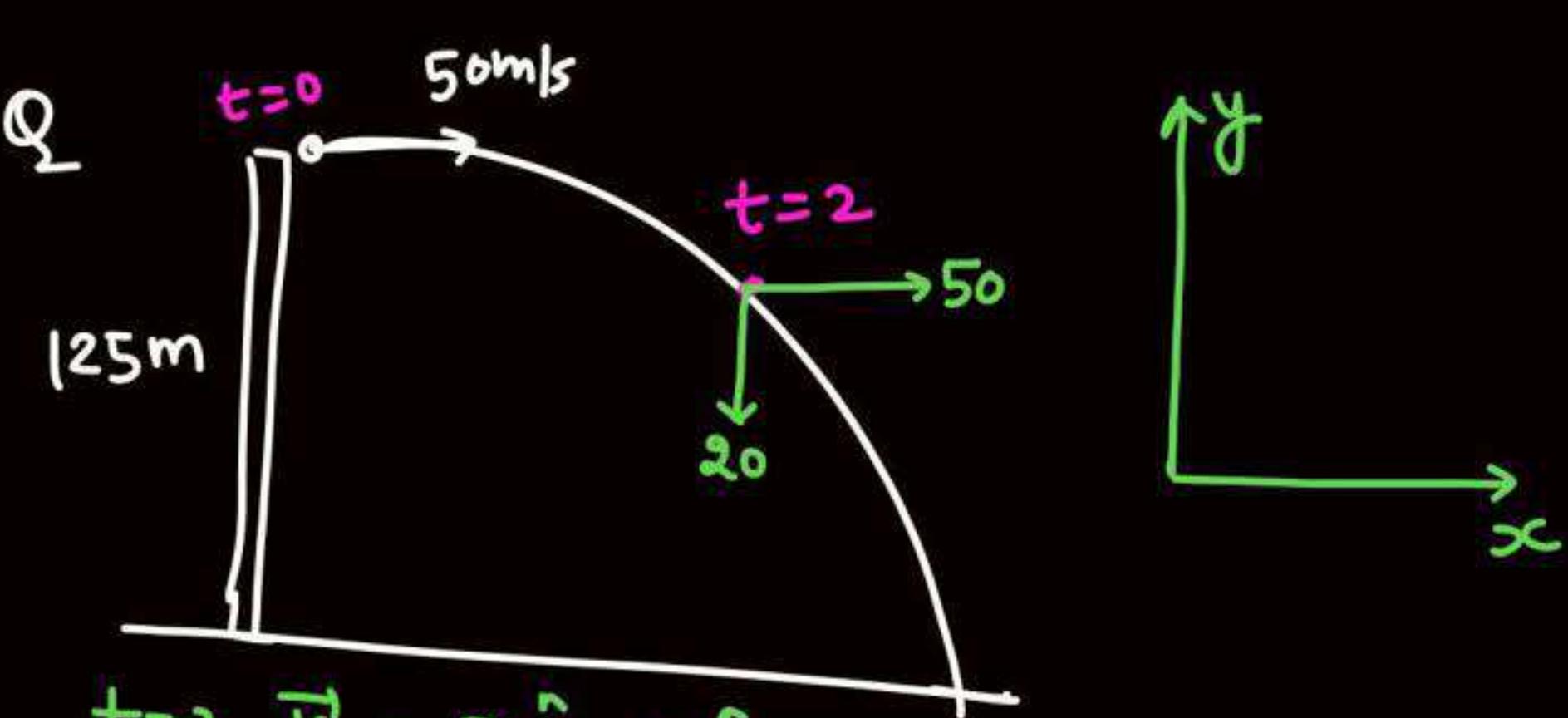
$$t=2, \vec{v} = 80\hat{i} - 80\hat{j}$$

$$t=4, \vec{v} = 80\hat{i} - 100\hat{j}$$

$$\rightarrow v_y = u_y + a_y t$$

$$= +60 + 10 \times 4$$

$$= 100 \text{ m/s}$$

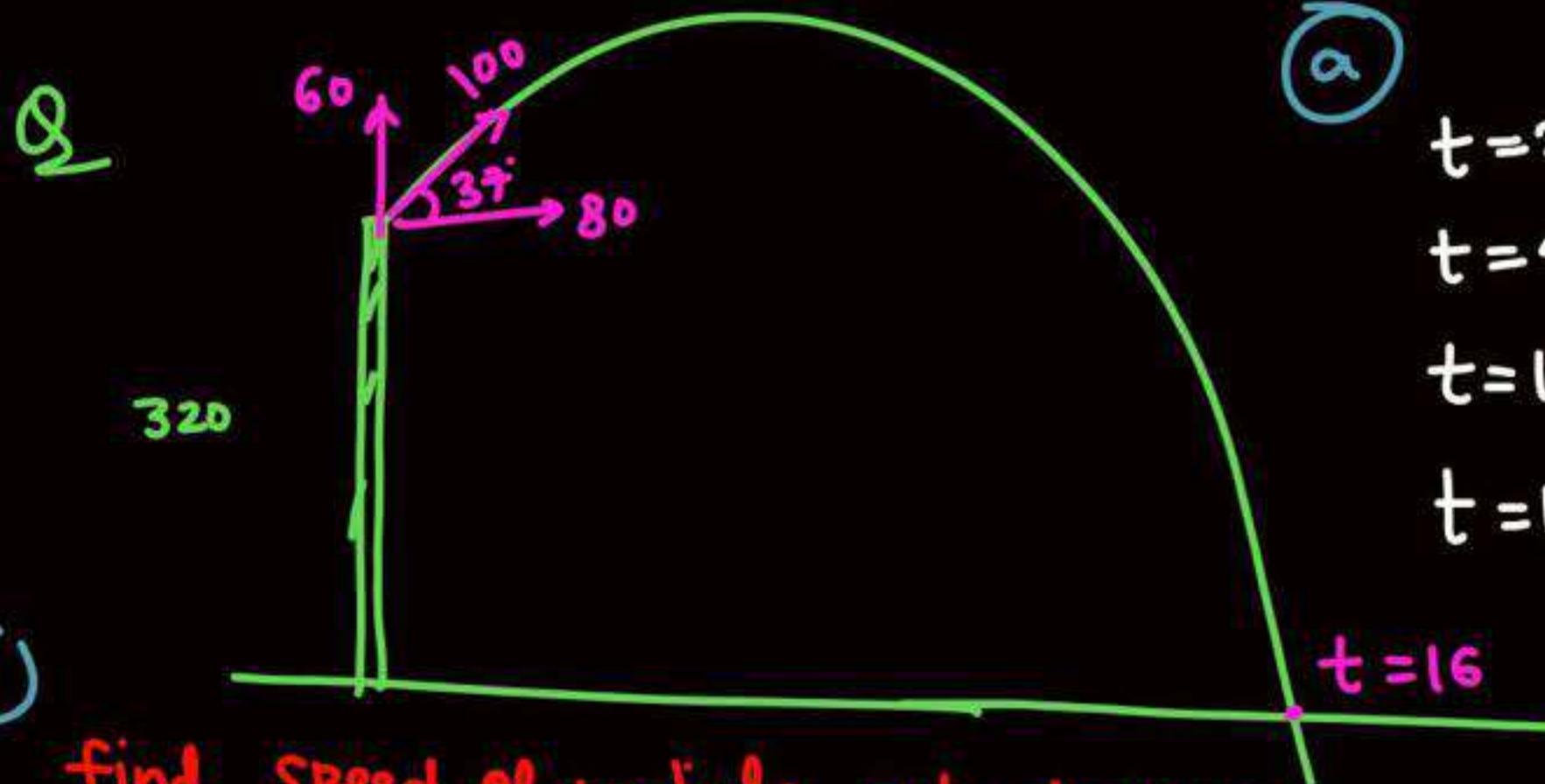


$$t=2, \vec{v} = 50\hat{i} - 20\hat{j}$$

$$\textcircled{y} \quad v = u + at$$

$$v = 0 - 10 \times 2$$

$$v = -20$$



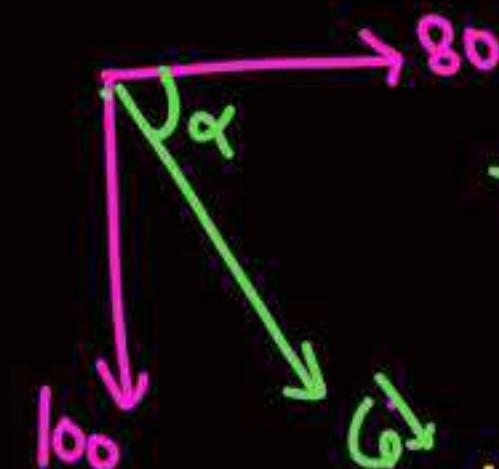
Q
b) find speed of particle at $t = 16 \text{ sec}$

$$\vec{V} = 80\hat{i} - 100\hat{j} \quad (\text{just before hit the ground})$$

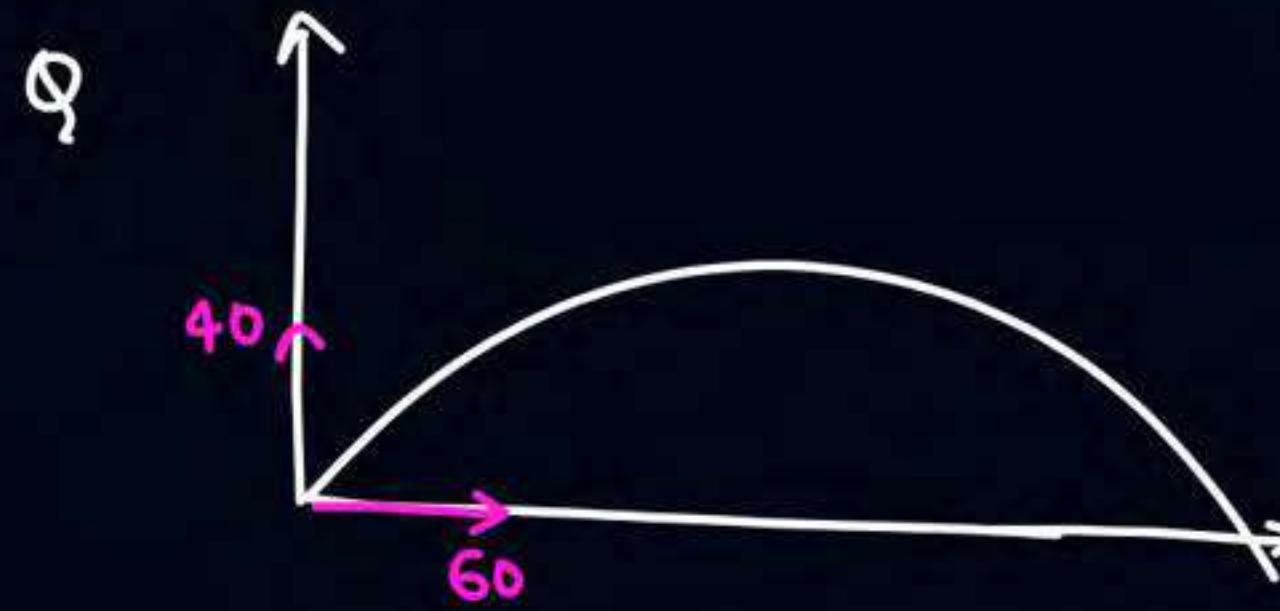
$$|\vec{V}| = \sqrt{(80)^2 + (100)^2}$$

- a)
- $t = 2, \vec{V} = 80\hat{i} + 40\hat{j}$
 - $t = 4, \vec{V} = 80\hat{i} + 20\hat{j}$
 - $t = 10, \vec{V} = 80\hat{i} - 40\hat{j}$
 - $t = 16, \vec{V} = 80\hat{i} - 100\hat{j}$
- c) find angle made by \vec{V} with horizontal at $t = 16 \text{ sec}$

$$\vec{V} = 80\hat{i} - 100\hat{j}$$



$$\tan \alpha = \frac{100}{80}$$



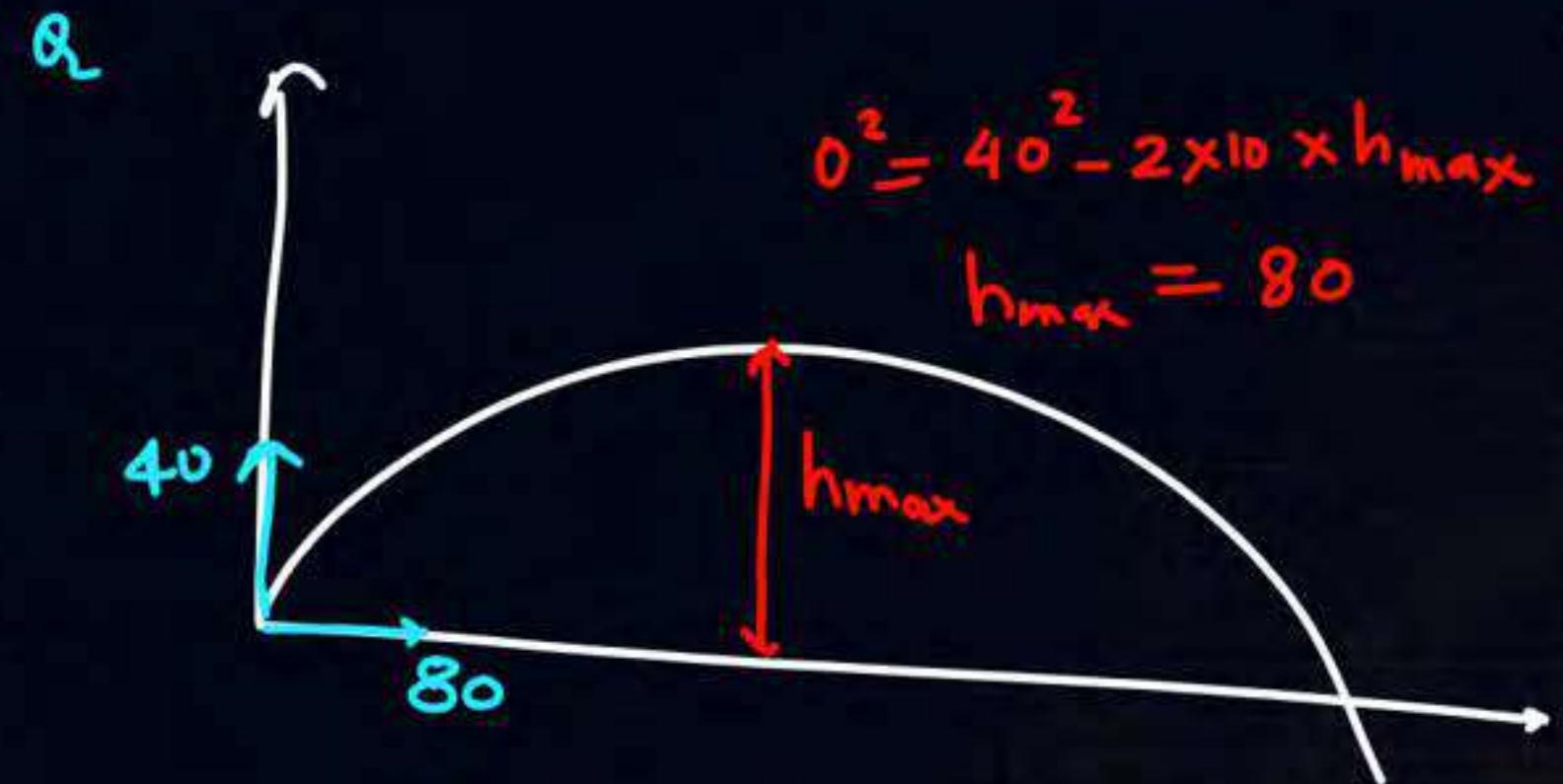
$$0^2 = 40^2 - 2 \times 10 \times h_{\max}$$

$$T = 4 + 4 = 8$$

$$h_{\max} = 80$$

$$R = 60 \times 8 = \underline{480}$$

V0



$$0^2 = 40^2 - 2 \times 10 \times h_{\max}$$

$$h_{\max} = 80$$

$$T = 4 + 4 = 8$$

$$h_{\max} = 80$$

$$R = 80 \times 8 = \underline{640}$$

Q

- * $(H_{max})_1 = (H_{max})_2 > (H_{max})_3$
- * $T_1 = T_2 > T_3$
- $(u_y)_1 = (u_y)_2 > (u_y)_3$
- $R_1 < R_2 = R_3$



Q

A particle is projected from ground with speed u at an angle θ with horizontal such that its maximum height is half of range. find θ

$$h_{\max} = \frac{1}{2} R$$

$$\frac{u^2 \sin^2 \theta}{2g} = \frac{1}{2} \frac{u^2 \sin 2\theta}{g}$$

$$\sin^2 \theta = \sin 2\theta$$

$$\sin^2 \theta = 2 \sin \theta \cos \theta$$

$$\tan \theta = 2$$

$$\boxed{\theta = \tan^{-1} 2}$$

Q. Two particle are projected with same speed u at angle 30° & 60° respectively. find ① Ratio of their max height
 ② " " Range
 ③ " " time of flight

$$\text{① } \frac{(h_{\max})_1}{(h_{\max})_2} = \frac{\frac{u^2 \sin^2 30}{2g}}{\frac{u^2 \sin^2 60}{2g}} = \frac{\left(\frac{1}{2}\right)^2}{\left(\frac{\sqrt{3}}{2}\right)^2} = \frac{1}{3}$$

$$\text{② } \frac{R_1}{R_2} = \frac{\frac{u^2 \sin(2 \times 30)}{g}}{\frac{u^2 \sin(2 \times 60)}{g}} = \frac{\sin 60}{\sin 120} = \frac{\sqrt{3}/2}{\sqrt{3}/2} = 1$$

(M-Z) $\theta = 30^\circ$
 $90 - \theta = 60^\circ \rightarrow R_1 = R_2$

$$\text{③ } T = \frac{2u \sin \theta}{g} \quad \frac{T_1}{T_2} = \frac{\sin 30}{\sin 60} = \frac{1/2}{\sqrt{3}/2} = \frac{1}{\sqrt{3}}$$

Q An arrow is projected such that its range is 400m and time of flight is 5 sec. find

- ① h_{\max}
- ② inclination of arrow at $t=0$
 $\theta = ?$

$$R = 400 = \frac{u^2 \sin 2\theta}{g}$$

$$5 = \frac{2usin\theta}{g}$$

$$u = \frac{25}{\sin\theta}$$

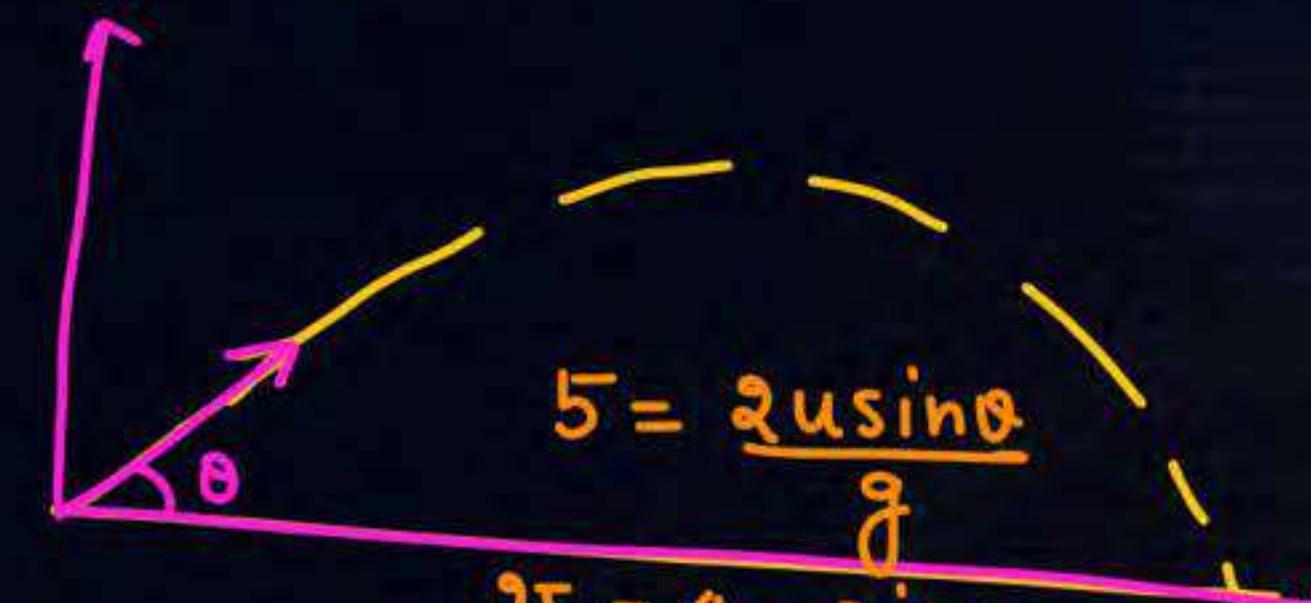
$$400 = \left(\frac{25}{\sin\theta}\right)^2 \cdot \frac{\sin 2\theta}{10}$$

$$400 = \frac{625}{\sin^2\theta} \cdot \frac{2 \sin\theta \cos\theta}{10}$$

$$400 = 125 \frac{\cos\theta}{\sin\theta} = 125 \cot\theta$$

$$\cot\theta = \frac{400}{125}$$

$$\tan\theta = 125/400 = \frac{5}{16}$$



$$5 = \frac{2usin\theta}{g}$$

$$25 = \frac{4}{100} u^2 \sin^2\theta$$

$$u^2 \sin^2\theta = 625$$

$$H_{\max} = \frac{u^2 \sin^2\theta}{2g} = \frac{625}{20}$$

Q An arrow is projected such that its range is 400m and time of flight is 5 sec.
find

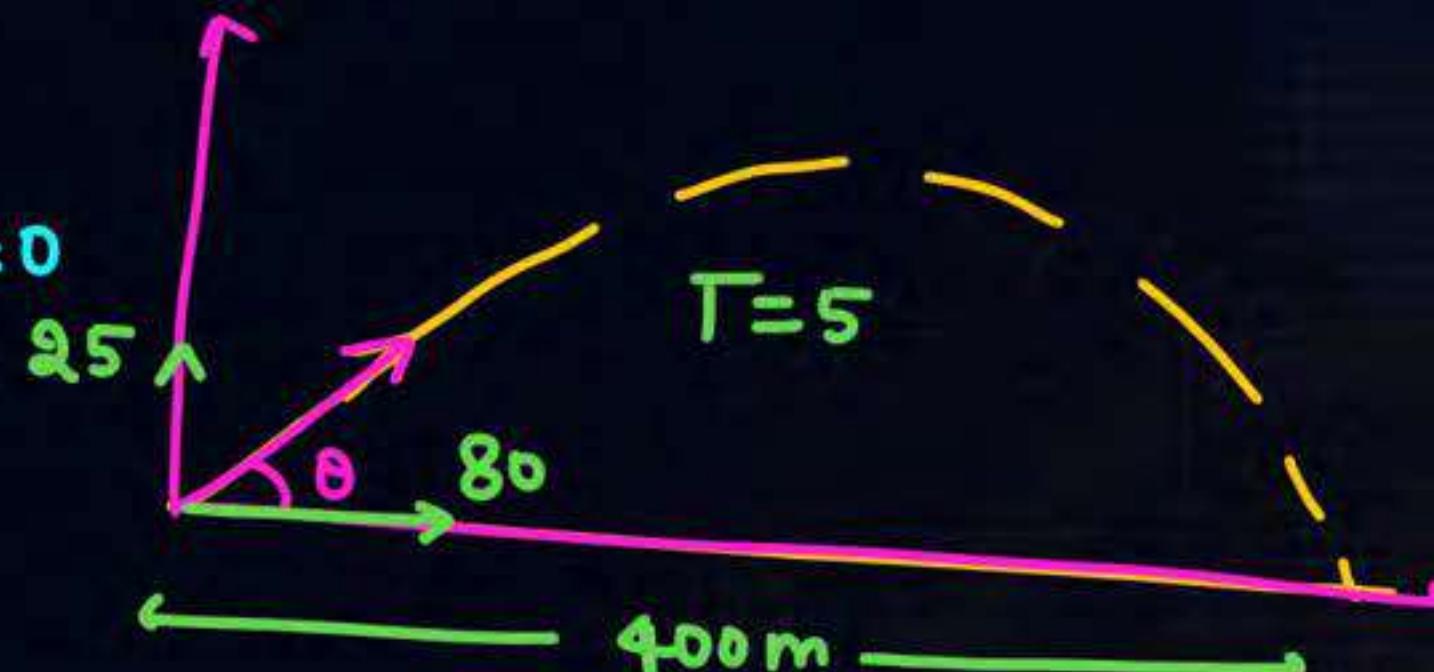
- ① h_{\max}
- ② inclination of arrow at $t=0$

$$\tan \theta = \frac{25}{80} = \frac{5}{16}$$

$$\vec{u} = 2.5\hat{i} + 80\hat{j}$$

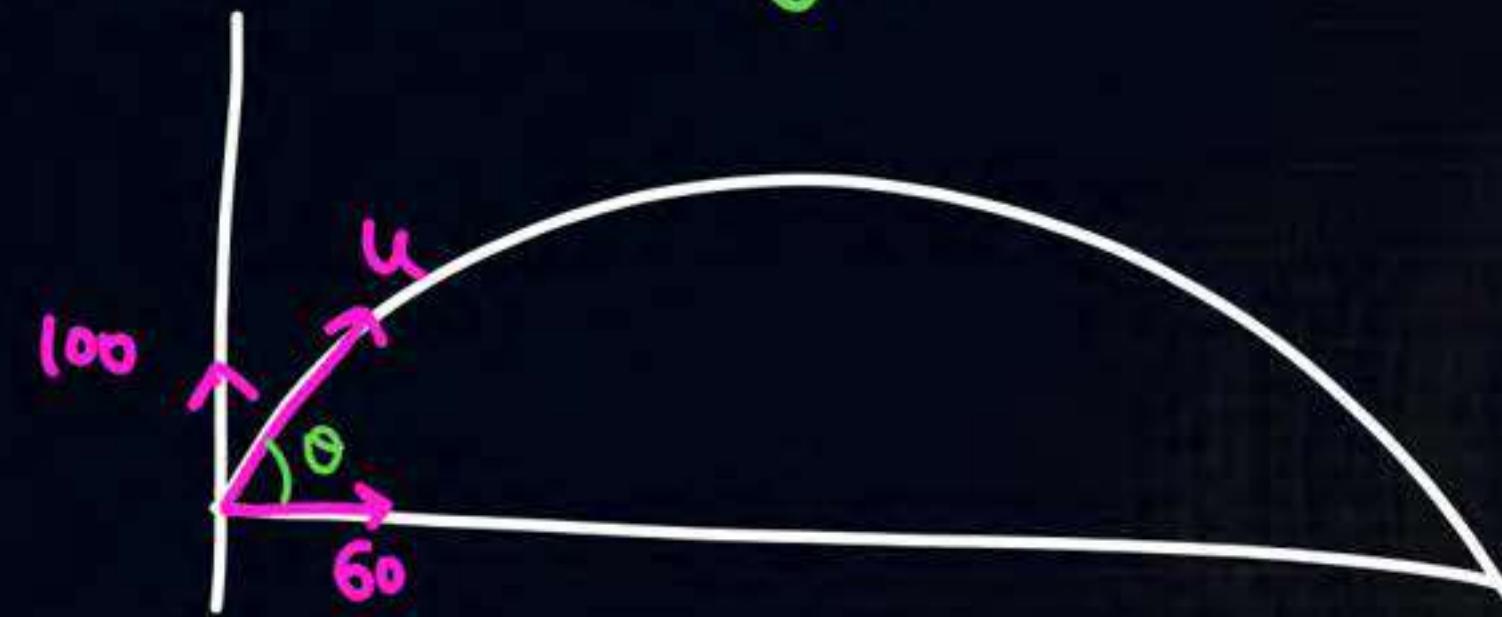
$$0^2 = (25)^2 - 2 \times g \times h_{\max}$$

$$h_{\max} = \frac{(25)^2}{2g} = \frac{625}{20}$$



Q. A particle is projected at angle θ such that its range is 1200 m and time of flight is 20 sec
find ① angle at which particle is projected.

$$\tan \theta = \frac{100}{60} = \frac{5}{3}$$



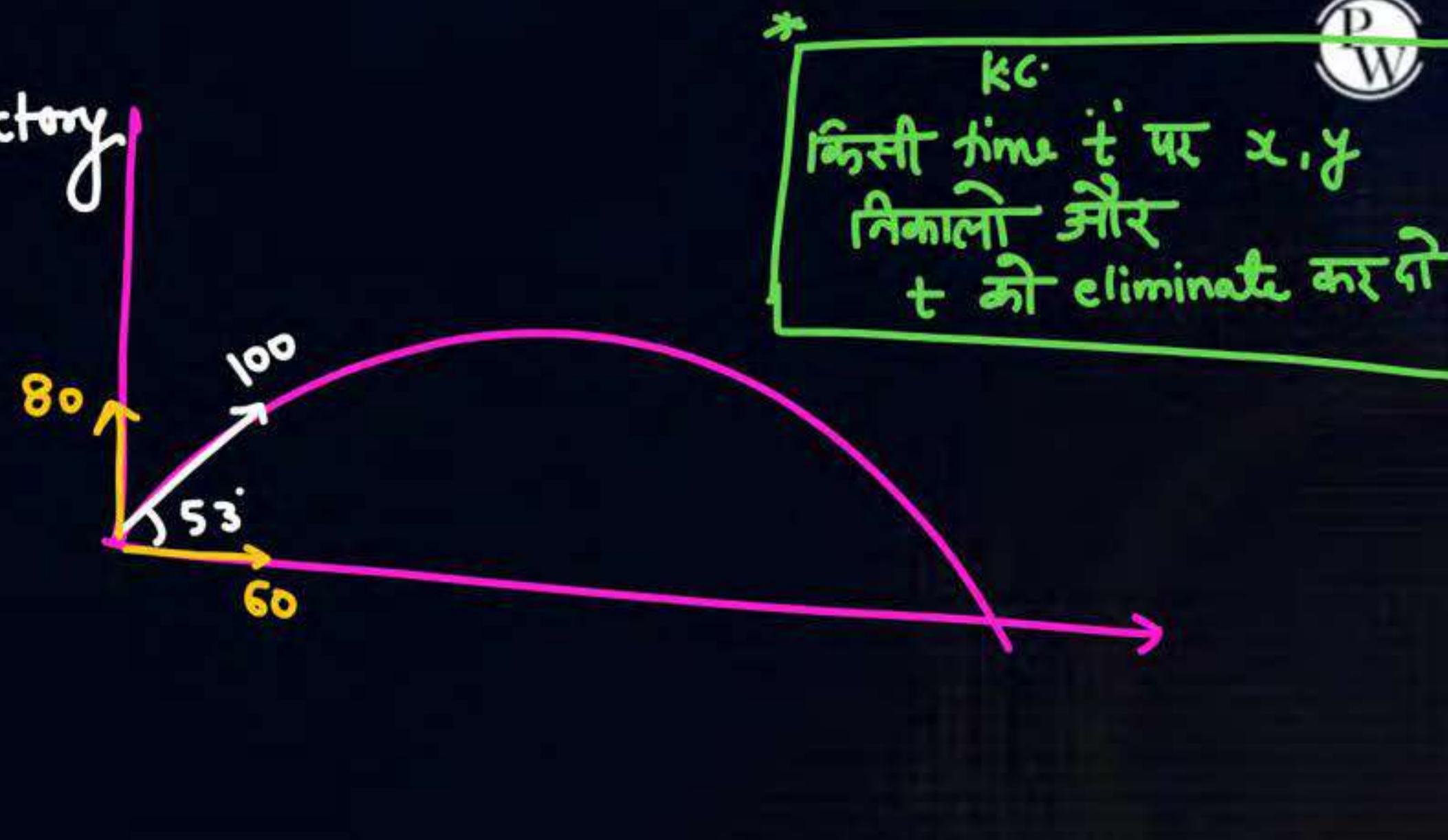
Q. Find equation of trajectory

$$x = 60t \quad t = \frac{x}{60}$$

$$y = 80t - \frac{1}{2} g t^2$$

$$y = 80 \frac{x}{60} - \frac{1}{2} g \left(\frac{x}{60}\right)^2$$

$$y = \frac{4}{3}x - \frac{5}{3600}x^2$$



KC
किसी time t पर x, y
मिकालों और
 t को eliminate करते

Q

find eqⁿ of trajectory

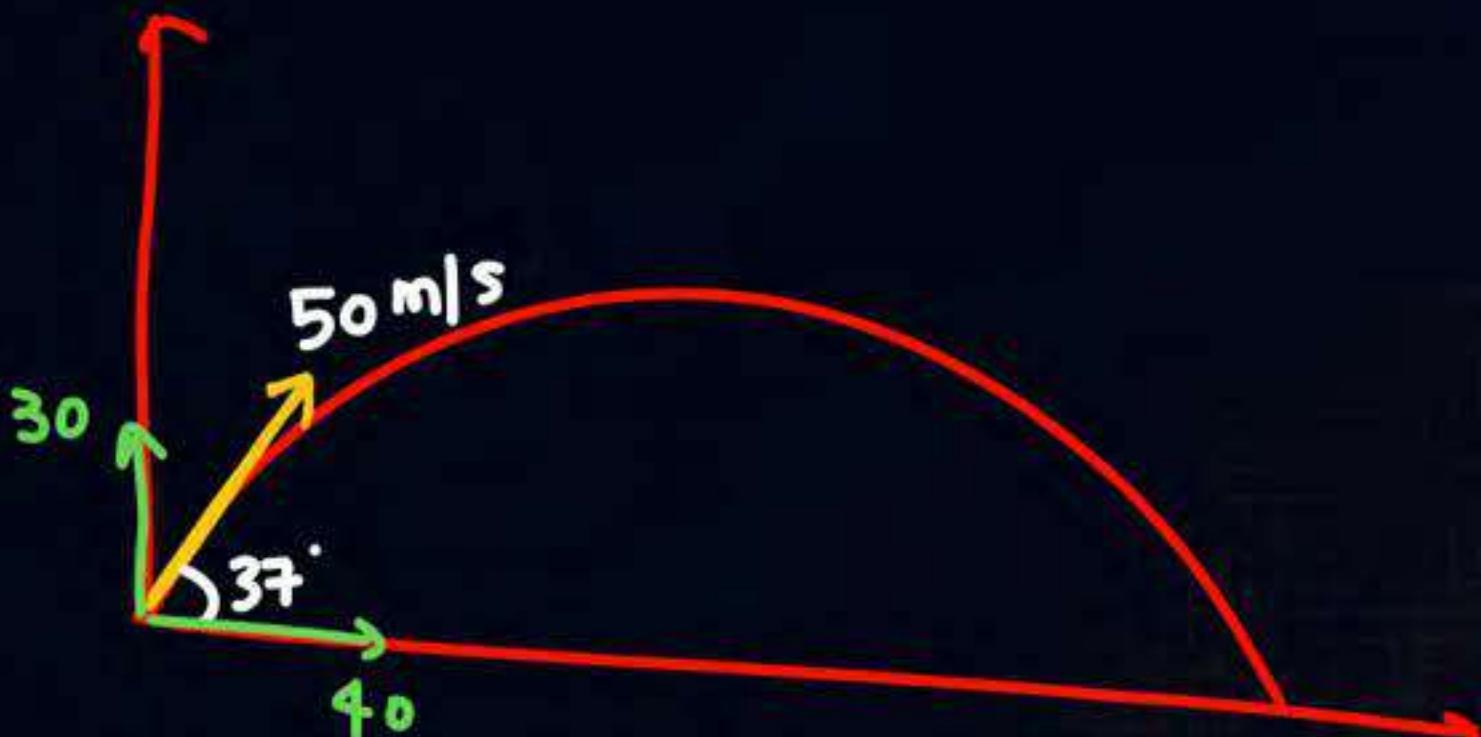
$$x = 40t$$

$$t = x/40$$

$$y = 30t - \frac{1}{2}g t^2$$

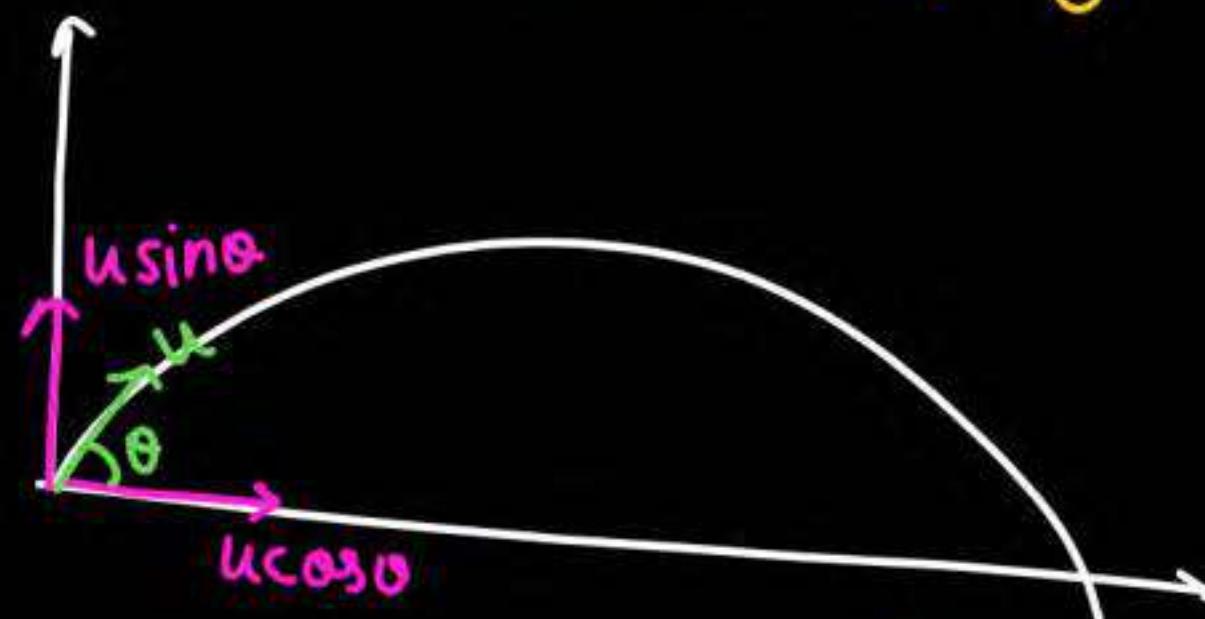
$$y = 30 \cdot \frac{x}{40} - \frac{1}{2}g \frac{x^2}{(40)^2}$$

$$y = \frac{3}{4}x - \frac{5}{1600}x^2$$



Equation of trajectory

Rough copy $\frac{2\pi}{T}$
 $\frac{2\pi}{T}$ calculation
 $\frac{2\pi}{T}$



$$t = \frac{x}{u \cos \theta}$$

$$x = u \cos \theta \cdot t$$

$$y = u \sin \theta \cdot t - \frac{1}{2} g t^2$$

$$y = u \sin \theta \cdot \frac{x}{u \cos \theta} - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta}$$

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta}$$

$$y = x \tan \theta - \frac{1}{2} g \left(\frac{x}{u \cos \theta} \right)^2$$

Q If eqn of trajectory is given by

$$y = x \sqrt{3} - \frac{x^2}{20}$$

Find ① u, Q, T, R, θ

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta} \quad (\text{Compare})$$

$$\sqrt{3} = \tan \theta$$

$$\boxed{\theta = 60^\circ}$$

$$\frac{1}{20} = \frac{g}{2 u^2 \cos^2 \theta}$$

$$\frac{1}{20} = \frac{10}{2 u^2 \cos^2 60^\circ}$$

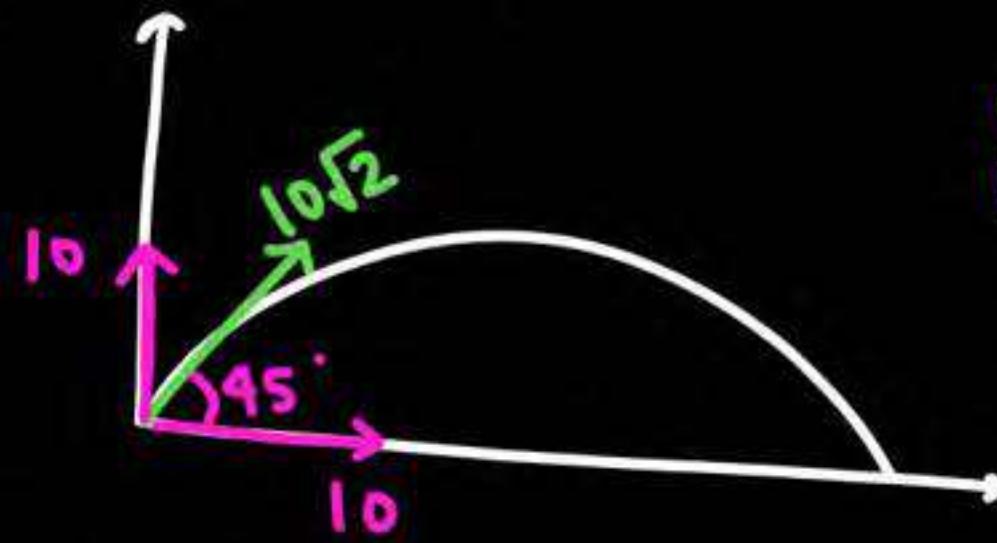
$$2u^2 \frac{1}{4} = 20 \times 10$$

$$\begin{aligned} u^2 &= 400 \\ \boxed{u &= 20} \end{aligned}$$



Q If eqn of trajectory is given by

$$y = x - \frac{x^2}{20}$$



① find u, θ, T, R, \dots

$$T = l + l = 2$$

$$R = 10 \times 2 = 20$$

$$y = x - \frac{x^2}{20}$$

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta}$$

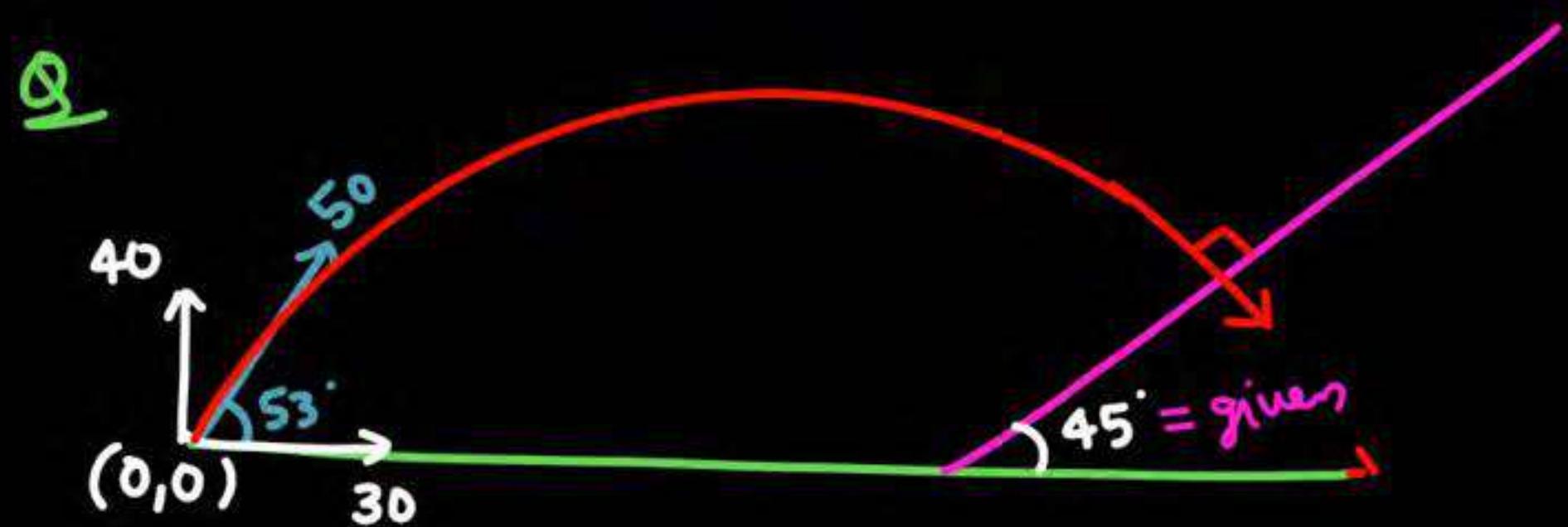
$$\tan \theta = 1$$

$$\theta = 45^\circ$$

$$\frac{1}{20} = \frac{g}{2 u^2 \cos^2 45^\circ}$$

$$2u^2 \frac{1}{2} = 200$$

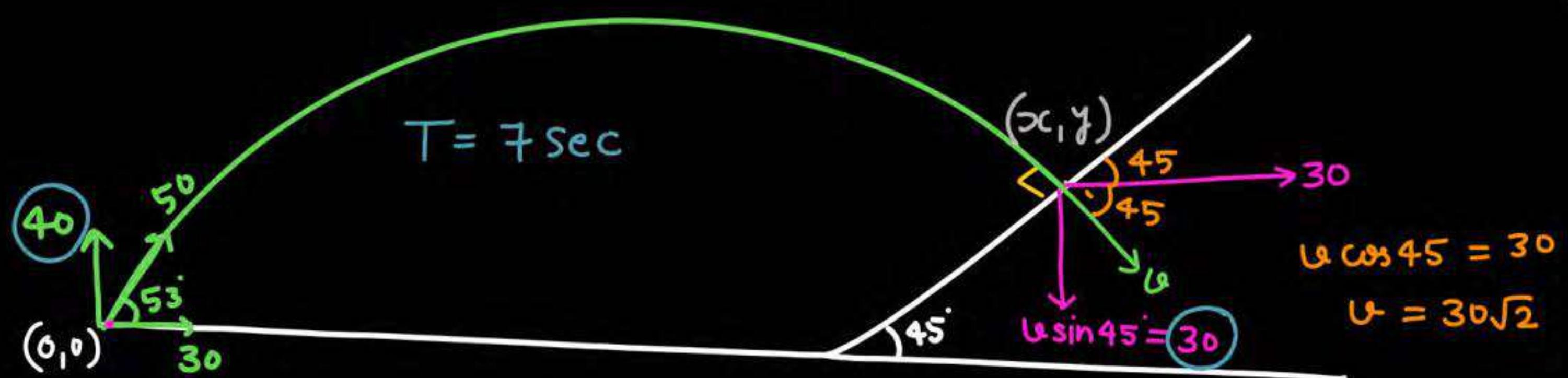
$$u = 10\sqrt{2}$$



particle strike the plane
perpendicularly.

find T .

Co-ordinate of point where
particle strike at plane



$$t = 7 \Rightarrow$$

$$x = 30 \times 7 = 210$$

$$y = 40 \times 7 - \frac{1}{2} \times 10 \times 7^2$$

JA find distance of striking point from projection point

Distance formula = $\sqrt{(x-0)^2 + (y-0)^2} = \checkmark$

Q

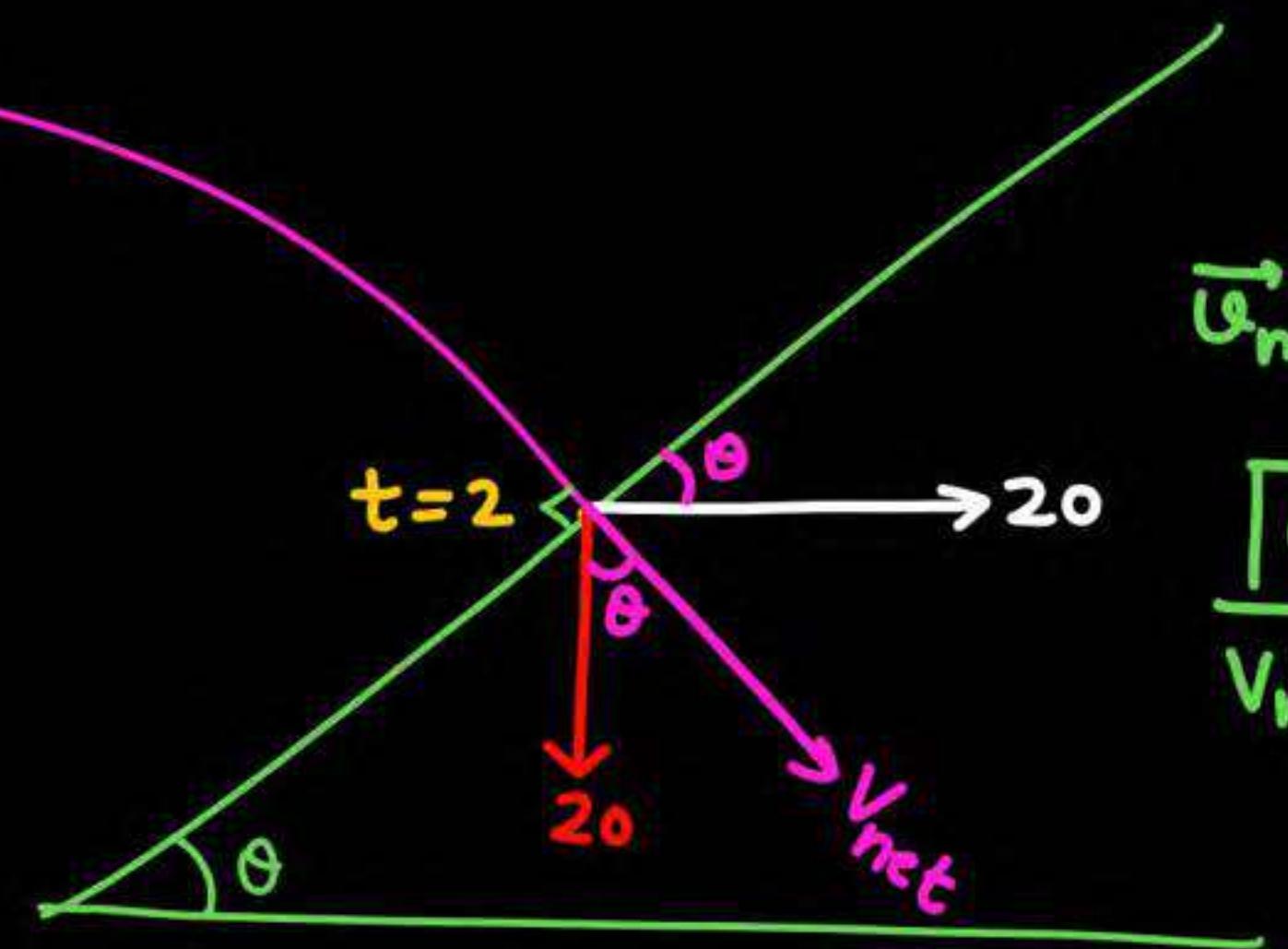
20 m/s

particle strike the
plane perpendicularly
find α

$$\textcircled{y} \quad v = u + at$$

$$v = -10 \times 2$$

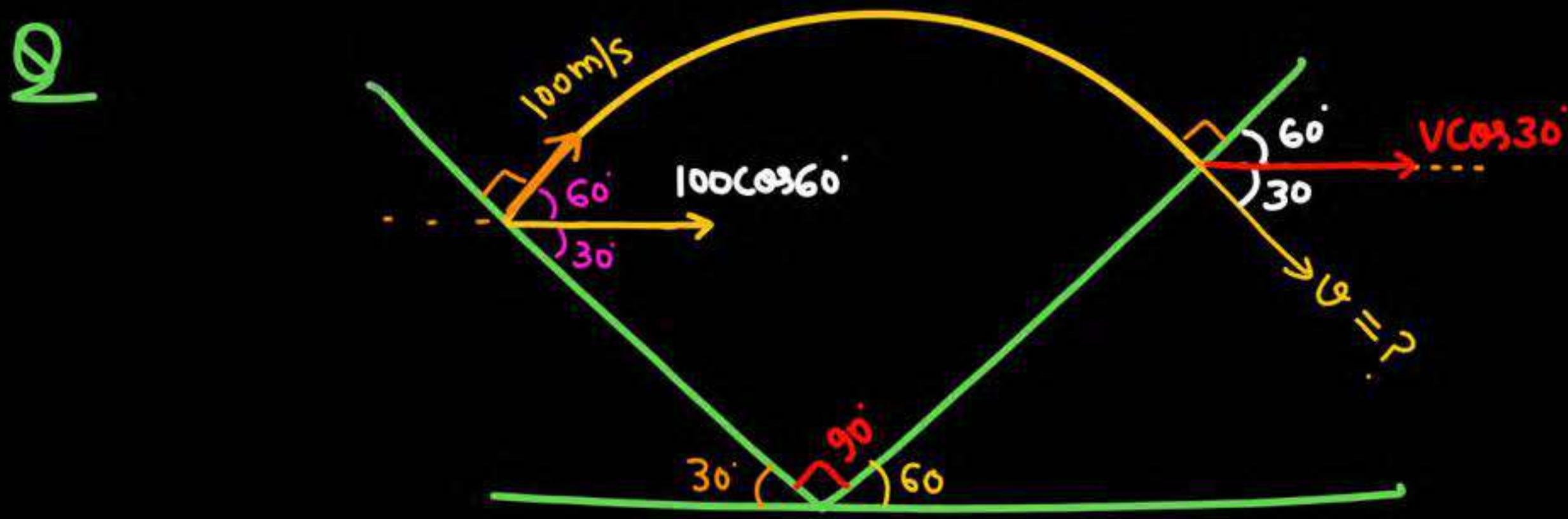
$$v = \theta 20 = u_f$$



$$\vec{v}_{net} = 20\hat{i} - 20\hat{j}$$

$$\boxed{\alpha = 45^\circ}$$

$$v_{net} = 20\sqrt{2}$$



$$100 \cos 60 = V \cos 30$$

$$100 \times \frac{1}{2} = V \frac{\sqrt{3}}{2}$$

$$V = \frac{100}{\sqrt{3}}$$

$$\vec{r} = 4t^2 \hat{i} + 2t^3 \hat{j} + 4t^4 \hat{k}$$

P
W

Q A particle is moving such that

$$x = 4t^2$$

$$y = 2t^3$$

$$z = 4t^4$$

① find velocity at $t = 1 \text{ sec}$

$$\vec{v} = 8\hat{i} + 6\hat{j} + 16\hat{k}$$

② find acc at $t = 2 \text{ sec}$

$$\vec{a} = 8\hat{i} + 24\hat{j} + 192\hat{k}$$

$$v_x = \frac{dx}{dt} = 8t \longrightarrow a_x = 8$$

$$v_y = \frac{dy}{dt} = 6t^2 \longrightarrow a_y = 12t$$

$$v_z = \frac{dz}{dt} = 16t^3 \longrightarrow a_z = 48t^2$$

$$\vec{v} = 8t\hat{i} + 6t^2\hat{j} + 16t^3\hat{k}$$

$$\vec{a} = 8\hat{i} + 12t\hat{j} + 48t^2\hat{k}$$

Q A particle is moving such that

Q

$$\vec{r} = 2t^2 \hat{i} + 4t^3 \hat{j} + 6t^2 \hat{k}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = 4t \hat{i} + 12t^2 \hat{j} + 12t \hat{k}$$

$$\boxed{\vec{a} = 4 \hat{i} + 24t \hat{j} + 12 \hat{k}}$$

Q A particle is moving such that

$$\vec{r} = 3t^2 \hat{i} + 2t^3 \hat{j} + 10t \hat{k}$$

find ① find \vec{v} & \vec{a} at $t=1\text{sec}$

$$\vec{v} = 6t \hat{i} + 6t^2 \hat{j} + 10 \hat{k}$$

$$\vec{a} = 6 \hat{i} + 12t \hat{j} + 0 \hat{k}$$

$$t=1 \quad \vec{v} = 6\hat{i} + 6\hat{j} + 10\hat{k}$$

$$\vec{a} = 6\hat{i} + 12\hat{j}$$

vector

② find angle b/w \vec{v} & \vec{a}
at $t=1\text{sec}$

$$\vec{a} \cdot \vec{v} = a v \cos \theta$$

$$\cos \theta = \frac{\vec{a} \cdot \vec{v}}{av} = \frac{36+72+0}{\sqrt{6^2+12^2} \sqrt{6^2+6^2+10^2}}$$

= ✓

प्र० कानूनी

$$Q \quad y = 2x - \frac{x^2}{6}$$

Range = ?

$$y = 2x \left(1 - \frac{x}{12} \right)$$

$$\boxed{R=12}$$

$$y = x \tan \theta \left(1 - \frac{x}{R} \right).$$

$$y = x \tan \theta - \frac{x^2 \tan \theta}{u \cos \theta \cdot 2u \sin \theta g}$$

$$y = x \tan \theta - \frac{1}{2} \frac{x^2}{u^2} \frac{\sin \theta}{\cos \theta} g$$

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta}$$

$$\Omega \quad y = ax - bx^2$$

find θ , & Range

$$R = \frac{a}{b}$$

$$y = ax \left(1 - \frac{bx^2}{ax}\right)$$

$$\tan \theta = a$$

$$y = ax \left(1 - \frac{x}{a/b}\right)$$

$$\theta = \tan^{-1} a$$

$$y = x \tan \theta \left(1 - \frac{x}{R}\right)$$

(Ques practice on diff & integration based ques)

Q $\vec{r} = 3t^2 \hat{i} + 4t \hat{j} - 6t^3 \hat{k}$

find \vec{v} , \vec{a} at $t = 1$ sec

$\vec{v} = \frac{d\vec{r}}{dt} = 6t \hat{i} + 4 \hat{j} - 18t^2 \hat{k} \Rightarrow t = 1 \quad \vec{v} = 6\hat{i} + 4\hat{j} - 18\hat{k}$

$\vec{a} = 6\hat{i} + 0\hat{j} - 36\hat{k}$

1D

A particle is moving on x -axis such that

Q find \vec{v}, \vec{a} , at $t=2 \text{ sec}$

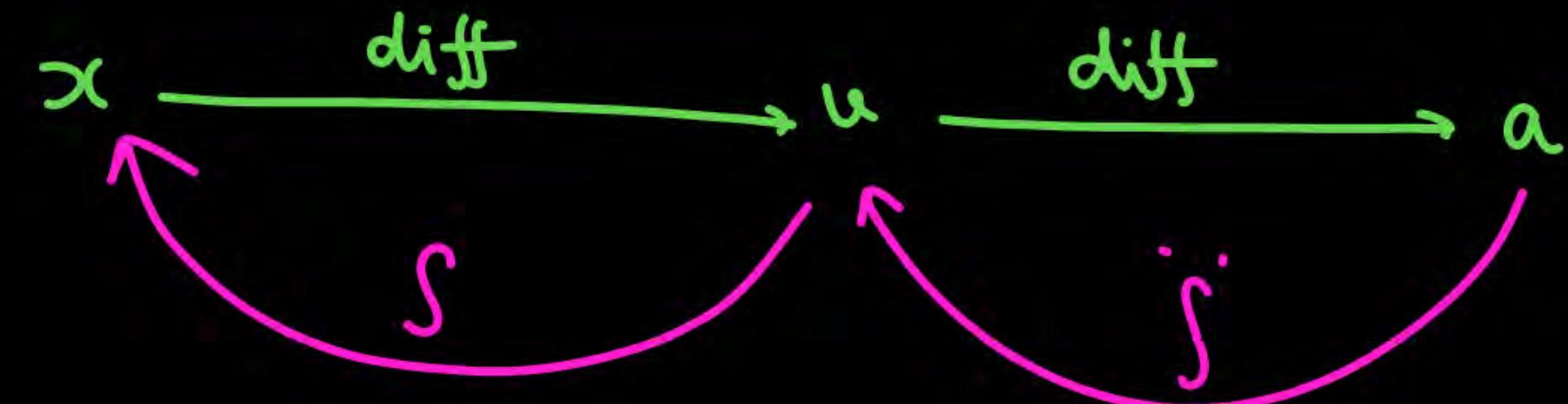
$$x = t^3 + 2t^2 + 6t$$

$$v = 3t^2 + 4t + 6$$

$$a = 6t + 4$$

$$t=2, v = 12+8+6$$

$$a = 16$$

P
W

at $t=0$

Q A particle start motion[^] from $x=0$
such that its v vs t relation
is given as

$$v = 4t^3 + 3t^2 + 2t$$

find location of particle $t=1 \text{ sec}$

$$x = \int v dt \text{ (indefinite)} \checkmark$$

$$x = \int (4t^3 + 3t^2 + 2t) dt$$

$$x = 4\frac{t^4}{4} + 3\frac{t^3}{3} + 2\frac{t^2}{2} + C$$

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

$$(t=0, x=0) 0=0+0+0+C$$

$$\boxed{C=0}$$

$$x = t^4 + t^3 + t^2 + 0$$

$$t=1, x = 1+1+1 = 3$$

Q A particle start motion at $t=0$

from $x=+10$, such that - - - - .

$$v = 4t^3 + 3t^2 + 2t$$

find location of particle at $t=1 \text{ sec}$

$$x = \int v dt$$

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

$$t=0, x=10 \text{ (put)}$$

$$10 = 0+0+0+C \Rightarrow \boxed{C=10}$$

$$x = t^4 + t^3 + t^2 + 10$$

$$t=1, x = 13 \text{ Ans}$$

Q A particle starts motion from $x=5$ at $t=0$, such that

$$v = t^2 + t$$

find location of particle at $t=6$ sec

$$x = \frac{t^3}{3} + \frac{t^2}{2} + C$$

$$t=0, x=5$$

$$5 = 0 + 0 + C$$

$$\boxed{C=5}$$

$$x = \frac{t^3}{3} + \frac{t^2}{2} + 5$$

$$t=6 \quad x = \frac{6^3}{3} + \frac{6^2}{2} + 5$$

$$x = 72 + 18 + 5 = 95$$

(M-2) Definite Integration

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

$$dx = v dt$$

$$\int_{x=5}^{x_f} dx = \int_{t=0}^{t=6} (t^2 + t) dt$$

$$\int_{5}^{x_f} dx = \int_{0}^{6} (t^2 + t) dt$$

$$x \Big|_5^{x_f} = \left(\frac{t^3}{3} + \frac{t^2}{2} \right) \Big|_0^6$$

$$x_f - 5 = \left(\frac{6^3}{3} + \frac{6^2}{2} \right)$$

$$- \left(\frac{0^3}{3} + \frac{0^2}{2} \right)$$

$$x_f - 5 = 72 + 18 - 0$$

$$x_f = 90 + 5$$

$$\boxed{x_f = 95}$$

Q A particle starts motion from rest from origin at $t=0$
such that $a = 6t$

find v, x (location) at $t = 2 \text{ sec}$

$$a = 6t$$

$$v = \int a dt = \int 6t dt$$

$$v = 6 \frac{t^2}{2} + C$$

$$v = 3t^2 + C$$

$$t=0, v=0$$

$$0=0+C$$

$$C=0$$

$$v = 3t^2$$

$$t=2, v=12$$

$$x = \int 3t^2 dt = 3 \frac{t^3}{3} + C'$$

$$x = t^3 + C'$$

$$t=0, x=0, 0=0+C' \Rightarrow C'=0$$

$$x = t^3$$

$$t=2, x=8$$

Q A particle starts motion at $t=0$ having initial velocity $v=+10$ and initial location at $x=20$
such that $a=24t^2$

find v, x (location) at $t=2$ sec

$$a = 24t^2$$

$$v = \int 24t^2 dt = 24 \frac{t^3}{3} + C$$

$$v = 8t^3 + C$$

put $t=0, v=10$

$$10 = 0 + C \Rightarrow C = 10$$

$$\boxed{v = 8t^3 + 10}$$

$$v = 8t^3 + 10$$

$$x = \int (8t^3 + 10) dt =$$

$$x = 8 \frac{t^4}{4} + 10t + C'$$

$$t=0, x=20 \Rightarrow C' = 20$$

$$x = 2t^4 + 10t + 20$$

$$t=2, v = 8 \times 8 + 10 = 74$$

$$x = 2 \times 16 + 10 \times 2 + 20 = 72$$

Q A particle is moving on x-axis such that its acc is given by $a = \frac{3}{v}$. at $t=0$ its velocity is 1 m/s find Velocity at $t=40$ sec

P
W

Sol

$$a = \frac{3}{v}$$

$$\text{at } t=0, v=1$$

$$\frac{dv}{dt} = \frac{3}{v}$$

$$\frac{1}{2} = 0 + C$$

$$\int v dv = \int 3 dt$$

$$\frac{v^2}{2} = 3t + \frac{1}{2}$$

$$\frac{v^2}{2} = 3t + C$$

$$v^2 = 6t + 1$$

$$t=40, v = \sqrt{6 \times 40 + 1} = \sqrt{241}$$

(सबसे पहले थे दरवा
given acc ए
पूछा क्या है)

$$\begin{aligned} v &= \frac{dx}{dt} \\ a &= \frac{dv}{dt} \\ a &= v \frac{dv}{dx} \end{aligned}$$

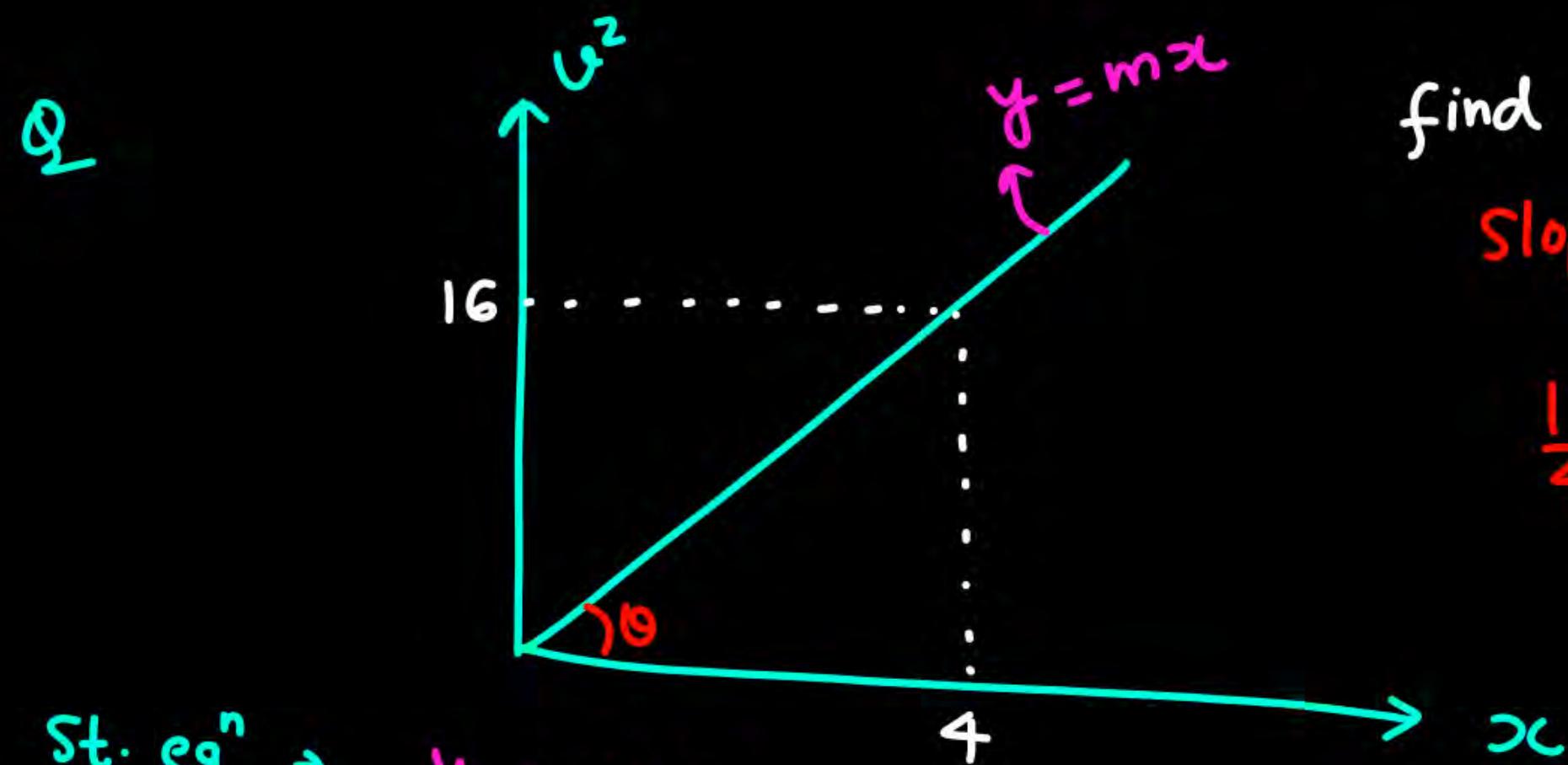
Q If $v = x^2 + 3x$
find acc at $x=2$

$$a = v \frac{dv}{dx} \quad \frac{dv}{dx} = 2x + 3$$

$$a = (x^2 + 3x)(2x + 3)$$

$$\text{put } x=2, a = (4+6)(4+3)$$

$$\boxed{a = 70}$$



find acc at $x=4$

$$\text{Slope} = \frac{dy}{dx} = \frac{d(v^2)}{dx}$$

$$\frac{16}{4} = 2v \frac{dv}{dx}$$

$$4 = 2a \Rightarrow \boxed{a=2}$$

St. eqⁿ $\Rightarrow y = mx$

$$v^2 = 4x$$

$$2v \frac{dv}{dx} = 4$$

$$\underline{\underline{a = 2}}$$

Q

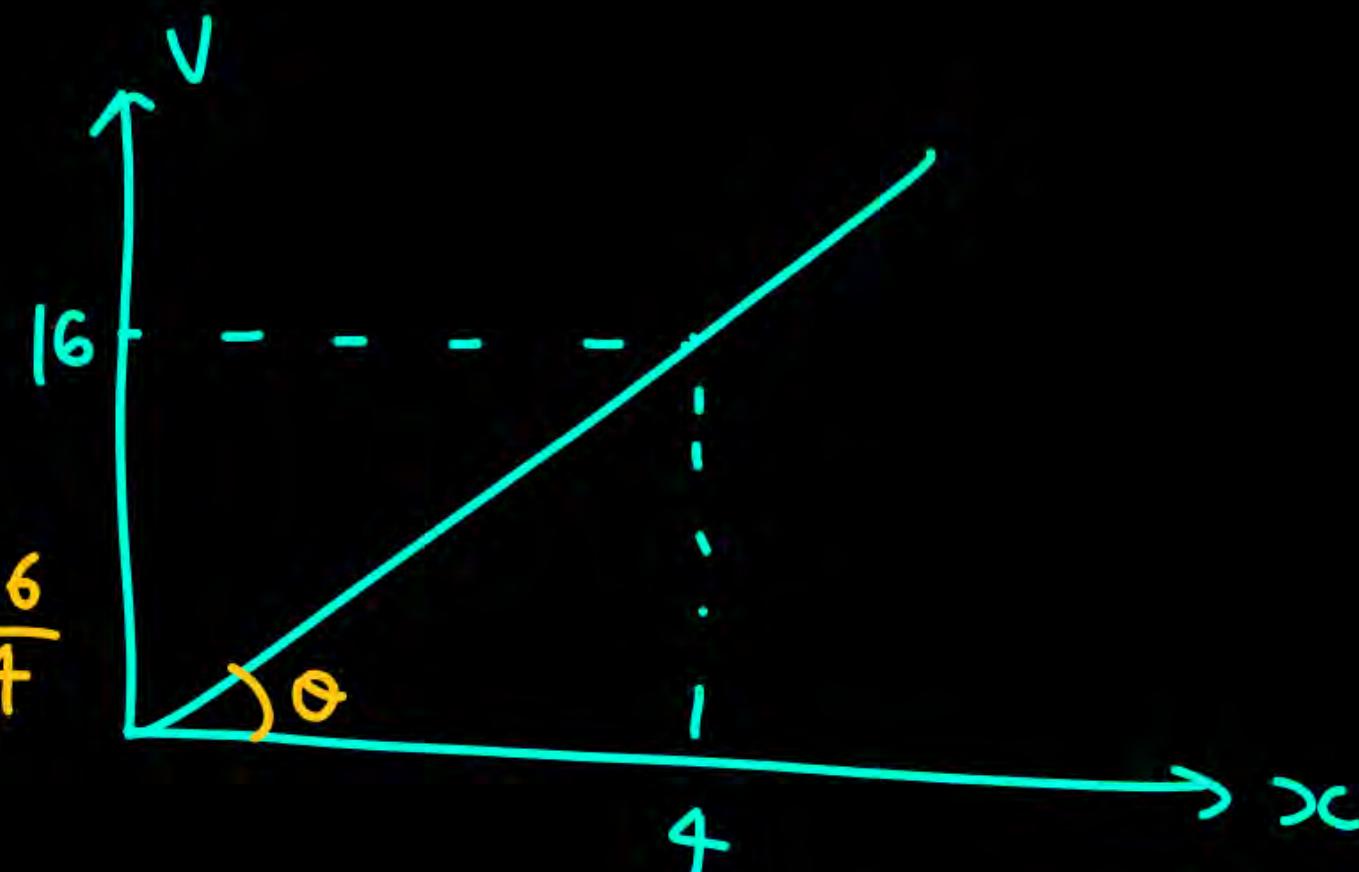
find acc

at $x = 4$

$$\text{Slope} = \frac{dy}{dx} = \frac{dv}{dx} = \frac{16}{4}$$

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

$$a = 16 \times \frac{16}{4} = 64$$



Q $x = \sqrt{v+1}$ find acc at $x=5$

$$x^2 = v + 1 \quad a = (x^2 - 1)(2x)$$

$$v = x^2 - 1 \quad x=5 \Rightarrow a = 240$$

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

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

-

Q position vector
 $\vec{r} = 3t^3 \hat{i} + 4t \hat{j} + t^2 \hat{k}$

find average acc of particle from $t = 1$ to $t = 2$ sec

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

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

$\vec{v} = \frac{d\vec{r}}{dt}$

$$\vec{v} = \frac{d\vec{r}}{dt} = 9t^2 \hat{i} + 4 \hat{j} + 2t \hat{k}$$

$t=2 \quad \vec{v}_f = 36 \hat{i} + 4 \hat{j} + 4 \hat{k}$

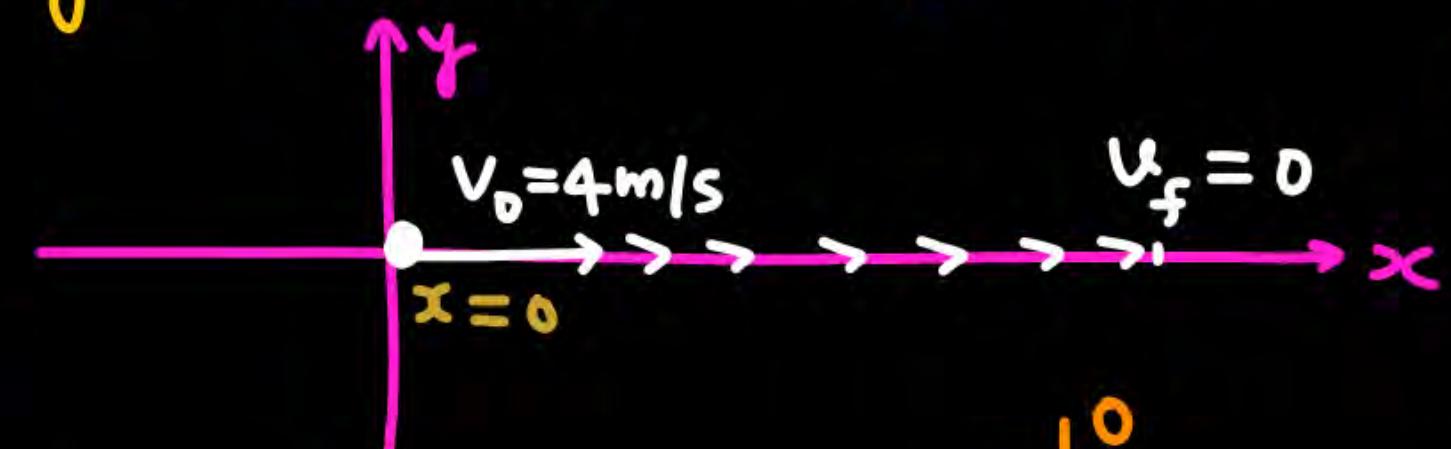
$t=1 \quad \vec{v}_i = 9 \hat{i} + 4 \hat{j} + 2 \hat{k}$

Avg acc = $\frac{27 \hat{i} + 2 \hat{k}}{2-1} = 27 \hat{i} + 2 \hat{k}$

~~$27 + 2 = 29$~~

magnitude $\sqrt{(27)^2 + 2^2}$

Q A particle is projected with velocity $v_0 = 4 \text{ m/s}$ along $+x$ -axis from origin and acc is $a = -3x^2$. Find where particle will come to at rest



$$a = -3x^2$$

$$\frac{dv}{dx} = -3x^2$$

$$\int_4^0 v dv = \int_0^{x_f} -3x^2 dx$$

$$\frac{v^2}{2} \Big|_4^0 = -\frac{x^3}{3} \Big|_0^{x_f}$$

$$\frac{0^2}{2} - \frac{4^2}{2} = -\left[\frac{x_f^3 - 0}{3} \right]$$

$$-8 = -x_f^3$$

$$\boxed{x_f = 2}$$

find acc when velocity become zero.

$$v = 0, x = \frac{2}{\sqrt{3}}$$

$$a = -3x^2$$

$$a = -12$$

Acc. of a particle moving on x-axis having initial speed v_0

Q with distance from origin is given by $a = \sqrt{x}$
 Distance covered by particle when its speed become thrice that
 of initial speed

$a > 0$, speed up, $v > 0$

$$a = \sqrt{x}$$

$$v \frac{du}{dx} = \sqrt{x}$$

$$\int_{V_0}^{3V_0} v du = \int_0^{x_f} x^{\frac{1}{2}} dx$$

$$\frac{v^2}{2} \Big|_{V_0}^{3V_0} = \frac{x^{\frac{1}{2}+1}}{\left(\frac{1}{2}+1\right)} \Big|_0^{x_f}$$

$$\frac{9V_0^2}{2} - \frac{V_0^2}{2} = \frac{2}{3} x^{3/2} \Big|_0^{x_f}$$

$$\frac{8V_0^2}{2} = \frac{2}{3} x_f^{3/2}$$

$$x_f^{3/2} = 6 \cdot V_0^2$$

$$x_f^3 = 36 V_0^4$$

$$x_f = (36 V_0^4)^{\frac{1}{3}}$$

Q

$$x = 2t$$

motion is 1D or 2D

$$y = 4t + 5$$

$$v_x = 2$$

$$\vec{v} = 2\hat{i} + 4\hat{j} = \text{Const}$$

$$v_y = 4 + 0$$

1D

$$x = a \sin \omega t$$

$$y = a (1 - \cos \omega t) = a - a \cos \omega t$$

find (a) \vec{v} ,

(b) Speed of particle

Soln

$$u_x = a \omega \cos \omega t$$

$$u_y = 0 - a \omega [-\sin \omega t]$$

$$v_y = a \omega \sin \omega t$$

$$\vec{v} = (a \omega \cos \omega t) \hat{i} + (a \omega \sin \omega t) \hat{j}$$

speed = ? magnitude

$$|\vec{v}| = \sqrt{(a \omega \cos \omega t)^2 + (a \omega \sin \omega t)^2}$$
$$= a \omega \sqrt{\cos^2 \omega t + \sin^2 \omega t}$$

$$\text{Speed} = a \omega$$

M/w

Ques Discuss ✓

P
V

Q₂ A particle is projected with 100 m/s at angle 53° with horizontal.
At what time it is moving at an angle 45° with horizontal while moving downward.

Relative motion.



Velocity of A wrt ground = $10 \text{ m/s} \hat{i}$

" " B " " = $6 \text{ m/s} \hat{i}$

Velocity of A wrt 'B' = $4 \text{ m/s} \hat{i}$

Velocity of A wrt B = $\vec{v}_{A/B}$ = B की रवाना पर बैठकर A की राह

P
W

$$\boxed{\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B}$$



$$\begin{aligned}\vec{v}_{A/B} &= \vec{v}_A - \vec{v}_B \\ &= 13\hat{i} - 10\hat{i} = 3\hat{i}\end{aligned}$$



$$\begin{aligned}\vec{v}_{B/A} &= \vec{v}_B - \vec{v}_A = (-10\hat{i}) - (6\hat{i}) \\ &= -16\hat{i}\end{aligned}$$

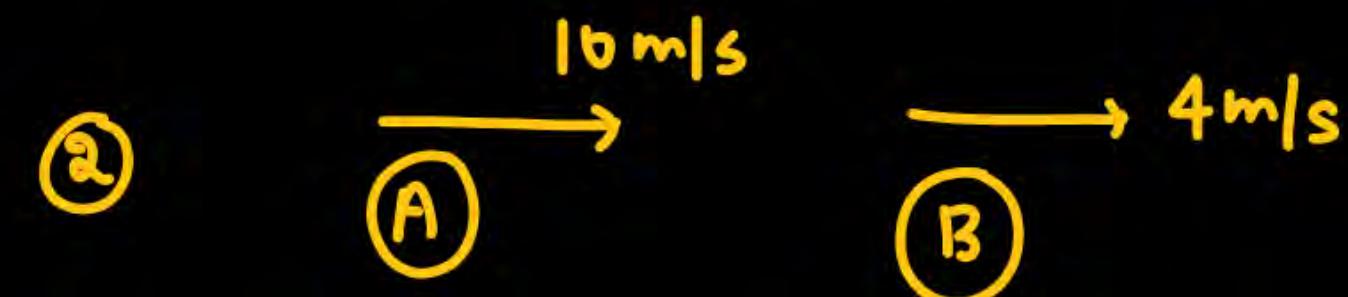


$$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B$$



$$\vec{v}_{B/A} = 8\hat{i} - 6\hat{i} = 2\hat{i}$$

$$\begin{aligned}\vec{v}_{A/B} &= \vec{v}_A - \vec{v}_B = 6\hat{i} - 8\hat{i} \\ &= -2\hat{i}\end{aligned}$$

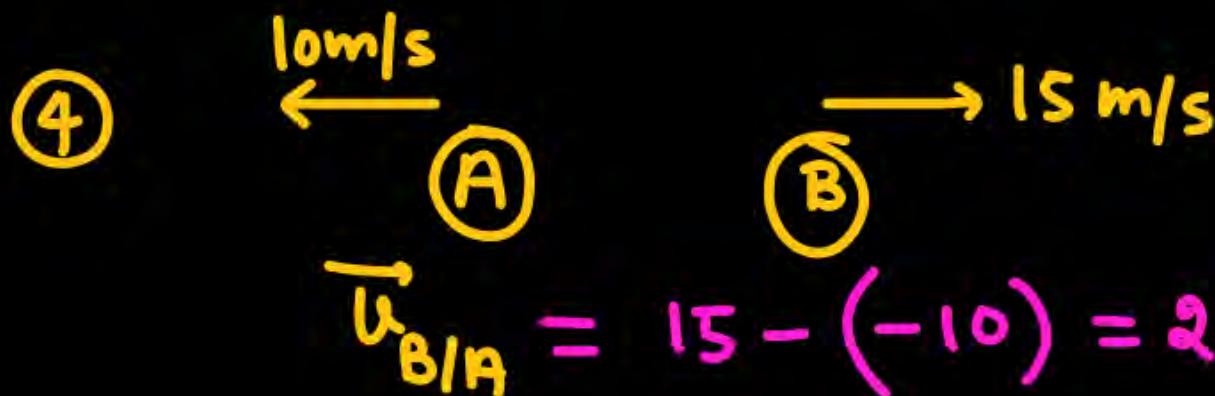


$$\vec{v}_{A/B} = 10 - 4 = 6\hat{i}$$

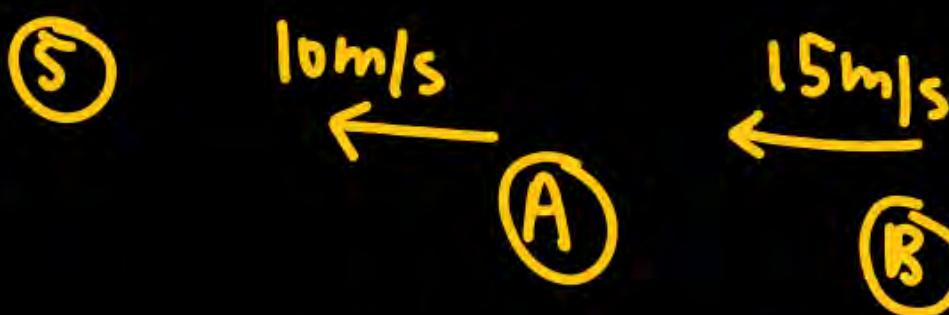
$$\vec{v}_{B/A} = 4 - 10 = -6\hat{i}$$



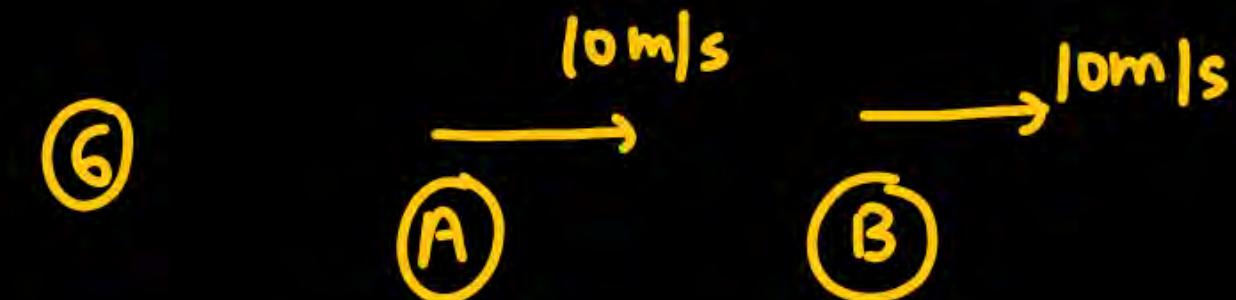
$$\vec{v}_{B/A} = (-10\hat{i}) - (6\hat{i}) = -16\hat{i}$$



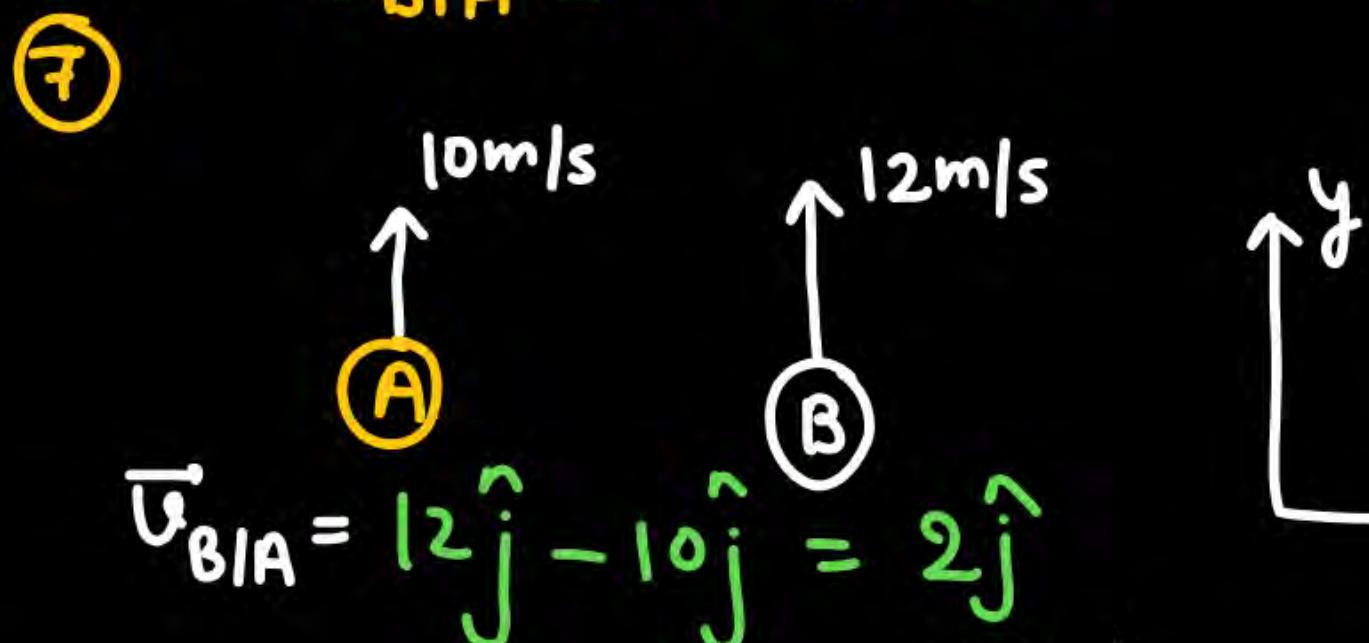
$$\vec{v}_{B/A} = 15 - (-10) = 25$$



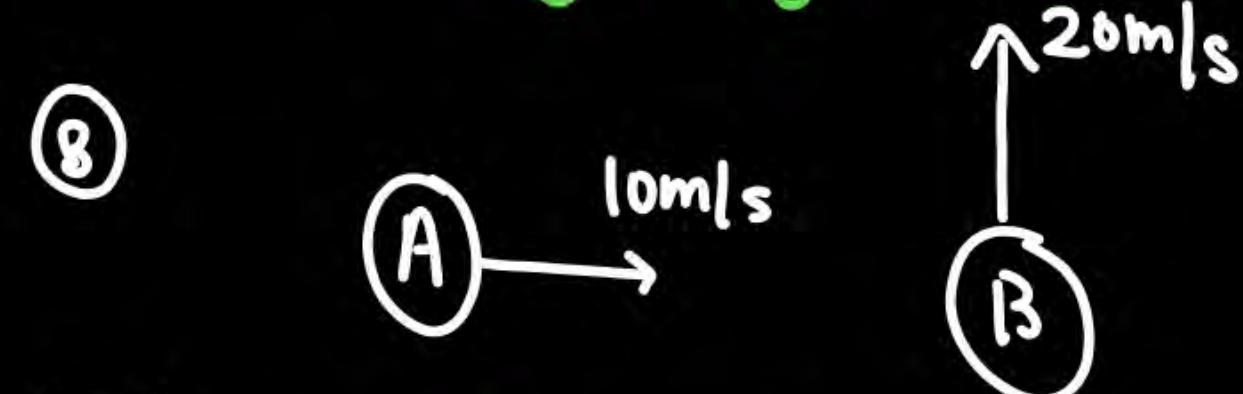
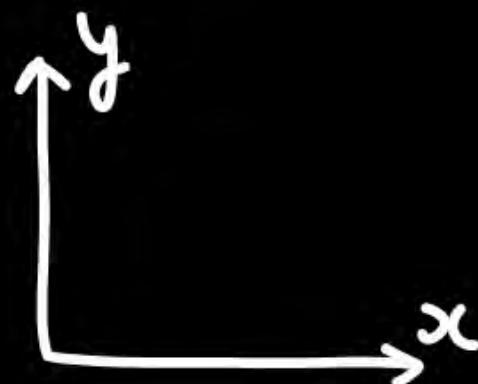
$$\begin{aligned}\vec{v}_{B/A} &= (-15) - (-10) \\ &= -5\hat{i}\end{aligned}$$



$$\vec{v}_{B/A} = 10 - 10 = 0$$

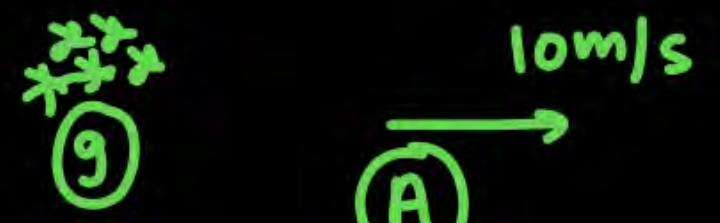


$$\vec{v}_{B/A} = 12\hat{j} - 10\hat{j} = 2\hat{j}$$

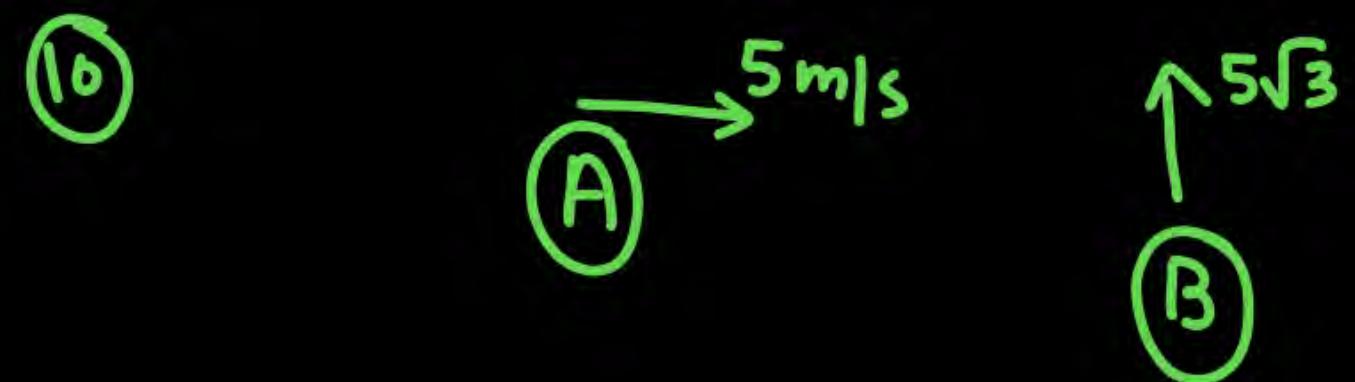


$$\vec{v}_{B/A} = 20\hat{j} - 10\hat{i}$$

P
W



$$\vec{v}_{B/A} = -10\sqrt{3}\hat{j} - 10\hat{i} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

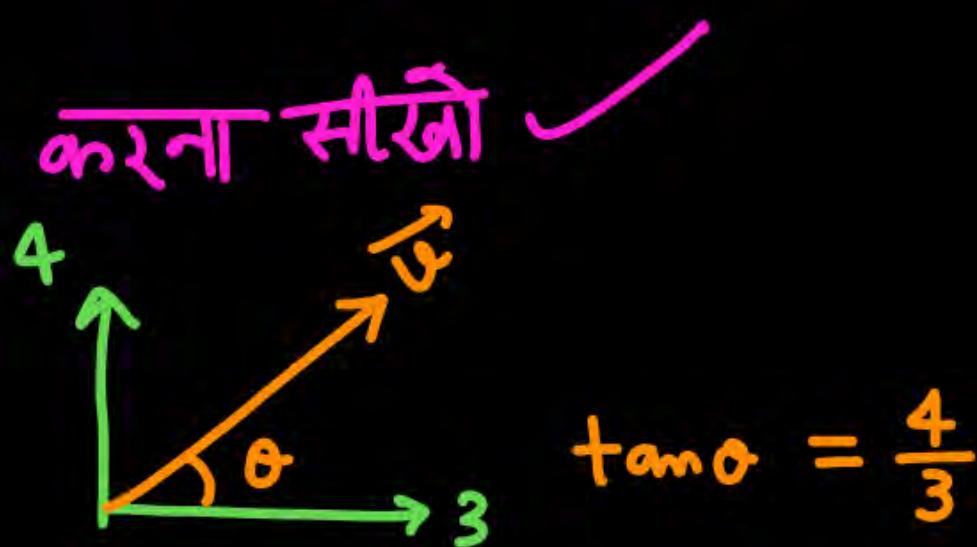


$$\vec{v}_{B/A} = 5\sqrt{3}\hat{j} - 5\hat{i} = -5\hat{i} + 5\sqrt{3}\hat{j}$$

P
W

Vector की Draw करना सीखो ✓

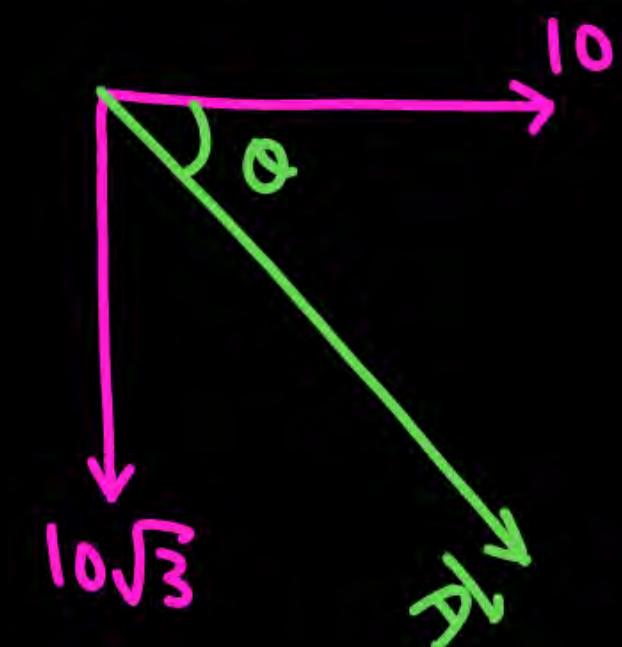
$$① \vec{v} = 3\hat{i} + 4\hat{j}$$



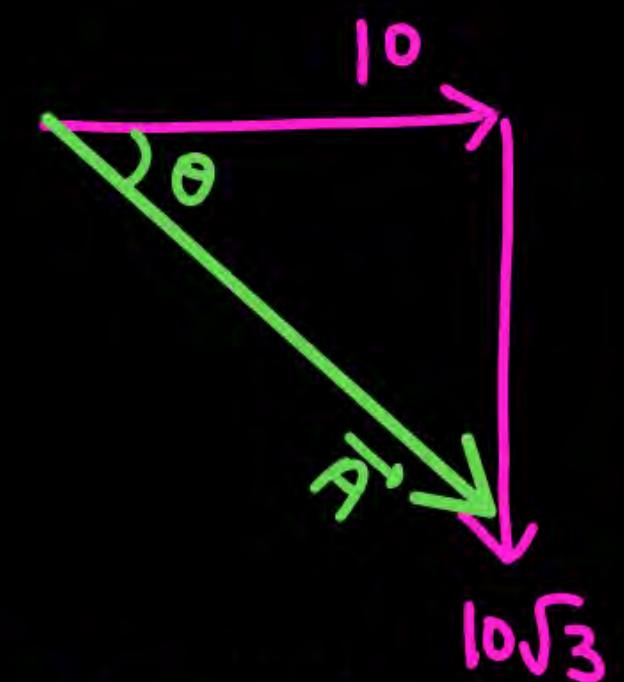
$$\tan \theta = \frac{4}{3}$$

$$② \vec{A} = 10\hat{i} - 10\sqrt{3}\hat{j}$$

$$\tan \theta = \frac{10\sqrt{3}}{10}$$

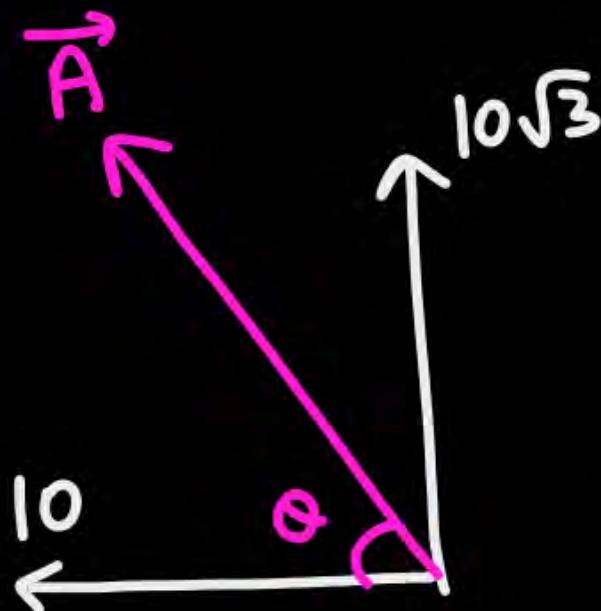


$$\vec{A} = 10\hat{i} - 10\sqrt{3}\hat{j}$$



$$\tan \theta = \frac{10\sqrt{3}}{10}$$

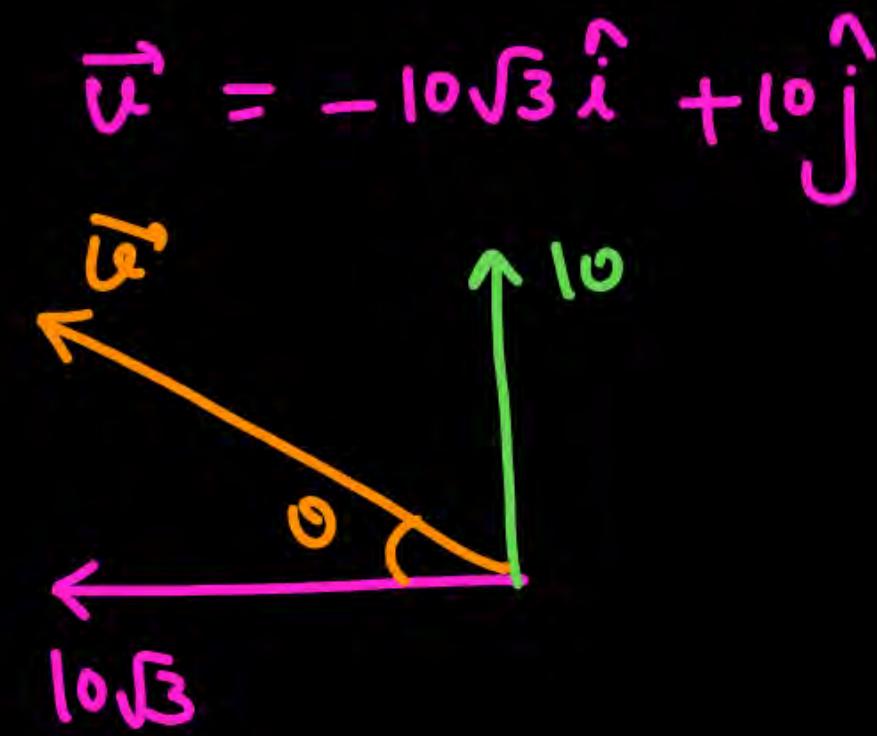
③ $\vec{A} = -10\hat{i} + 10\sqrt{3}\hat{j}$



$$\tan \theta = \frac{10\sqrt{3}}{10}$$

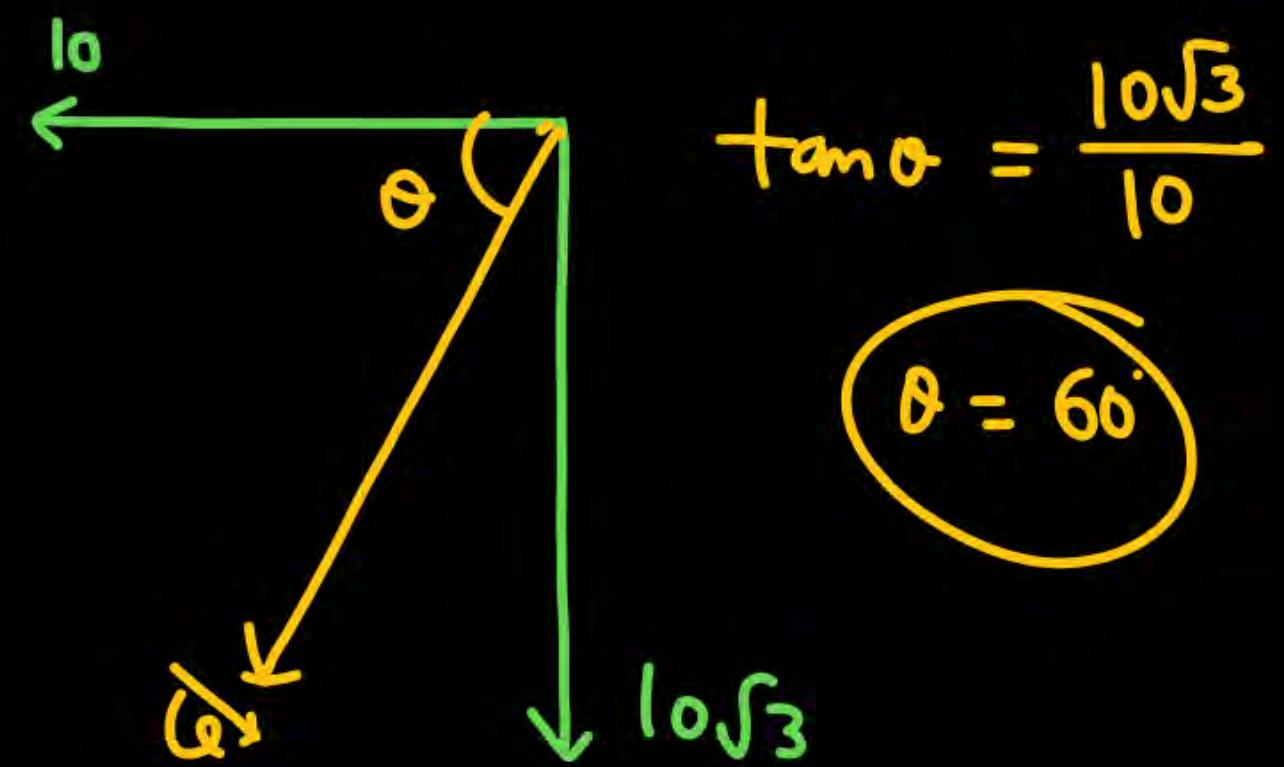
$\theta = 60^\circ$

④ $\vec{v} = 10\hat{j} - 10\sqrt{3}\hat{i}$

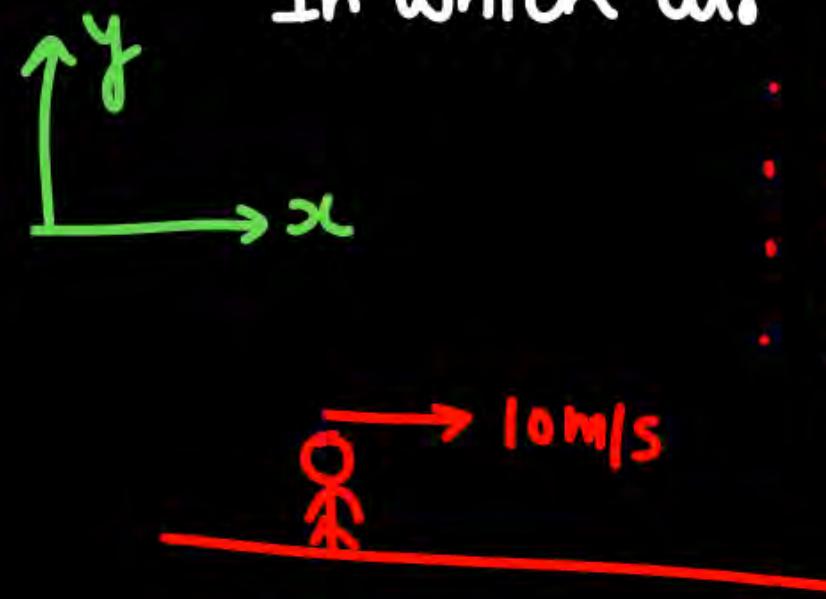


5

$$\vec{v} = -10\hat{i} - 10\sqrt{3}\hat{j}$$



Q A man is moving along $+x$ -axis (east dir) with speed 10 m/s and rain is falling vertically downward with speed $10\sqrt{3}$ m/s. In which dirⁿ man should hold umbrella to protect himself.



$$\vec{v}_{\text{man}} = 10\hat{i}$$

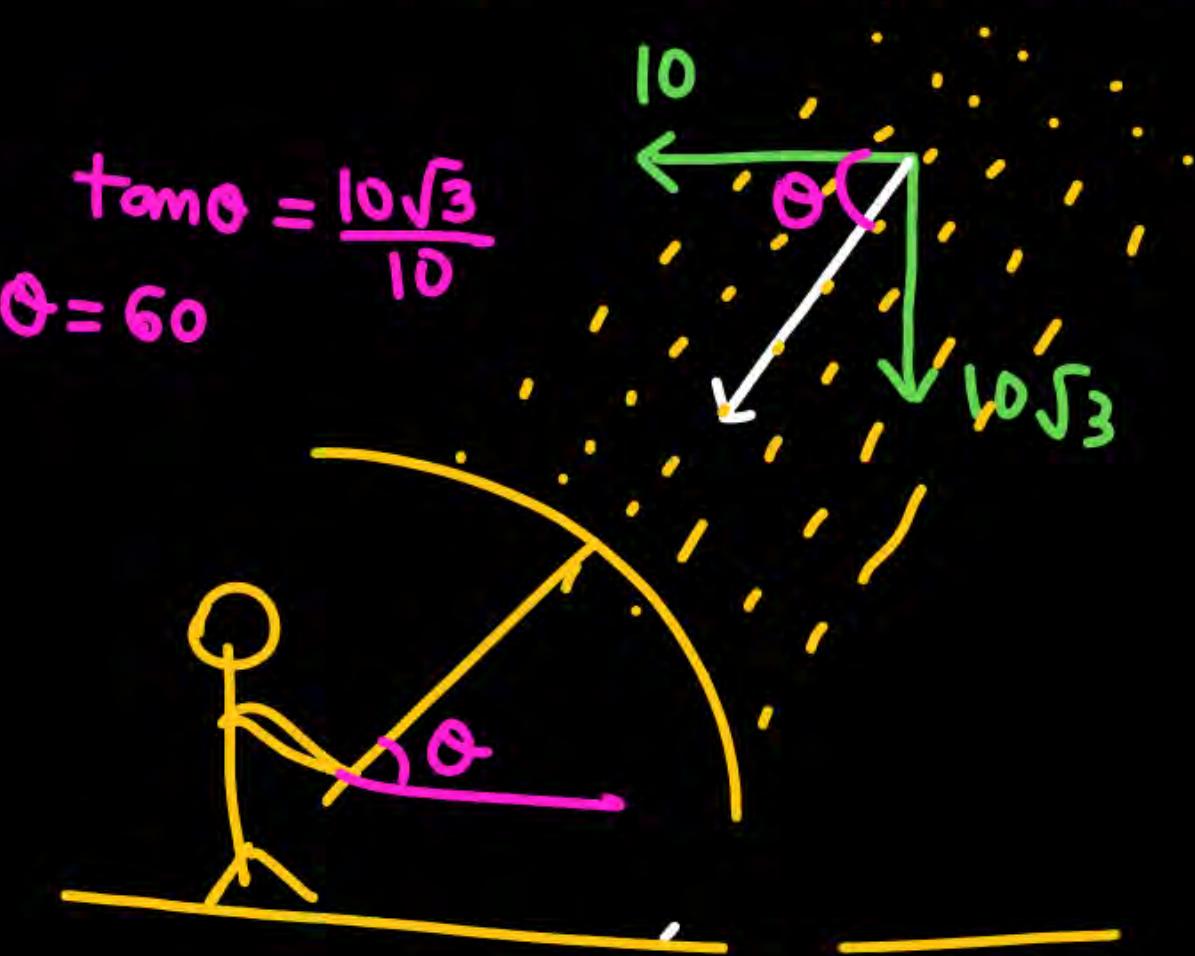
$$\vec{v}_{\text{rain}} = -10\sqrt{3}\hat{j}$$

$$\vec{v}_{\text{rain/man}} = \vec{v}_r - \vec{v}_m$$

$$\vec{v}_{r/m} = -10\sqrt{3}\hat{j} - 10\hat{i} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

$$\tan \theta = \frac{10\sqrt{3}}{10}$$

$$\theta = 60$$



Draw \vec{v}_r

Q A man is moving in east dirⁿ with speed 10m/s in a car.

A bird is flying with speed $10\sqrt{3}$ in south dirⁿ.

① find velocity of bird observed by man.

$$\vec{v}_{\text{man}} = 10\hat{i}$$

$$\vec{v}_{\text{bird}} = -10\sqrt{3}\hat{j}$$

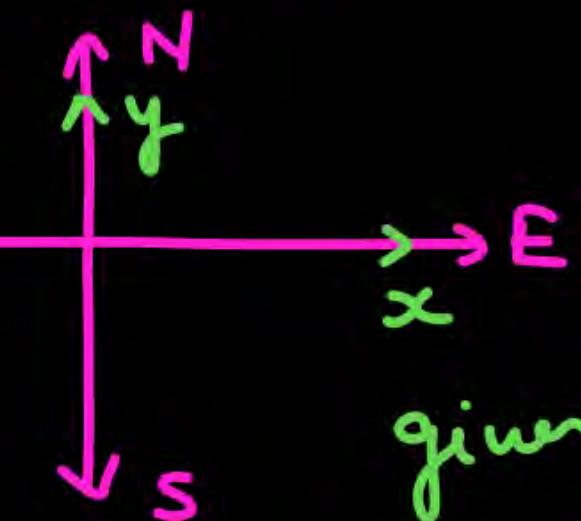
$$\vec{v}_{\text{b/m}} = \vec{v}_b - \vec{v}_m$$

$$= -10\sqrt{3}\hat{j} - 10\hat{i}$$

$$\vec{v}_{\text{b/m}} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

$$|\vec{v}_{\text{b/m}}| = \sqrt{10^2 + (10\sqrt{3})^2}$$

$$= 20 \quad (60^\circ \text{ south of west})$$

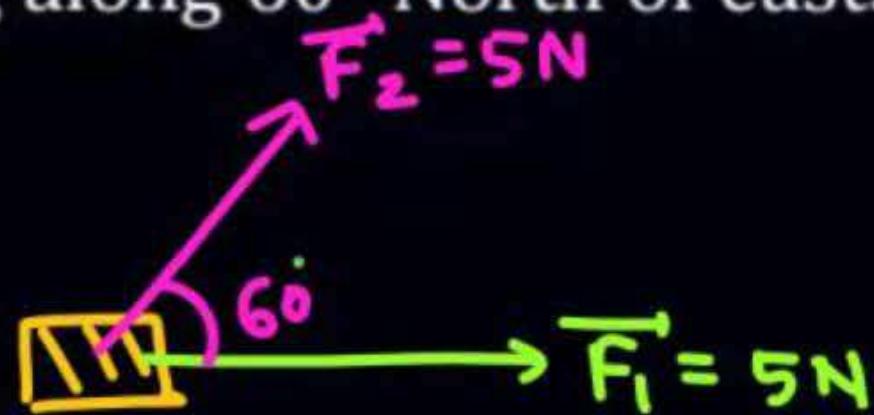


given



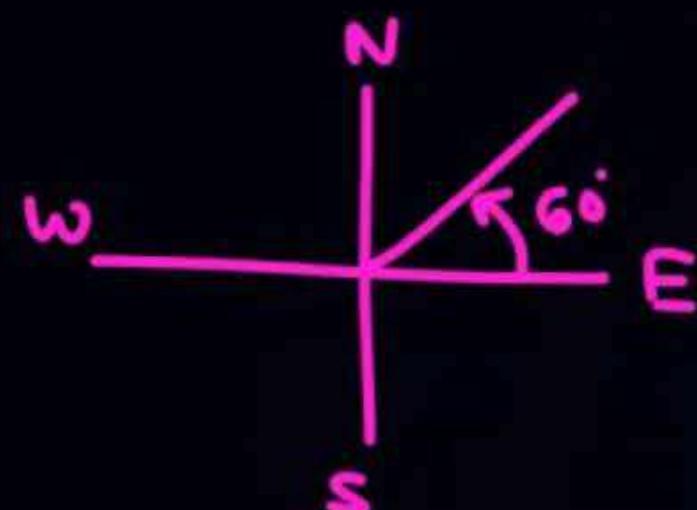
Question

A block is applied two forces of magnitude 5 N each. One force is acting towards east and the other acting along 60° North of east. The resultant of the two forces (in N) is of magnitude :



Ans

$$5\sqrt{3}$$



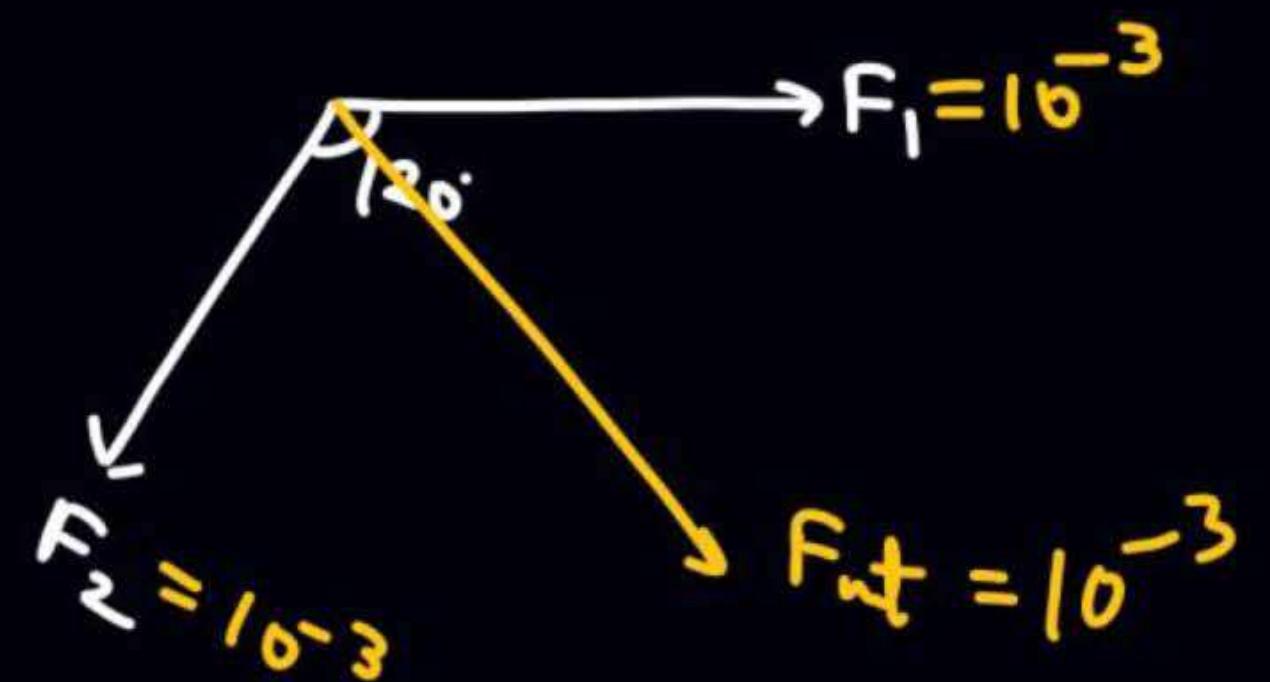
Ans : $\sqrt{75}$

Question

P
W

Two forces act on a particle simultaneously as shown in the figure. Find net force in milli newton on the particle. [Dyne is the CGS unit of force]

$$F_2 = 100 \times 10^{-5} \text{ N} = 10^{-3} \text{ N}$$



$$F_2 = 100 \text{ dyne}$$

$\therefore 1.0 \text{ Mili newton}$

$$F_1 = 10^{-3} \text{ N}$$

Ans : 1

Question

P
W

$$2x \quad x$$

The resultant of two forces, one double the other in magnitude is perpendicular to the smaller of the two forces. The angle between two forces is :-

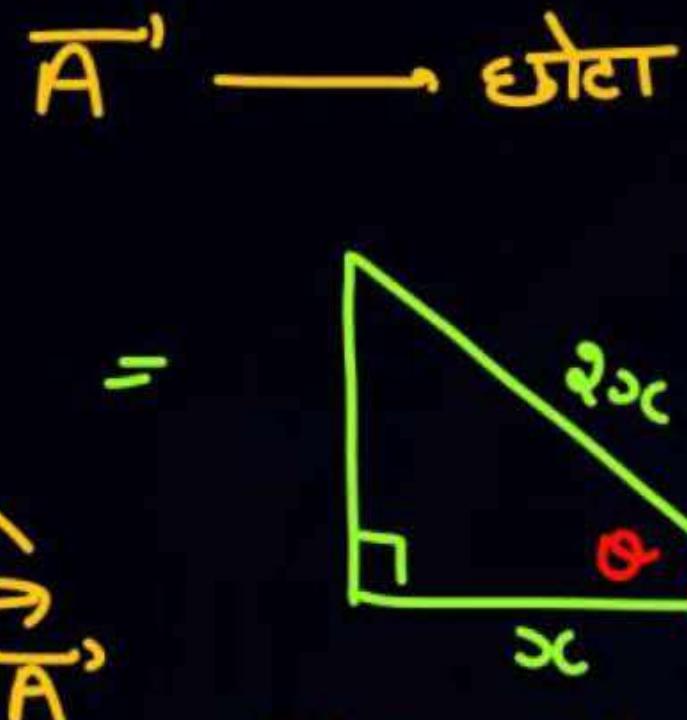
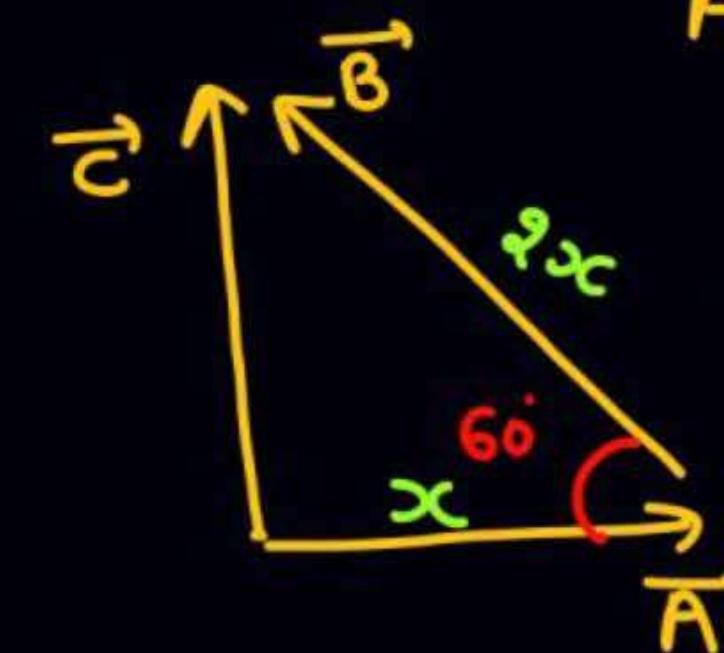
A 150°

B 90°

C 60°

D 120°

$$\vec{A} + \vec{B} = \vec{C}$$



$$\cos \theta = \frac{x}{\sqrt{5}x} = \frac{1}{\sqrt{5}}$$

$$\theta = 60^\circ$$

Ans : (D)

Question

P
W

If the resultant of two forces of magnitudes P and Q acting at a point at an angle of 60° is $\sqrt{7}Q$, then P/Q is $\therefore = x$

$$R = \sqrt{P^2 + Q^2 + 2PQ \cos \theta}$$

A 1

B $3/2$

C 2

D 4

E $-3 \times$

$$\sqrt{7}Q = \sqrt{P^2 + Q^2 + 2PQ \cos 60^\circ}$$

$$7Q^2 = P^2 + Q^2 + PQ$$

$$P^2 - 6Q^2 + PQ = 0$$

$$\frac{P^2}{Q^2} - 6 + \frac{P}{Q} = 0$$

$$x^2 - 6 + x = 0$$

$$x^2 + x - 6 = 0$$

$$(x+3)(x-2) = 0$$

$x = -3$

$x = 2$ ✓

Ans : (C)

Question

$$a=1$$

$$b=1$$

$$|\hat{a}| = 1$$

$$|\hat{a} + \hat{b}| = \sqrt{3}$$

If the angle between the unit vectors \hat{a} and \hat{b} is 60° , then $|\hat{a} - \hat{b}|$ is :-

A

0

B

1

C

2

D

4

$$\textcircled{1} \quad \hat{a} + \hat{b} = \vec{c}$$

$$c = \sqrt{a^2 + b^2 + 2ab \cos \theta}$$

$$= \sqrt{1+1+2 \times 1 \times 1 \cos 60^\circ} = \sqrt{3}$$

$$\textcircled{2} \quad \hat{a} - \hat{b} = \vec{D}$$

$$D = \sqrt{a^2 + b^2 - 2ab \cos \theta}$$

$$D = \sqrt{1+1-2 \times 1 \times 1 \cos 60^\circ}$$

$$D = 1$$

$$|\hat{a} - \hat{b}| = |\vec{D}|$$

Ans : (B)

Question

The sum of two \vec{P} and \vec{Q} is \vec{R} such that $|\vec{R}| = |\vec{P}|$. The angle θ (in degree) that the resultant of $2\vec{P}$ and \vec{Q} will make with \vec{Q} is,

$$\vec{P} + \vec{Q} = \vec{R}$$

$$R = P = x$$

$$R = \sqrt{P^2 + Q^2 + 2PQ \cos \theta}$$

$$x = \sqrt{x^2 + Q^2 + 2xQ \cos \theta}$$

$$x^2 = x^2 + Q^2 + 2xQ \cos \theta$$

$$\theta + 2x \cos \theta = 0$$

$$\theta = -2x \cos \theta$$

$$\beta = 90^\circ$$



[JEE Main 2020]

$$\begin{aligned} \vec{R}_{\text{new}} &= 2\vec{P} + \vec{Q} \\ \vec{C} &= \vec{A} + \vec{B} \\ \tan \beta &= \frac{A \sin \theta}{B + A \cos \theta} \\ &= \frac{2x \sin \theta}{-2x \cos \theta + 2x \cos \theta} = \frac{1}{0} \end{aligned}$$

Ans : (90°)

Question

Two vectors \vec{P} and \vec{Q} have equal magnitudes. If the magnitude of $\vec{P} + \vec{Q}$ is n times the magnitude of $\vec{P} - \vec{Q}$, then angle between \vec{P} and \vec{Q} is : [JEE Main 2021]

$$= \vec{s}$$

A $\sin^{-1} \left(\frac{n-1}{n+1} \right)$

$$\sqrt{P^2 + Q^2 + 2PQ\cos\theta} = n \sqrt{P^2 + Q^2 - 2PQ\cos\theta}$$

B $\cos^{-1} \left(\frac{n-1}{n+1} \right)$

$$P = Q = x$$

$$x^2 + x^2 + 2x^2\cos\theta = n^2(x^2 + x^2 - 2x^2\cos\theta)$$

$$2 + 2\cos\theta = n^2(2 - 2\cos\theta)$$

$$1 + \cos\theta = n^2 - n^2\cos\theta$$

$$\cos\theta = \frac{n^2 - 1}{n^2 + 1}$$

D $\cos^{-1} \left(\frac{n^2 - 1}{n^2 + 1} \right)$

$$\cos\theta + n^2\cos\theta = n^2 - 1$$

$$\cos\theta(1 + n^2) = n^2 - 1$$

$$\theta = \cos^{-1} \left(\frac{n^2 - 1}{n^2 + 1} \right)$$

Ans : (D)

Question

Match List I with List II

Choose the correct answer from the options given below :

A

(a) \rightarrow (iv), (b) \rightarrow (i), (c) \rightarrow (iii), (d) \rightarrow (ii)

B

(a) \rightarrow (iv), (b) \rightarrow (iii), (c) \rightarrow (i), (d) \rightarrow (ii)

C

(a) \rightarrow (iii), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (i)

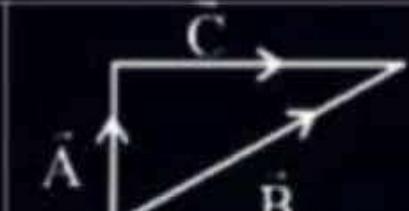
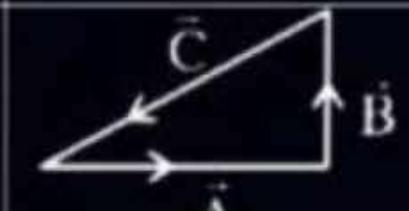
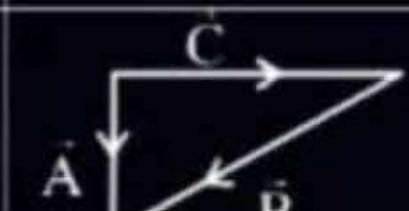
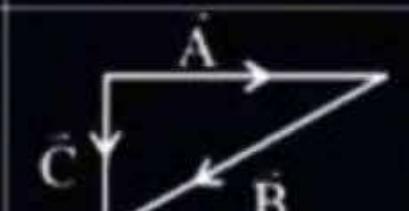
D

(a) \rightarrow (i), (b) \rightarrow (iv), (c) \rightarrow (ii), (d) \rightarrow (iii)

- i) $\vec{A} + \vec{C} = \vec{B}$
 ii) $\vec{A} + \vec{B} + \vec{C} = 0$
 iii) $\vec{C} + \vec{B} = \vec{A}$

v) $\vec{A} + \vec{B} = \vec{C}$ PW

[JEE Main 2021]

	List I	List II
(a)	$\vec{C} - \vec{A} - \vec{B} = 0$ iv) $\vec{C} = \vec{A} + \vec{B}$	(i) 
(b)	$\vec{A} - \vec{C} - \vec{B} = 0$ iii) $\vec{A} = \vec{B} + \vec{C}$	(ii) 
(c)	$\vec{B} - \vec{A} - \vec{C} = 0$ i) $\vec{B} = \vec{A} + \vec{C}$	(iii) 
(d)	$\vec{A} + \vec{B} = -\vec{C}$ ii) -	(iv) 

Ans : (B)

Question

Two vectors \vec{A} and \vec{B} have equal magnitude. If magnitude of $\vec{A} + \vec{B}$ is equal to two times the magnitude of $\vec{A} - \vec{B}$, then the angle between \vec{A} and \vec{B} will be : [JEE Main 2022]

A $\sin^{-1}\left(\frac{3}{5}\right)$

$$\sqrt{A^2 + B^2 + 2AB\cos\theta} = 2 \sqrt{A^2 + B^2 - 2AB\cos\theta}$$

B $\sin^{-1}\left(\frac{1}{3}\right)$

$$x^2 + x^2 + 2x^2\cos\theta = 4(x^2 + x^2 - 2x^2\cos\theta)$$

$$2 + 2\cos\theta = 4(2 - 2\cos\theta)$$

$$1 + \cos\theta = 4(1 - \cos\theta)$$

$$1 + \cos\theta = 4 - 4\cos\theta$$

$$5\cos\theta = 4 - 1 = 3$$

$$\cos\theta = \frac{3}{5}$$

C $\cos^{-1}\left(\frac{3}{5}\right)$

D $\cos^{-1}\left(\frac{1}{3}\right)$

Ans : (C)

Q Resultant of $\vec{A} + \vec{B}$ is \vec{R}_1 on reversing the vector \vec{B}
 the resultant become \vec{R}_2 . what is value of $R_1^2 + R_2^2$

① $A^2 + B^2$

② $A^2 - B^2$

③ $2(A^2 + B^2)$

④ $2(A^2 - B^2)$

$$R_1 = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$R_2 = \sqrt{A^2 + B^2 - 2AB \cos \theta}$$

$$\vec{A} - \vec{B} = \vec{R}_2$$

$$\vec{R}_1 + \vec{B} = \vec{R}_1$$

Square & add

$$R_1^2 + R_2^2 = A^2 + B^2 + A^2 + B^2$$

- Q Sum of two Unit vectors is also $\vec{a} + \vec{b} = \vec{c}$ a Unit vector find
- ① angle between two vector
 - ② Find magnitude of their difference.

$$\vec{A} + \vec{B} = \vec{C}$$

Unit vector

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$l = \sqrt{l + l + 2 \times l \times l \cos \theta}$$

$$l = l + l + 2 \cos \theta$$

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

$$\theta = 120^\circ$$

$$\theta = -60^\circ \times$$

$$\theta = 60^\circ \times$$

$$A = 1, B = 1, C = 1$$

$$② \vec{A} - \vec{B} = \vec{D}$$

$$D = \sqrt{A^2 + B^2 - 2AB \cos \theta}$$

$$D = \sqrt{l + l - 2 \times l \times l \times \left(-\frac{1}{2}\right)}$$

$$= \sqrt{l + l + l} = \sqrt{3}$$

Q If $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$ and B is finite ($\vec{B} \neq \vec{0}$)
 then

① \vec{A} is parallel to \vec{B}

② $\vec{A} = \vec{B}$

③ \vec{A} is perpendicular to \vec{B}

④ $|\vec{A}| = |\vec{B}|$

$$\sqrt{A^2 + B^2 + 2AB \cos \theta} = \sqrt{A^2 + B^2 - 2AB \cos \theta}$$

~~$$A^2 + B^2 + 2AB \cos \theta = A^2 + B^2 - 2AB \cos \theta$$~~

$$2AB \cos \theta = -2AB \cos \theta$$

$$2AB \cos \theta + 2AB \cos \theta = 0$$

$$4AB \cos \theta = 0$$

$$\cos \theta = 0$$

$$\theta = 90^\circ$$



Q. Car is moving with velocity 10 m/s east. A bird is flying with velocity $10\sqrt{3} \text{ m/s}$ along south. Find.

① Velocity of bird observed by man in the car.

② In which direction man will observe the bird velocity.

Rain Man Problem

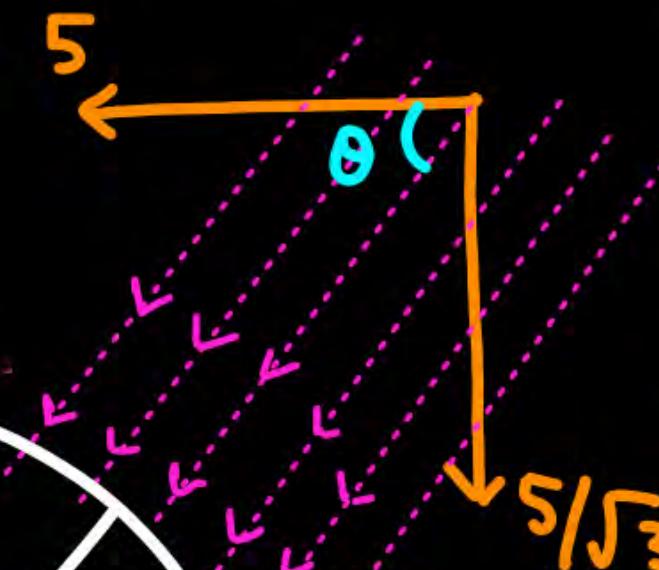


Q A girl is moving horizontally with velocity 5m/s along east
rain is falling vertically downward with velocity $5/\sqrt{3}$ m/s.
In which dirⁿ she should hold his umbrella to protect himself
from rain



$$v_r = \frac{5}{\sqrt{3}}$$

$$\vec{v}_{r/girl} = \vec{v}_r - \vec{v}_{girl} = -\frac{5}{\sqrt{3}}\hat{j} - 5\hat{i}$$



$$\tan \theta = \frac{5/\sqrt{3}}{5}$$

$$\theta = 30^\circ$$

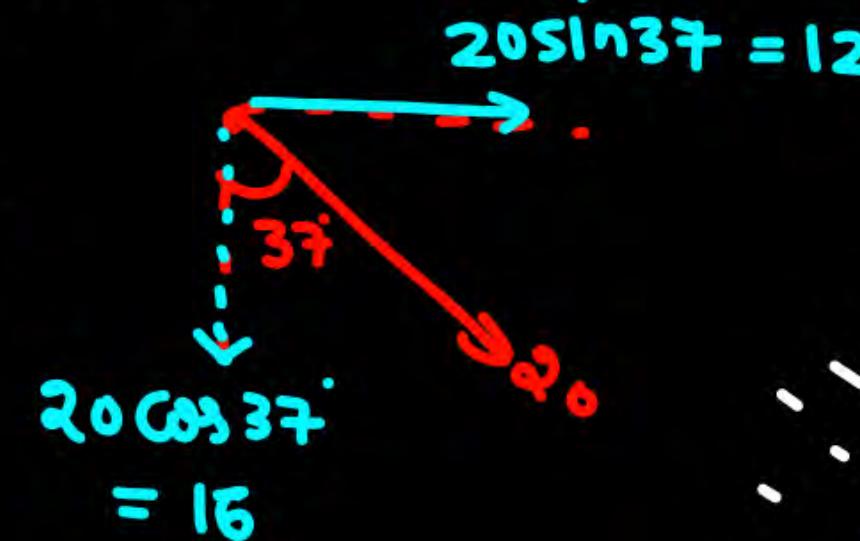
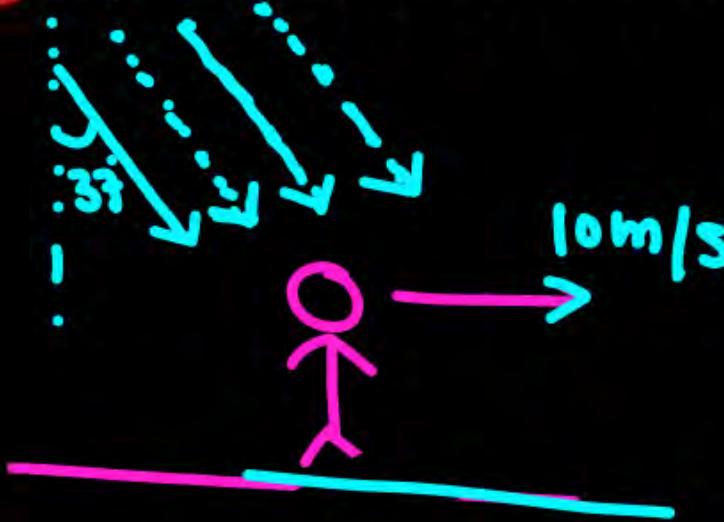


Rain Man Problem



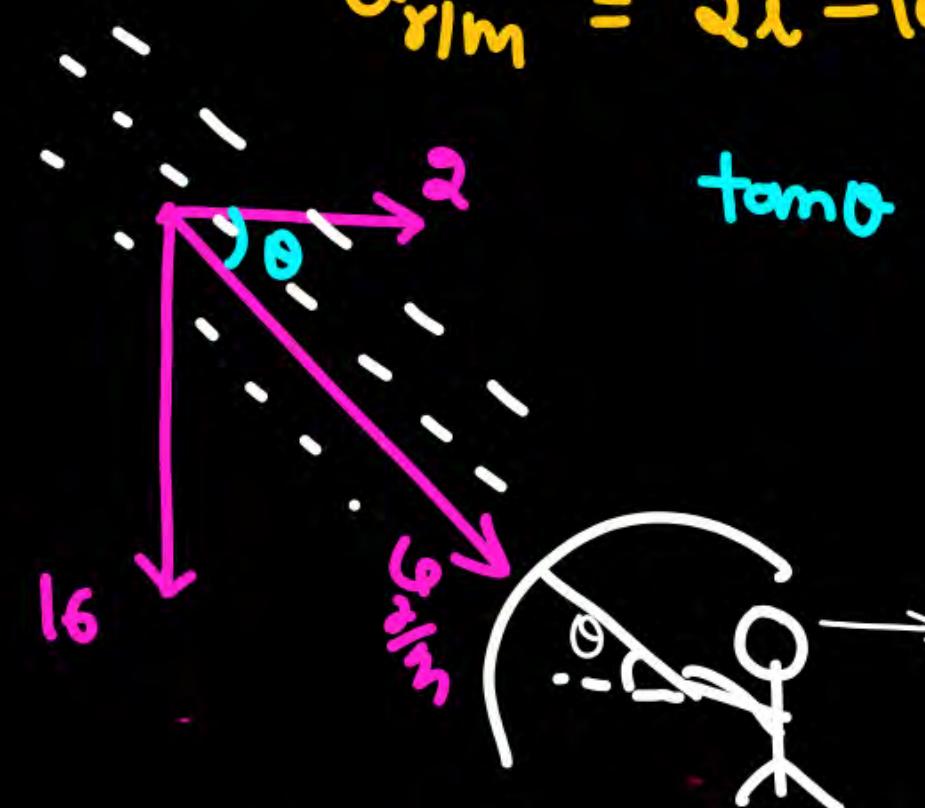
Q A man is moving horizontal with velocity 10 m/s along east. Rain is falling with speed 20 m/s at angle 37° with vertical as shown in diagram.

(a) In which dirⁿ man should hold Umbrella - - - - -

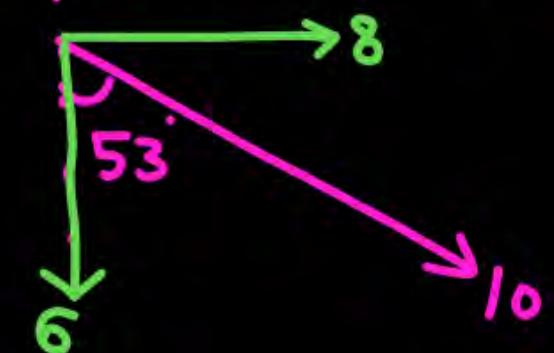
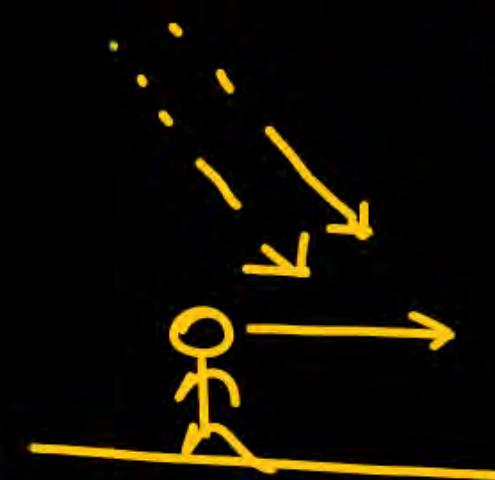


$$\begin{aligned}\vec{v}_m &= 10\hat{i} \\ \vec{v}_r &= 12\hat{i} - 16\hat{j} \\ \vec{v}_{r/m} &= 2\hat{i} - 16\hat{j}\end{aligned}$$

$$\tan \theta = \frac{16}{2} \Rightarrow (\theta = \tan^{-1} 8)$$



Q Rain is falling with speed 10 m/s at angle 53° with vertical
 A man is moving with speed 2 m/s along east as shown in diagram
 (a) In which dirⁿ man should hold umbrella to protect him self.



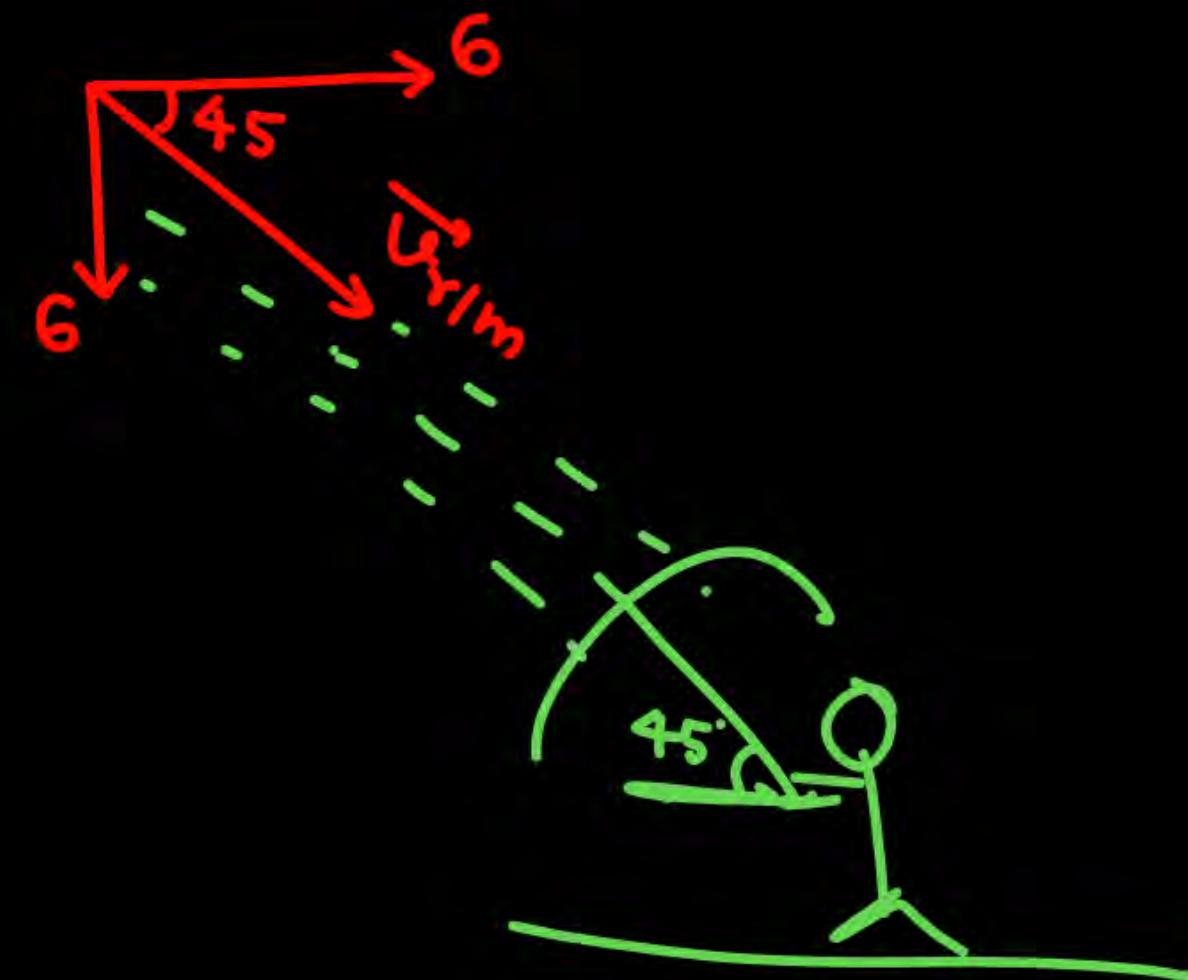
$$\vec{v}_r = 8\hat{i} - 6\hat{j}$$

$$\vec{v}_m = 2\hat{i}$$

$$\vec{v}_{r/m} = 6\hat{i} - 6\hat{j}$$

(b) what should be velocity of man so that
 rain appear falling vertically to him

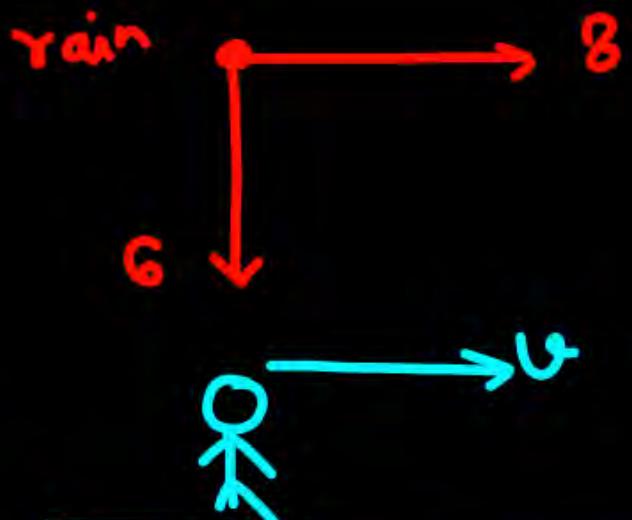
Ans 8



$$v_y \sin 53 = 8$$

$$v_y \cos 53 = 6$$

$$v_y = 10$$



v = 8 Ans

m-2

$\vec{v}_{ym} = (8\hat{i} - 6\hat{j}) - v\hat{i}$

$= (8-v)\hat{i} - 6\hat{j}$

$8-v = 0$

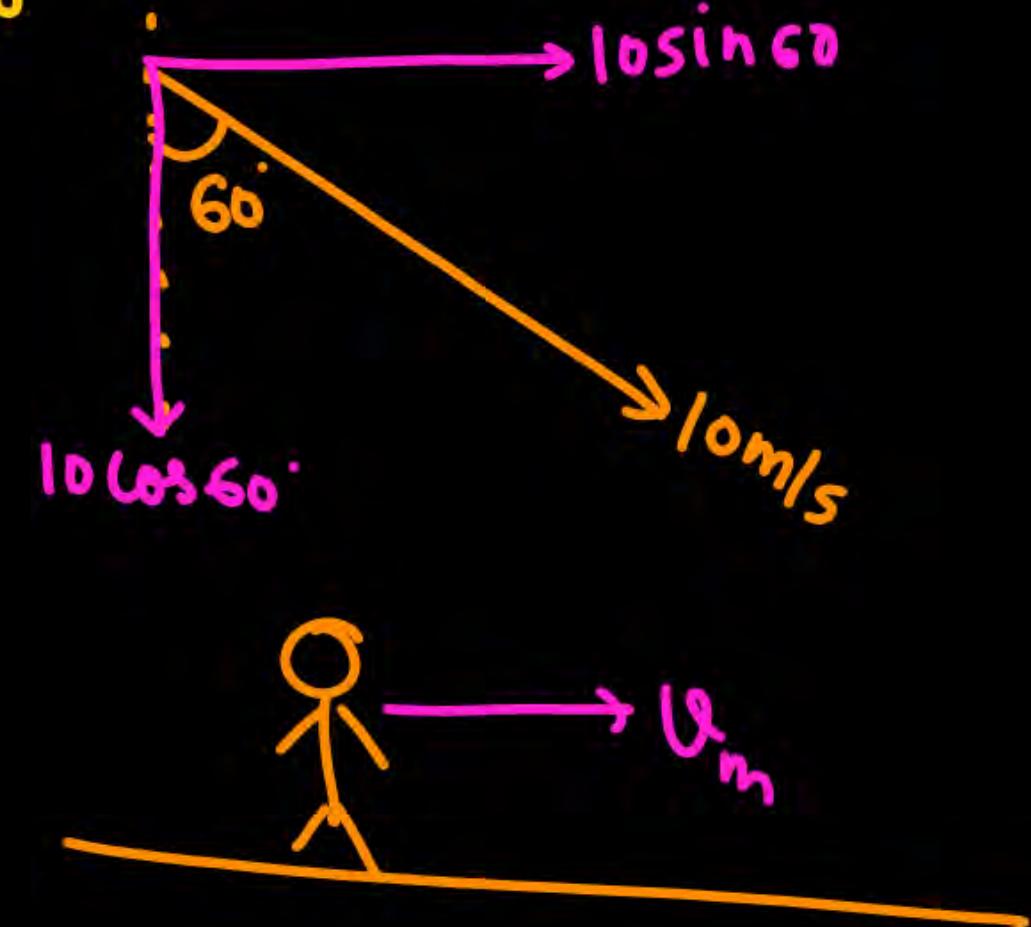
v = 8

only \hat{j} remains

Q rain is falling with speed 10 m/s at angle 60° with vertical what should be velocity of man so that rain falls vertically on his head.

P
W

$$V_m = 10 \sin 60 = 10 \frac{\sqrt{3}}{2} = 5\sqrt{3}$$



Q To a stationary man, rain appear to be falling at an angle 30° with the vertical. As he starts moving with speed of 5 m/s he finds that rain is falling vertically. Speed of rain wrt man.



$$v \sin 30 = 5$$

$$v = 10$$

speed of rain wrt ground

$$\vec{v}_r = 10 \sin 30 \hat{i} - 10 \cos 30 \hat{j}$$

$$\vec{v}_r = 5 \hat{i} - 5\sqrt{3} \hat{j}$$

$$\vec{v}_{r/m} = (5 \hat{i} - 5\sqrt{3} \hat{j}) - 5 \hat{i} = -5\sqrt{3} \hat{j}$$

Question-2

junt by Clm kopy से फ़ादलित

P
W

Rain is falling vertically downwards with a velocity of 3 km/hr. A man walks in the rain with a velocity of 4 km/hr. The raindrops will fall on the man with a velocity of.

- A 1 km/hr
- B 3 km/hr
- C 4 km/hr
- D 5 km/hr

$$\vec{v}_r = -3\hat{j}$$

$$\vec{v}_m = 4\hat{i}$$

$$\vec{v}_{r|m} = -3\hat{j} - 4\hat{i} = -4\hat{i} - 3\hat{j}$$

magnitude = $\sqrt{(-4)^2 + (-3)^2} = \sqrt{16 + 9} = \sqrt{25} = 5$

Ans. (D)

Question-3

To a stationary man, rain appears to be falling at an angle 30° with the vertical. As he starts moving with a speed of 0.5 m/s he finds that the rain is falling vertically. Then the speed of rain w.r.t. the moving man is:

- A 0.5 m/s
- B 1 m/s
- C $0.5\sqrt{3} \text{ m/s}$
- D $\sqrt{3} \text{ m/s}$

Ans. (C)

notes

Q

A man holding flag is running with speed 10 m/s along east
 Wind is flowing with speed $10\sqrt{3} \text{ m/s}$ along south.
 In which dir flag will flutter

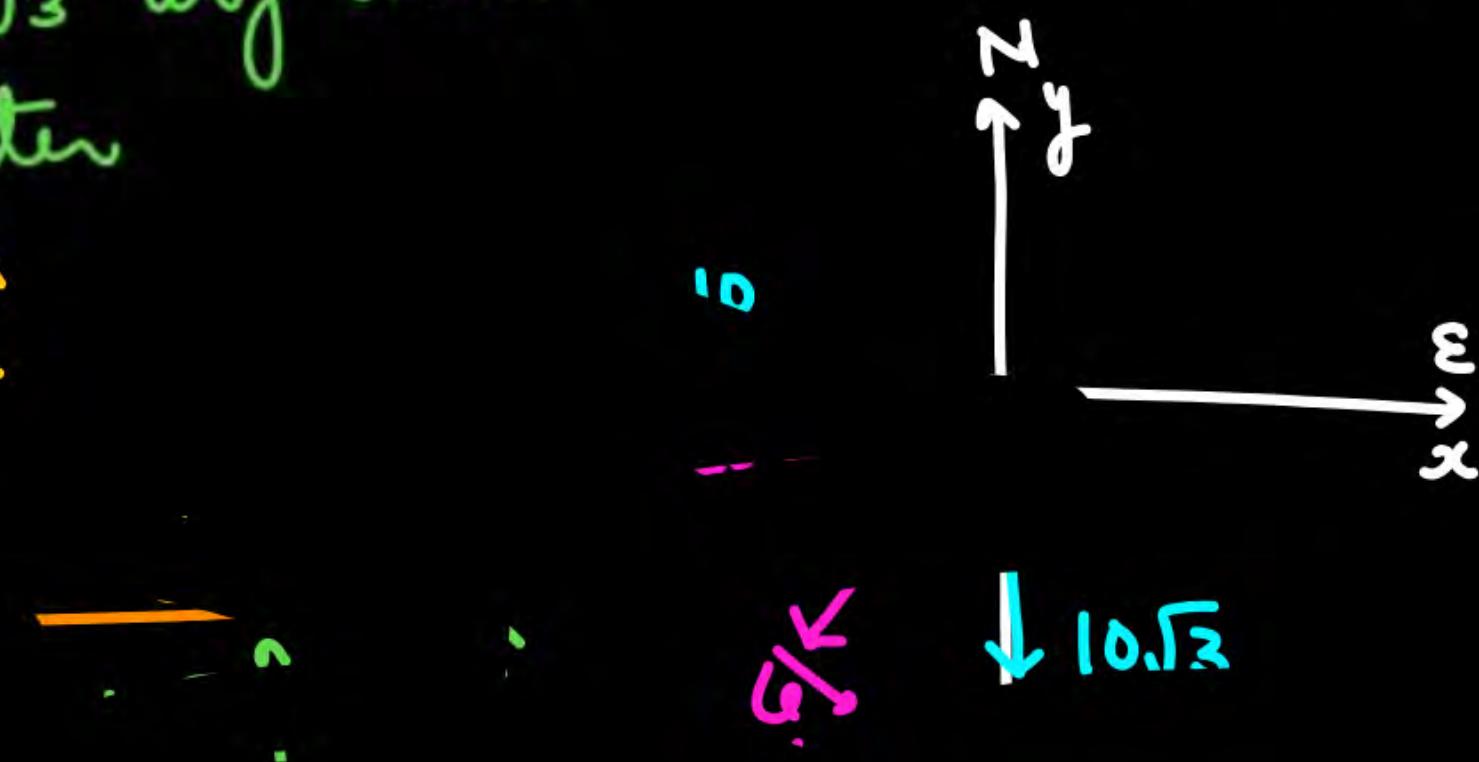


- N.Y

$$\overrightarrow{V}_{\text{man}} = 10\hat{i}$$



nd/main =



$$\vec{v}_{\text{man}} = 10 \hat{i}$$

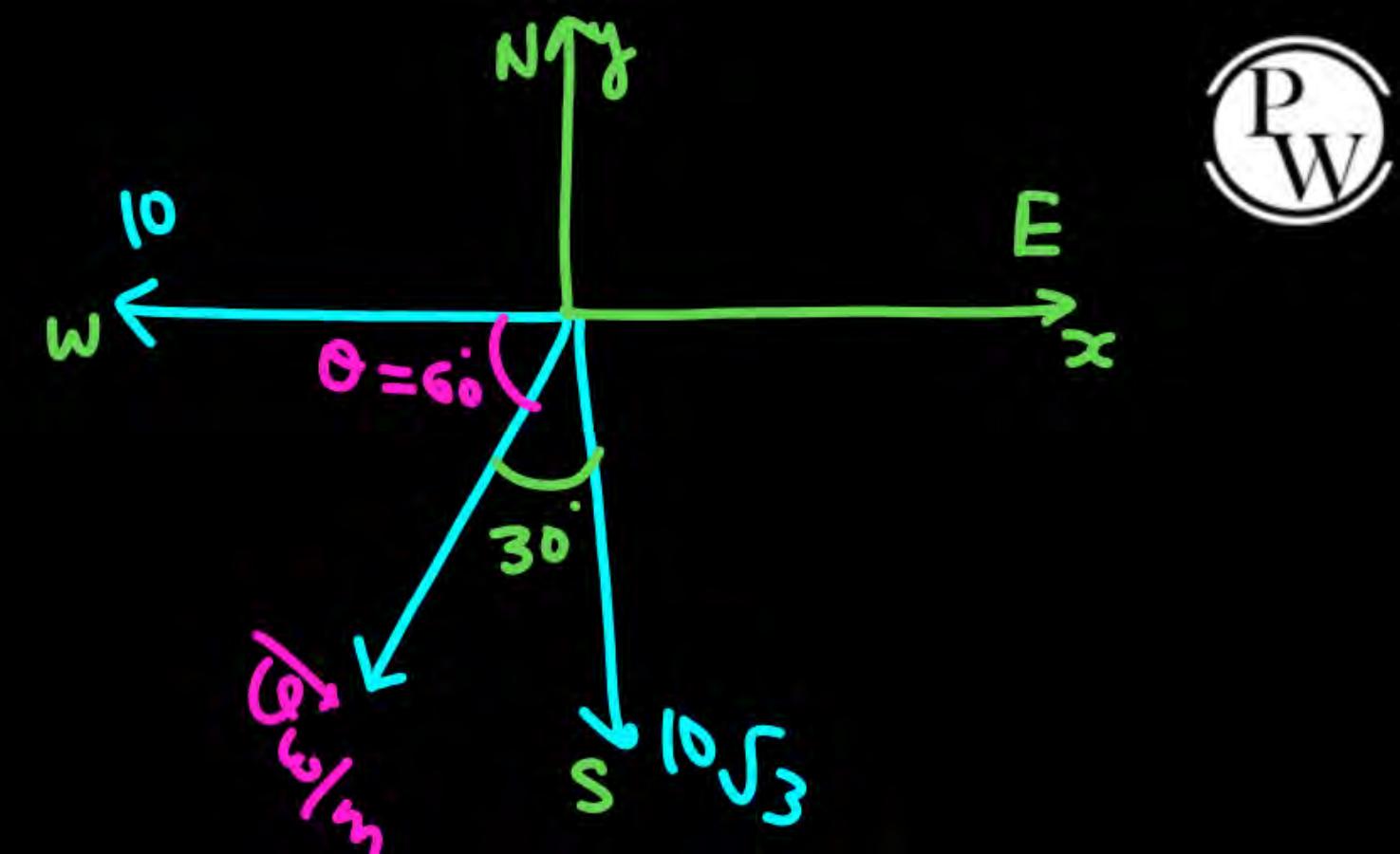
$$\vec{v}_{\text{wind}} = -10\sqrt{3} \hat{j}$$

$$\vec{v}_{\text{wind/man}} = -10\sqrt{3} \hat{j} - 10 \hat{i}$$

Ans \Rightarrow 60° south of west

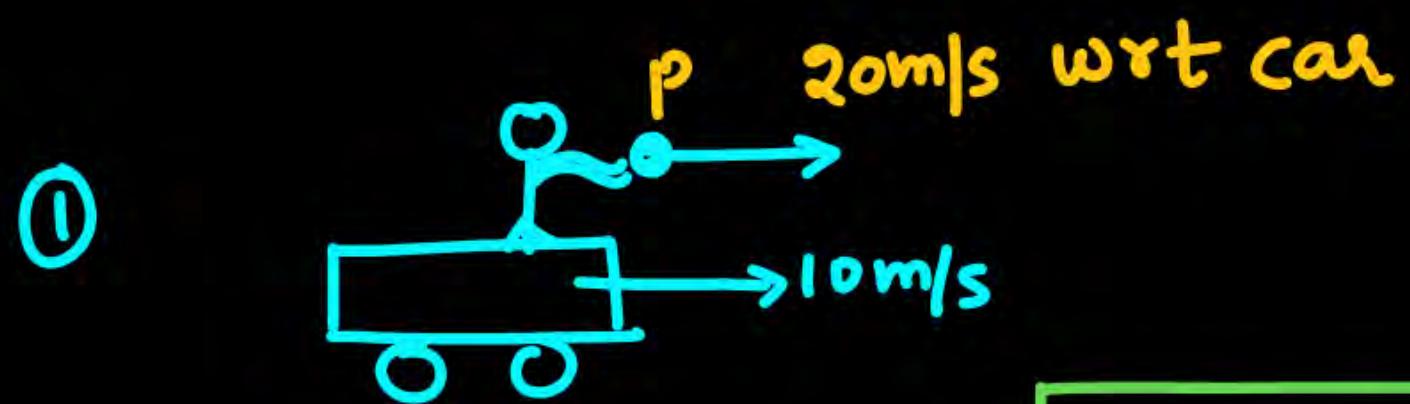
30° west of south

~~South West~~



P
W

P
W

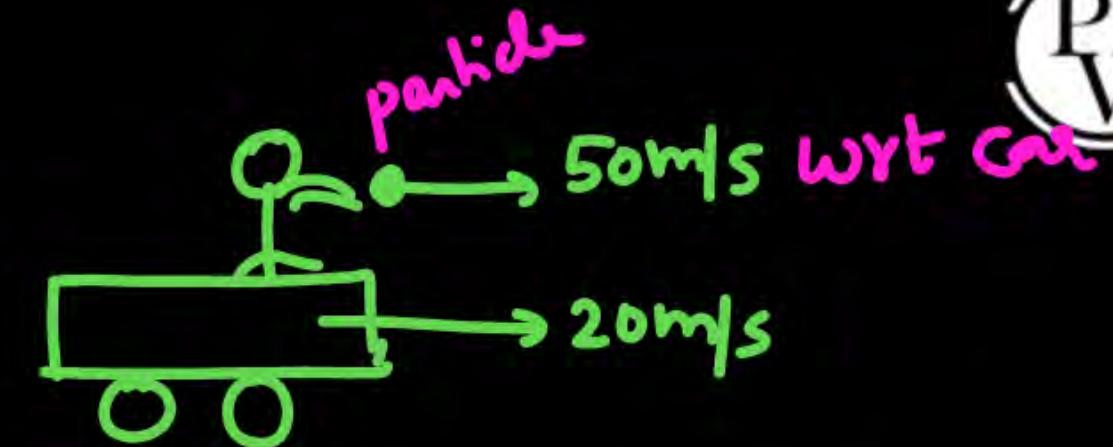


$$\vec{v}_{P/c} = \vec{v}_P - \vec{v}_c$$

$$20\hat{i} = \vec{v}_P - 10\hat{i}$$

$$\vec{v}_P = 30\hat{i} \Rightarrow (\text{wrt ground})$$

$$\boxed{\vec{v}_P = \vec{v}_{P/c} + \vec{v}_c}$$

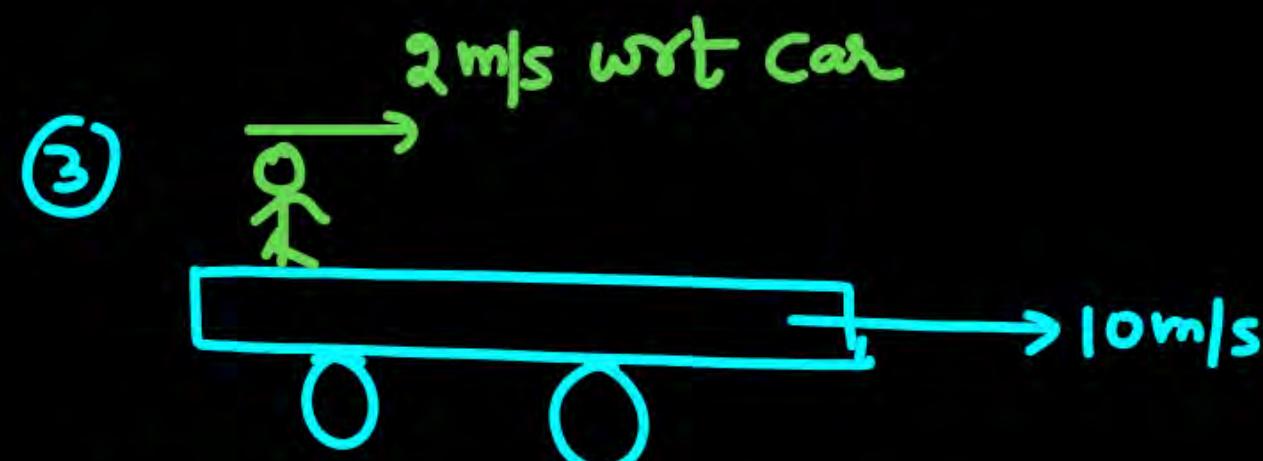


$$\vec{v}_P = (20 + 50) = 70\hat{i}$$

$$\vec{v}_{P/c} = \vec{v}_P - \vec{v}_c$$

$$50\hat{i} = \vec{v}_P - 20\hat{i}$$

$$\boxed{\vec{v}_P = 70\hat{i}}$$



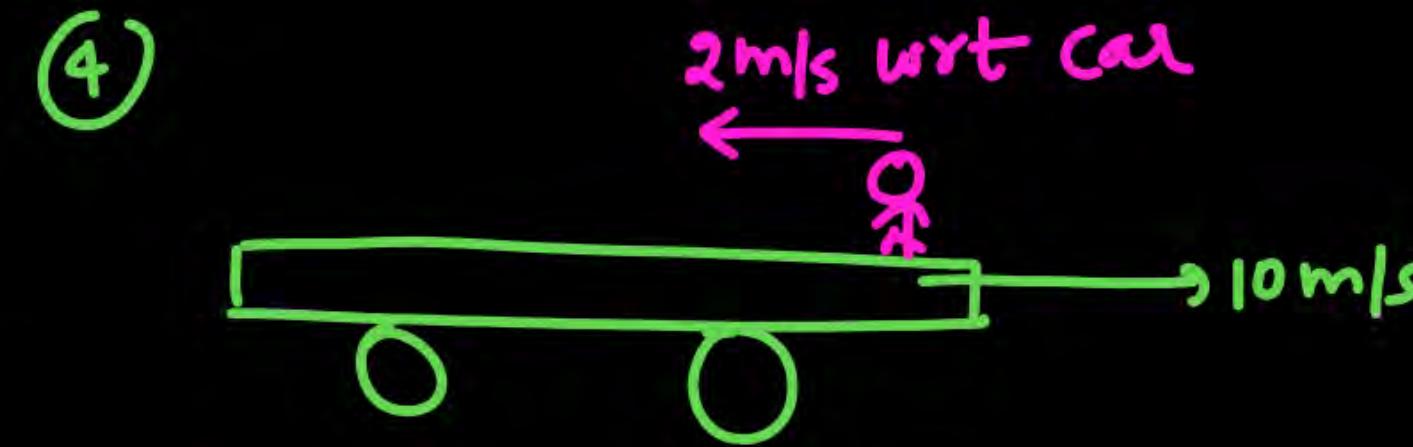
$$\vec{v}_{m/ground} = ? = 10 + 2 = 12 \hat{i}$$

$$\vec{v}_{m/c} = 2 \hat{i}$$

$$\vec{v}_m - \vec{v}_c = 2 \hat{i}$$

$$\vec{v}_m - 10 \hat{i} = 2 \hat{i}$$

$$\vec{v}_m = 12 \hat{i}$$



$$\vec{v}_{m/ground} = 8 \hat{i}$$

$$\vec{v}_{m/c} = -2 \hat{i}$$

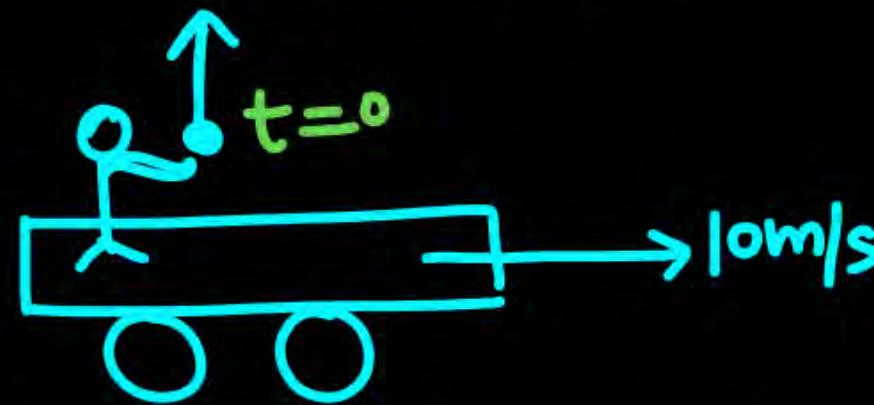
$$\vec{v}_m - \vec{v}_c = -2 \hat{i}$$

$$\vec{v}_m - 10 \hat{i} = -2 \hat{i}$$

$$\vec{v}_m = 8 \hat{i}$$

20m/s wrt car

⑤



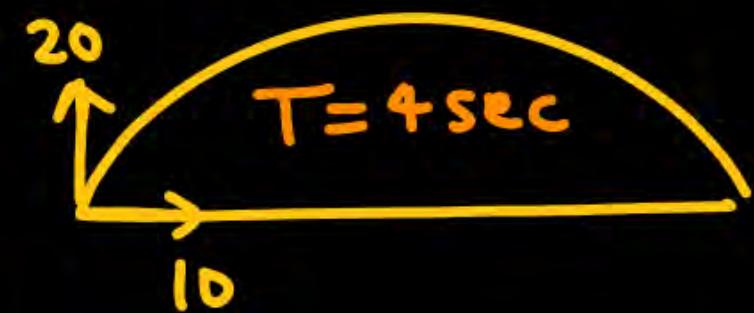
find velocity of particle
in ground frame at $t = 0^+$

$$\vec{v}_{p/c} = 20\hat{j}$$

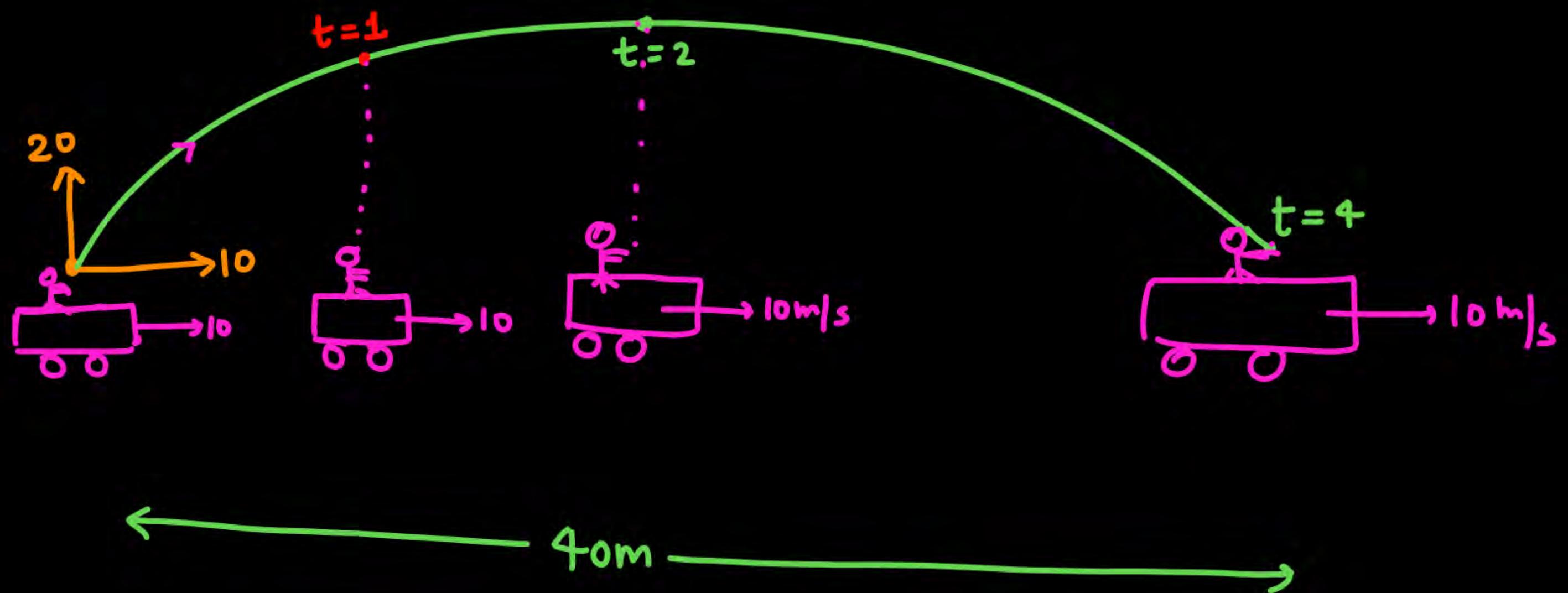
$$\vec{v}_p - \vec{v}_c = 20\hat{j}$$

$$\vec{v}_p - 10\hat{i} = 20\hat{j}$$

$$\vec{v}_p = 10\hat{i} + 20\hat{j}$$

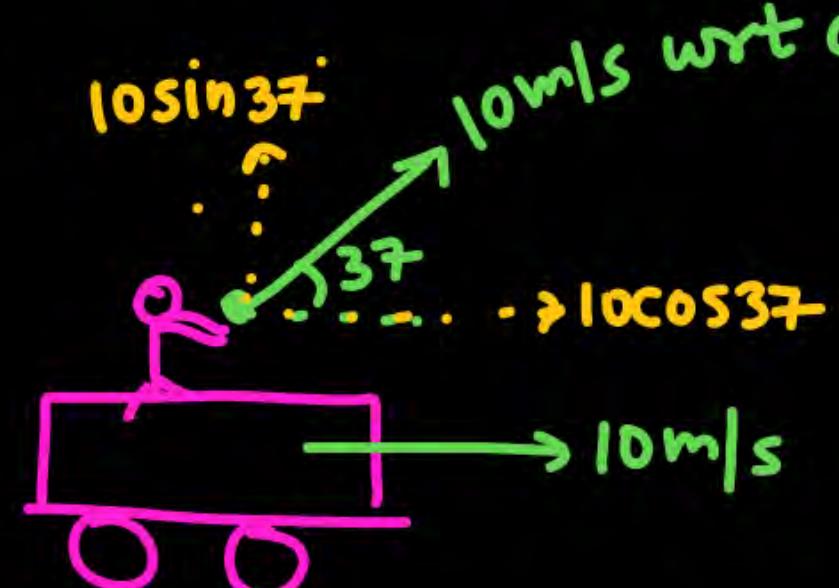


P
W



$10\sin 37^\circ$

37°



$$\vec{v}_p = ?$$

$$t = 0^+$$

Q

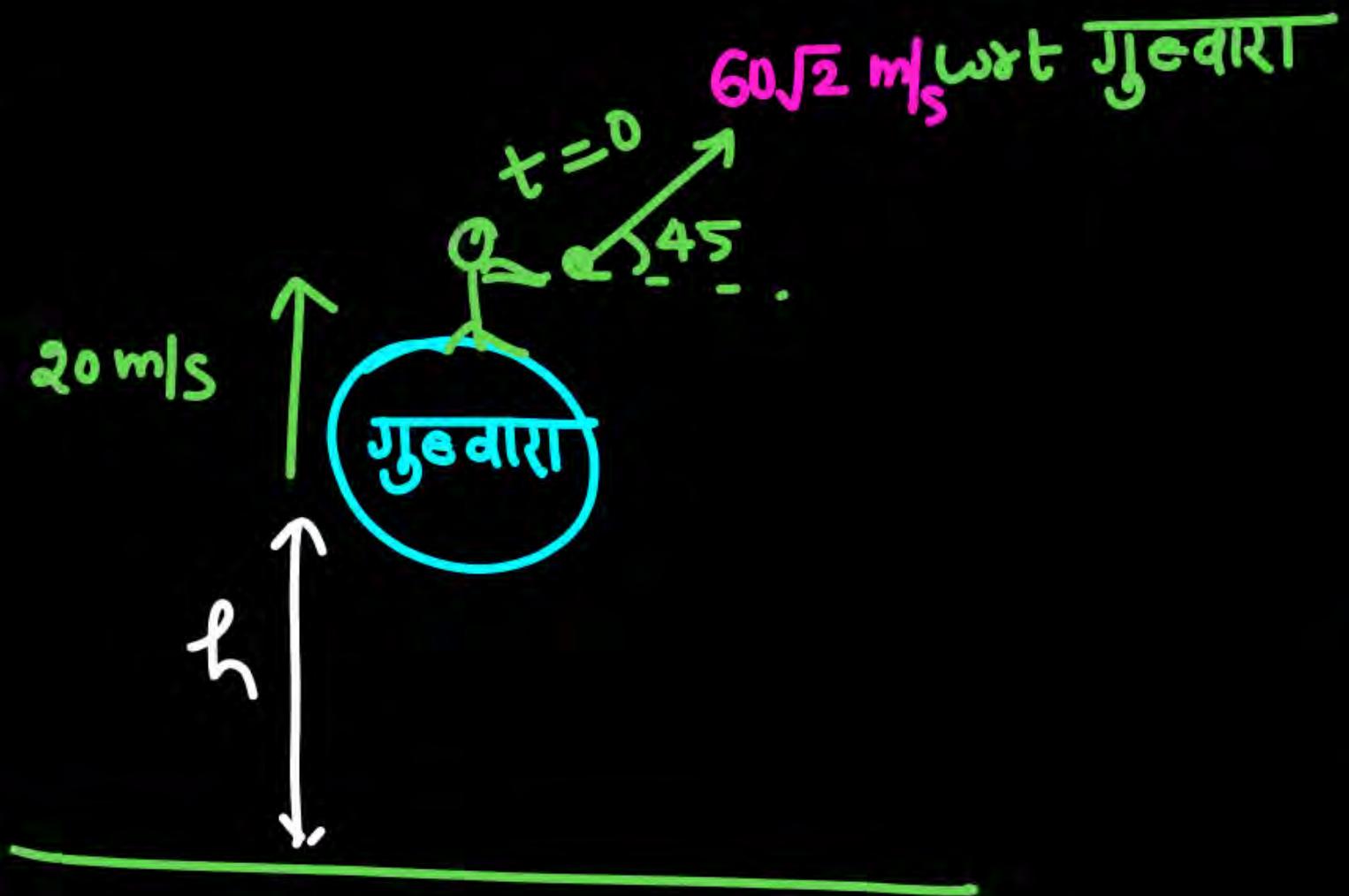
$$\vec{v}_{P/C} = 8\hat{i} + 6\hat{j} = \vec{v}_P - \vec{v}_C$$

$$\vec{v}_C = 10\hat{i}$$

$$8\hat{i} + 6\hat{j} = \vec{v}_P - 10\hat{i}$$

$$\boxed{\vec{v}_P = 18\hat{i} + 6\hat{j}}$$

Q



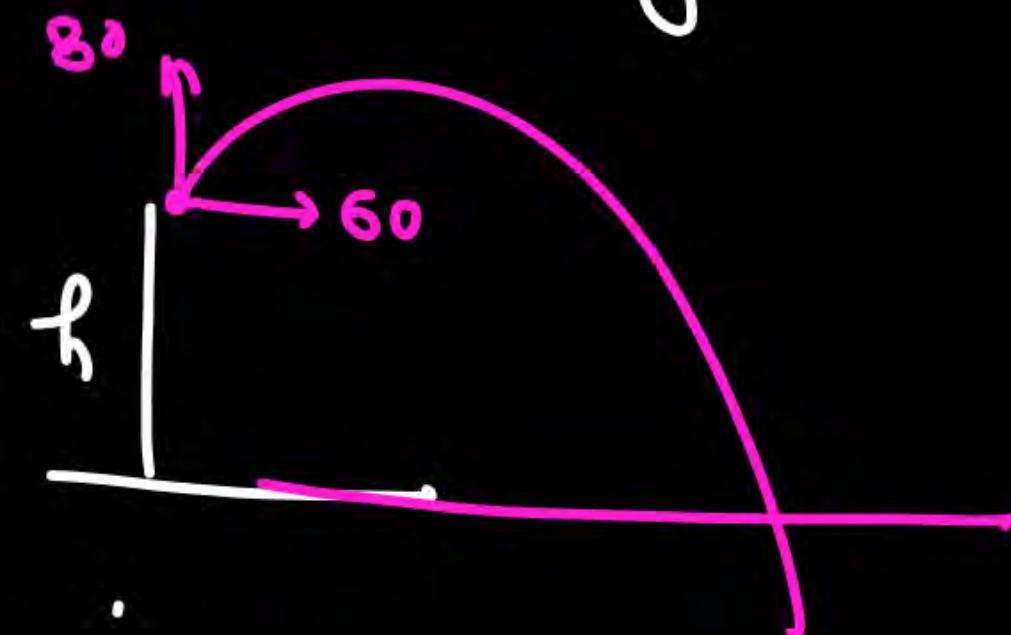
$$t=0^+ \quad \vec{v}_P = ? \quad (\text{wrt ground})$$

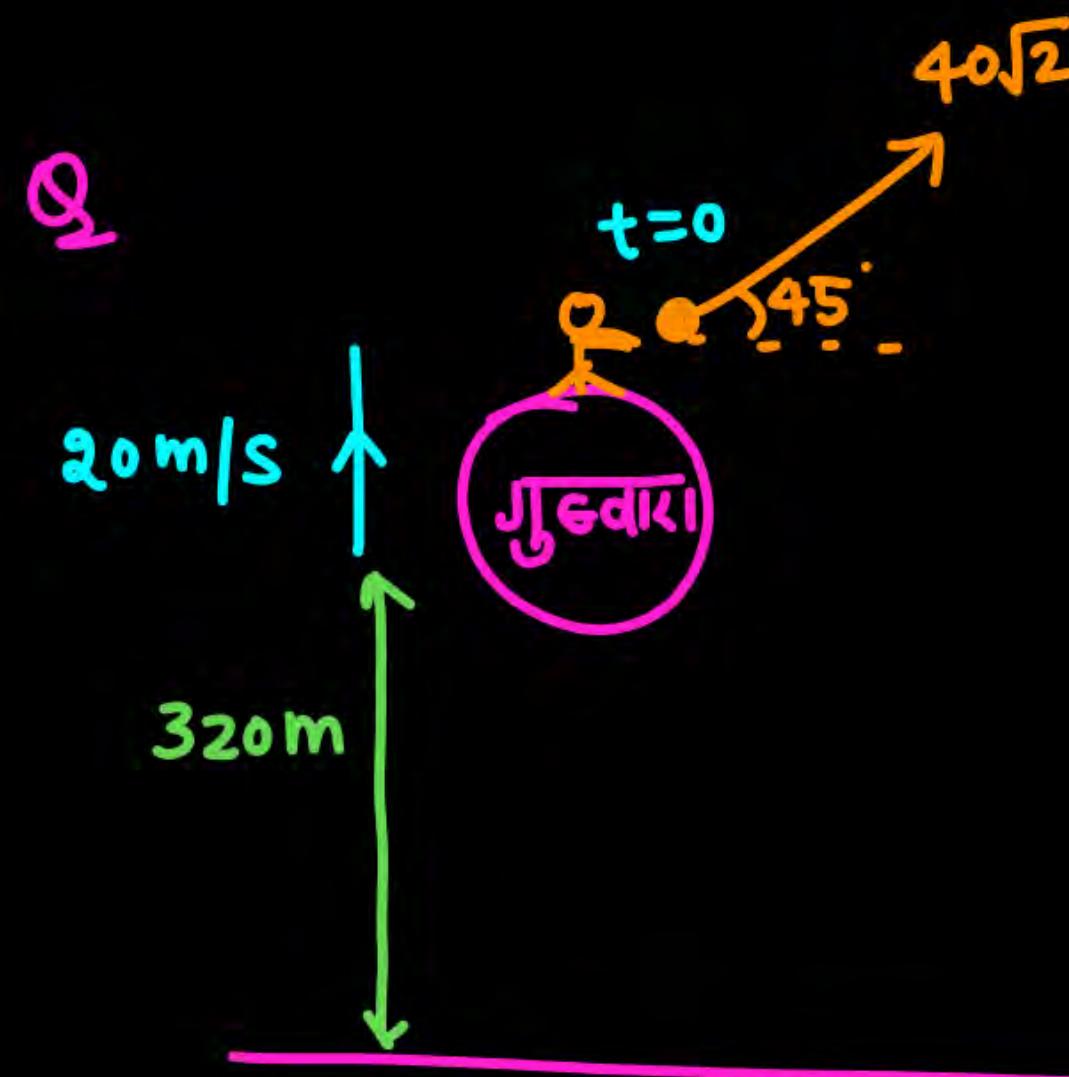
$$\vec{v}_{P/\text{जुडवारा}} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P - \vec{v}_{\text{जुडवारा}} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P - 20\hat{j} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P = 60\hat{i} + 80\hat{j}$$





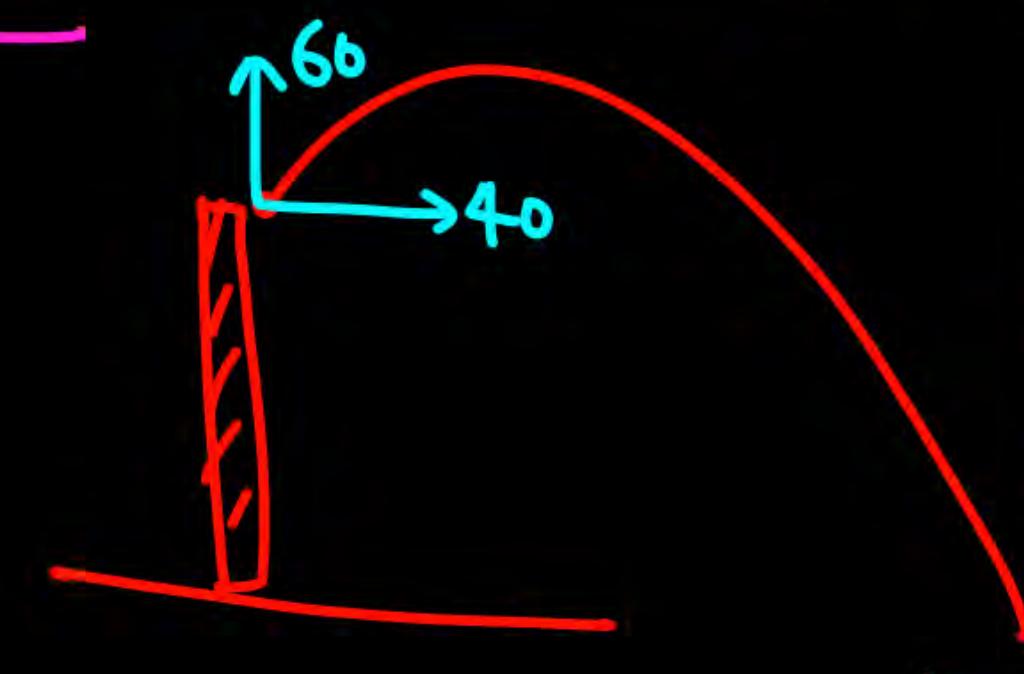
$t = 0^+$, $\vec{v}_{\text{particle}} = ?$

$$\vec{v}_{P/\text{ज्योति भवानी}} = 40\hat{i} + 40\hat{j}$$

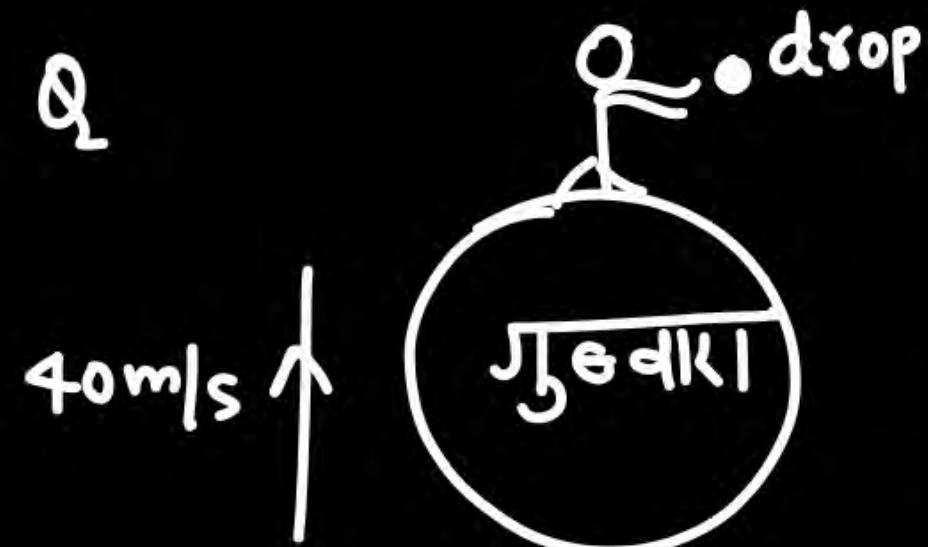
$$\vec{v}_P - \vec{v}_{\text{ज्योति भवानी}} = 40\hat{i} + 40\hat{j}$$

$$\vec{v}_P - 20\hat{j} = 40\hat{i} + 40\hat{j}$$

$$\underline{\underline{\vec{v}_P = 40\hat{i} + 60\hat{j}}}.$$



Q



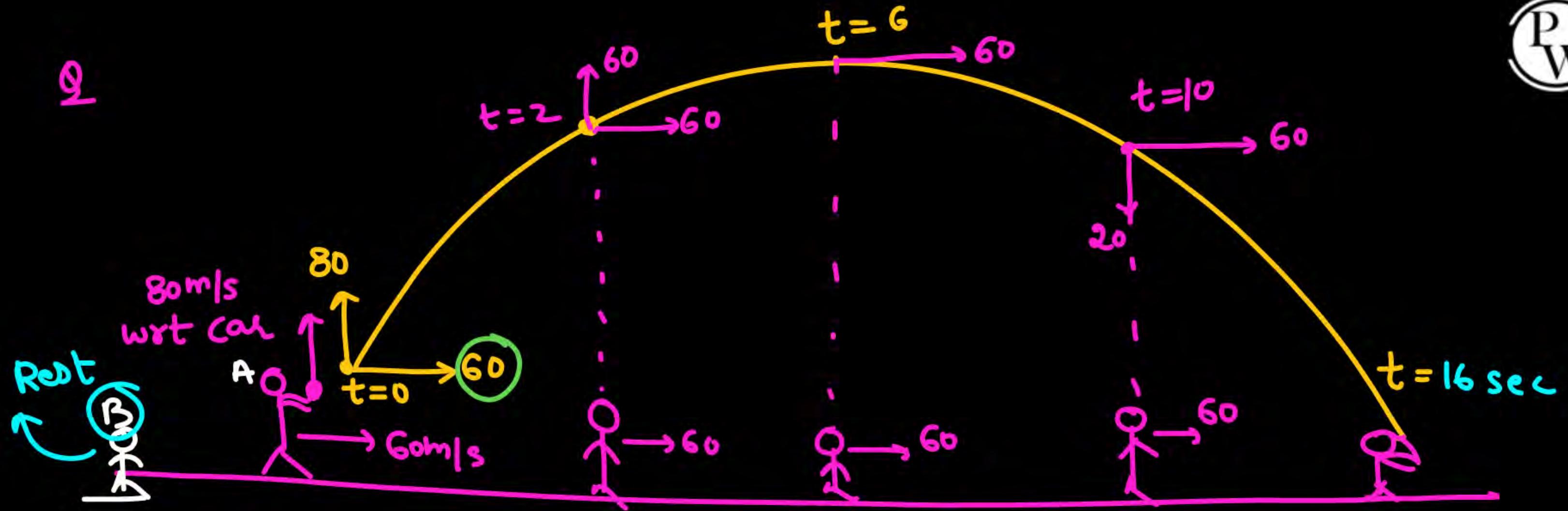
$$\vec{U}_{P/Jुडवारा} = 0 \quad (\text{drop})$$

$$\vec{U}_P - \vec{U}_{जुडवारा} = 0$$

$$\boxed{\vec{U}_P = 40\hat{j}}$$

9

P
W



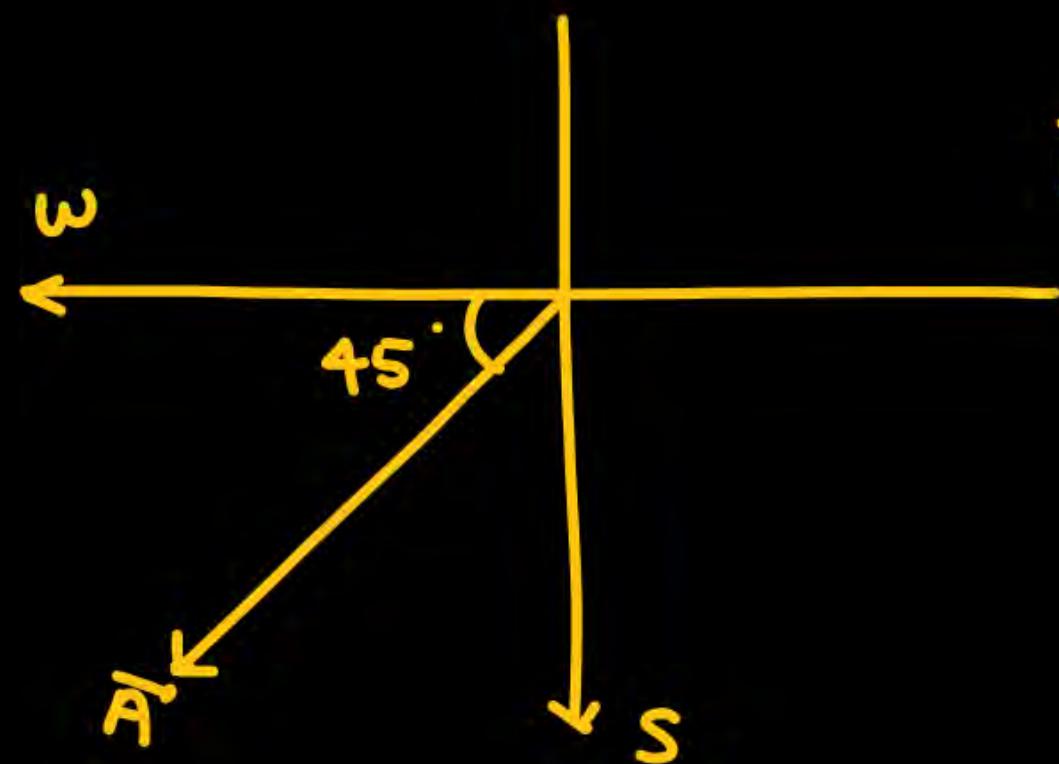
$$\vec{U}_{P/C} = +80 \hat{j}$$

$$\vec{v}_p - \vec{v}_c = 80\hat{j}$$

$$\vec{r}_p = 60\hat{i} + 80\hat{j}$$

A → St. line

B → parabola



\vec{A} की dirⁿ \Rightarrow 45° west of south
45° south of west

South-west

By danfallit 45° ✓