

## 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  $120^\circ$ .  
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  $0^\circ$
- B  $60^\circ$
- C  $90^\circ$
- D  $180^\circ$

Ans : (A)

## Question

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

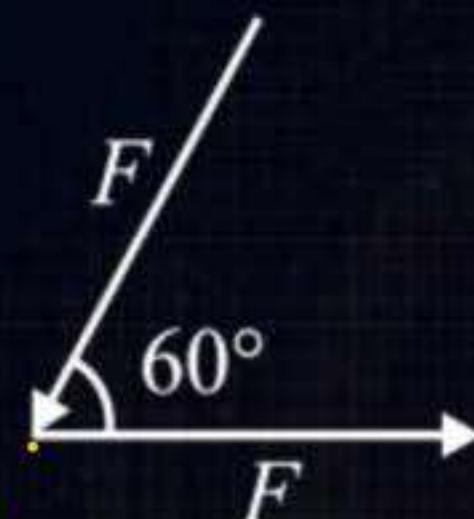
- A  $2.5 \text{ N}$
- B  $5 \text{ N}$
- C  $5\sqrt{3} \text{ N}$
- D  $10 \text{ N}$

~~$$F_{\text{net}} = \sqrt{5^2 + 5^2 + 2 \times 5 \times 5 \cos 60^\circ}$$

$$= \sqrt{25 + 25 + 25} = 5\sqrt{3}$$~~

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

$$= 5$$



(B)

Ans : (C)

## Question

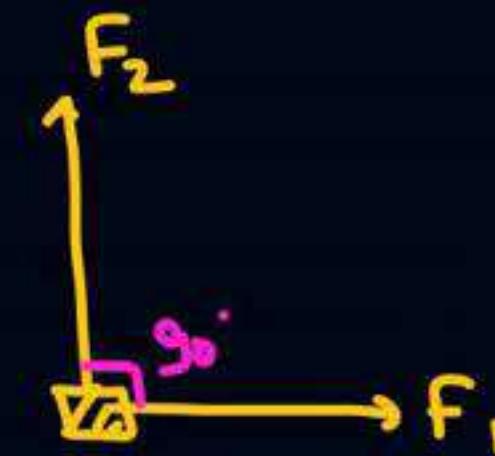
Force  $F_1$  and  $F_2$  act on a point mass in two mutually perpendicular directions. The resultant force on the point mass will be

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

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

B 8 N

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

C 18 N

$$4 < C < 16$$

D 20 N

Ans : (B)

## Question

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

A  $2\text{ N}$  and  $2\text{ N}$

$$0 \leq C \leq 4$$

B  $1\text{ N}$  and  $1\text{ N}$

$$0 \leq C \leq 2$$

C  $1\text{ N}$  and  $3\text{ N}$

$$2 \leq C \leq 4$$

D  $1\text{ N}$  and  $4\text{ N}$

$$3 \leq C \leq 5$$

~~ans not~~

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

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

B Along y-axis

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

C Along z-axis

D In indeterminate form

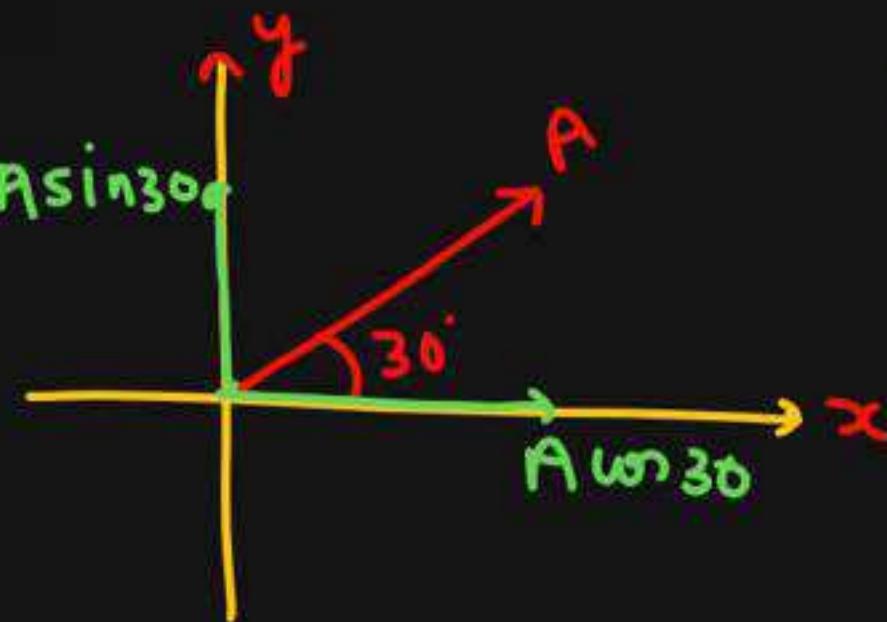
Ans. (C)

## Question



A vector lying in x-y plane has a magnitude  $\underline{3}$ , and makes an angle  $30^\circ$  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

$$d_1 =$$

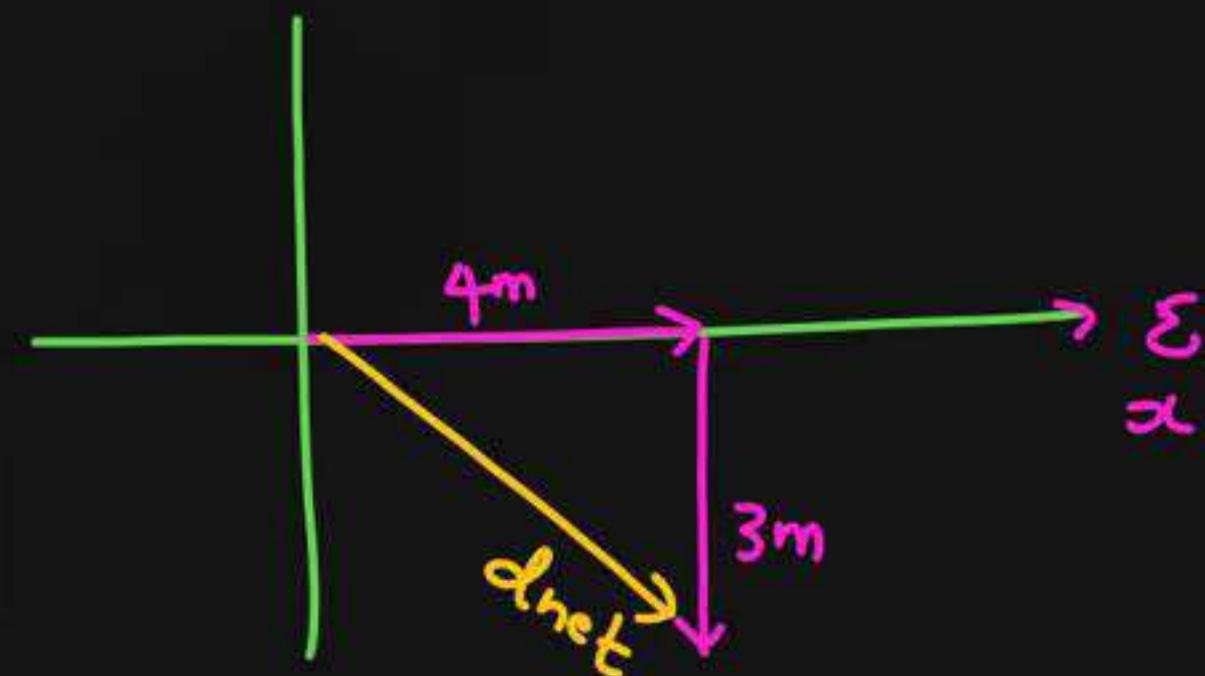
A boy walks 4 m east and then 3 m south. Find the resultant displacement of the boy.

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

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

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

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

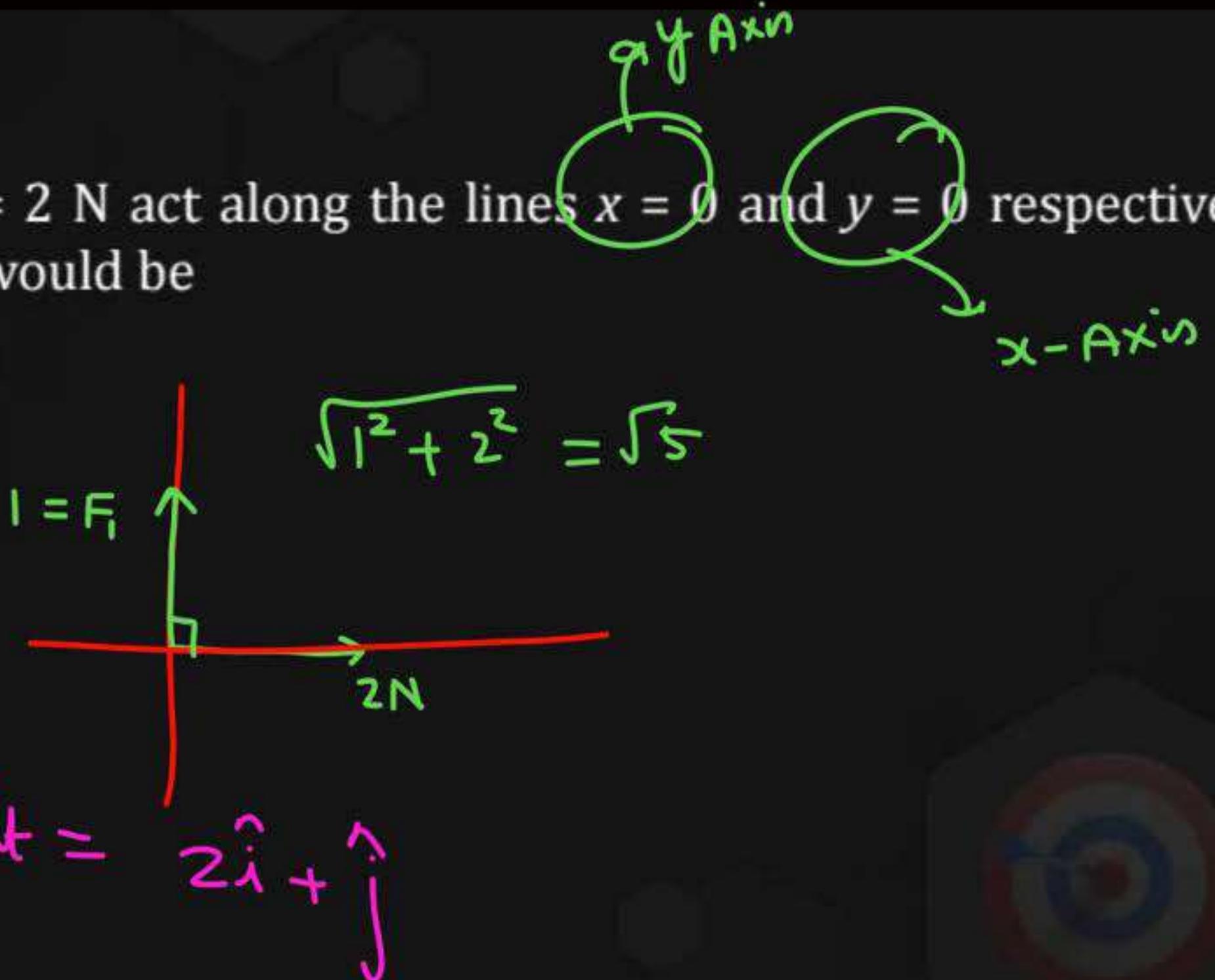
Ans. (B)

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

X

B

8 N

✓

C

18 N

X

D

20 N

X

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

$$4 \leq C \leq 16$$

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  $5i + 8j$  and  $2i + 7j$  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.

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

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

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

$$-2y = 1$$

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

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

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

$$z=0$$

$$x+y=0$$

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

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

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

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

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

Question

③



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  $K^{\text{th}}$  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 ( $\rho$ ) 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 ~~LT<sup>2</sup>~~

FT<sup>2</sup>

L

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

B ~~F<sup>-1</sup>A<sup>-2</sup>T<sup>-1</sup>~~

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

C ~~FA<sup>2</sup>T~~

FA<sup>2</sup>T

D ~~AT<sup>2</sup>~~

AT<sup>2</sup>

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

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)  $\frac{1}{1.01}$

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

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

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)  $45^\circ$
- (ii)  $60^\circ$
- (iii)  $90^\circ$
- (iv)  $120^\circ$
- (v)  $150^\circ$

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

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)  $4\pi$

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

Ans. (i)  $240^\circ$ , (ii)  $480^\circ$ , (iii)  $720^\circ$

H/W

P.E.

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

$$B = L^2$$

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

$D_F \gamma kT$

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

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

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

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$kT$  की dim put कर  
रहा है

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

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

$$x = 1$$

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

$$y+3=1$$

$$2+3=1$$

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 সমীক্ষা

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

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

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

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

$$x - y = 0$$

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

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

$$3y + 3 = 0$$

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

~~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  $\alpha$  and  $\beta$  are constants, dimensions of  $\alpha$  will be:

(JEE Main-2021)

- A [MLT<sup>-2</sup>]
- B [M<sup>0</sup>LT<sup>0</sup>]
- C [M<sup>2</sup>LT<sup>-2</sup>]
- D [MLT<sup>-1</sup>]

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  $\alpha, \beta$  are constants,  $x$  is displacement,  $k$  is Boltzmann constant and  $t$  is the temperature. The dimensions of  $\beta$  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.  $\text{Nms}^{-1}$
- II.  $\text{J kg}^{-1}$
- III. Nm
- IV.  $\text{Nm}^{-2}$

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  
 obj II page → 9  
 exercise  
 1, 2, 5, 8,  
 HCV pdf  
 download  
 graph

plugin  
 Introduction to  $\frac{P}{W}$

$\frac{P}{W}$

1, 2

H/W  
 Calculations  
 OP  $\cancel{AT}$

(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

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

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

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

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

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  $\alpha + \beta + \gamma$

$P = L^{-2}$

$Q = T$

$Ru = 1$

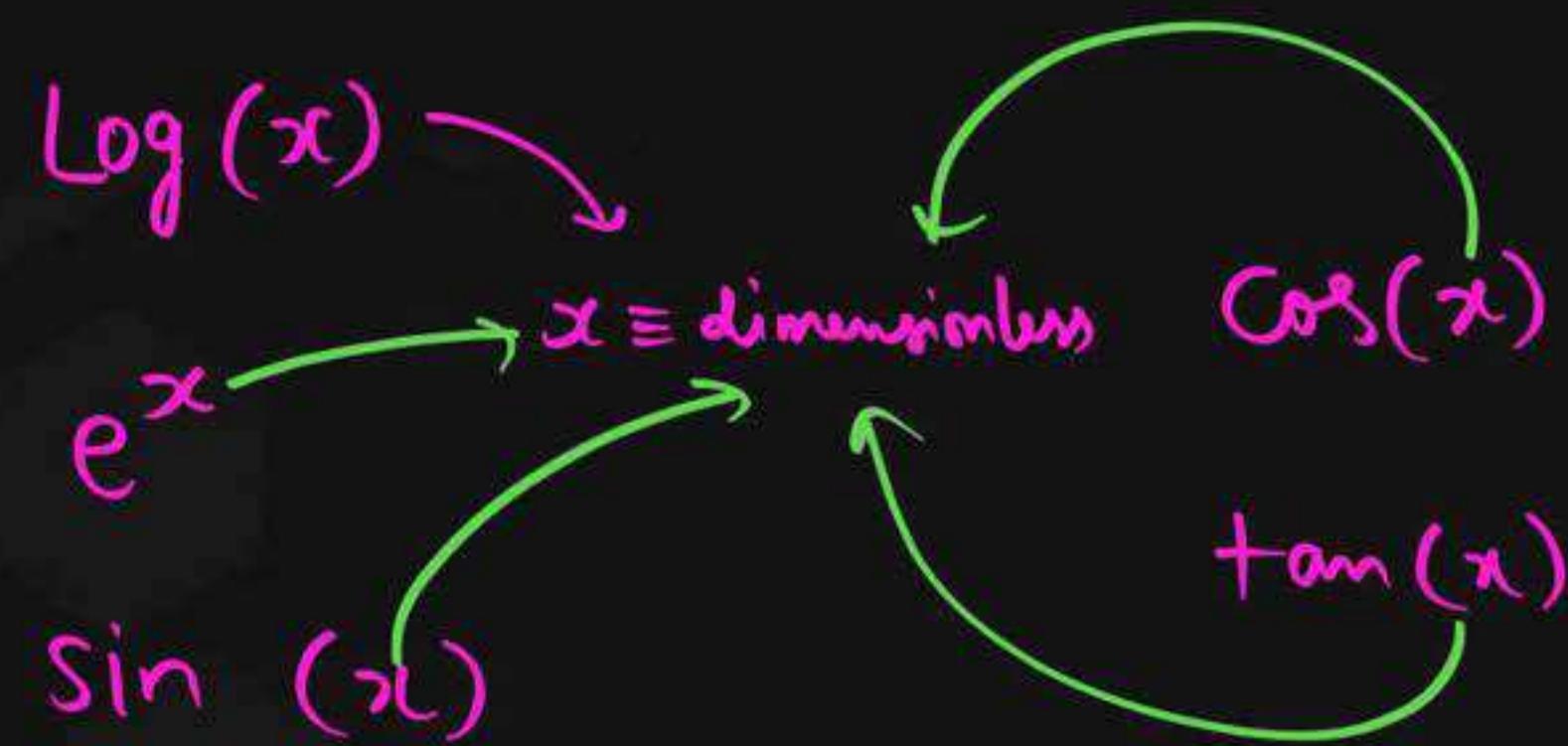
$R LT^{-1} = 1$

$R = L^T T$

$\frac{PQ}{yR}$

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

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



$$y = \log (x)$$

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  $\tau$

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

$$\pi = 3.14$$

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

$$t = \tau$$

$$\tau = T^1$$

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

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

$$A = L^2$$

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

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

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

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

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

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

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

$\Omega$

Potential Energy

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

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

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

find D.F. of  $K$  &  $a$

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

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

$\Omega$

(meter)

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

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

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

JEE mains 2021, 22,

\* 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  
 $\gamma$  → radius     $\rho$  → density  
 $g$  → acceleration due to gravity

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

frequency      pressure  
                    density

अब Last pages जरूर देखना



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

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

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

$$A = L^2$$

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

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

*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

  - never has a nonzero dimension,
  - always has a nonzero dimension,
  - may have a nonzero dimension,
  - 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  $\omega$ , (b) angular acceleration  $\alpha$ ,  
 (c) torque  $\Gamma$  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  $\mu_r$ .

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  $\alpha$  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  $10 \text{ m/s}^2$ . 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 =  $10^3 \text{ kg/m}^3$ ,  $g = 9.8 \text{ m/s}^2$  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  $\omega$ . Assuming the relation to be  $K = kI^\alpha \omega^\beta$  where  $k$  is a dimensionless constant, find  $\alpha$  and  $\beta$ . 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,  $\rho$  = density,  $P$  = pressure,  $V$  = volume,  $\eta$  = 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.  $36 \times 10^{-6}$  cm/(minute)<sup>2</sup>  
9. 0.0089 m/s, 31 m/s  
10.  $10 \times 10^{-4}$  N/m<sup>2</sup>,  $10 \times 10^{-2}$  dyne/cm<sup>2</sup>  
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  $\eta$

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

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

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

$$Q = mL$$

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

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

$\Omega$  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*

*Ct<sup>3</sup> → Displacement*

*CT<sup>3</sup> = L*

$$C = LT^{-3}$$

P W

*At → Displacement*

$$AT = L$$

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

*Bt<sup>2</sup> → Displacement*

$$BT^2 = L$$

$$B \Rightarrow LT^{-2}$$

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

$v \rightarrow$  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

~~B~~  $C = [m^0 L^0 T^0]$

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

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  $v = Ax^2 + Bx + \frac{C}{t^2}$

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

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

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

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

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

$$\boxed{C = LT}$$

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

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

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

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

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

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

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

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

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

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

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

$$F = AV$$

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

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

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

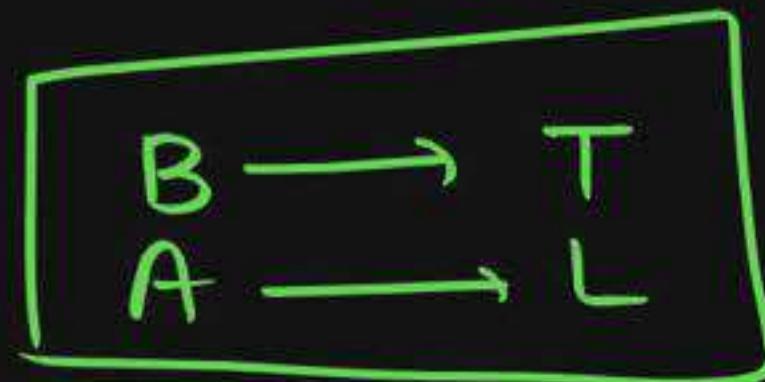
$$\boxed{B = m L^3 T^{-2}}$$

16

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

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

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



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

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

```
graph LR; A --> LT1T; LT1T --> L;
```

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

(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

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 

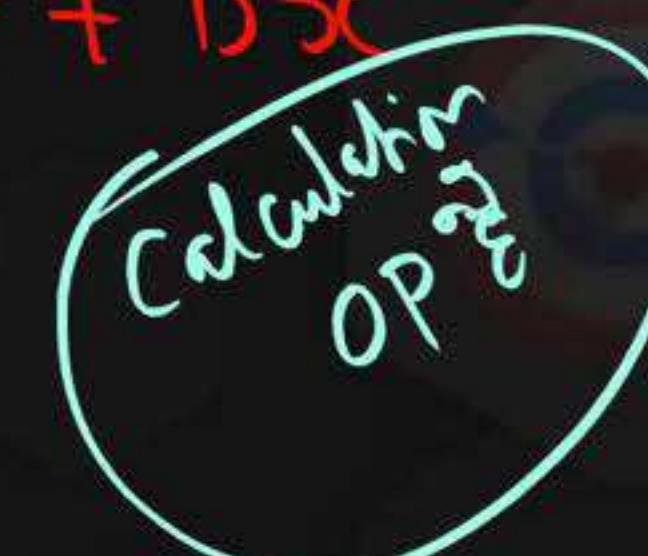
obj II page → 9 , (1,2)

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

P  
W

**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

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

Energy of one photon

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

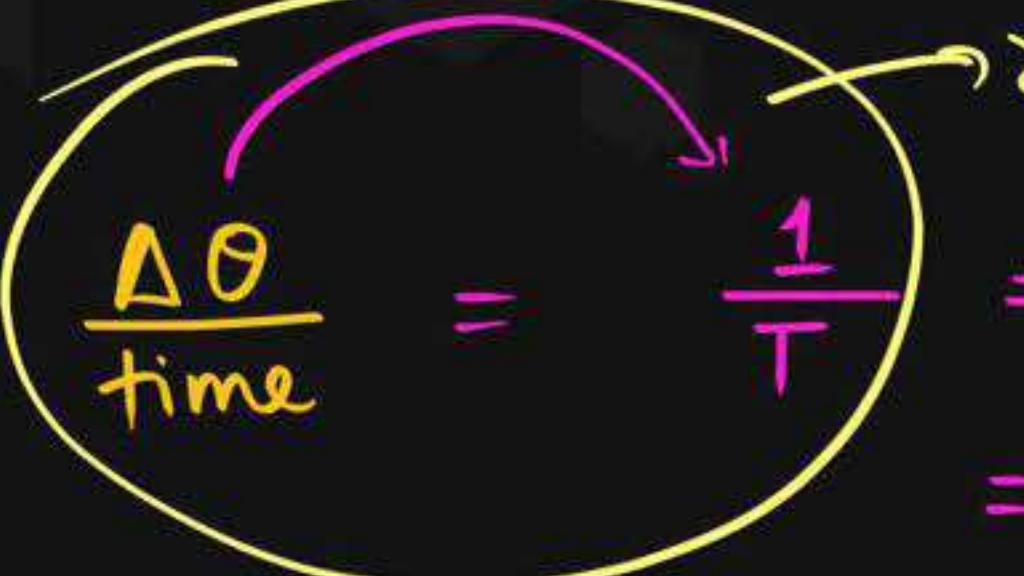
$$\frac{m L^2 T^{-2}}{T^{-1}}$$

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

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

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

Solve


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

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

रवृत्तायां

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

Correct

Q

A planet is orbiting around earth with orbital velocity  $V$

$$V = \sqrt{\frac{GM}{r}} \quad \text{check ?}$$

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

Dimensional formulae

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

mass of earth

radius of orbit

gravitational const

RHS

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

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 <sup>Correct</sup> wrong

Overall formula is <sup>wrong</sup>

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

Same 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 =  $\Delta V$

$$\Delta V = V_f - V_i$$

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

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)

Unit  
CGS

gm cm/sec

gm/cm<sup>3</sup>

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

momentum  $P = m v$  mass

velocity = Displacement / time

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

dimension of mass 1  
length 1  
time -1

## 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 formula

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

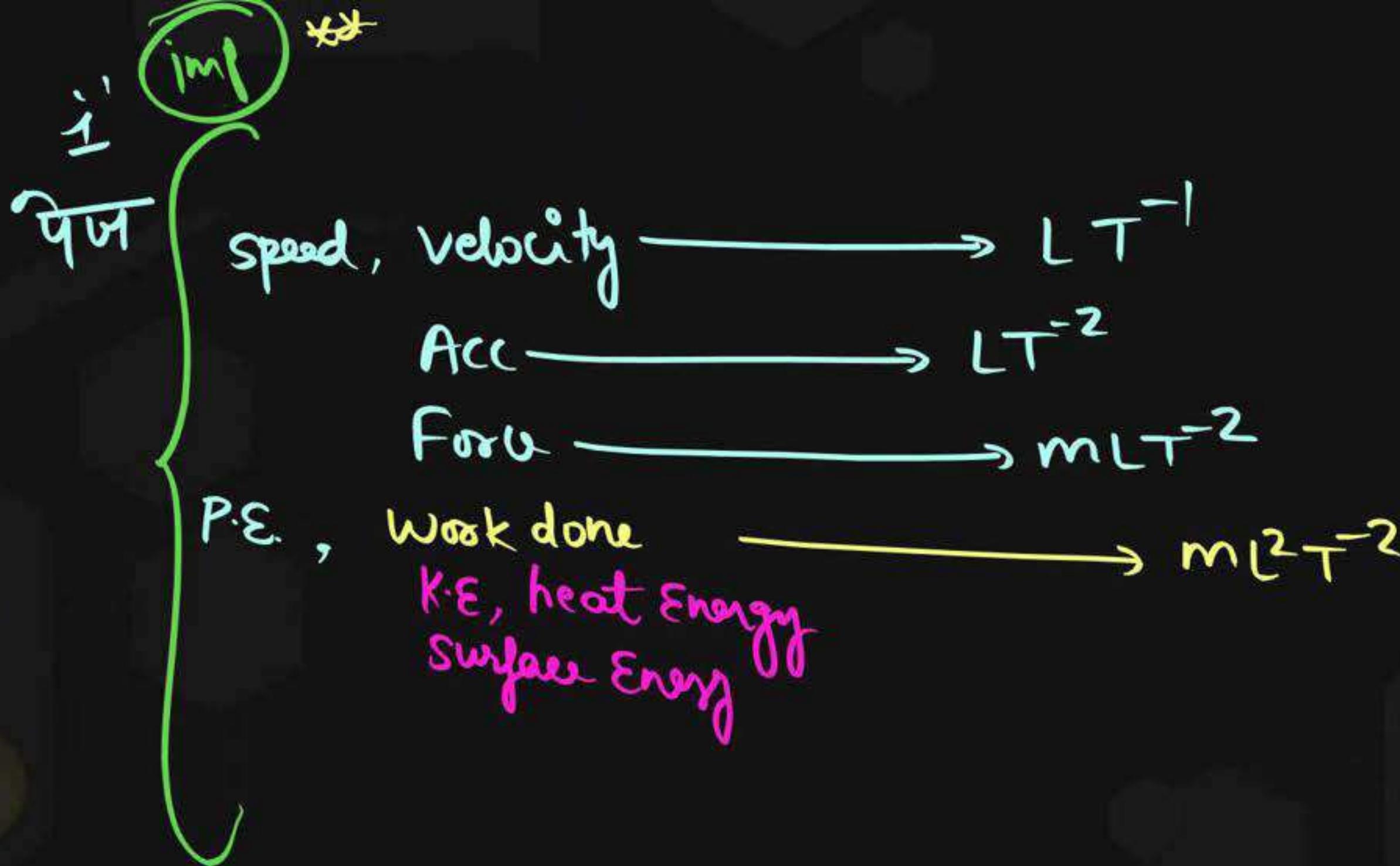
\* acceleration =  $\frac{\text{Velocity}}{\text{time}}$  (a)  $\longrightarrow \frac{LT^{-1}}{T} = LT^{-2} \Rightarrow [m^0 LT^{-2}]$

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

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

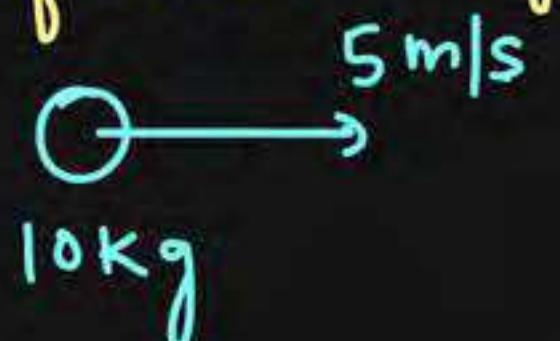
Same dimensional (D.F.)

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.



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

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

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

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

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

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

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

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

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

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

$\rho$  Vol  $\rightarrow \text{kg/m}^3$

$\text{g}/\text{cm}^3$

Unit (mks)	Unit (Gns)
---------------	---------------

Unit  
C6S

## Dimensional formula

L = LT<sup>-1</sup>

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

$\text{m}^\circ \text{L T}^{-1}$

[MLT-1]

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

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

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

Vol<sup>n</sup>

$$\xrightarrow{\quad} L \cdot L \cdot L \Rightarrow$$

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

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

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

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

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

$$L T^{-1}$$

$$L T^{-1}$$

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.

$\mu/\omega$  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,  
 $\text{H} \downarrow \omega$  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  $\pi$ 

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  $\cancel{ab/V^2}$

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

$$PV/n = \frac{PV}{n} = \frac{PV}{\text{mol}}$$

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.

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

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

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

$$x = L$$

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 &  $\eta$  is coefficient of viscosity. Dimension formula of  $\eta$  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

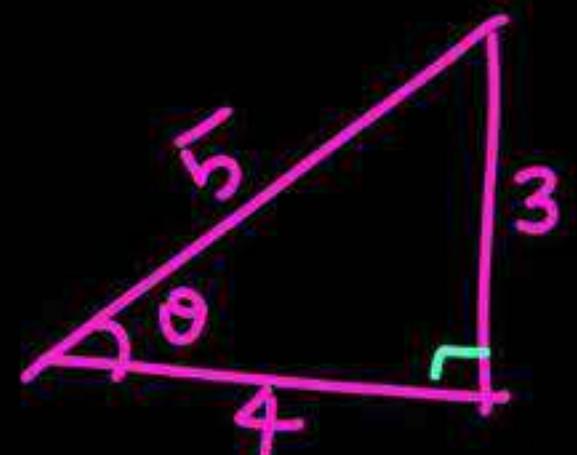
$$\cos \theta = \frac{4}{5}$$

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

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

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

• ~~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 ( $\ell$ ) are taken as the fundamental units. Then the dimension of mass ( $m$ ) in terms of  $t$ ,  $v$  and  $\ell$  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.

$\mu$  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)

 $\mu \propto$ 

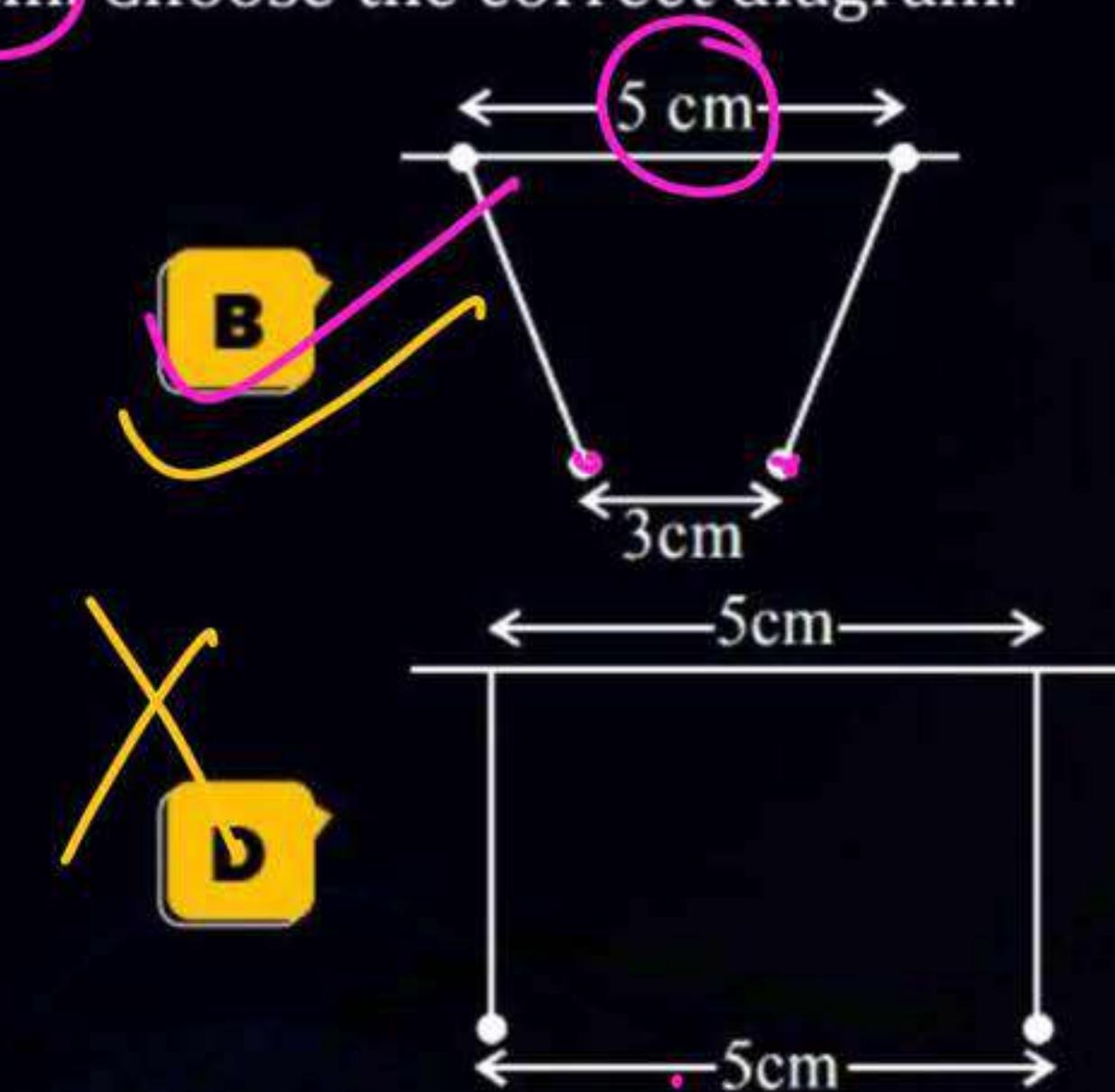
$$F = 6\pi\lambda\eta v$$

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

Ans : (A)

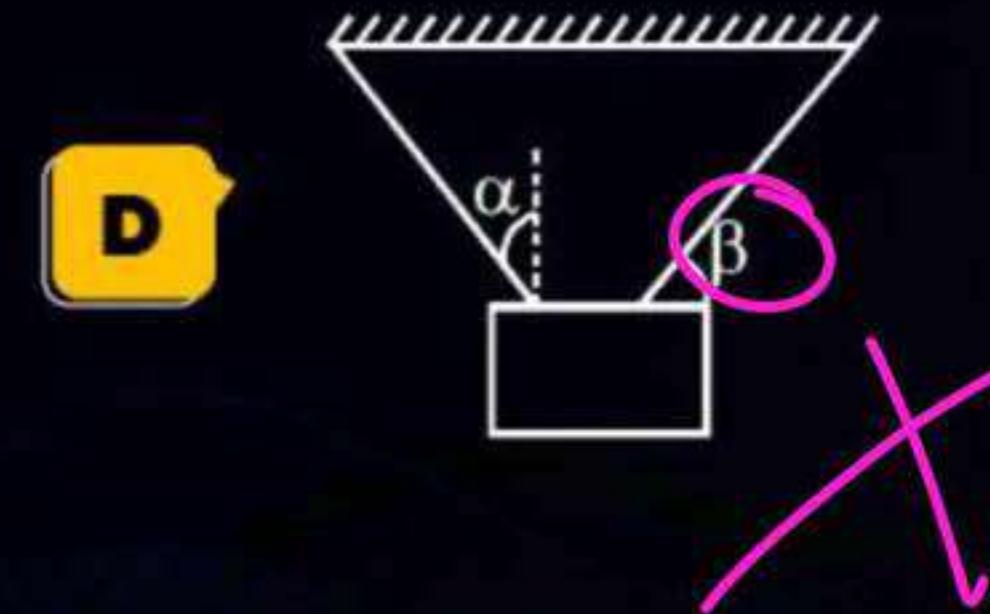
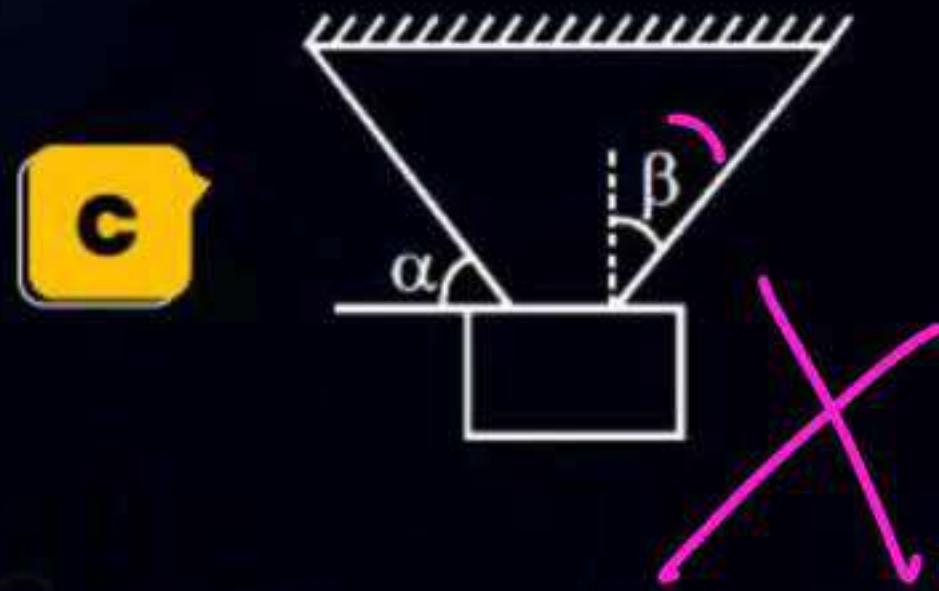
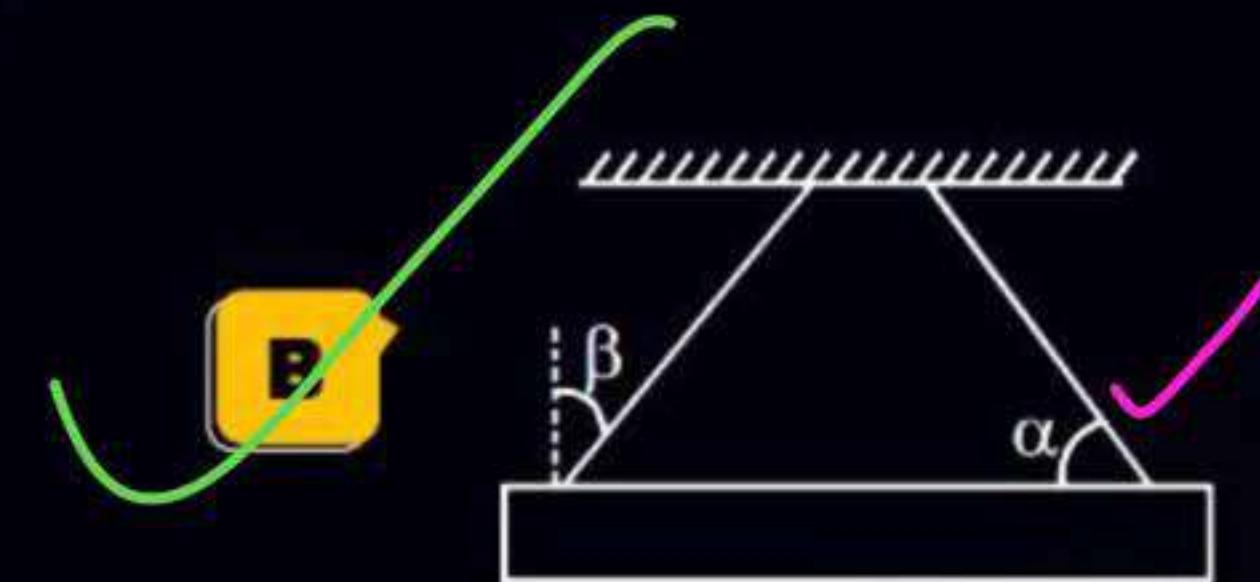
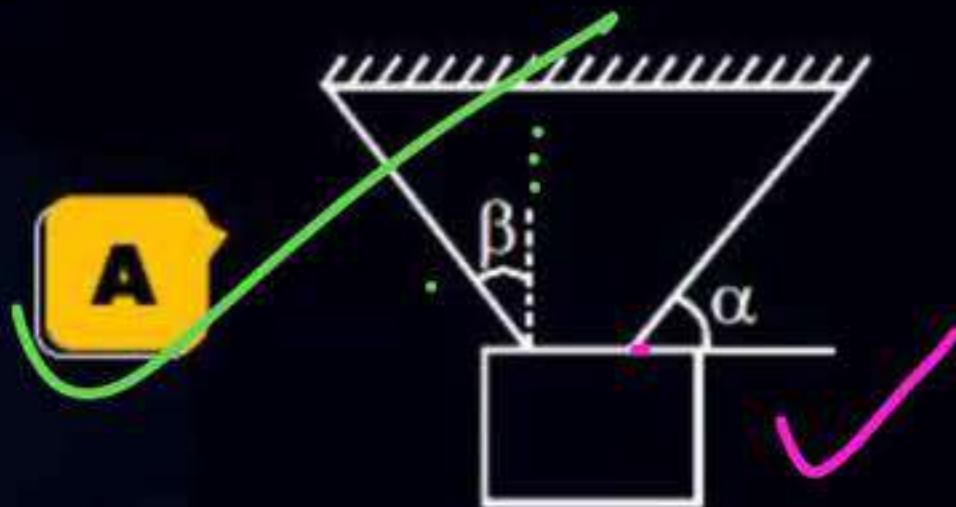
## Question

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.



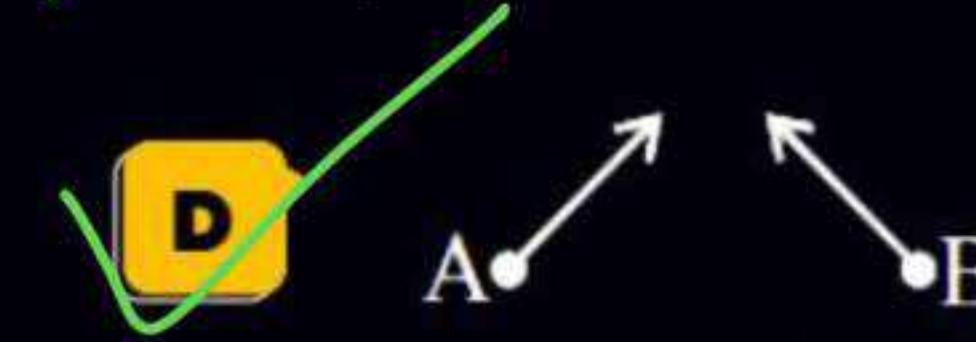
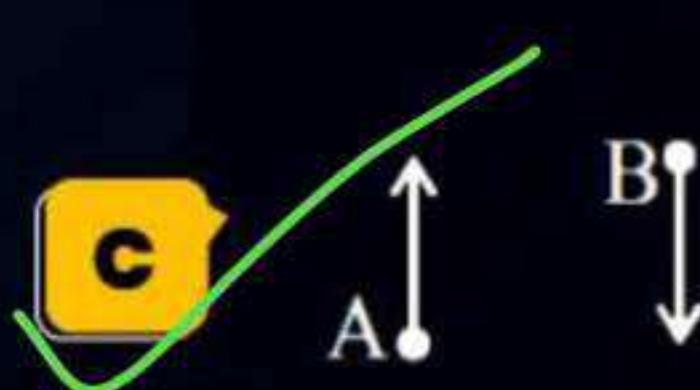
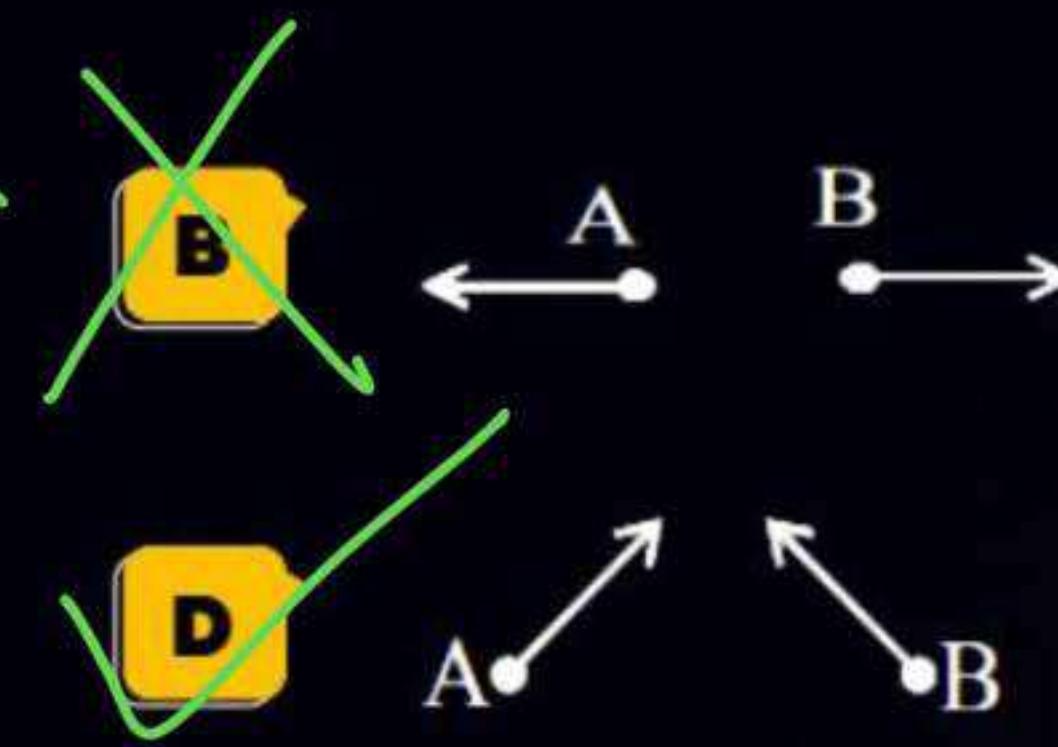
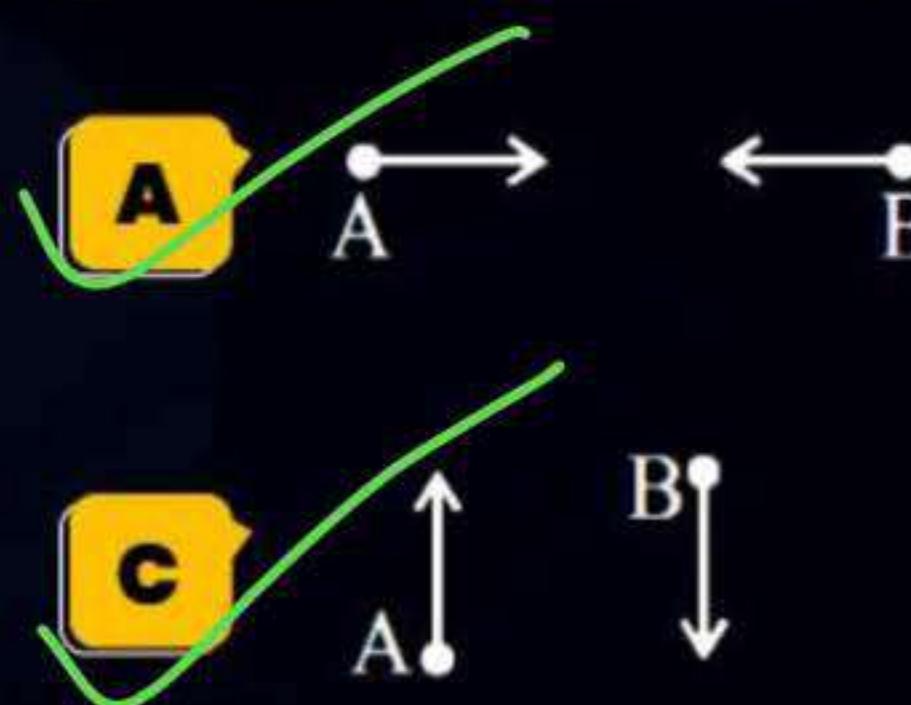
## Question

A body of mass  $m$  is suspended by two strings (right string equals an angle  $\alpha$  with horizontal & left an angle  $\beta$  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.  $\Psi$  can represent

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

Handwritten notes and equations:

- Wavelength  $\lambda$  (circled in green)
- Change in Wavelength  $\Delta\lambda$  (circled in blue)
- Equation:  $L = L \sqrt{\frac{2\Psi}{mv^2}} \cos \theta$  (circled in pink)
- Dimensionless (circled in pink)
- Dimensionless (underlined in green)
- $\Psi \equiv mv^2$  (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  $\alpha$  is constant and  $t$  is time. The constant  $\alpha$

- 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

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

$$= 10^5 \text{ dyne}$$

Q

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

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

$$= 37500000$$

$$= 375 \times 10^5$$

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

Q

Convert 1 Joule into CGS system  
 " " " erg

(erg → Unit of energy in  
 CGS system)

$$\begin{aligned}
 1J &= 1 \frac{\text{kg} \cdot \text{m}^2}{\text{sec}^2} & \xrightarrow{\text{convert into CGS}} & \frac{1 \times 1000 \text{ gm} \times (100 \text{ cm})^2}{\text{sec}^2} \\
 & & = & 10^7 \frac{\text{gm} \cdot \text{cm}^2}{\text{sec}^2} \\
 & & = & 10^7 \text{ erg.}
 \end{aligned}$$

$MLT^{-2}$ 

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

$$F = m \cdot a$$

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

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

$$= 15 \text{ N}$$

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

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

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

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

$$x - y = 0$$

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

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

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

$$\begin{aligned} 3y + 3 &= 0 \\ 3 &= -3y = +3/2 \end{aligned}$$

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  $\alpha$  and  $\beta$  are constants, dimensions of  $\alpha$  will be:

(JEE Main-2021)

- A [MLT<sup>-2</sup>]
- B [M<sup>0</sup>LT<sup>0</sup>]
- C [M<sup>2</sup>LT<sup>-2</sup>]
- D [MLT<sup>-1</sup>]

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

$$\boxed{\beta = m T^{-2}}$$

$$W = \alpha^2 \beta e^{(\quad)}$$

~~$ML^2 T^{-4} = \alpha^2 m T^{-2}$~~

~~$\alpha^2 = L^2$~~

$$\alpha = L$$

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  $4\vec{A} + \vec{B}$

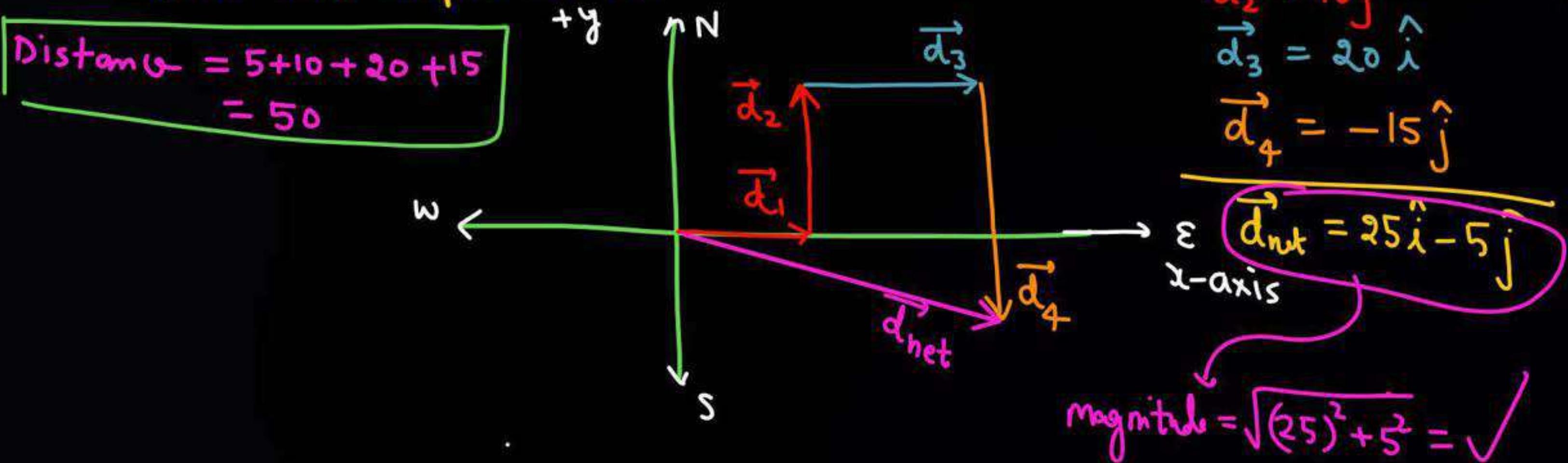
$$4\vec{A} + \vec{B} = 12\hat{i} + 5\hat{j} + 8\hat{k}$$

Ans  $\Rightarrow -20 \times \left( \frac{12\hat{i} + 5\hat{j} + 8\hat{k}}{\sqrt{12^2 + 5^2 + 8^2}} \right)$

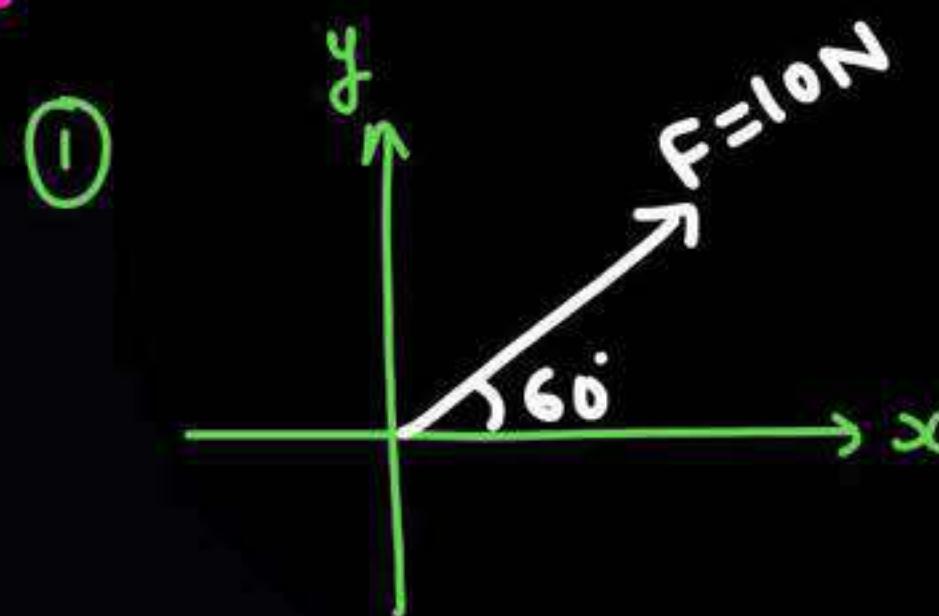
minus

## 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



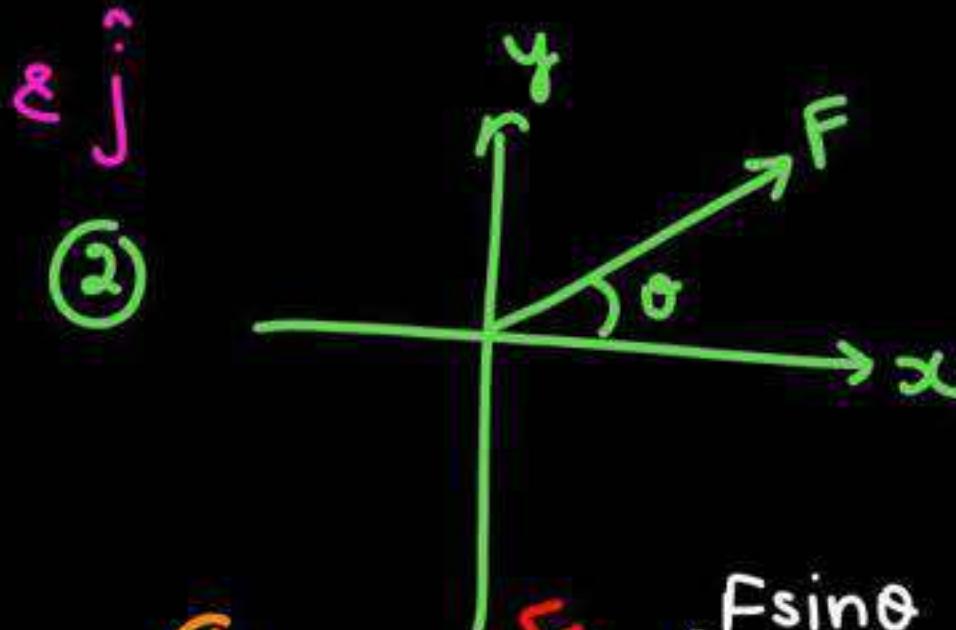
Q Resolve the vector into  $\hat{i}$  &  $\hat{j}$



$$\vec{F} = 10\cos 60 \hat{i} + 10\sin 60 \hat{j}$$

$$= 10 \times \frac{1}{2} \hat{i} + 10 \frac{\sqrt{3}}{2} \hat{j}$$

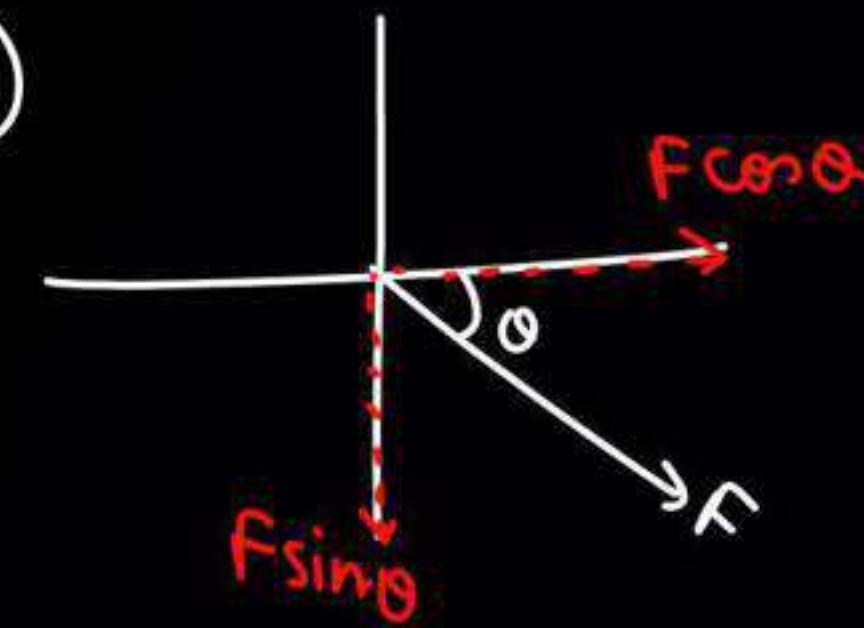
$$\boxed{\vec{F} = 5\hat{i} + 5\sqrt{3}\hat{j}}$$



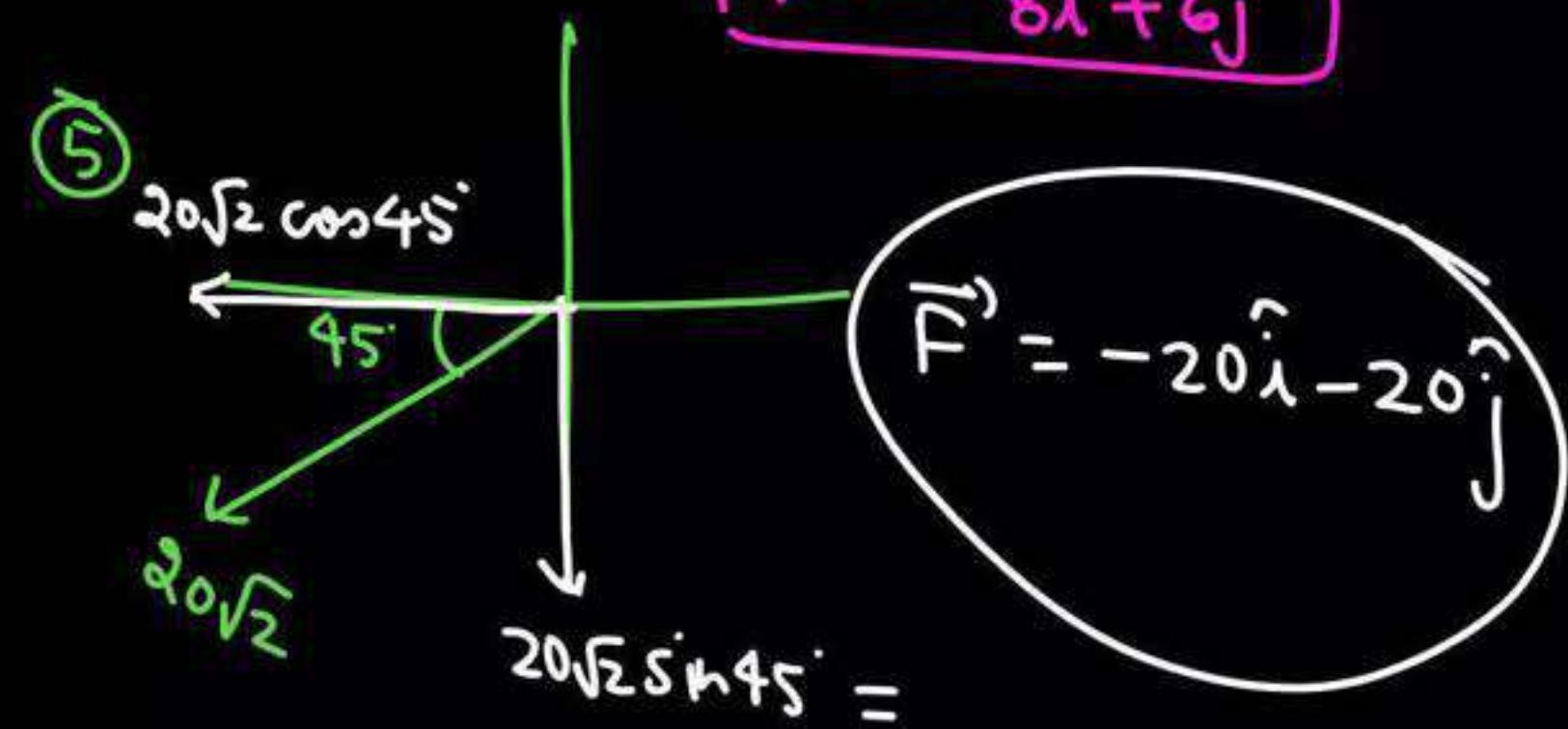
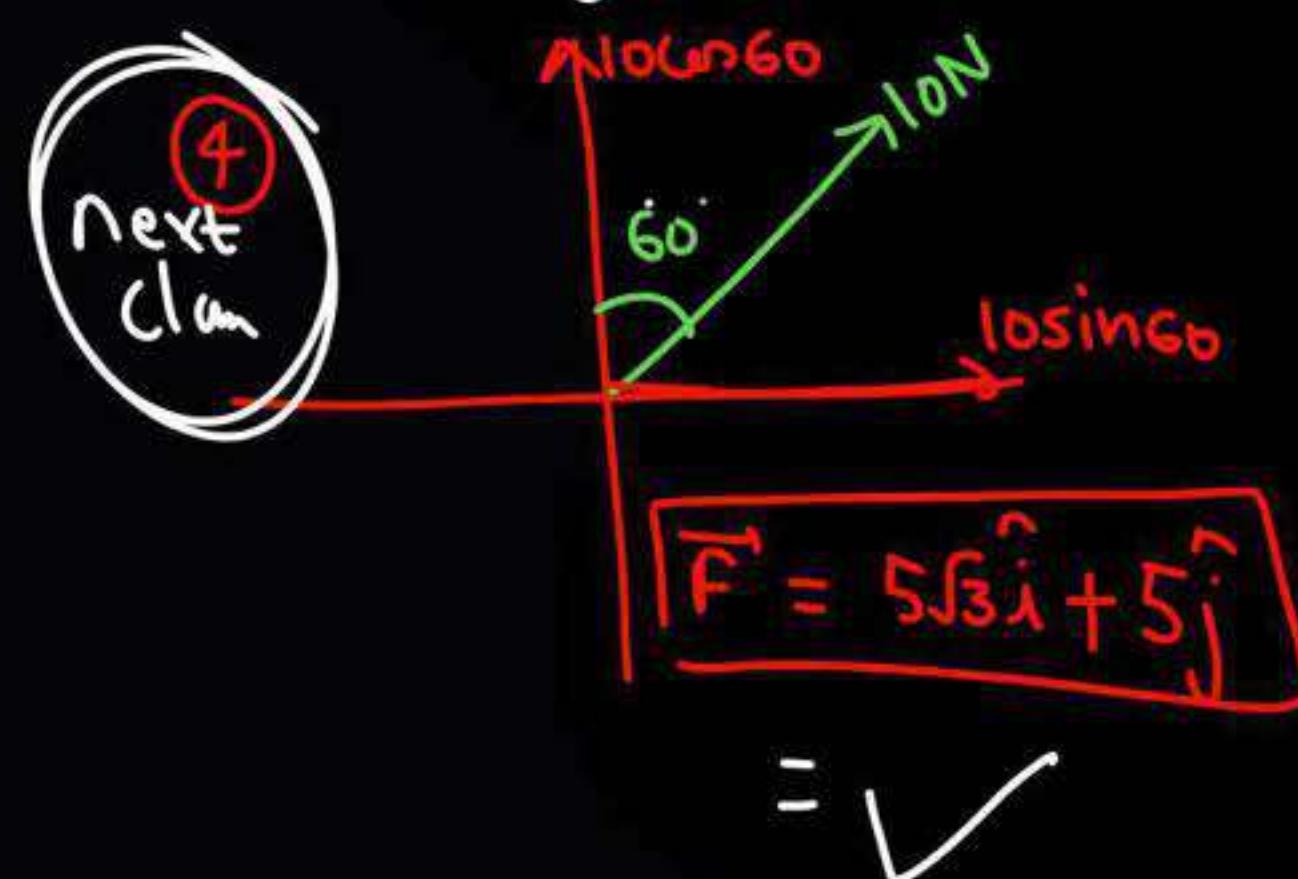
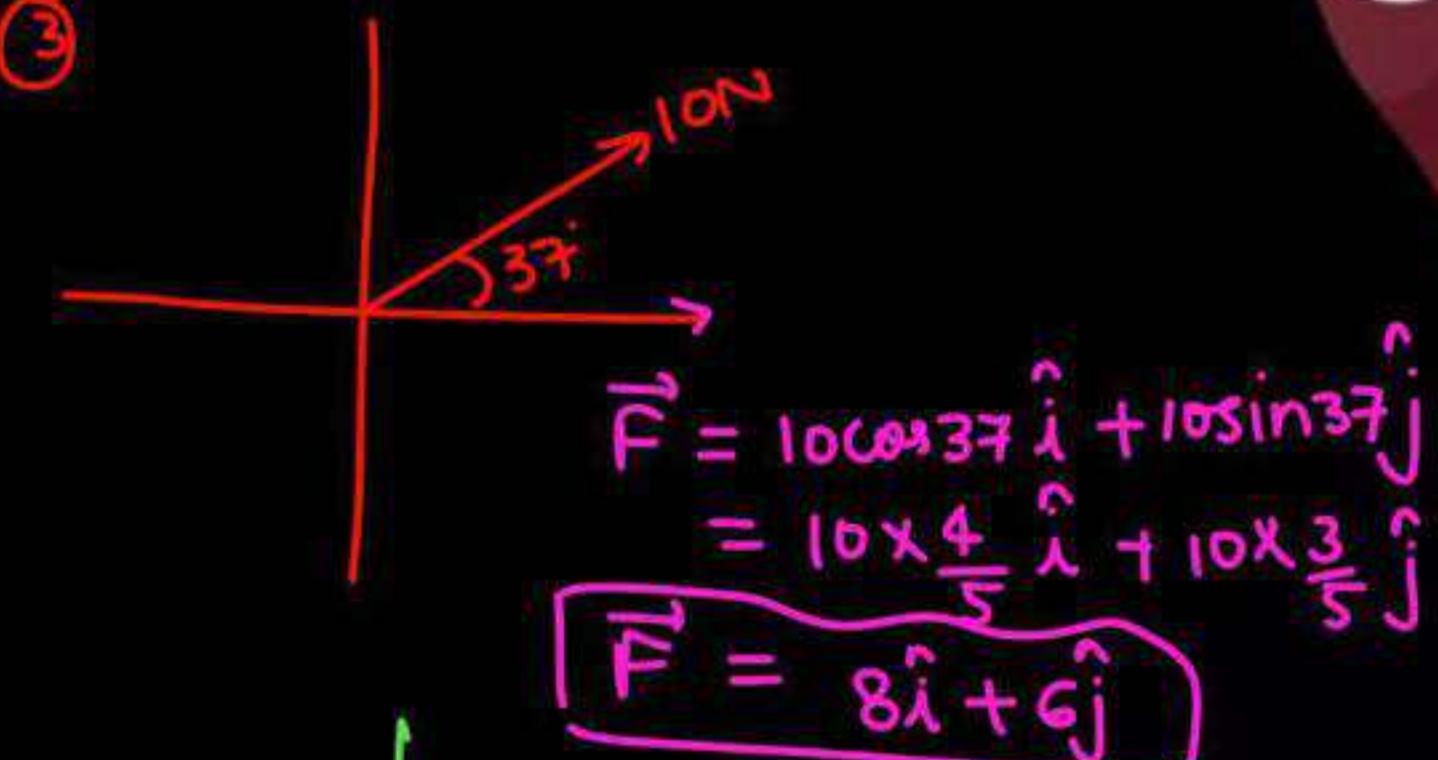
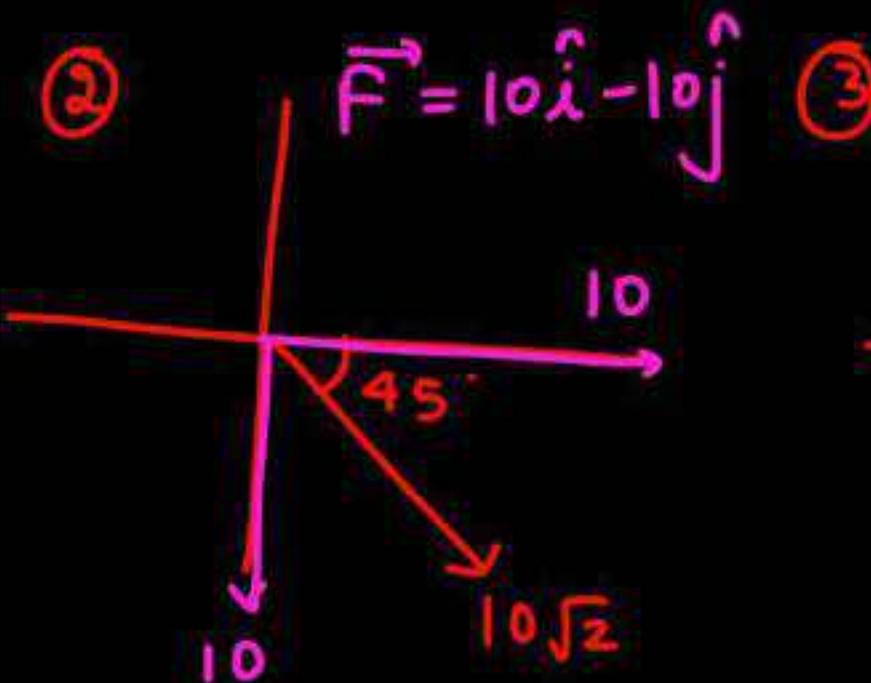
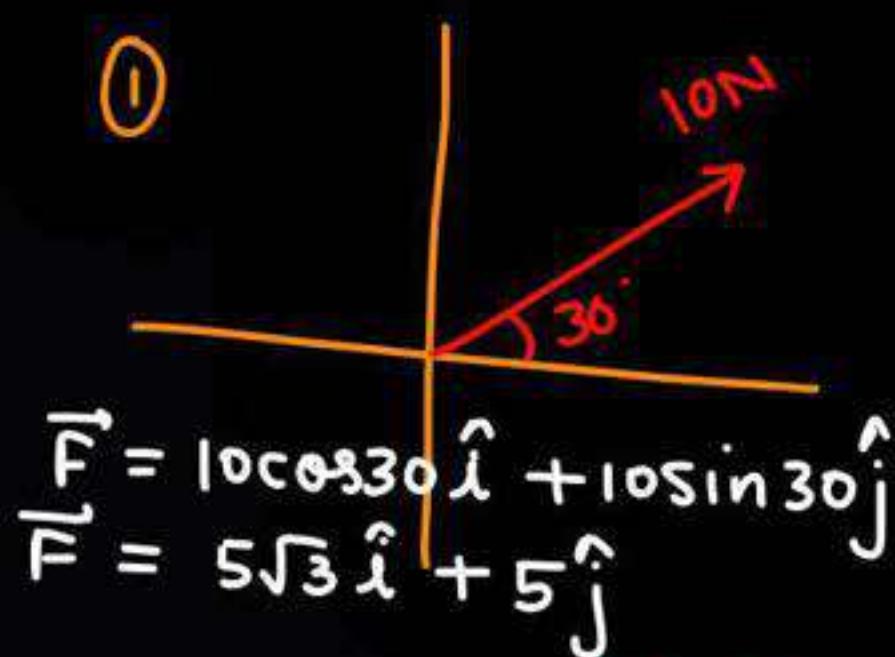
$$\vec{F} = F \cos \theta \hat{i} + F \sin \theta \hat{j}$$



$$\begin{aligned} \vec{F} &= -F \cos \theta \hat{i} \\ &\quad + F \sin \theta \hat{j} \end{aligned}$$



$$\begin{aligned} \vec{F} &= F \cos \theta \hat{i} \\ &\quad - F \sin \theta \hat{j} \end{aligned}$$



Q If angle b/w  $\vec{A}$  &  $\vec{B}$  is  $30^\circ$ .

$$A = 10$$

$$B = 20$$

find  $|\vec{A} - \vec{B}|$  = magnitude of  $\vec{A} - \vec{B}$

① m<sub>1</sub> direct

$$D = \sqrt{A^2 + B^2 - 2AB \cos \theta}$$

$\vec{A}$  &  $\vec{B}$  form  
acute angle

(m<sub>2</sub>)

$$\begin{aligned} D &= \sqrt{A^2 + B^2 + 2AB \cos(180 - \theta)} \\ &= \sqrt{100 + 400 + 2 \times 10 \times 20 \cos 150^\circ} \\ &= \sqrt{500 + 2 \times 10 \times 20 \left(-\frac{\sqrt{3}}{2}\right)} \\ &= \sqrt{500 - 200\sqrt{3}} \end{aligned}$$

$$\begin{aligned} D &= \sqrt{100 + 400 - 2 \times 10 \times 20 \frac{\sqrt{3}}{2}} \\ &= \sqrt{500 - 200\sqrt{3}} \end{aligned}$$



(2, 4, 7)

P

$\vec{x} (3, 9, 5)$

$$\vec{x} = \hat{i} + 5\hat{j} - \frac{1}{2}\hat{k}$$

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

①  $\vec{A} = 3\hat{i} + 4\hat{j}$   
 $A = \sqrt{3^2 + 4^2} = 5$

②  $\vec{A} = -3\hat{i} + 4\hat{j}$   
 $A = \sqrt{3^2 + 4^2} = 5$

③  $\vec{A} = 3\hat{i} - 4\hat{j}$   
 $A = 5$

④  $\vec{A} = -3\hat{i} - 4\hat{j}$   
 $A = 5$

⑤  $\vec{A} = 6\hat{i} + 2\hat{j} + 3\hat{k}$

$$A = \sqrt{6^2 + 2^2 + 3^2} = 7$$

⑥  $\vec{A} = 5\hat{i} - 12\hat{j} + 13\hat{k}$

$$A = \sqrt{5^2 + 12^2 + 13^2} = 13\sqrt{2}$$

⑦  $\vec{A} = \hat{i} + \hat{j} + \hat{k}$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

⑧  $\vec{A} = \hat{i} - \hat{j} + \hat{k}$

$$A = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{3}$$

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  $10 \text{ m/s}$  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  $10 \text{ m/s}$  along  $\vec{A} = 3\hat{i} - 4\hat{j}$   
and net force on the मिडिय is  $50 \text{ N}$  in the Dir<sup>n</sup> of  $\vec{B}$   
mass of मिडिय is  $2 \text{ kg}$   $\vec{B} = [6\hat{i} + 8\hat{j}]$

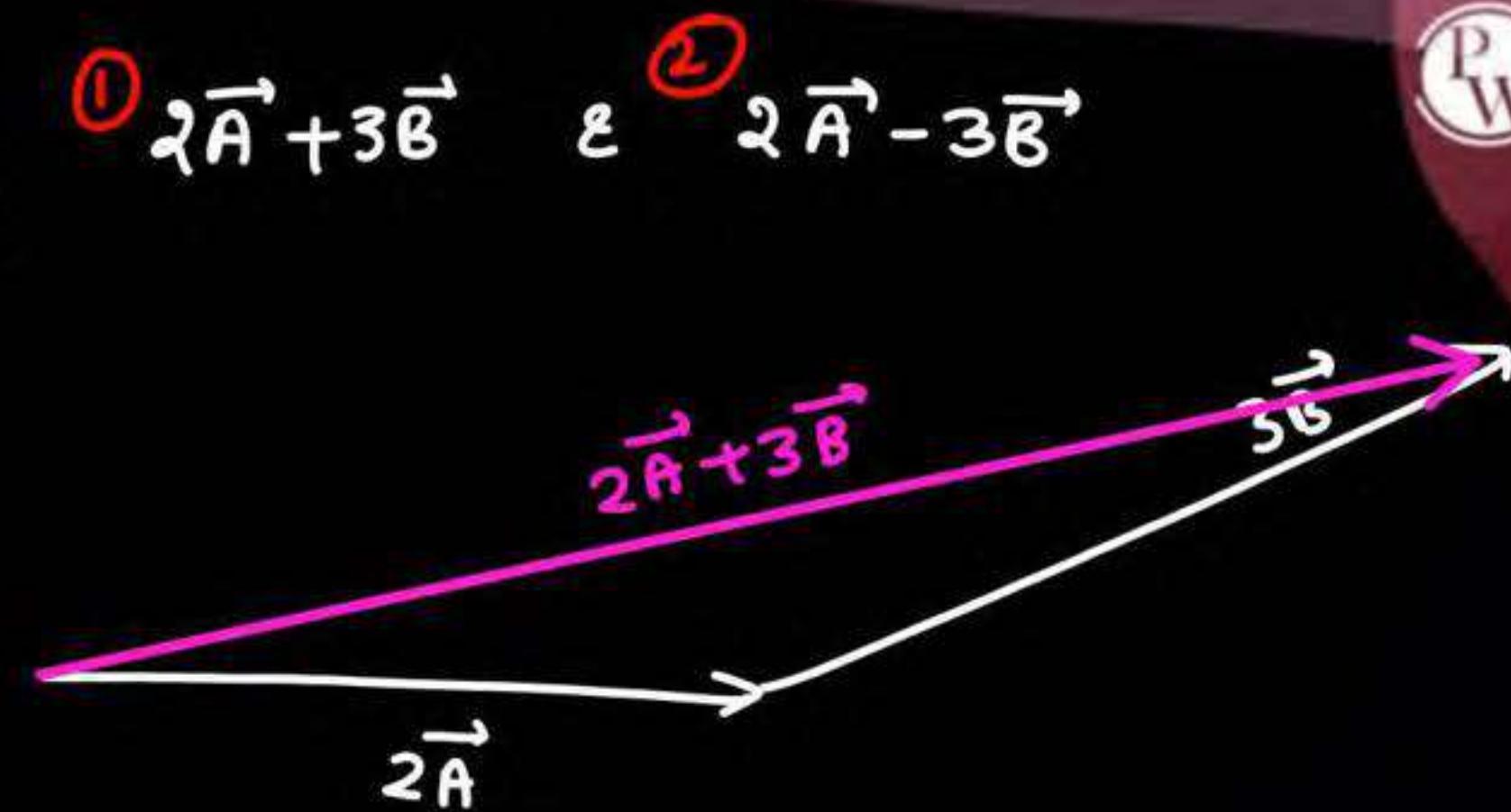
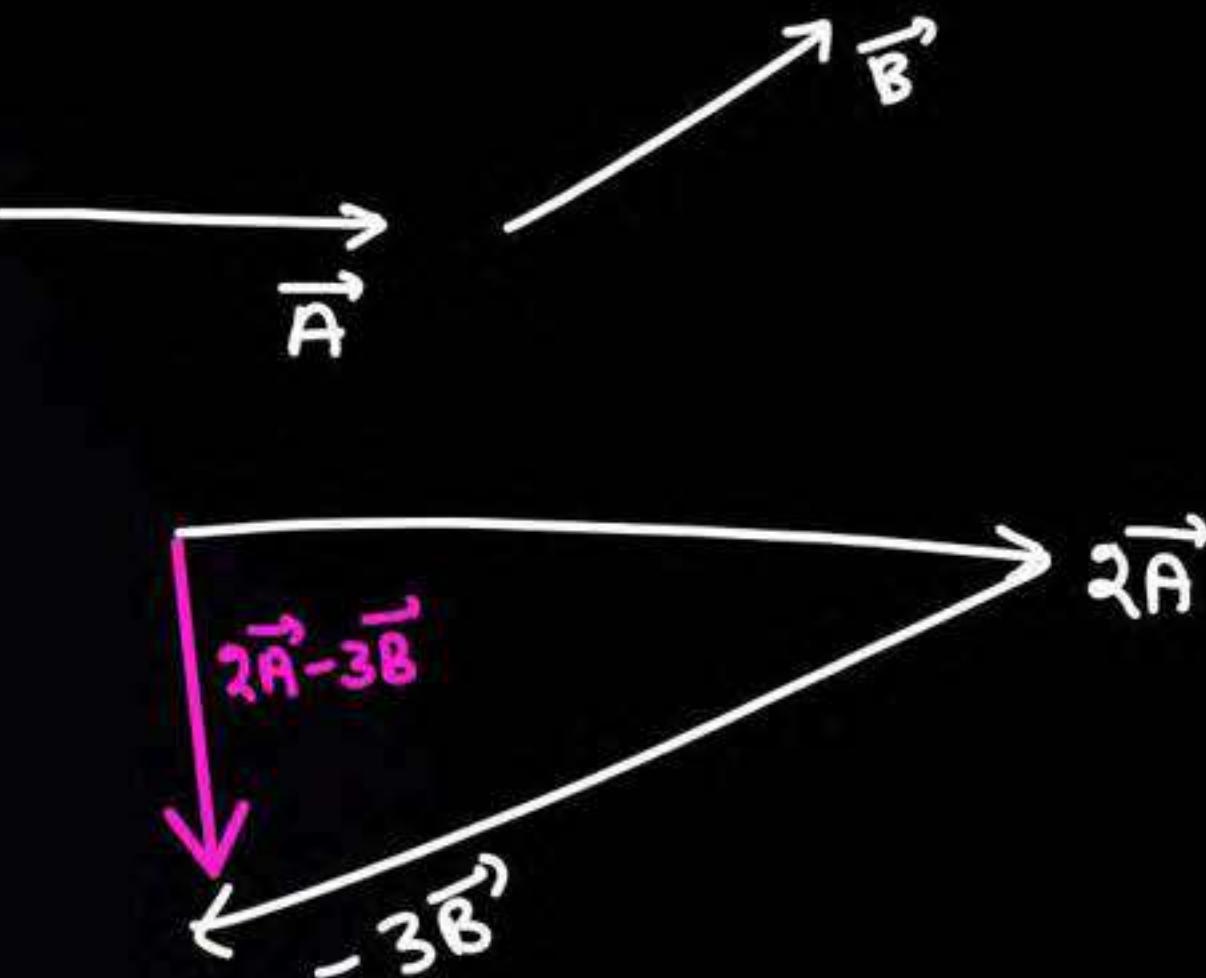
① find velocity of मिडिय at  $t = 14 \text{ sec}$

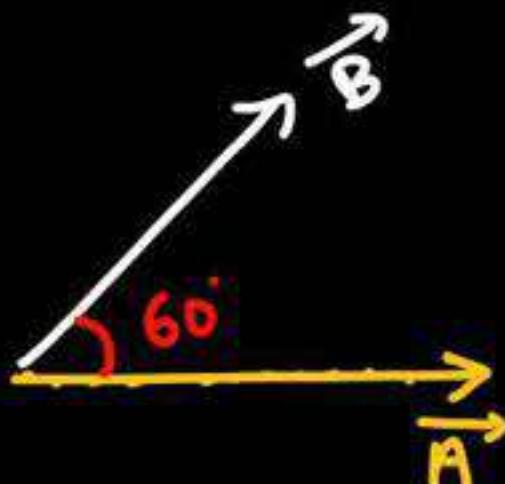
$$u_i = 10 \cdot \hat{A} = 10 \cdot \frac{3\hat{i} - 4\hat{j}}{5}$$
$$\vec{v} = \vec{u} + \vec{a}t$$

$$\vec{F} = 50 \hat{B} = 50 \times \frac{6\hat{i} + 8\hat{j}}{10}$$
$$\vec{a} = \frac{\vec{F}}{m} = 15\hat{i} + 20\hat{j}$$

Q

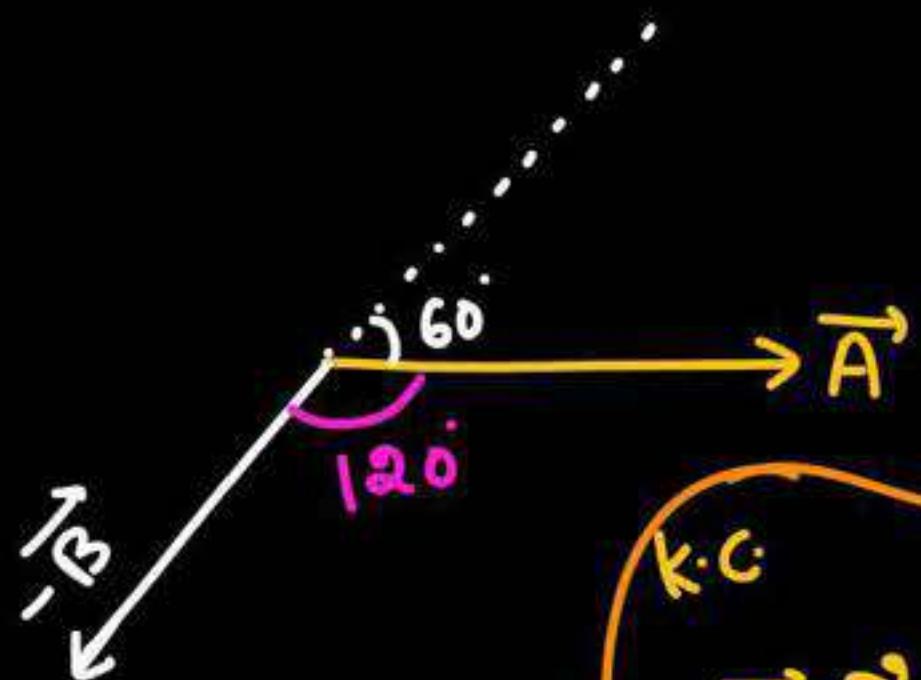
Draw rough diagram of ①  $2\vec{A} + 3\vec{B}$  & ②  $2\vec{A} - 3\vec{B}$





Angle between  $\vec{A}$  &  $\vec{B}$  =  $60^\circ$

$$\begin{aligned} \text{Angle between } \vec{A} \text{ & } -\vec{B} &= 180^\circ - 60^\circ \\ &= 120^\circ \end{aligned}$$



K.C

$\vec{A}$  और  $\vec{B}$  के बीच  
आगे angle  $\theta$  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  $60^\circ$

(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  $\vec{A}$

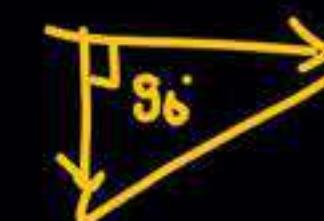
$$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

$$C = \sqrt{10^2 + 20^2 - 2 \times 10 \times 20 \times \cos 60^\circ}$$

$$= \sqrt{360}$$

$$\tan \alpha = \frac{B \sin \theta}{A - B \cos \theta} = \frac{20 \sin 60^\circ}{10 - 20 \cos 60^\circ} = \frac{10\sqrt{3}}{0}$$

$$\alpha = 90^\circ$$



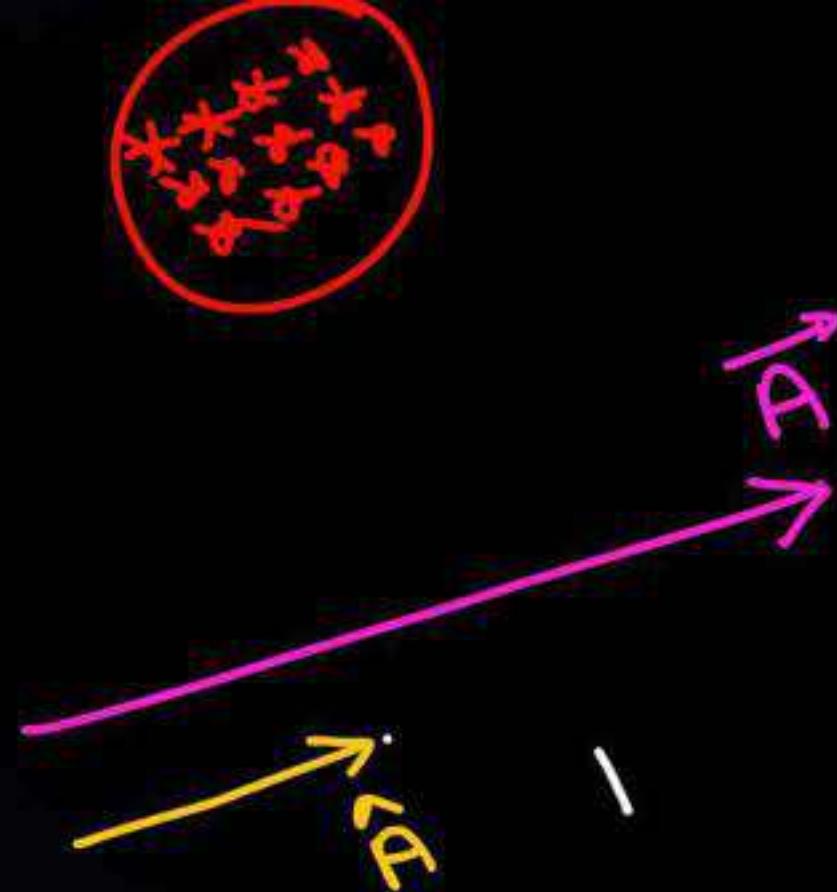
(B)  $\vec{A} \text{ तथा } \vec{B}$  के बीच angle =  $60^\circ$   
 $\vec{A} \perp \vec{B}$  .. .. =  $120^\circ$

$$\vec{D} = \vec{A} - \vec{B}$$

$$\begin{aligned}
 D &= \sqrt{10^2 + (20)^2 + 2 \times 10 \times 20 \times \cos 120^\circ}, \quad \tan \alpha = \frac{20 \sin 120^\circ}{10 + 20 \cos 120^\circ} \\
 D &= \sqrt{10^2 + 20^2 + 2 \times 10 \times 20 \cos(180^\circ - 60^\circ)} \\
 &= \sqrt{10^2 + 20^2 + 2 \times 10 \times 20 \left(-\frac{1}{2}\right)} \\
 &= \sqrt{100 + 400 - 200} \\
 &= \sqrt{300} \\
 &= \frac{20 \sqrt{3}/2}{10 + 20 \left(-\frac{1}{2}\right)} = \frac{10\sqrt{3}}{0}
 \end{aligned}$$

$\alpha = 90^\circ$

$\vec{A}, \hat{A}$  = parallel vectors



\*\*\* K.C.

$\hat{A}$  → Unit vector

ये ऐसा Vector हैं

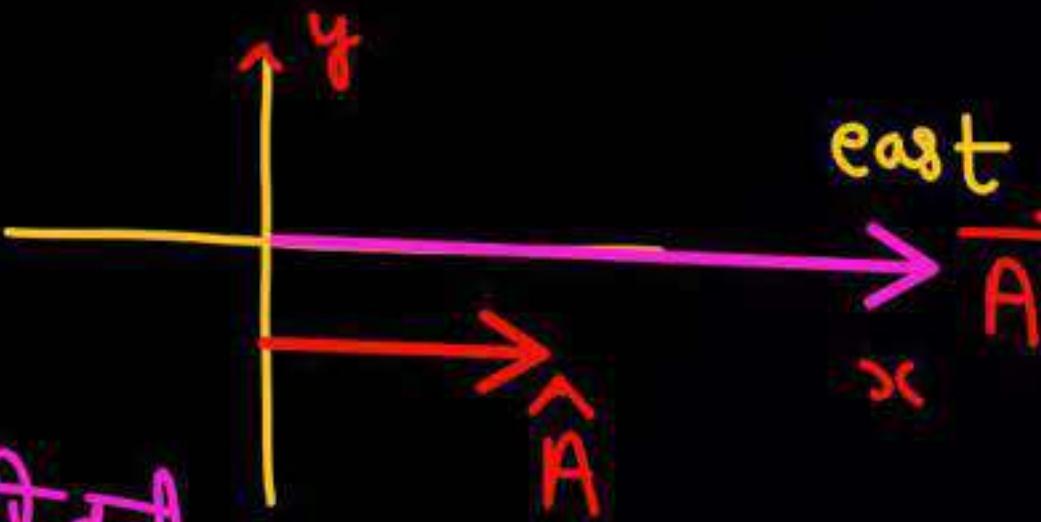
जिसकी magnitude 1 है

और dir<sup>n</sup>  $\vec{A}$  की तरफ की है

Q  $\vec{A} = 5\text{ N east}$

$\hat{A} = \text{east}$

dir<sup>n</sup> 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"

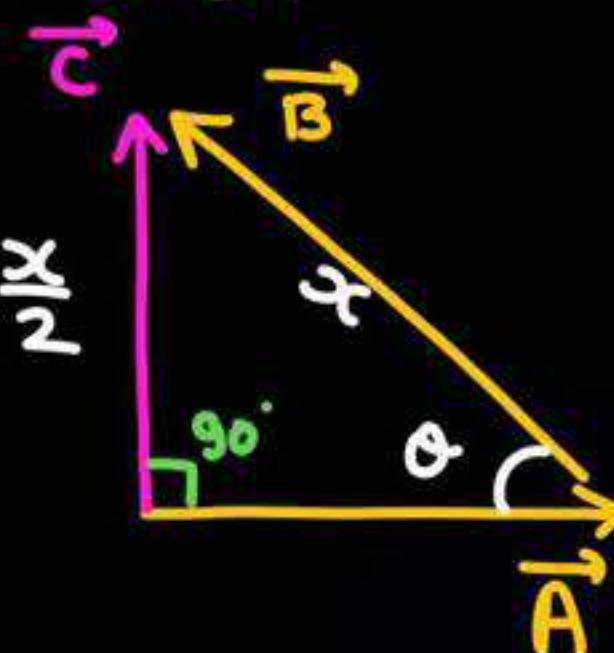
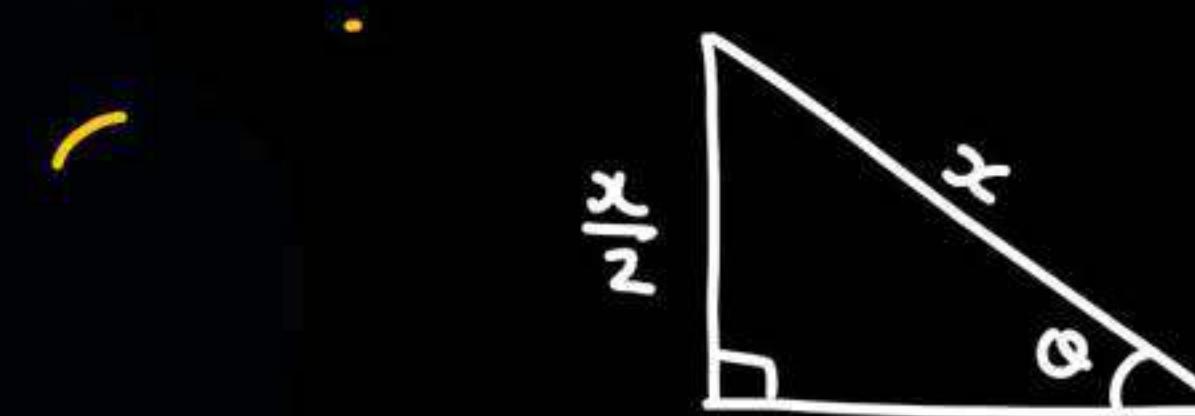
Q A particle is moving with speed 20 m/s along -y Axis

$$\vec{v} = 20 \text{ m/s } (-\hat{j}) = -20\hat{j}$$

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  $\vec{A}$  &  $\vec{B}$ .

$$\vec{A} + \vec{B} = \vec{R}$$

$$R = \sqrt{a^2 + a^2 + 2 \cdot a \cdot a \cos \theta}$$

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

$$\theta = 120^\circ$$

$$R_{\text{new}} = \sqrt{a^2 + (2a)^2 + 2 \cdot a \cdot 2a \cos \theta}$$

$$a\sqrt{3} = \sqrt{a^2 + 4a^2 + 4a^2 \cos \theta}$$

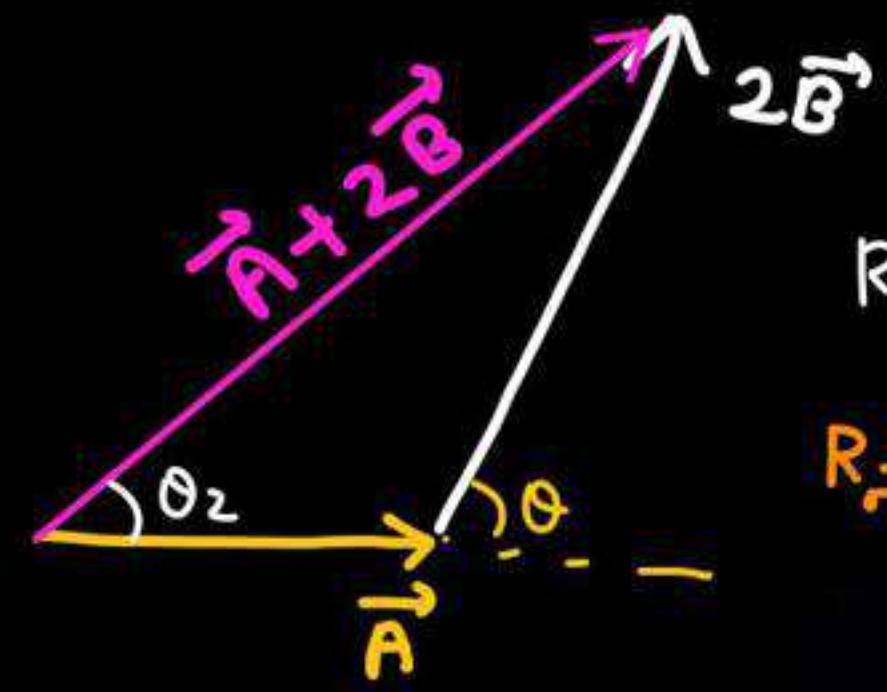
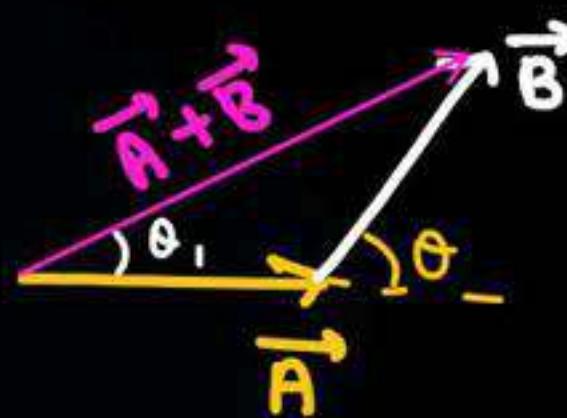
$$3a^2 = 5a^2 + 4a^2 \cos \theta$$

$$-2a^2 = 4a^2 \cos \theta$$

~~$2B+A$~~  X  
 $2\vec{B} + \vec{A}$  ✓

Q  $\vec{A}$  has magnitude 10N,  $\vec{B}$  has magnitude 20N  
 angle between  $\vec{A}$  &  $\vec{B}$  is  $60^\circ$ . 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)

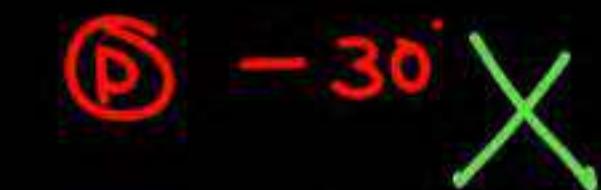
150°

(C)

120°

(D)

-30°



$$\cos \theta = -\frac{\sqrt{3}}{2}$$

$\theta = 150^\circ$

Basic  
maths  
461

$\theta = 210^\circ$

Q magnitude of  $\vec{A}$  is 10

" "  $\vec{B}$  is 20

angle between  $\vec{A} \& \vec{B}$  is  $60^\circ$ .

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  $60^\circ$ . 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

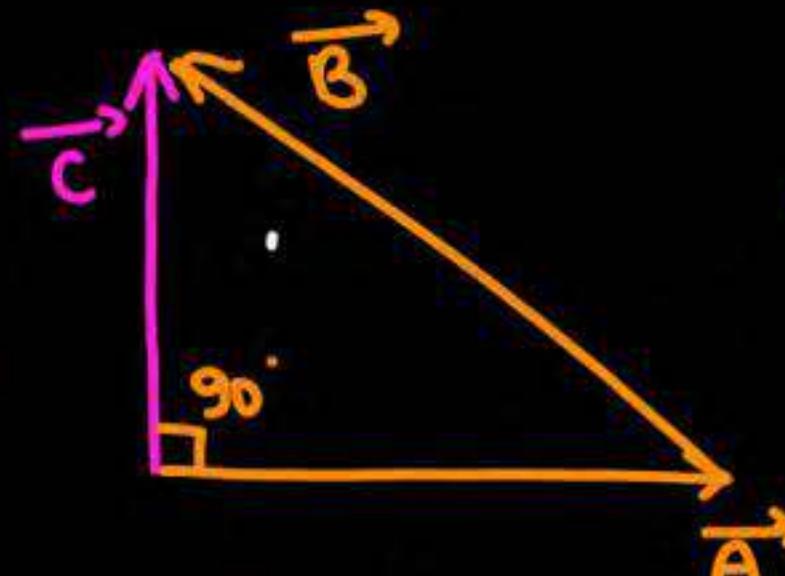
**Q2**

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

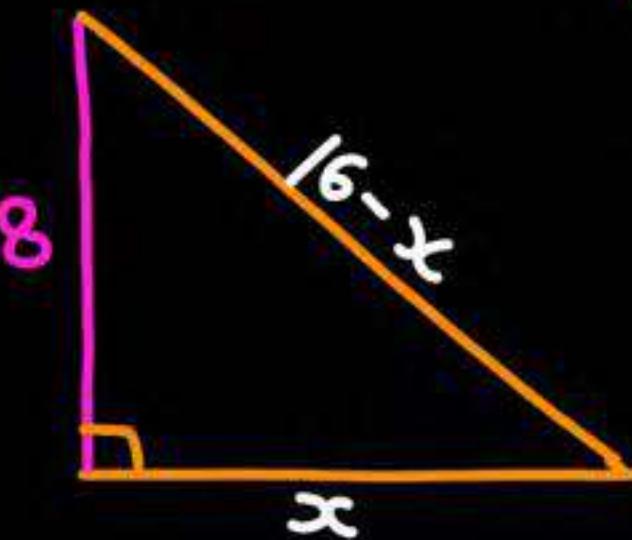
Method  
2

△ बनाने की क्रिया करो



$$\vec{A} + \vec{B} = \vec{C}$$

=



$$8^2 + x^2 = (16-x)^2$$

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  $60^\circ$ .

$$A = x$$

$$B = x$$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$= \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cos 60^\circ}$$

$$= \sqrt{x^2 + x^2 + 2x^2 \frac{1}{2}}$$

$$\boxed{C = x\sqrt{3}}$$

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  $120^\circ$ .

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

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

$$= \sqrt{2x^2 + 2x^2 \left(-\frac{1}{2}\right)}$$

$$\boxed{C = x}$$

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  $90^\circ$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$C = \sqrt{x^2 + x^2 + 2 \cdot x \cdot x \cdot \cos 90^\circ}$$

$$= \sqrt{x^2 + x^2 + 0}$$

$$\boxed{C = x\sqrt{2}}$$

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  $60^\circ$  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  $90^\circ$  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  $60^\circ$   
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°

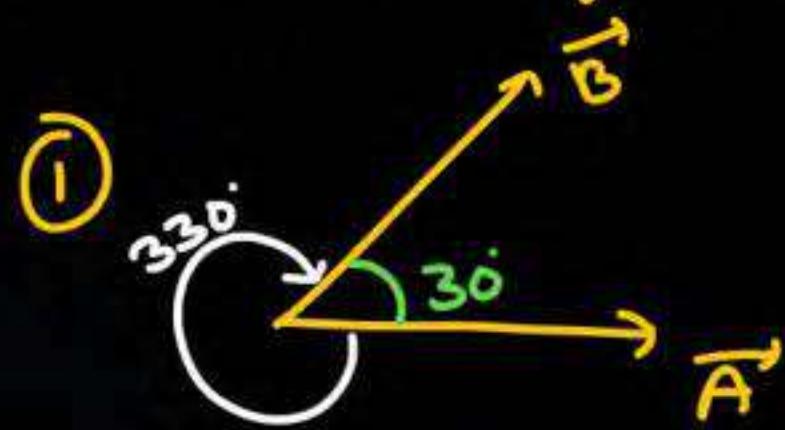
and  $\vec{B}$  become twice to its initial value & added to  $\vec{A}$

find magnitude of new resultant

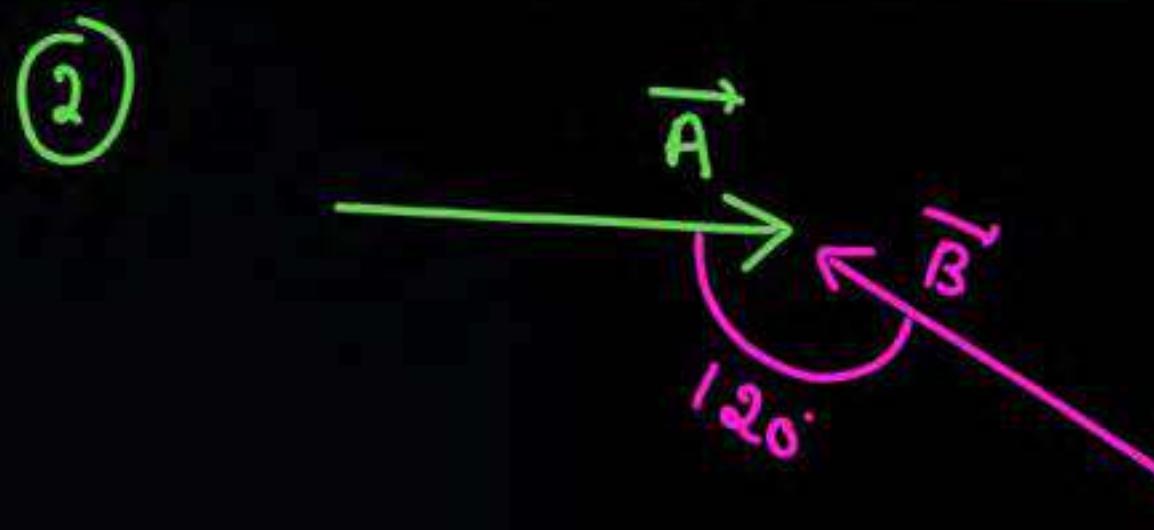
$$\begin{aligned} C &= \sqrt{100 + 144 + 120} \\ &= \sqrt{364} \end{aligned}$$

$$C_{\text{new}} = \sqrt{10^2 + (12)^2 + 2 \times 10 \times 12 \cos 60^\circ}$$

find angle b/w  $\vec{A}$  &  $\vec{B}$



angle b/w vectors =  $30^\circ$  ✓  
=  $330^\circ$  ✗

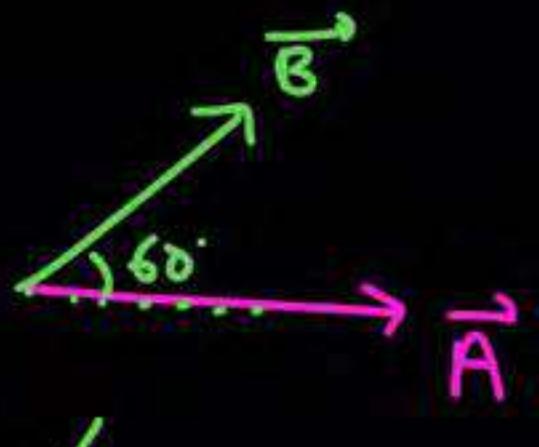


angle between Vectors  
=  $120^\circ$

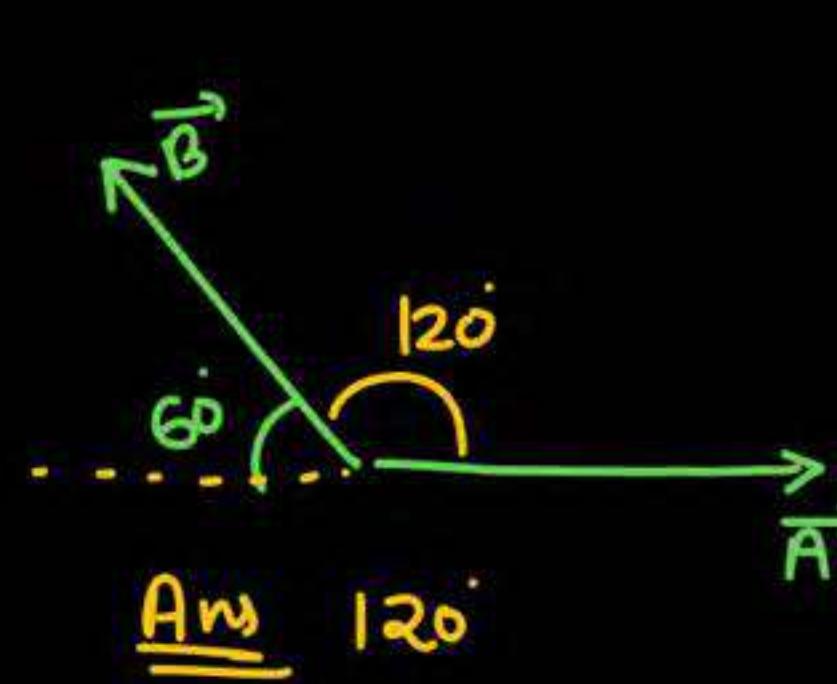
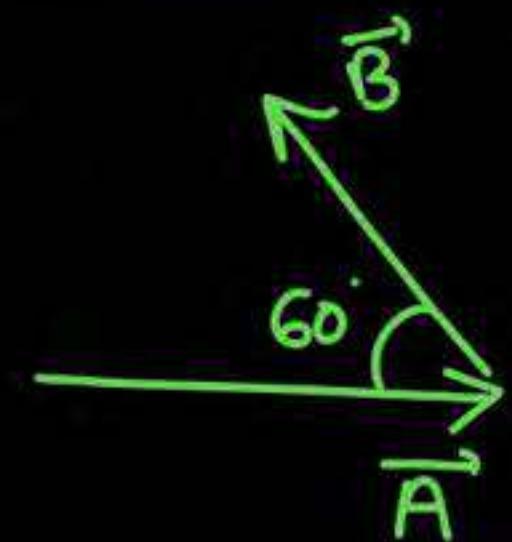
③



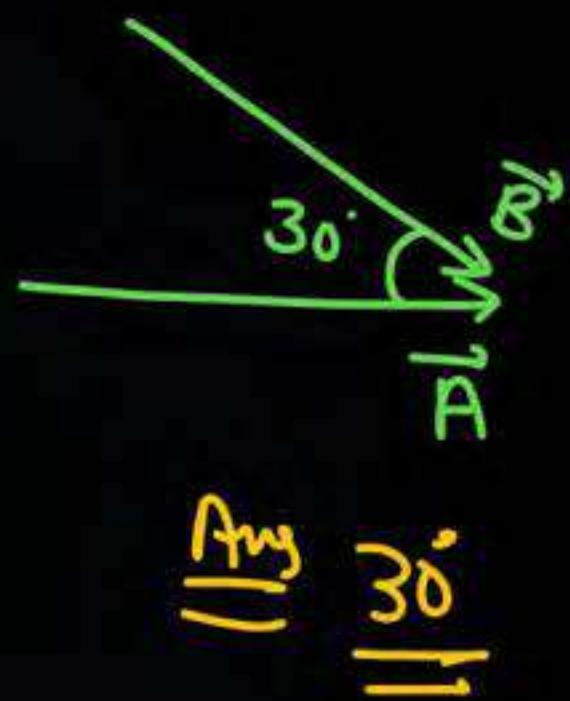
Soln



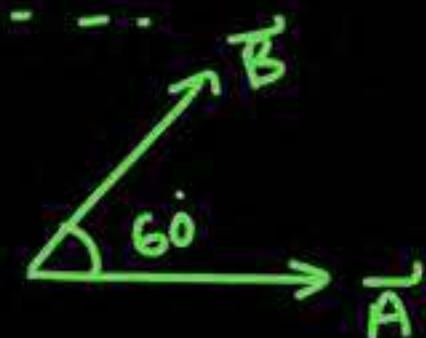
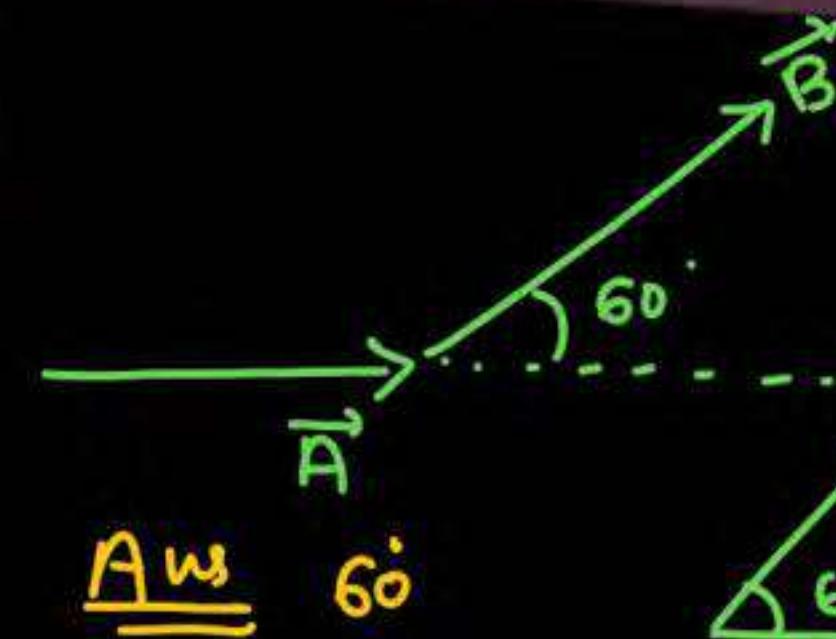
④



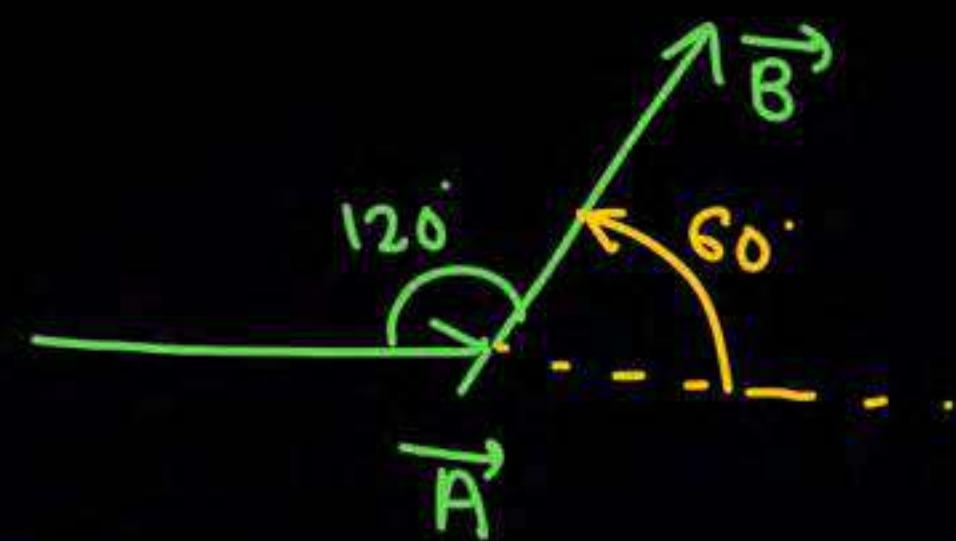
⑤



⑥

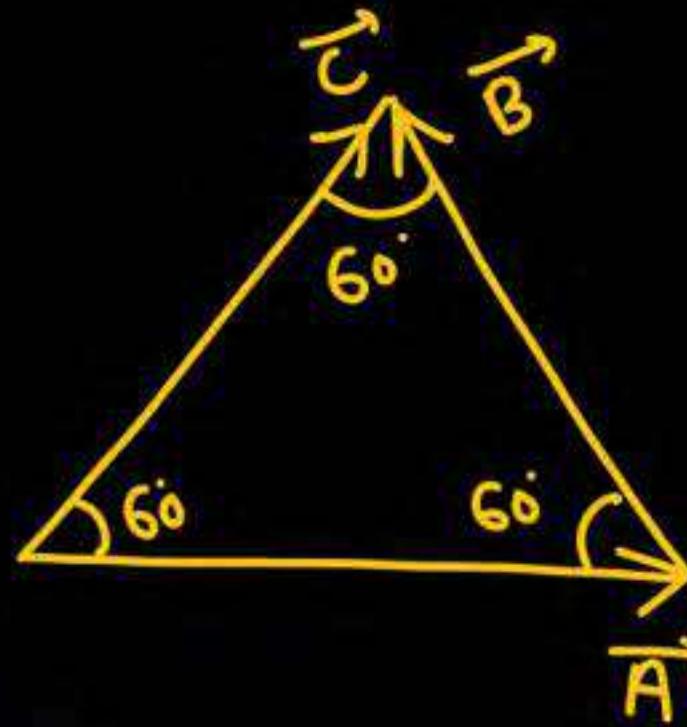


⑦



$$\underline{\text{Ans}} = 60^\circ$$

8

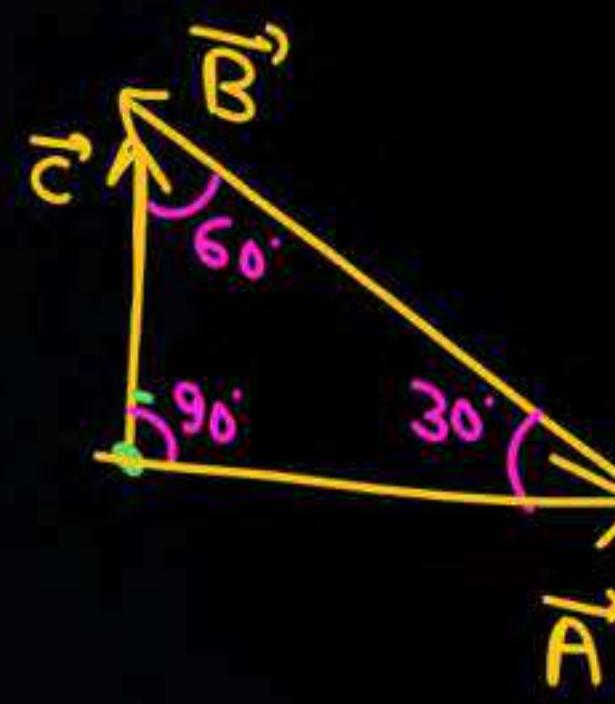


Angle between  $\vec{A}$  &  $\vec{B}$  =  $120^\circ$

$$\vec{B} \cdot \vec{c} = 60$$

$$\vec{A} \text{ } \& \text{ } \vec{C} = 60^\circ$$

9

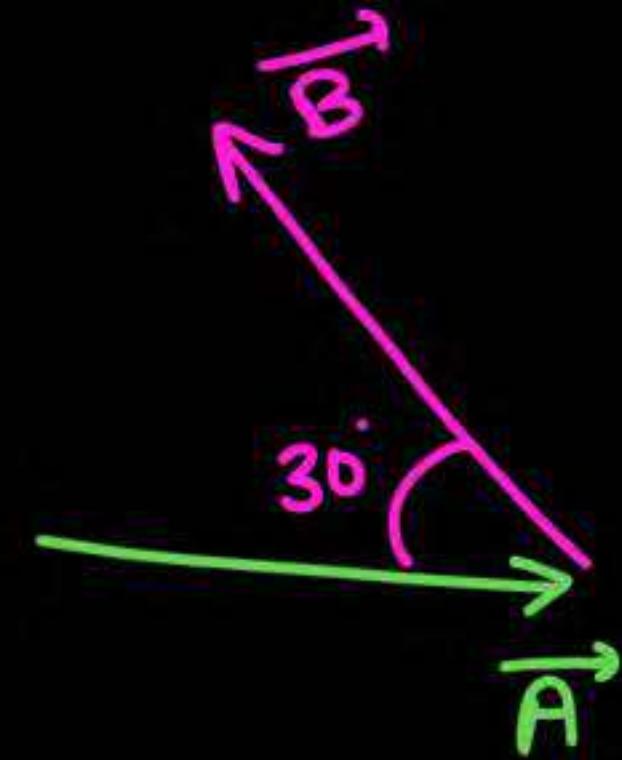


$$\text{Angle between } \vec{A} \text{ & } \vec{B} = 180 - 30 = 150^\circ$$

$$\overrightarrow{B} \text{ } \overrightarrow{C} = 60$$

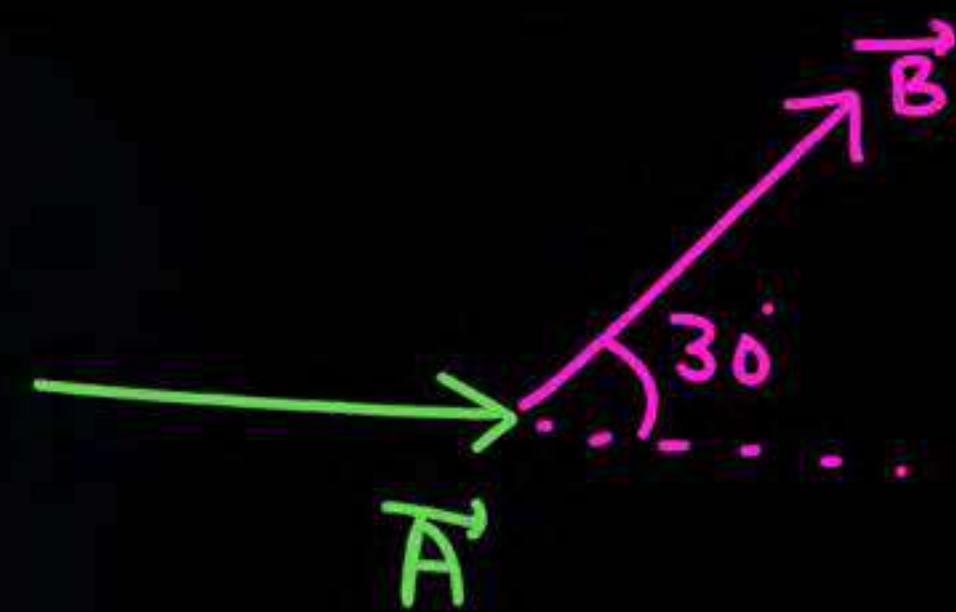
$$\bar{A} \otimes \bar{U} = g_0$$

Q  
R



Angle b/w  $\vec{A}$  &  $\vec{B}$  =  $180 - 30 = 150^\circ$

Q  
R



Angle b/w  $\vec{A}$  &  $\vec{B}$  =  $30^\circ$

$\vec{A} + \vec{B}$   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

$$\vec{A} + \vec{B} = \vec{C}$$

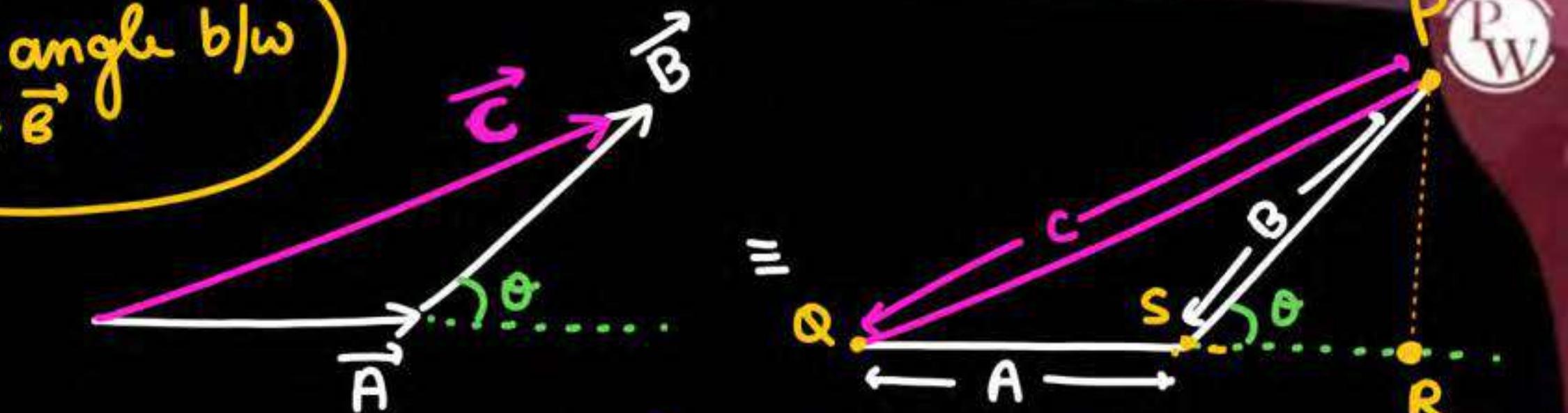
$$\text{magnitude of } \vec{A} = A$$

$$\text{'' } \quad \vec{B} = B$$

$$\text{'' } \quad \vec{C} = C$$

$$\text{length of } \vec{C} = \text{mag. of } \vec{C}$$

$\theta \rightarrow \text{angle b/w}$   
 $\vec{A} \& \vec{B}$



$$(PR)^2 + (QR)^2 = (PQ)^2$$

$$(B \sin \theta)^2 + (A + B \cos \theta)^2 = C^2$$

$$B^2 \sin^2 \theta + A^2 + B^2 \cos^2 \theta + 2AB \cos \theta = C^2$$

$$A^2 + B^2 (\sin^2 \theta + \cos^2 \theta) + 2AB \cos \theta = C^2$$

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$\cos \theta = \frac{SR}{B}$$

$$SR = B \cos \theta$$

$$\sin \theta = \frac{PR}{B}$$

$$PR = B \sin \theta$$

Q

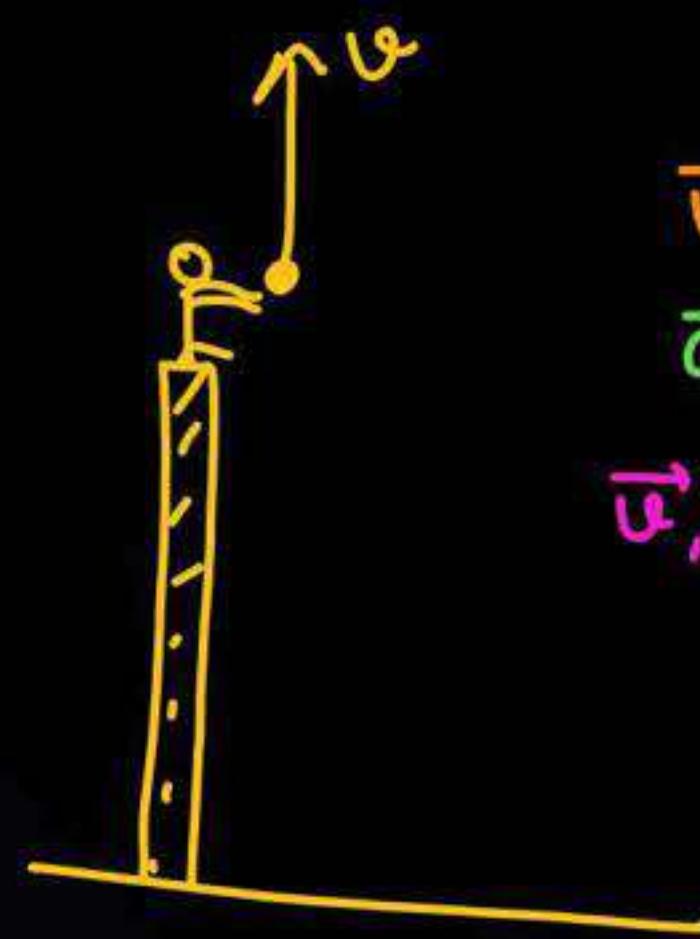
Two forces 10N and 20N are acting on a block having 60° angle between them. find magnitude of resultant of them

$$C = \sqrt{A^2 + B^2 + 2AB \cos \theta}$$

$$= \sqrt{(10)^2 + (20)^2 + 2 \times 10 \times 20 \times \cos 60^\circ}$$

$$= \sqrt{500 + 200} = \sqrt{700} \text{ Ans}$$

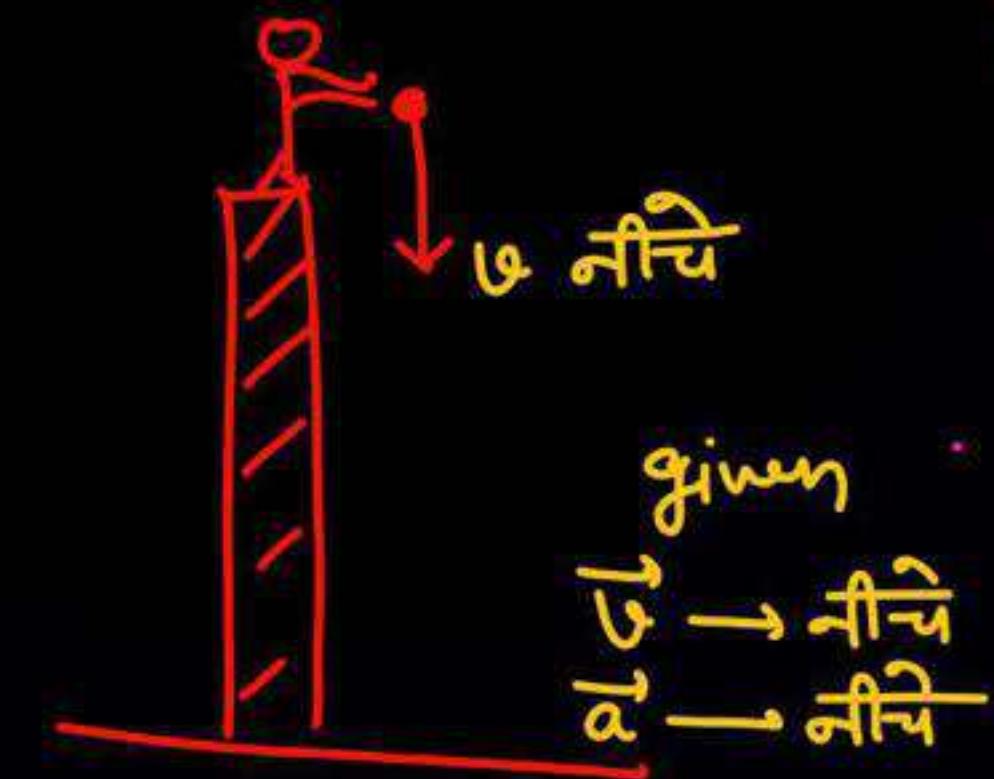
Q



$\vec{v} \rightarrow$  ऊपर  
 $\vec{a} \rightarrow$  नीचे } Kinematics  
 $\vec{v}, \vec{a}$  are antiparallel.

No lag  $\Rightarrow$  thumb up  
 lag  $\Rightarrow$  " down

②



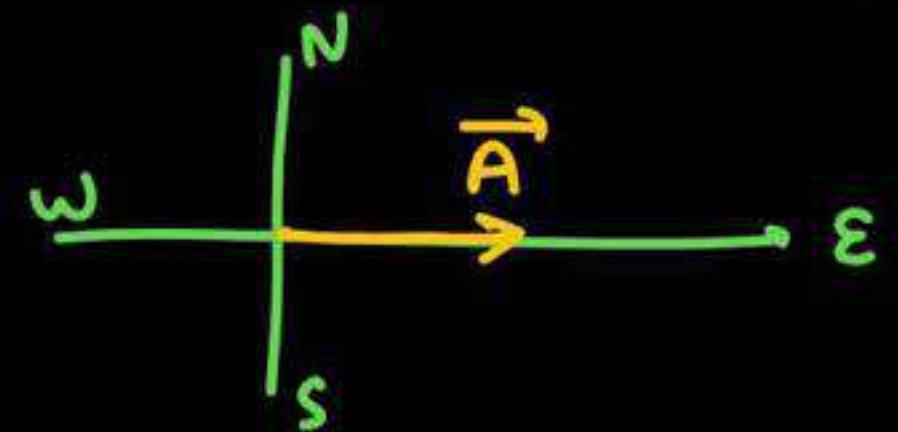
given  
 $\vec{v} \rightarrow$  नीचे  
 $\vec{a} \rightarrow$  नीचे

$\vec{v}, \vec{a}$  one parallel  
vector

Q

$$\vec{F} = 10N \text{ (along east)}$$

newton  
(force)



find, draw

$$2\vec{A} = 20N \text{ (along east)}$$

$$3\vec{A} = 30N \quad (" " )$$

$$\frac{\vec{A}}{2} = \frac{1}{2}\vec{A} = 5N \quad (" )$$



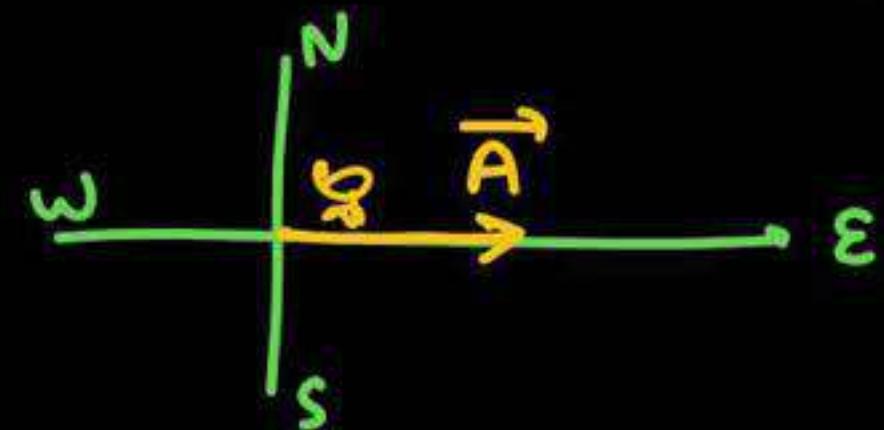
$$-2\vec{A} = 20N \text{ (west)}$$

$$-5\vec{A} = 50N \text{ (west)}$$

/

Q

$$\vec{v} = 10 \text{ m/s (along east)}$$

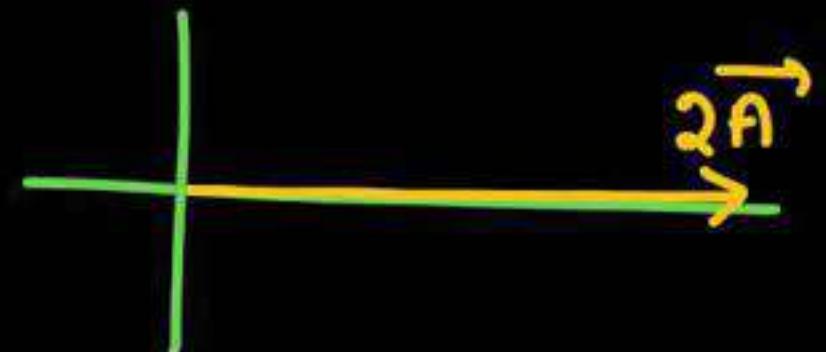


find, draw

$$2\vec{v} = 20 \text{ m/s (along east)}$$

$$3\vec{v} = 30 \text{ m/s (" " )}$$

$$\frac{\vec{v}}{2} = \frac{1}{2}\vec{A} = 5 \text{ m/s (" " )}$$



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

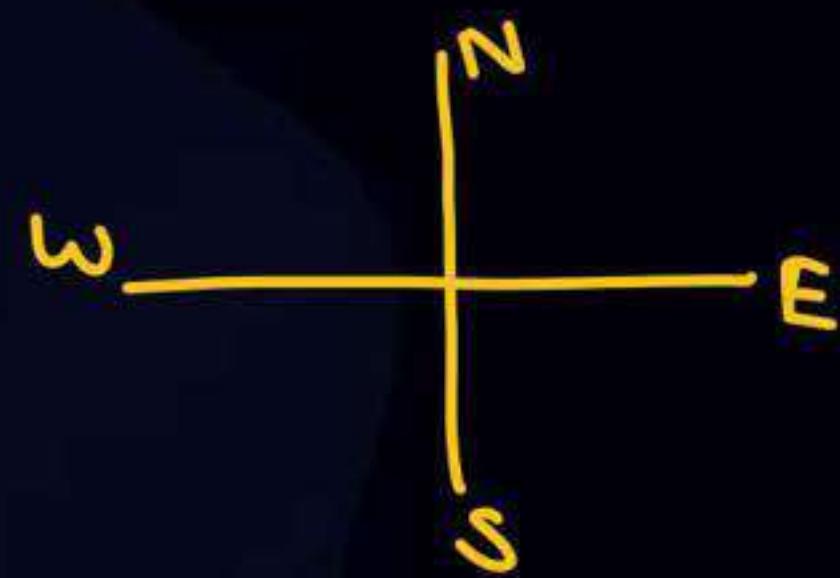
\*  $b^2 - 4ac = 0 \longrightarrow$  1 root

\*  $b^2 - 4ac < 0 \longrightarrow$  No real root  
imaginary root

Q Represent vector  $\vec{P}$  & vector  $\vec{Q}$

$\vec{P} = 20 \text{ N}$  along east

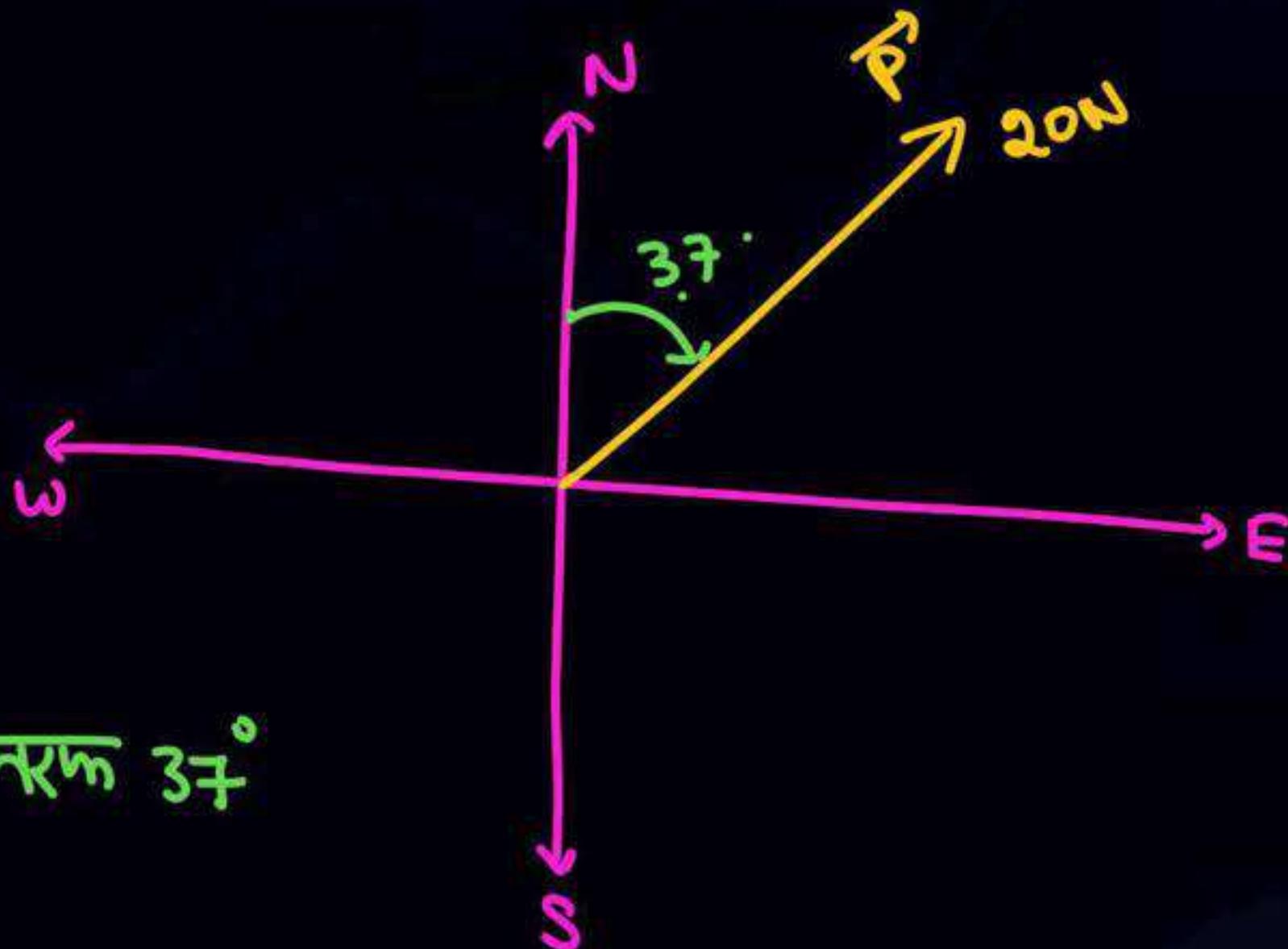
$\vec{Q} = 40 \text{ N}$  along North



Q Represent  
 $\vec{P}$  of magnitude  
20 N in direction  
of  $37^\circ$  east of  
north.

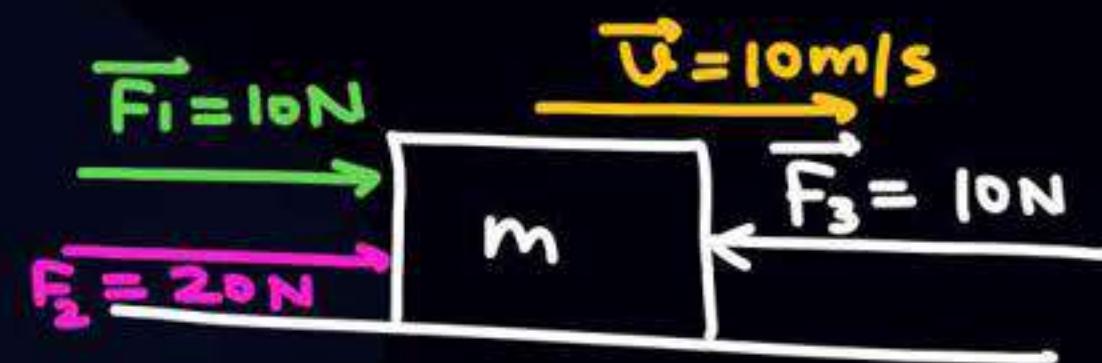
Q Represent  
 $\vec{P}$  of magnitude  
20N in direction  
of  $37^\circ$  east of  
north

III  
North से East की तरफ  $37^\circ$



② parallel vector → Two vectors are said to be parallel if they have same direction.

Q Block is moving with velocity  $10\text{m/s}$  along east dir<sup>n</sup>



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

$$= \frac{4}{5} \cdot \hat{B} = \frac{4}{5} \left( \frac{3\hat{i} + 4\hat{j}}{5} \right) = \frac{12\hat{i} + 16\hat{j}}{25}$$

$$\textcircled{2} \quad \text{Component of } \vec{A} \text{ perpendicular to } \vec{B} = \vec{A} - \vec{A}_{||}$$

$$= (4\hat{i} - 2\hat{j}) - \frac{12\hat{i} + 16\hat{j}}{25}$$

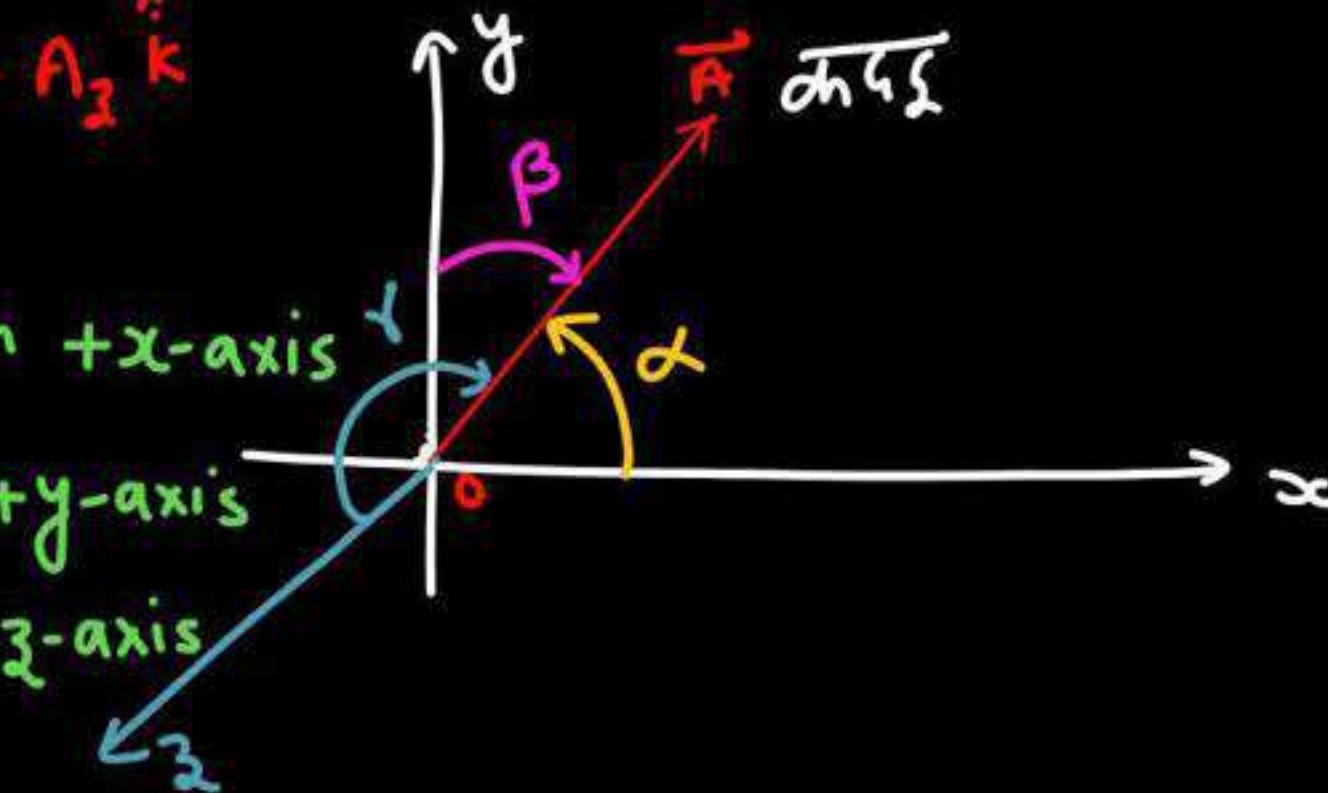
$$= \frac{88\hat{i} - 66\hat{j}}{25}$$

Direction Cosine

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

If  $\vec{A}$  makes angle  $\alpha$  with  $+x$ -axis

" " " +y-axis  
" " " +z-axis



Component of  $\vec{A}$  along  $x$ -Axis =  $A \cos \alpha = A_x$

," " " =  $A \cos \beta = A_y$

," " " =  $A \cos \gamma = A_z$

$$\cos \alpha = \frac{A_x}{A}$$

$$\cos \beta = \frac{A_y}{A}$$

$$\cos \gamma = \frac{A_z}{A}$$

$$\text{Q} \quad \vec{A} = 2\hat{i} + 3\hat{j} + 6\hat{k}$$

$$A = |\vec{A}| = \sqrt{2^2 + 3^2 + 6^2} = 7$$

$$\cos \alpha = \frac{A_x}{A} = \frac{2}{7}$$

$$\cos \beta = \frac{A_y}{A} = \frac{3}{7}$$

$$\cos \gamma = \frac{A_z}{A} = \frac{6}{7}$$

direction cosine



$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

$$\sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma = 1 \times \\ = 2 \checkmark$$

$$\rightarrow 1 - \sin^2 \alpha + 1 - \sin^2 \beta + 1 - \sin^2 \gamma = 1$$

$$\sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma = 2.$$

\*\*\*

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

$$\vec{a} = 4\hat{i} + 7\hat{j}$$

$$\vec{b} = 2\hat{i} + 3\hat{j}$$

$$\textcircled{1} \quad \vec{a} \times \vec{b} = ?$$

$$\textcircled{2} \quad \vec{b} \times \vec{a} = ?$$

$$\vec{a} \times \vec{b} = (3\hat{i} + 4\hat{j}) \times (2\hat{i} + 5\hat{j})$$

$$= 6\hat{i} \times \hat{i} + 15\hat{i} \times \hat{j} + 8\hat{j} \times \hat{i} + 20\hat{j} \times \hat{j}$$

$$= 0 + 15\hat{k} - 8\hat{k} + 0$$

$$= 7\hat{k} = \vec{c}$$

$$\vec{c} \perp \vec{a}, \vec{c} \perp \vec{b}$$

$$Q \quad \vec{a} = 4\hat{i} + 7\hat{j}$$
$$\vec{b} = 2\hat{i} + 3\hat{j}$$

$$\vec{a} \times \vec{b} = (4\hat{i} + 7\hat{j}) \times (2\hat{i} + 3\hat{j})$$
$$= 0 + 12\hat{k} - 14\hat{k} + 0$$
$$= -2\hat{k}$$

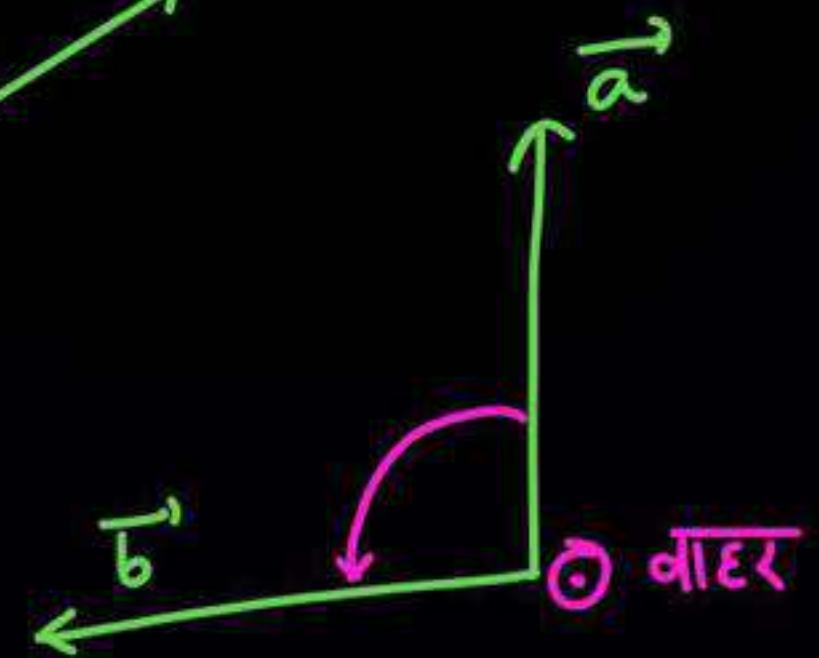
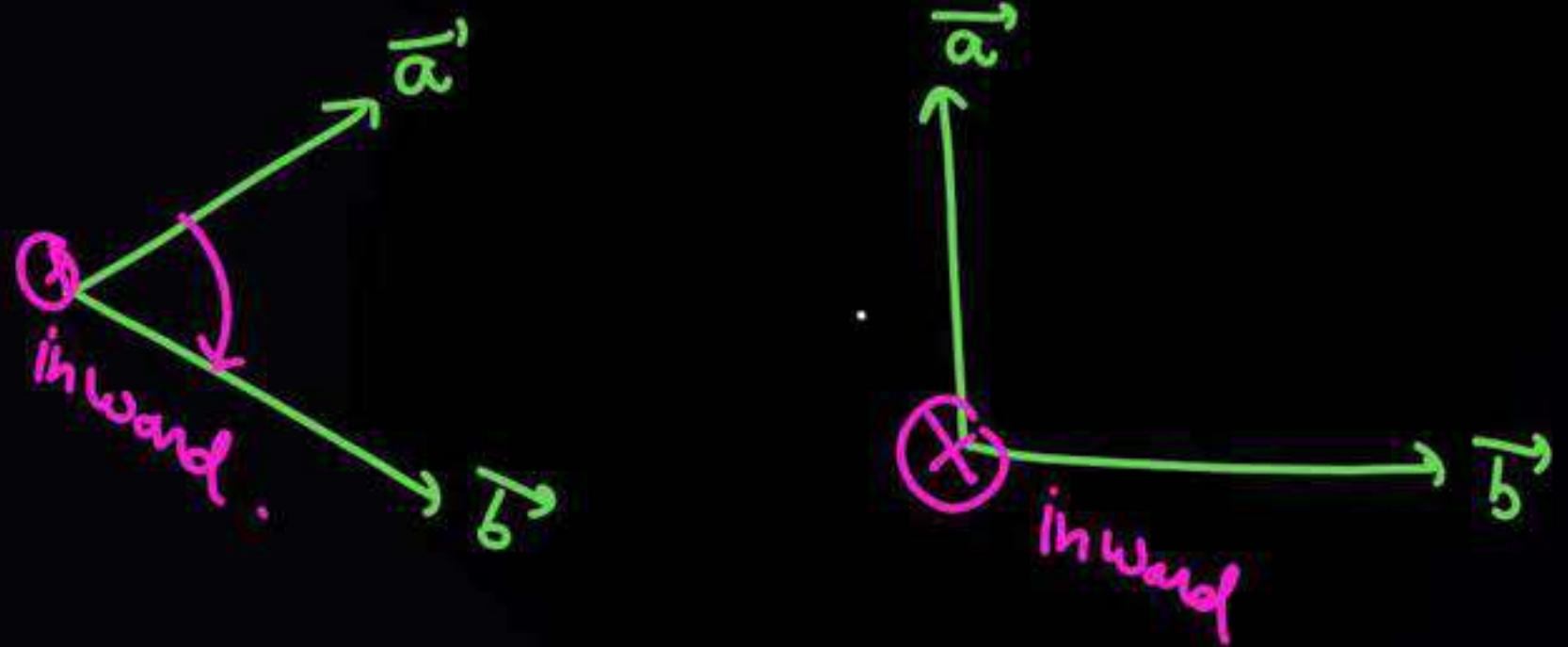
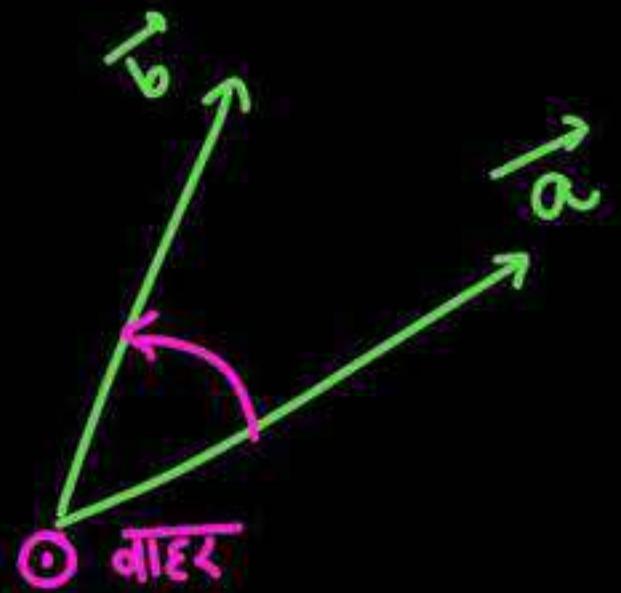
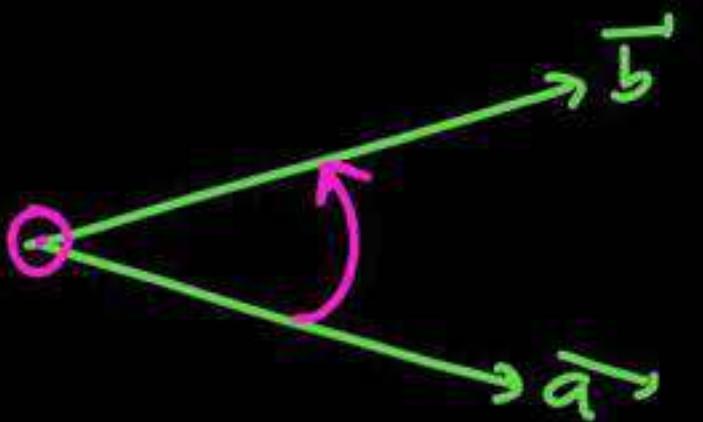
$$\vec{b} \times \vec{a} = (2\hat{i} + 3\hat{j}) \times (4\hat{i} + 7\hat{j})$$
$$= 0 + 14\hat{k} - 12\hat{k} + 0$$

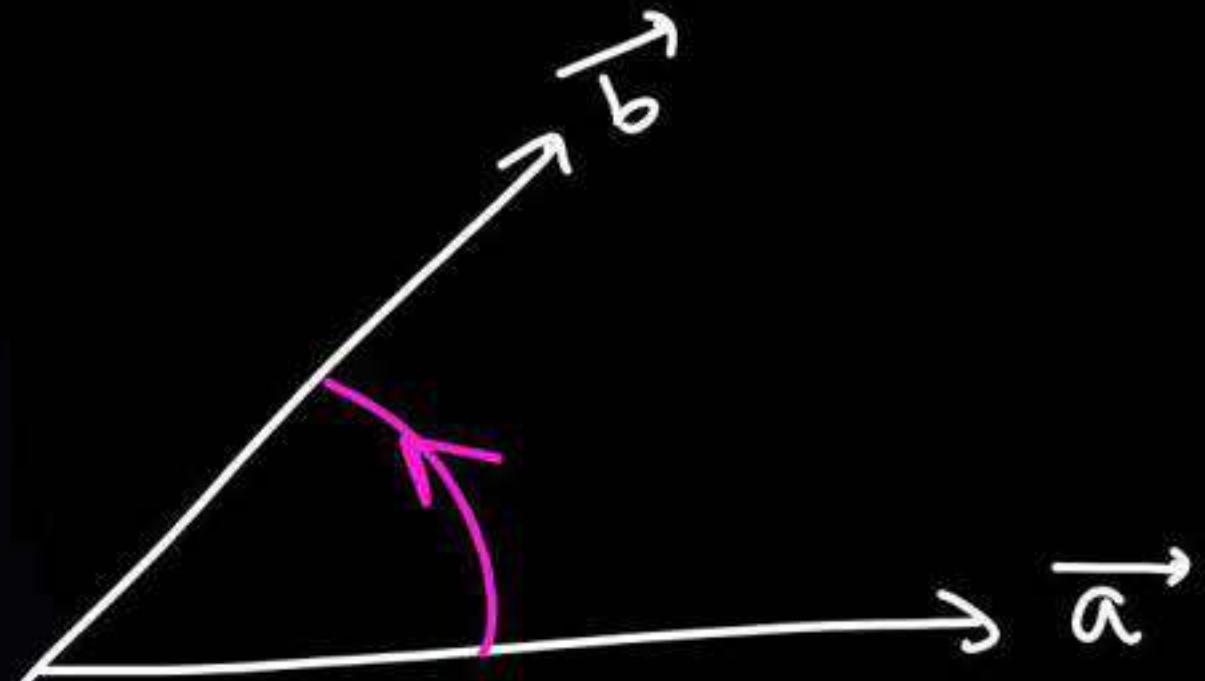
$$\boxed{\vec{b} \times \vec{a} = + 2\hat{k}}$$

$$\boxed{\vec{a} \times \vec{b} = - \vec{b} \times \vec{a}}$$

Q Find dir of  $\vec{a} \times \vec{b}$

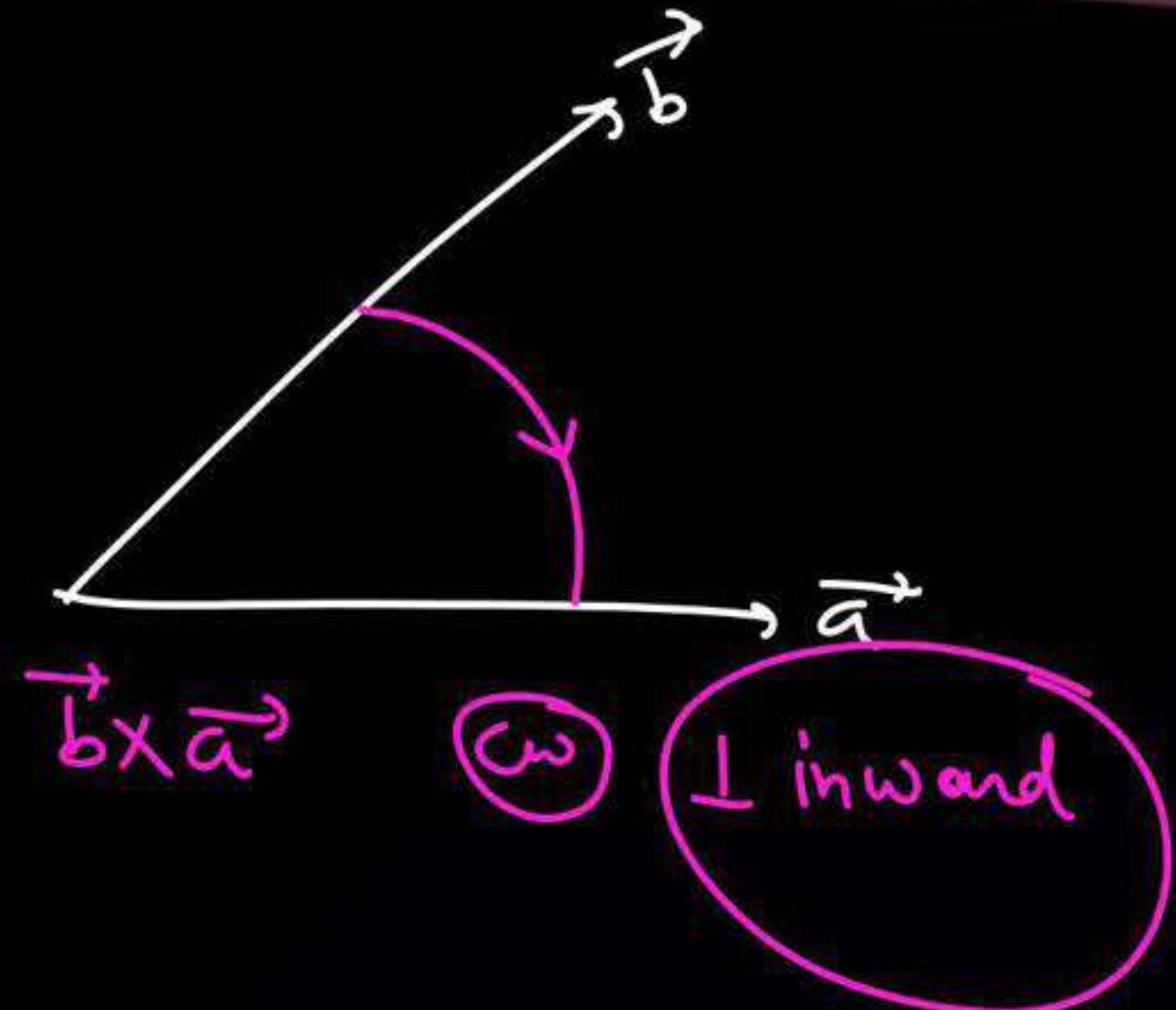
PW





$$\vec{a} \times \vec{b} = \text{dir}^n$$

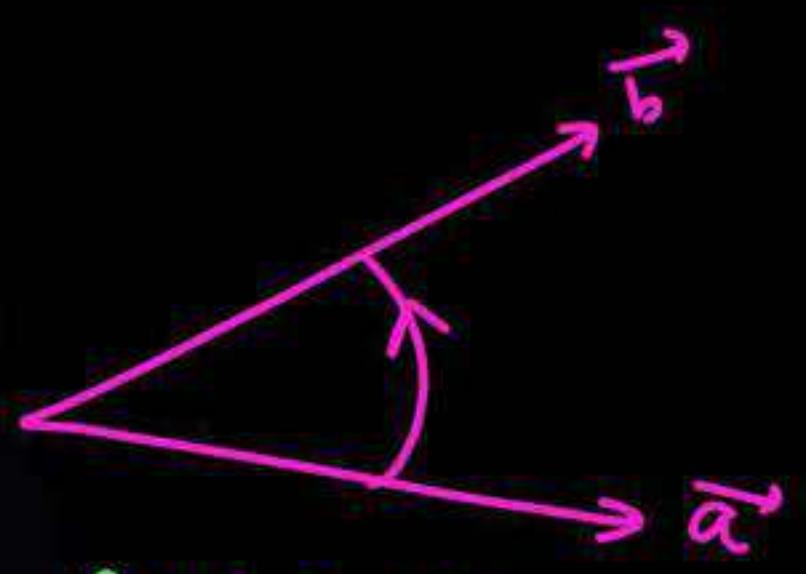
Acw =



$$\vec{b} \times \vec{a}$$

cw

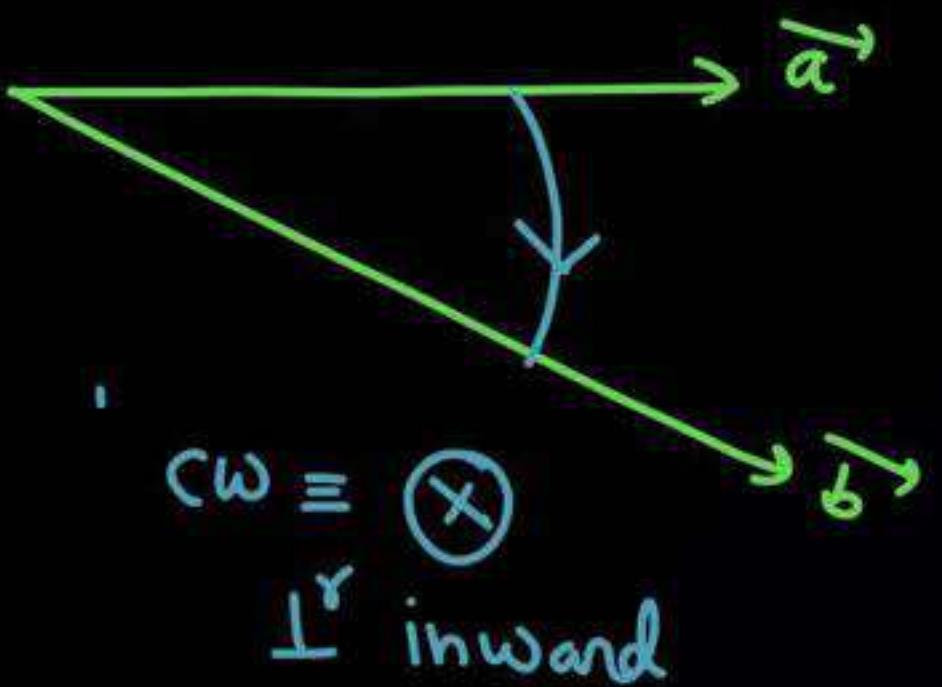
L inward



ACW sense

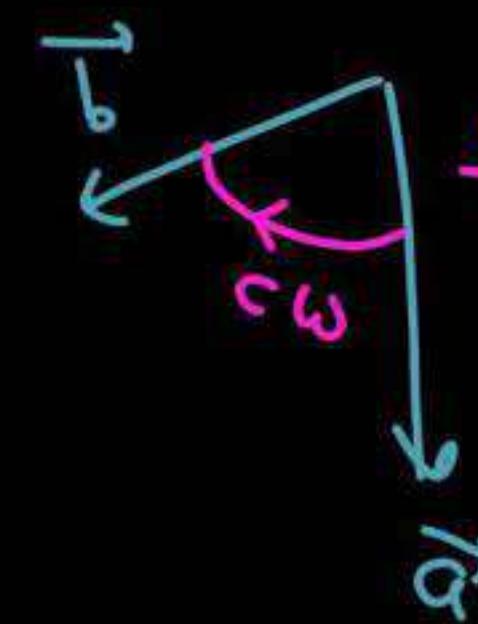
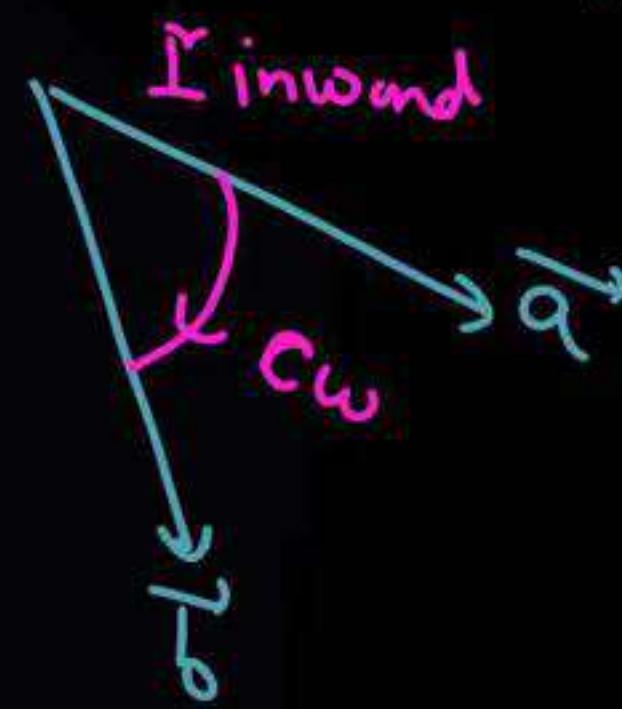
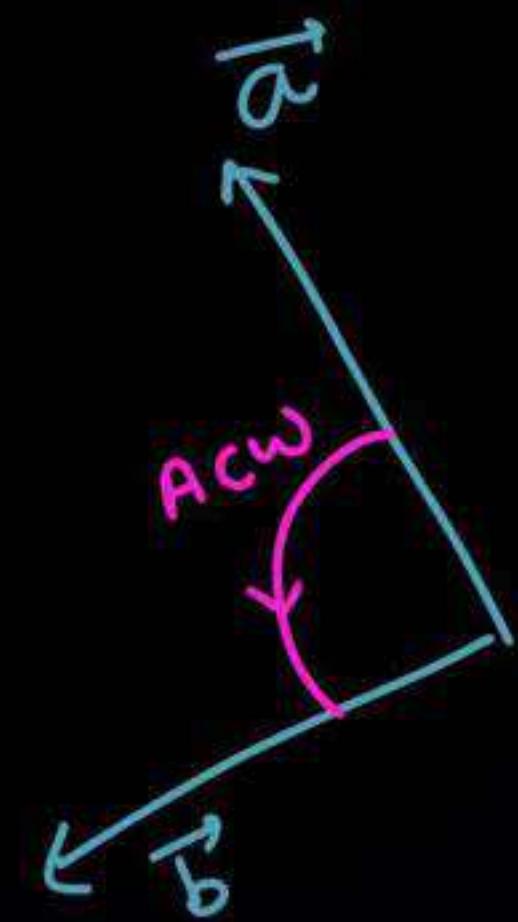
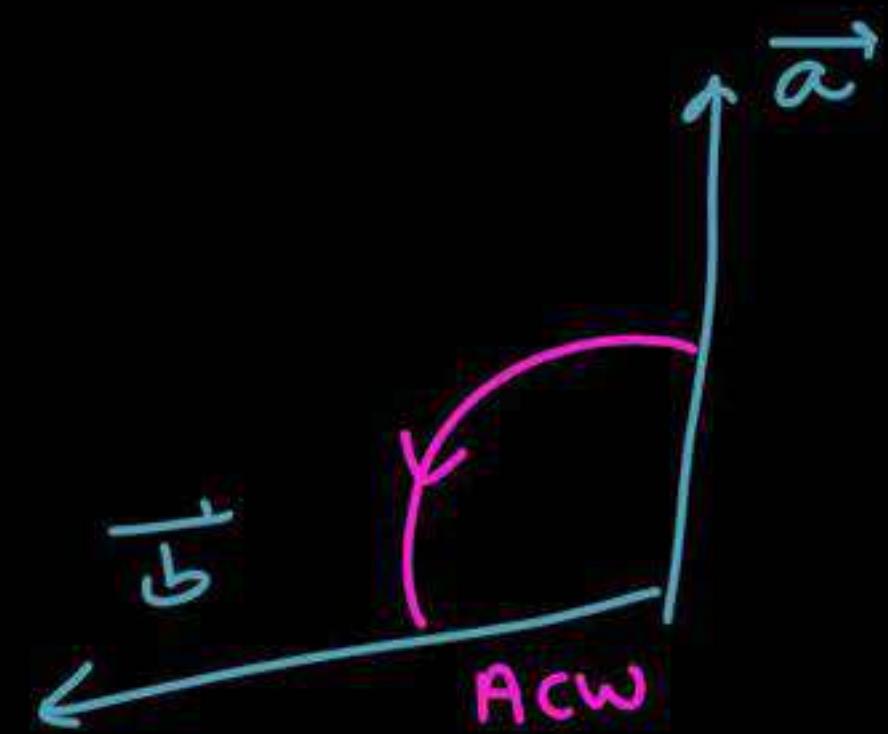
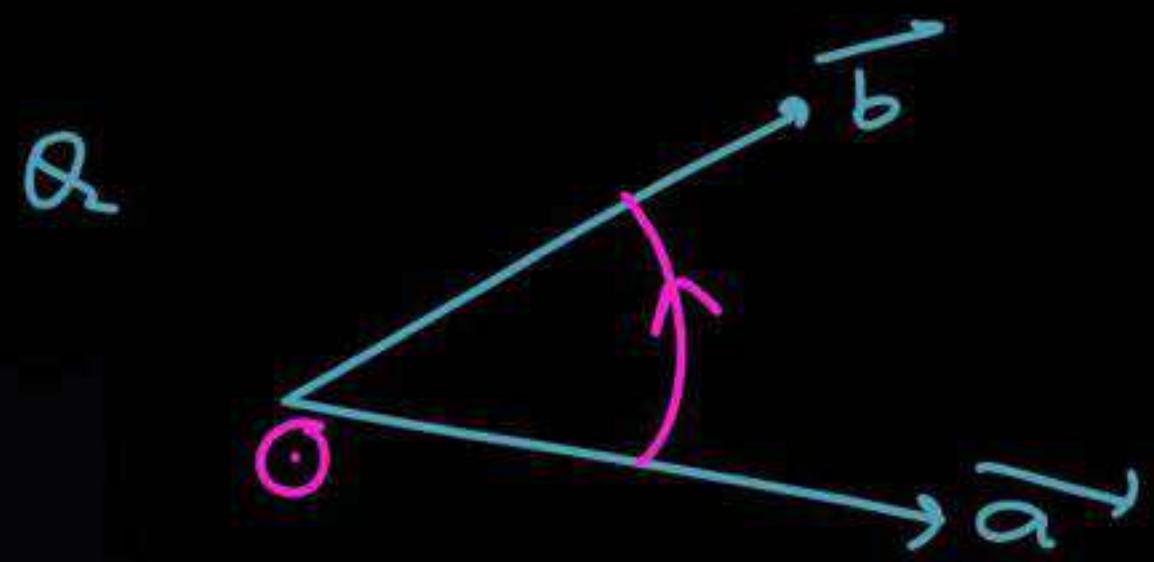
III

$\odot = (\perp^y \text{ outward})$



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  $\alpha$

$$\vec{A} \cdot \vec{B} = 0$$

$$2\alpha - 6 + 20 = 0$$

$$2\alpha + 14 = 0$$

$$\boxed{\alpha = -7}$$

Q Find angle b/w  $\vec{A}$  &  $\vec{B}$

$$\vec{A} = \hat{i} + \hat{j}$$

$$\vec{B} = 3\hat{i} + 4\hat{j}$$

$$\underline{\vec{A} \cdot \vec{B} = AB \cos \theta}$$

$$7 = \sqrt{2} \cdot 5 \cos \theta$$

$\frac{\cos \theta}{\text{Ans}}$

$$\cos \theta = \frac{7}{5\sqrt{2}}$$

$$\theta = \cos^{-1}\left(\frac{7}{5\sqrt{2}}\right)$$

$$\vec{A} \cdot \vec{B} = 3+4$$

$$= 7$$

$*+\alpha*$

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$\cos \theta = \frac{\vec{A} \cdot \vec{B}}{AB}$$

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  $\overrightarrow{A} = 4\hat{i} + 6\hat{j}$

$$\overrightarrow{B} = 12\hat{i} + 18\hat{j}$$

$$\frac{4}{12} = \frac{6}{18}$$

$$\overrightarrow{A} \uparrow \uparrow \overrightarrow{B}$$

$$\Omega \quad \vec{A} = 3\hat{i} - 4\hat{j} + 5\hat{k}$$

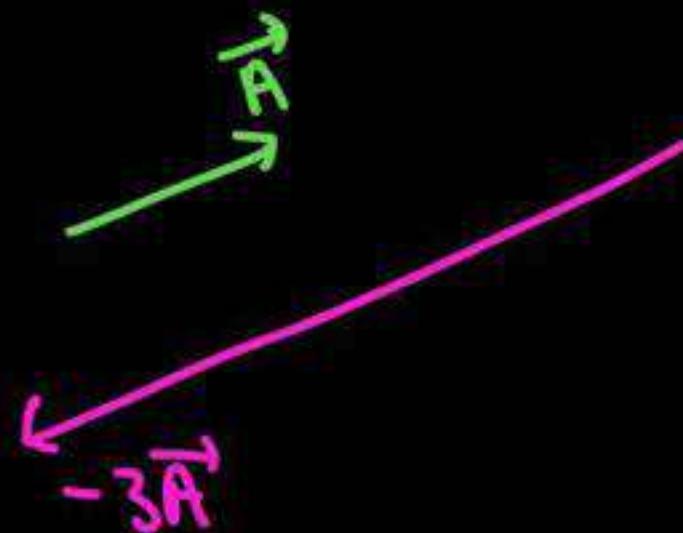
$$\vec{B} = -9\hat{i} + 12\hat{j} - 15\hat{k}$$

$$= -3(3\hat{i} - 4\hat{j} + 5\hat{k})$$

$$\boxed{\begin{aligned} \frac{3}{-9} &= \frac{-4}{12} = \frac{5}{-15} \\ &= -\frac{1}{3} \end{aligned}}$$

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

$\theta = 0$

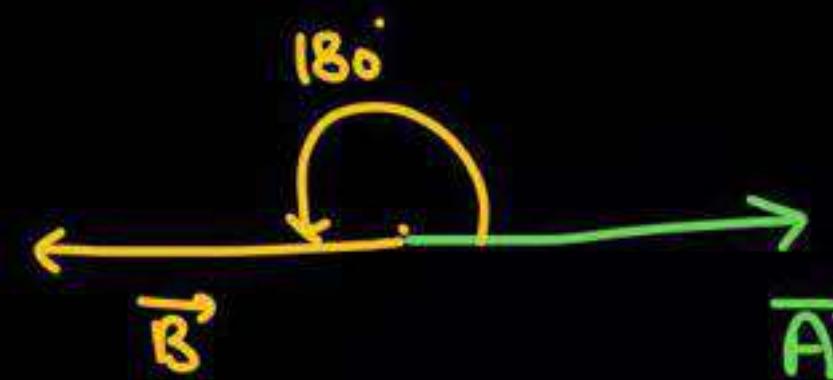
$\theta = 180$

$\theta = 90$

parallel

Antiparallel

$\perp$



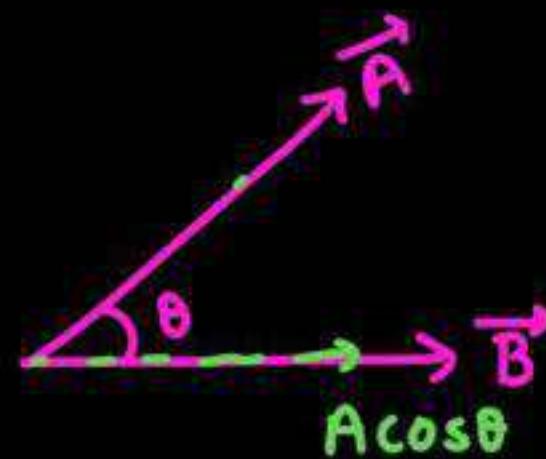
$\Omega$ 

$$\vec{A} = 3\hat{i} + 4\hat{j}$$

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

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$A \cos \theta = \frac{\vec{A} \cdot \vec{B}}{B}$$



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  $\vec{B}$

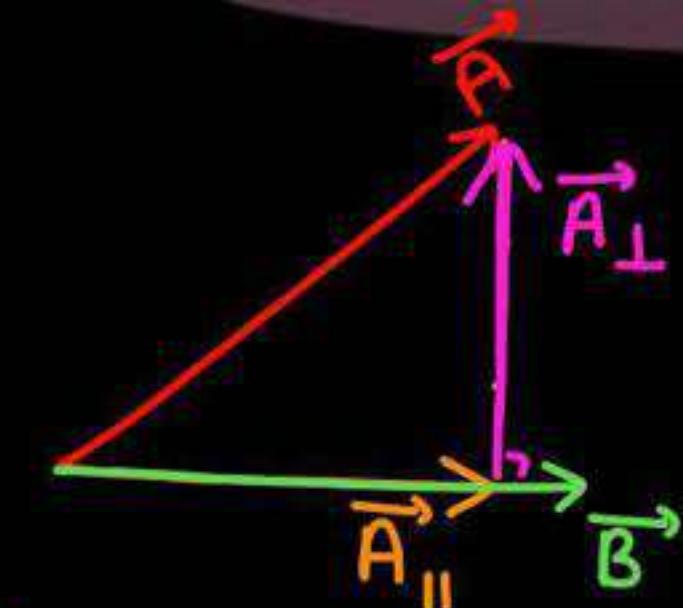
Component of  $\vec{A}$  along  $\vec{B} = \frac{\vec{A} \cdot \vec{B}}{B}$

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  $\vec{A} = \frac{\hat{i}}{\sqrt{3}} + \frac{\hat{j}}{\sqrt{3}} + \frac{\hat{k}}{\sqrt{3}}$

$$|\vec{A}| = \sqrt{\left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{\sqrt{3}}\right)^2}$$
$$= \sqrt{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}} = 1$$

⑤  $\vec{A} = \frac{\vec{P} + \vec{Q} + \vec{R}}{|\vec{P} + \vec{Q} + \vec{R}|}$

⑥  $\vec{A} = \frac{\vec{P} + \vec{Q} - \vec{R}}{|\vec{P} + \vec{Q} - \vec{R}|} = \frac{\vec{S}(\text{let})}{|\vec{S}|}$

$$\vec{P} + \vec{Q} + \vec{R} = \vec{S} \text{ (let)}$$

$$\vec{A} = \frac{\vec{S}}{|\vec{S}|}$$

⑦  $\vec{A} = \frac{\vec{P} + \vec{Q} + \vec{R}}{|\vec{P} + \vec{Q} - \vec{R}|}$

$\vec{A}$  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  $\alpha$

$$\vec{A} = 6\hat{i} + \alpha\hat{j}$$

$$|\vec{A}| = 1$$

$$\sqrt{(6)^2 + \alpha^2} = 1$$

$$36 + \alpha^2 = 1$$

$$\alpha^2 = 1 - 36$$

$$\alpha^2 = -64$$

$$\boxed{\alpha = \pm 8}$$

$$\alpha = 8 \quad \checkmark$$

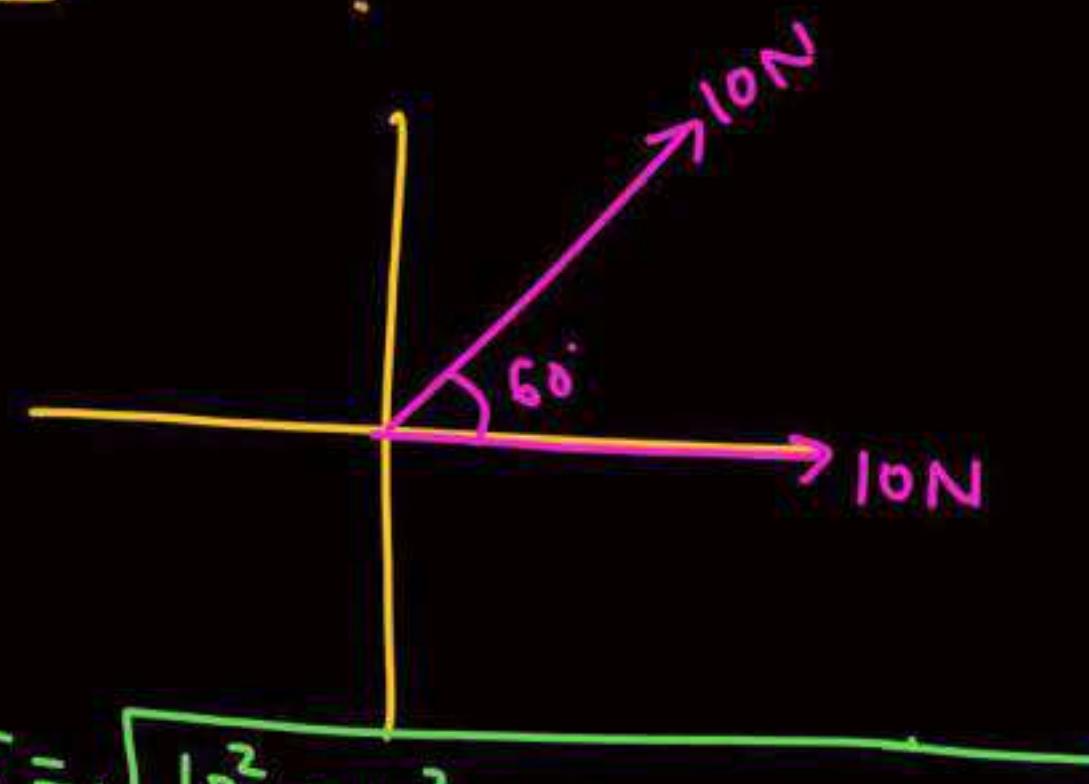
$$\alpha = -8 \quad \checkmark$$

$$\vec{A} = 6\hat{i} + 8\hat{j}$$

$$\vec{A} = 6\hat{i} - 8\hat{j}$$

Q

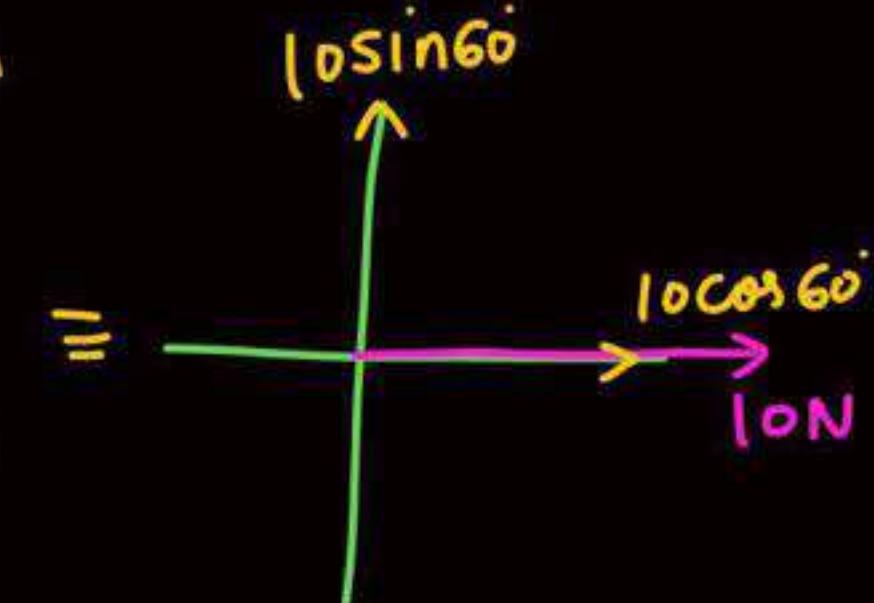
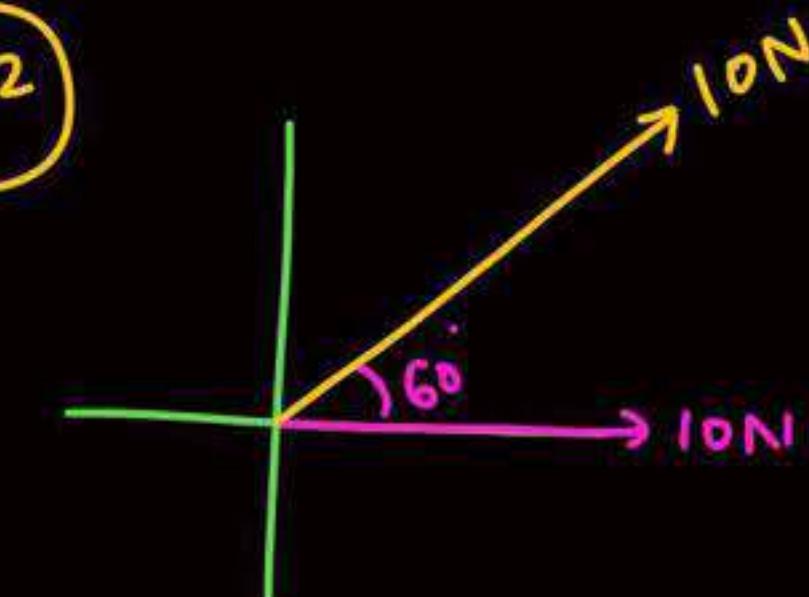
Find net force



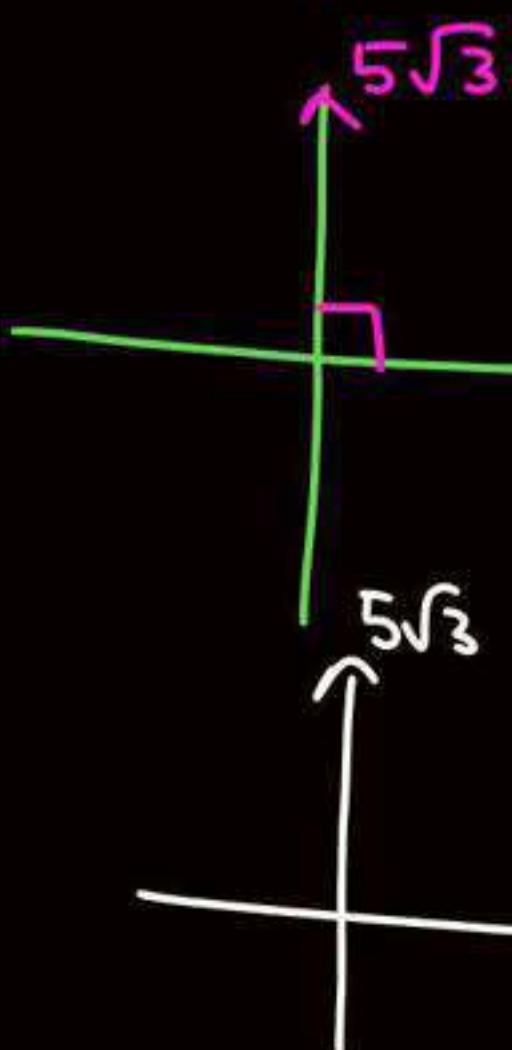
$$c = \sqrt{10^2 + 10^2 + 2 \times 10 \times 10 \cos 60}$$

$$= 10\sqrt{3}$$

m-2



$$\vec{F}_{\text{net}} = 15\hat{i} + 5\sqrt{3}\hat{j}$$

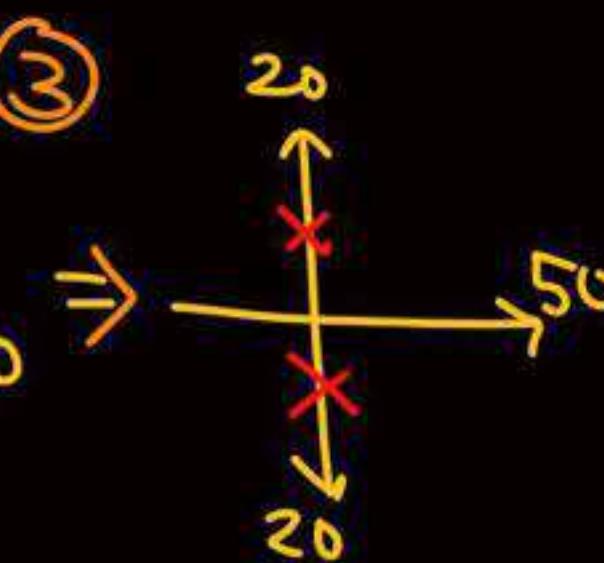
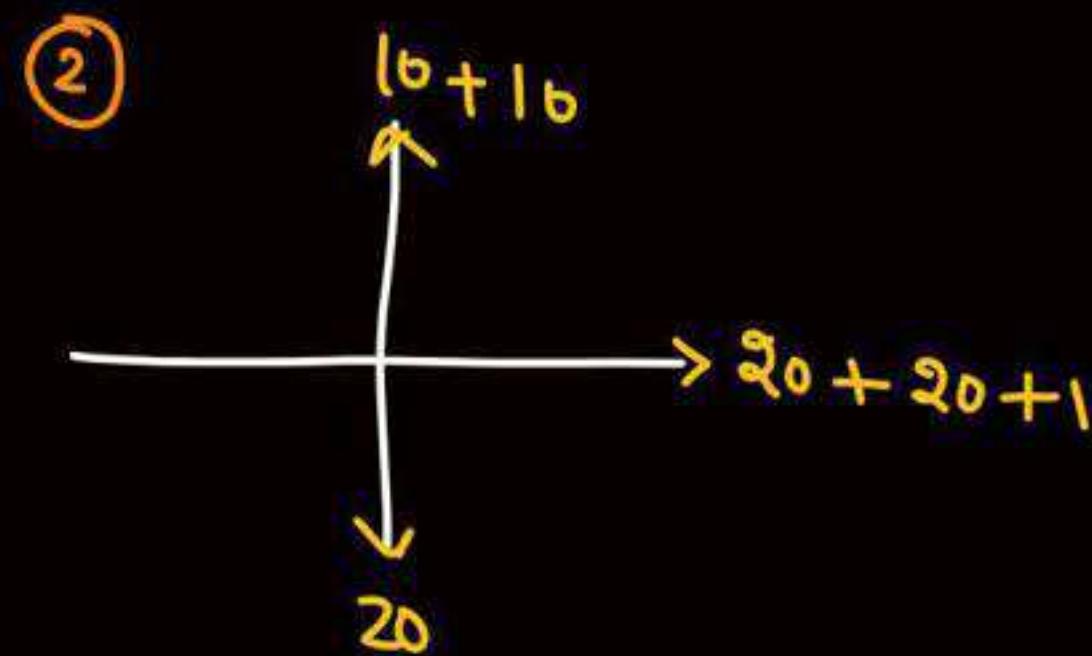
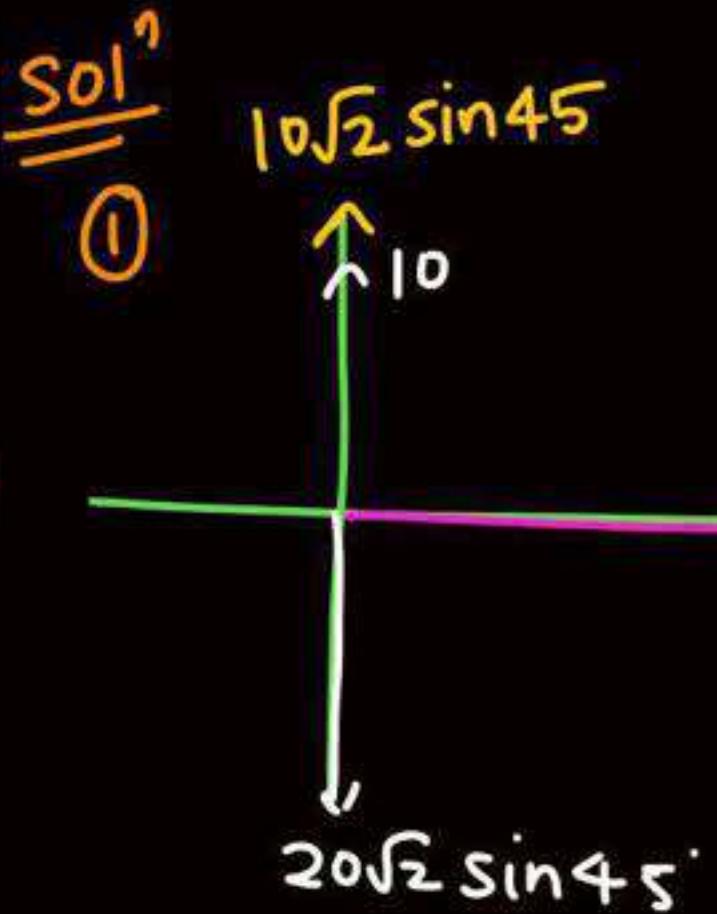
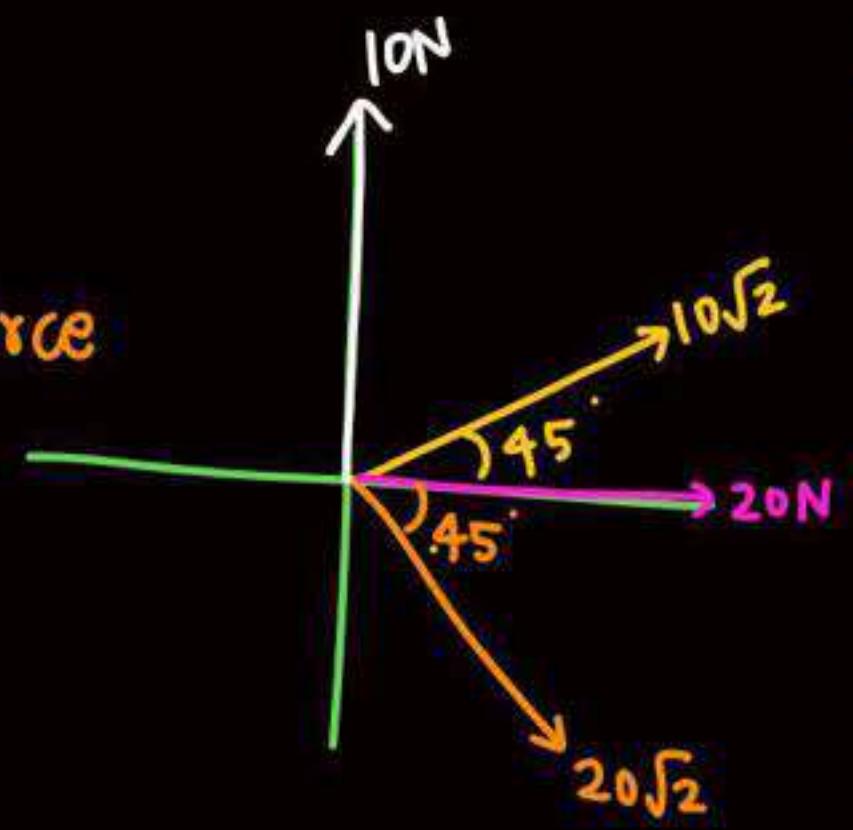


$$|\vec{F}_{\text{net}}| = \sqrt{15^2 + (5\sqrt{3})^2}$$

$$= \sqrt{225 + 75}$$

$$= 10\sqrt{3}$$

Q2 find net force



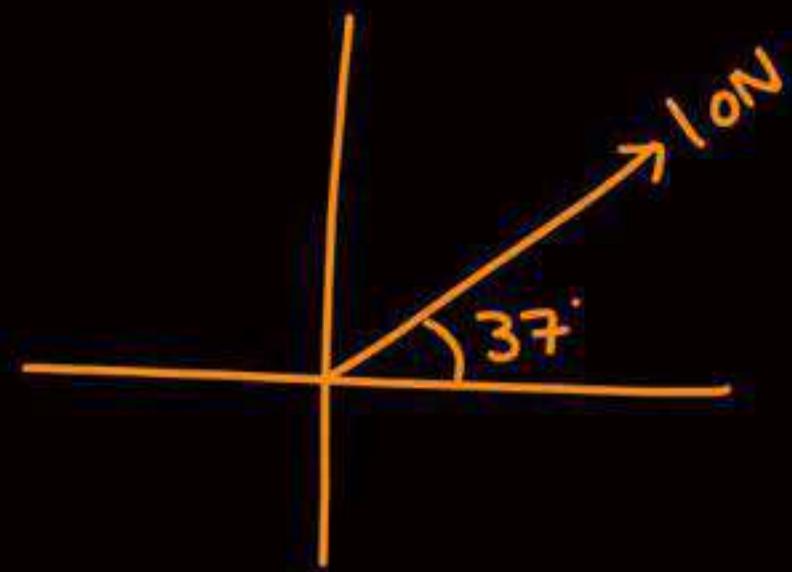
K.C.

- \* सभी forces को  $x-y$  में तात्पुरी
- \*  $(x-y)$  में collect

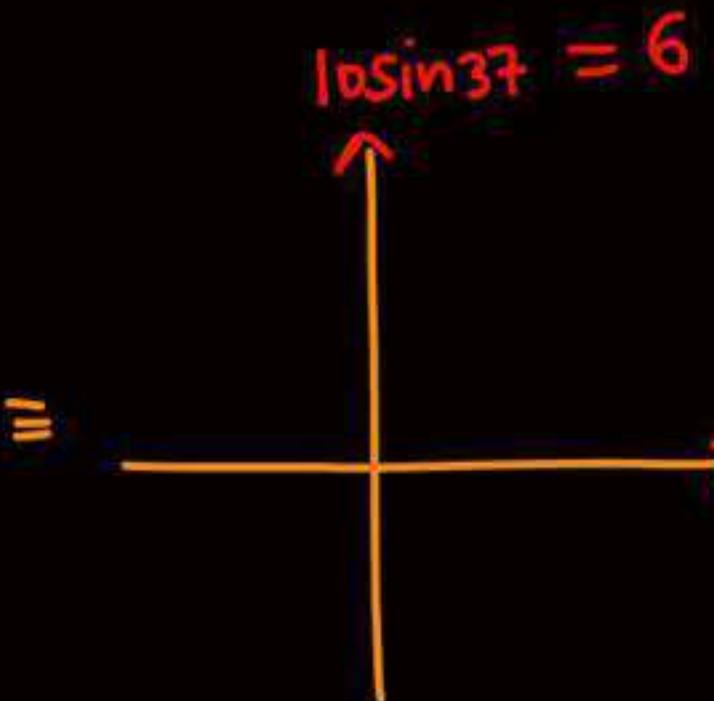
④

$\vec{F}_{\text{net}} = 50\hat{i}$

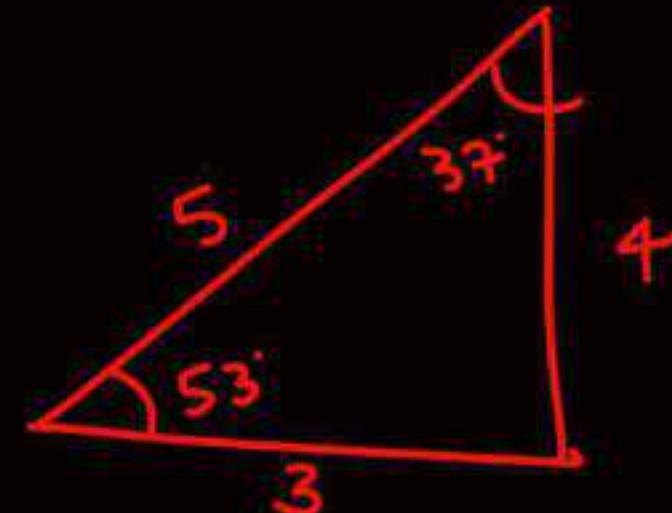
#



≡



$$\rightarrow 10 \cos 37^\circ = 8$$

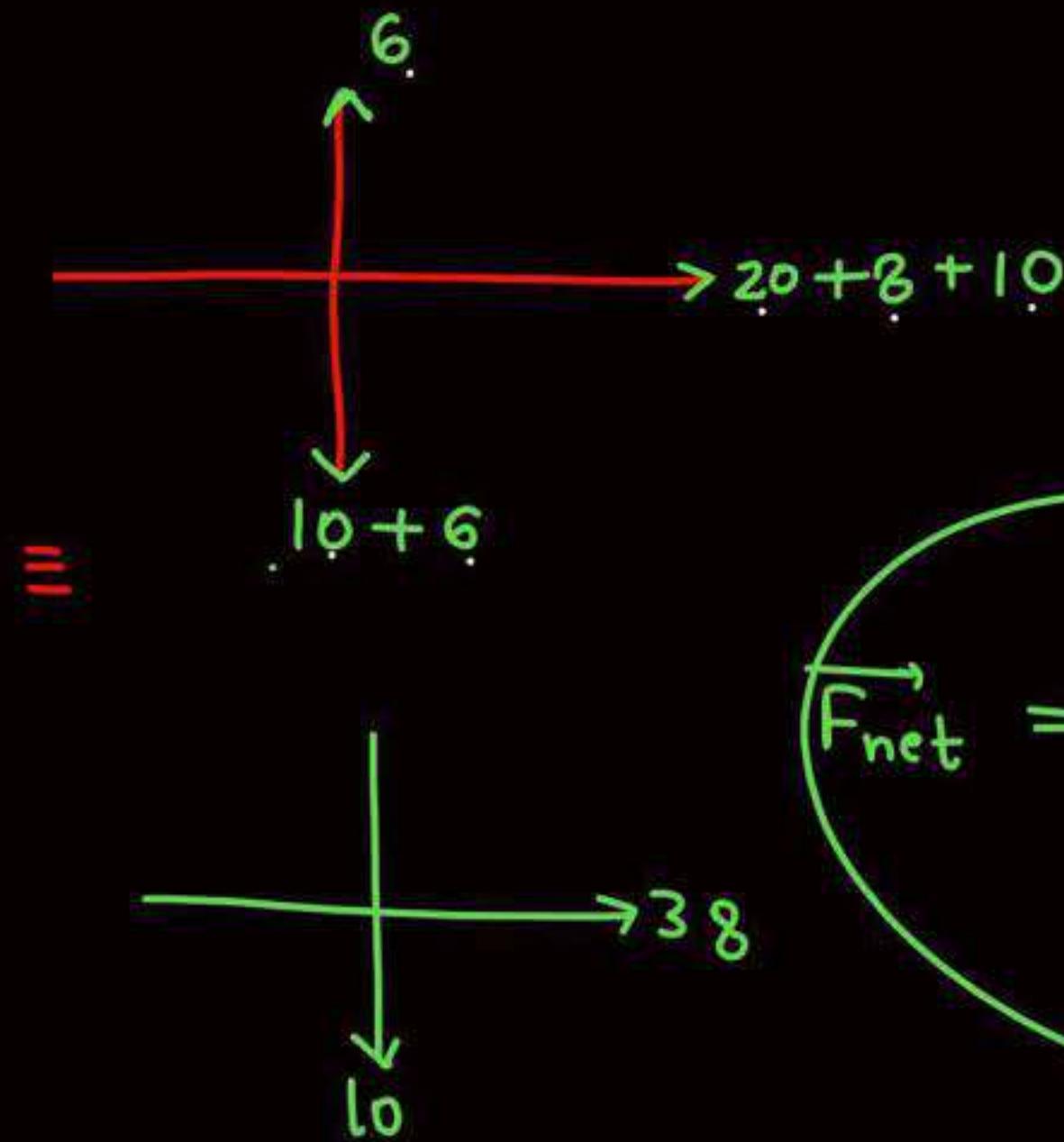
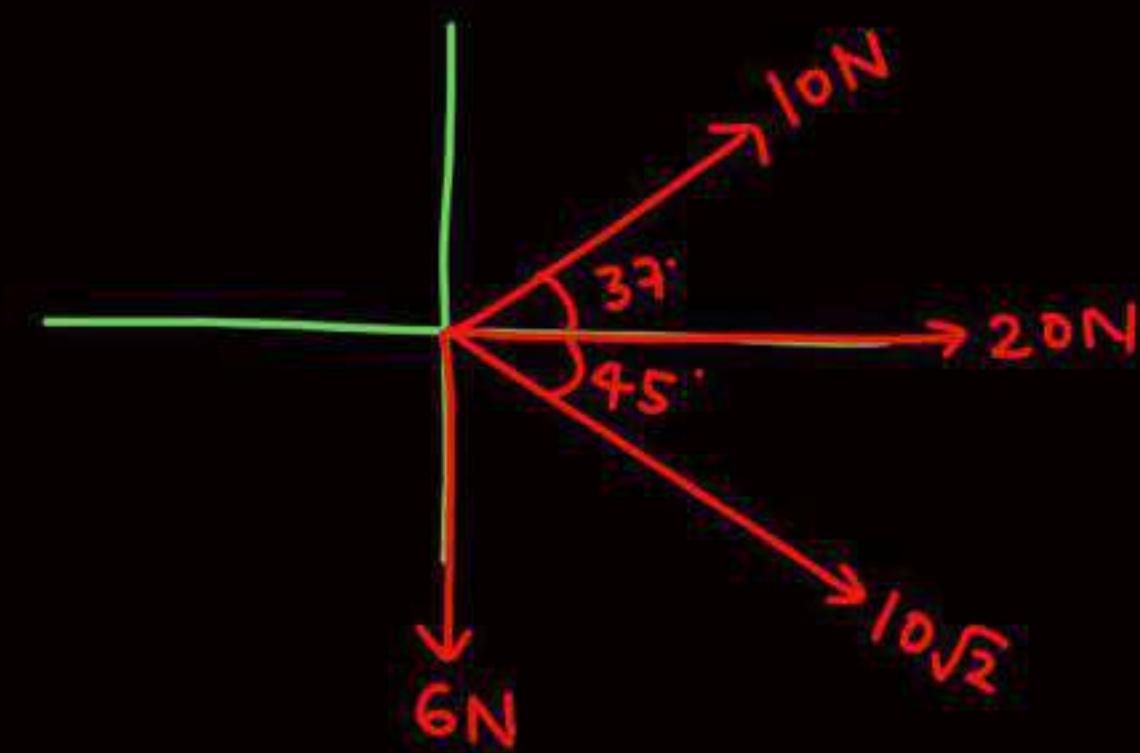


$\sin 37^\circ = \frac{3}{5} = \cos 53^\circ$

$\cos 37^\circ = \frac{4}{5} = \sin 53^\circ$

Q

Find net force



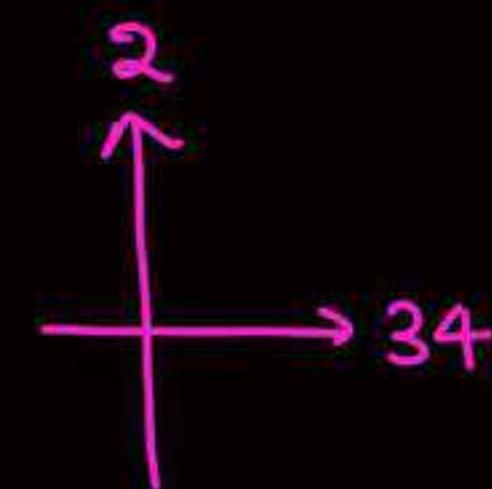
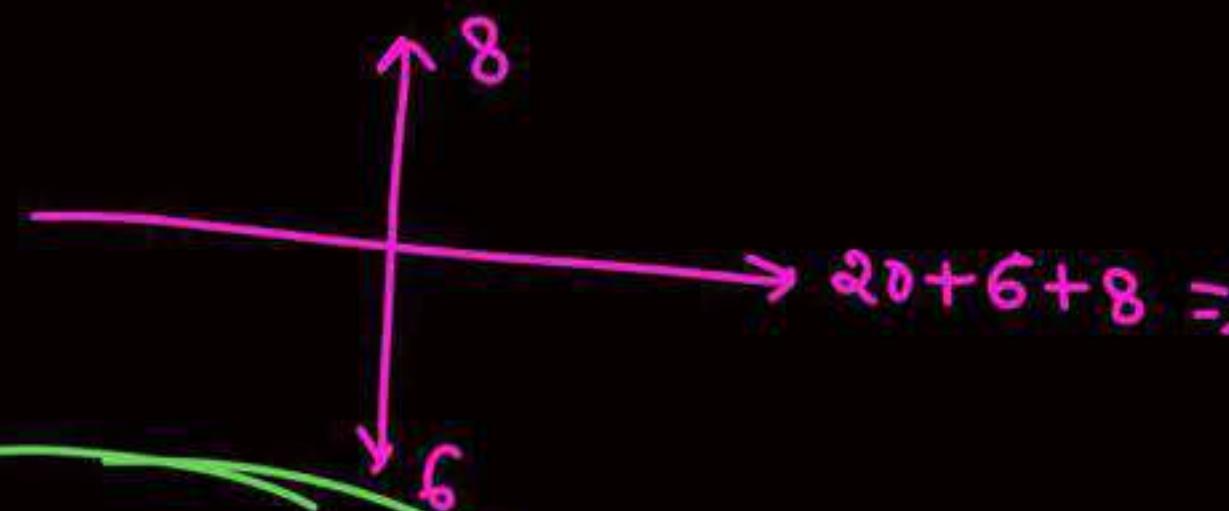
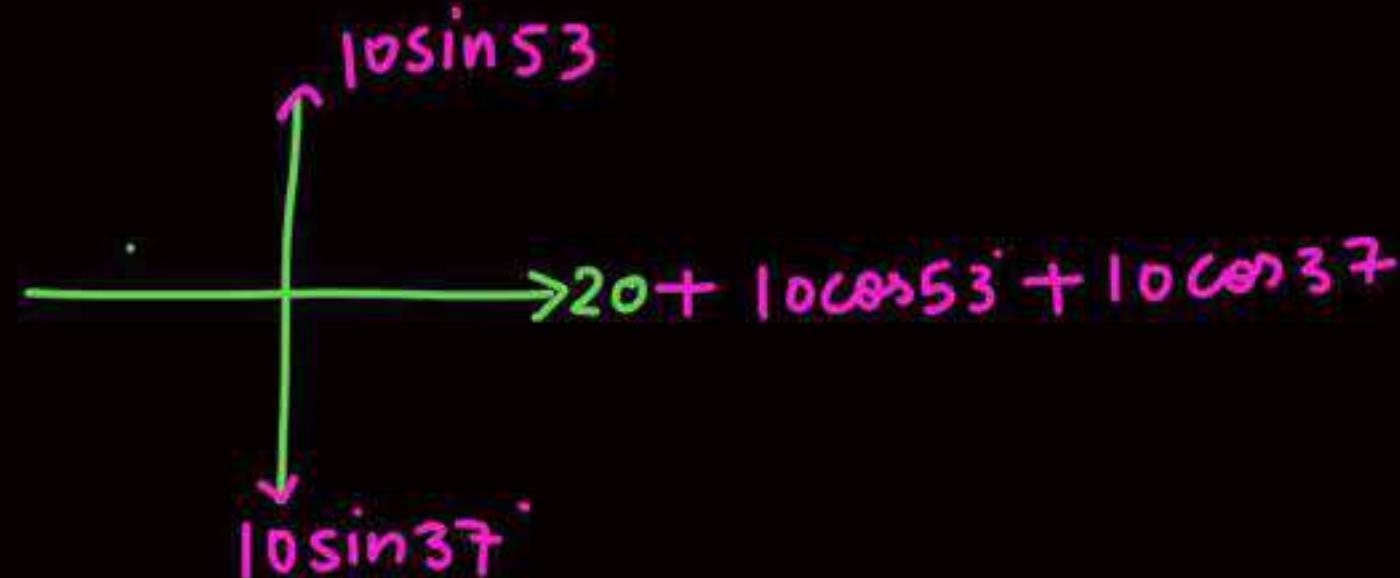
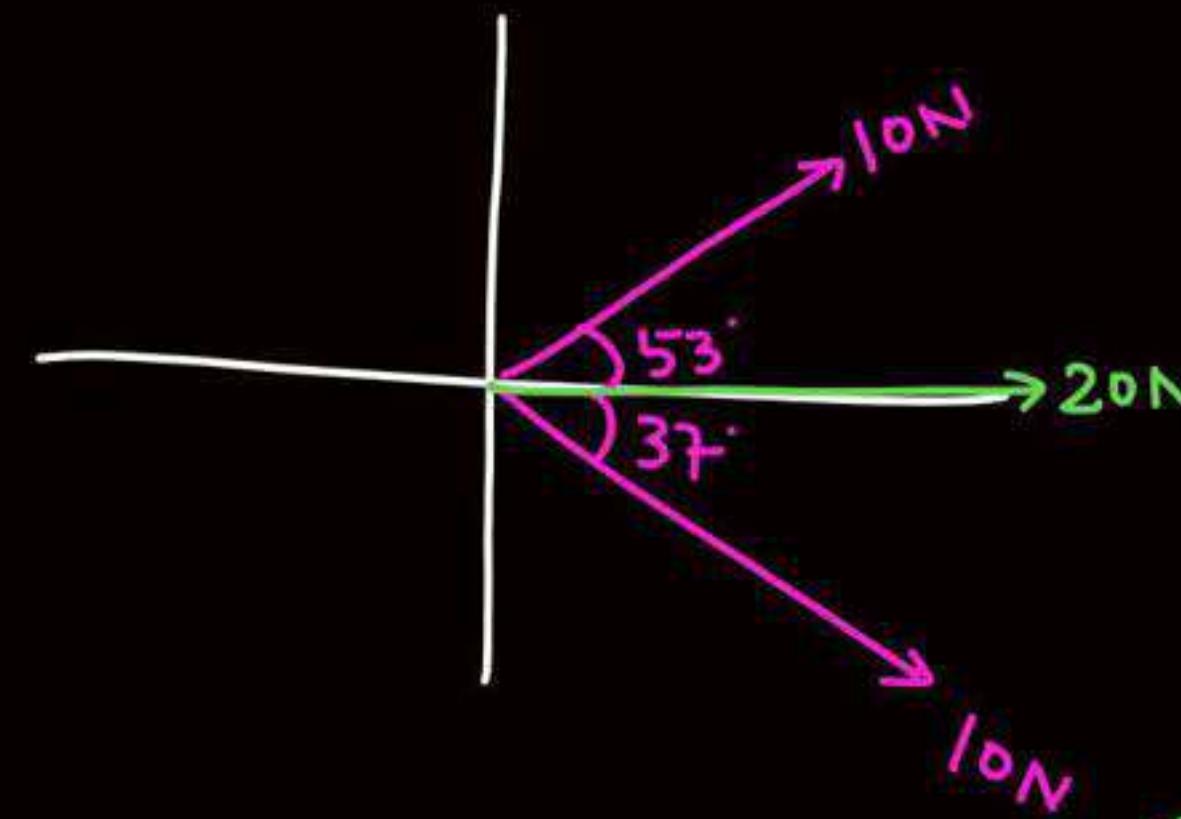
=

$$10 + 6$$

$$6$$

$$\text{F}_{\text{net}} = 38\hat{i} - 16\hat{j}$$

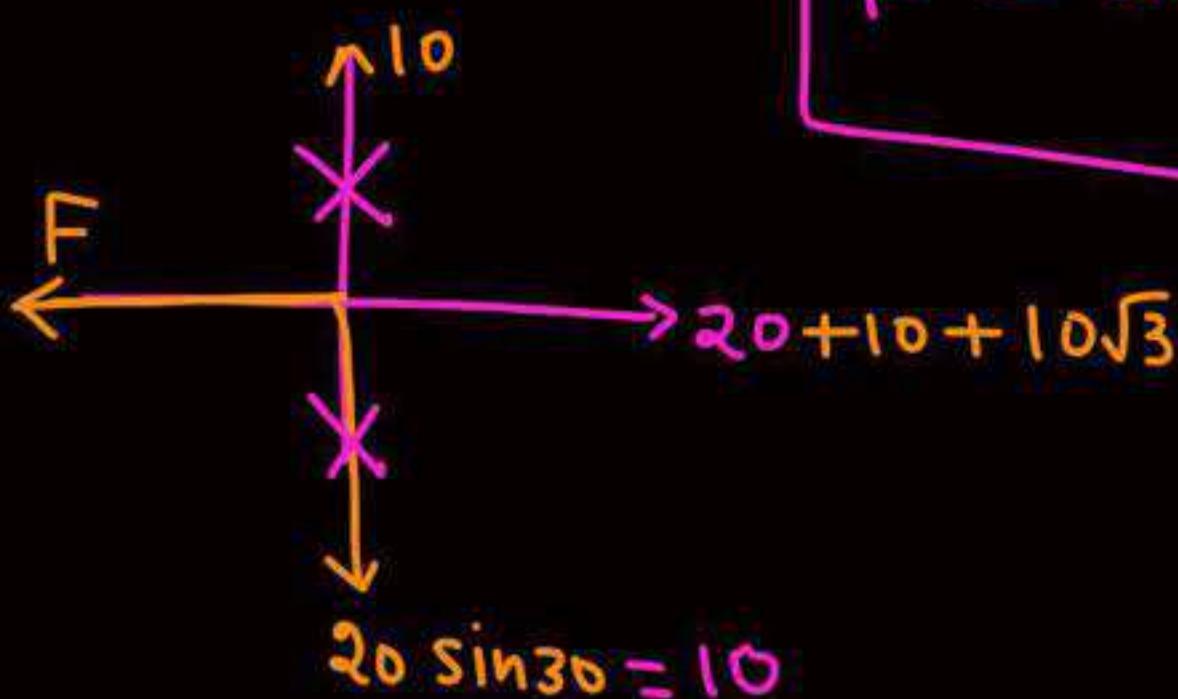
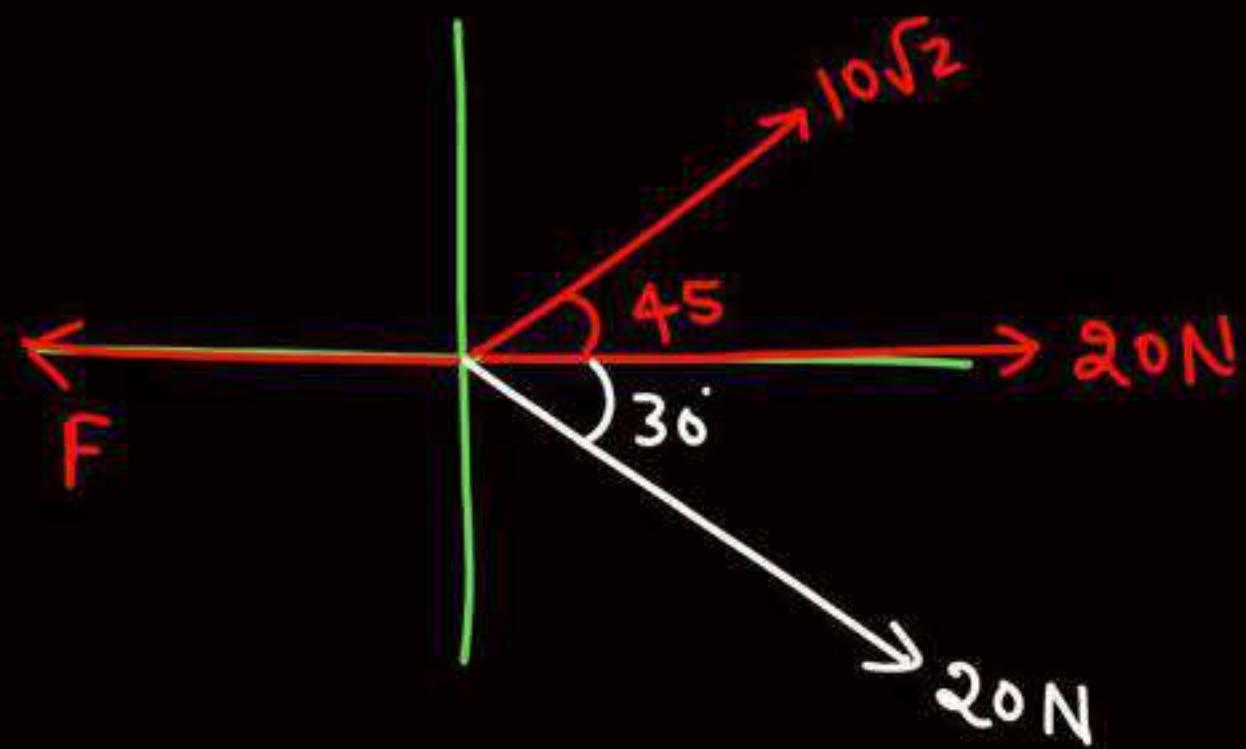
Q Find net force



$$\vec{F}_{\text{net}} = 34\hat{i} + 2\hat{j}$$

Q

Find the value of  $F$  so that net force is zero.

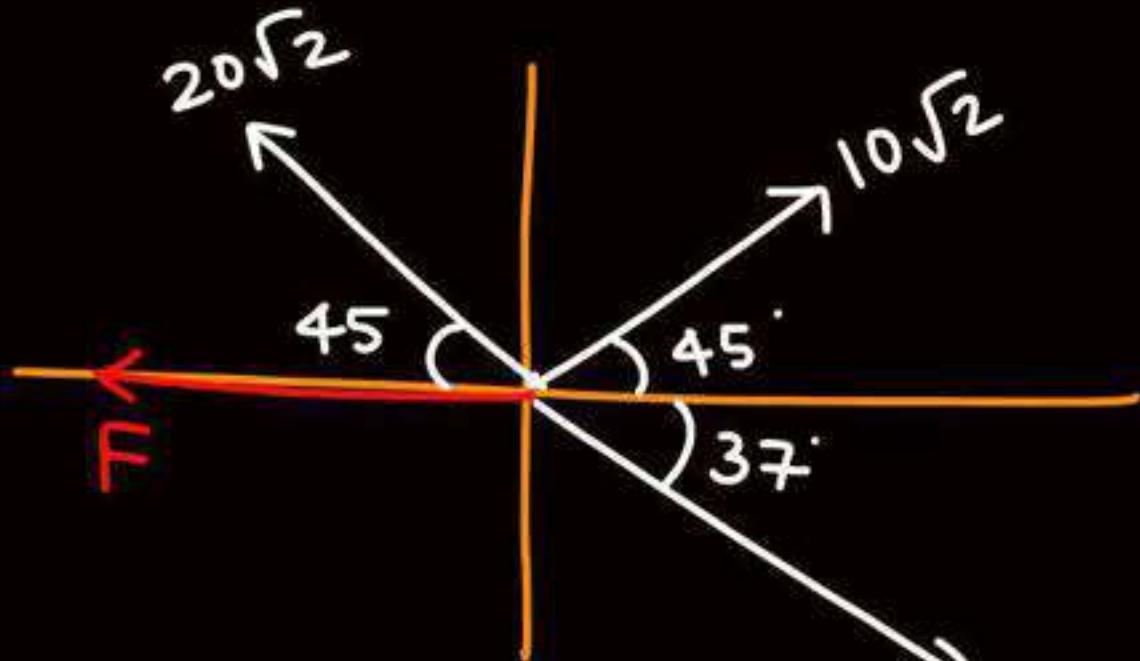


$$F = 30 + 10\sqrt{3}$$

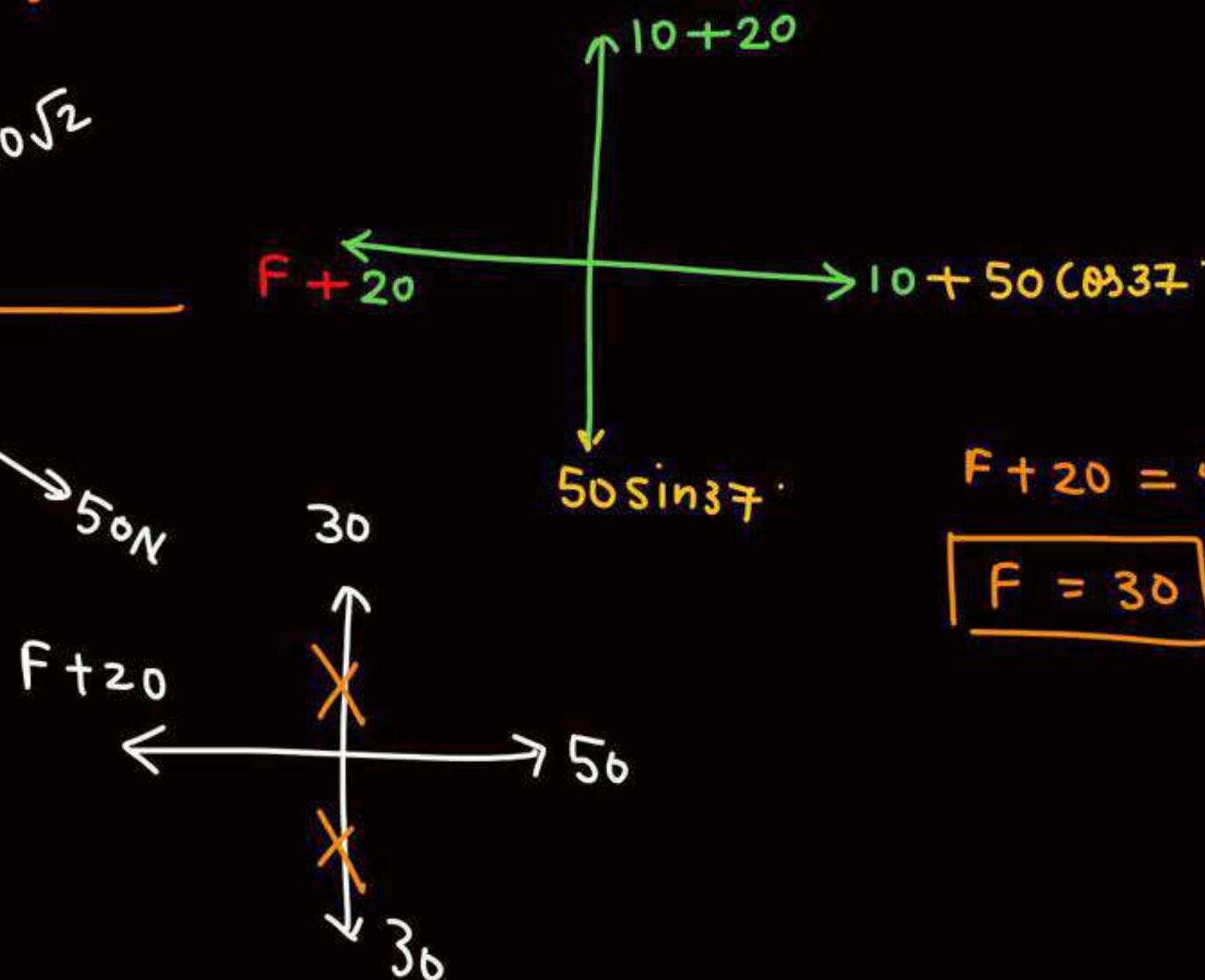
Ans

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

$$\begin{aligned}\vec{A} &= 5\hat{i} + 3\hat{j} \\ \vec{B} &= 4\hat{i} + 10\hat{j} \\ \hline \vec{A} \cdot \vec{B} &= 20 + 30 = 50\end{aligned}$$

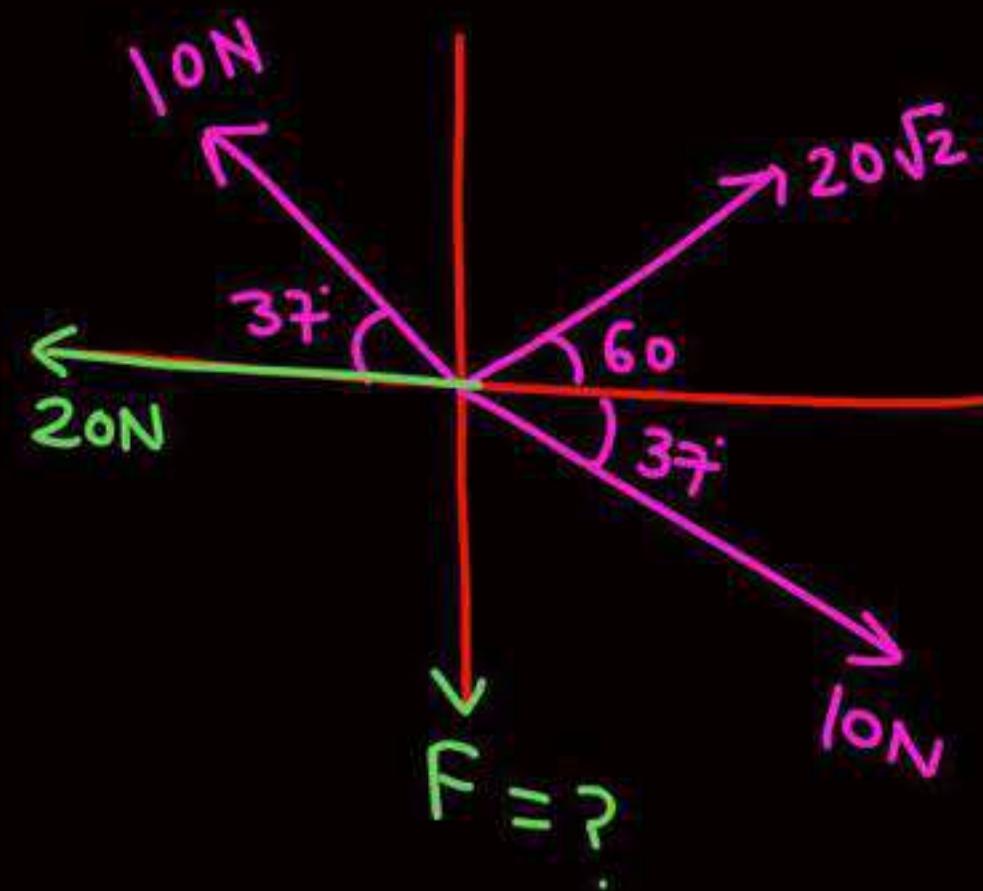
$$\begin{array}{l} \textcircled{3} \\ \theta \\ \begin{array}{l} \overrightarrow{A} = 2\hat{i} + 3\hat{j} + 4\hat{k} \\ \overrightarrow{B} = 3\hat{i} + 4\hat{j} + 5\hat{k} \end{array} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 6 + 12 + 20 \\ = 38 \end{array}$$

$$\begin{array}{l} \textcircled{5} \\ \overrightarrow{A} = 2\hat{i} - 3\hat{j} \\ \overrightarrow{B} = 5\hat{i} + 2\hat{j} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 10 - 6 = 4 \end{array}$$

$$\begin{array}{l} \textcircled{4} \\ \theta \\ \begin{array}{l} \overrightarrow{A} = 3\hat{i} + 2\hat{j} + 3\hat{k} \\ \overrightarrow{B} = 2\hat{i} + 3\hat{j} + 4\hat{k} \end{array} \\ \hline \overrightarrow{A} \cdot \overrightarrow{B} = 6 + 6 + 12 = 24 \end{array}$$

Q

Find the value of  $F$  so that  $\vec{F}_{\text{net}}$  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'n next page

But पहले सम्म करो

Soln

$$\vec{F}_1 = a\hat{i} + 5\hat{j} + 3\hat{k}$$

$$\vec{F}_2 = (b-3)\hat{i} - b\hat{j} - 3\hat{k}$$

$$\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 = (a+b-3)\hat{i} + (5-b)\hat{j} + (3-3)\hat{k}$$

$$\vec{F}_{\text{net}} = 0 \Rightarrow a+b-3=0, \quad 5-b=0$$
$$a+b=3 \quad b=5$$

$$b=5, \quad a+b=3$$

$$a+5=3$$

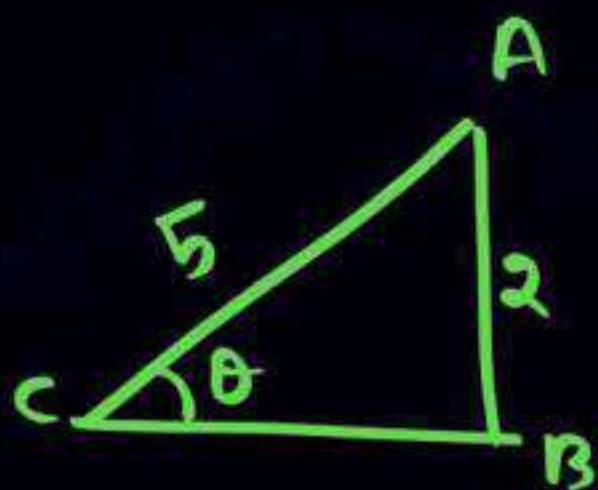
$$a=-2$$

## Trigonometry

Q

$$\sin \theta = \frac{2}{5}$$

$$\tan \theta = \frac{2}{\sqrt{21}}$$



$$CB = \sqrt{25 - 4} = \sqrt{21}$$

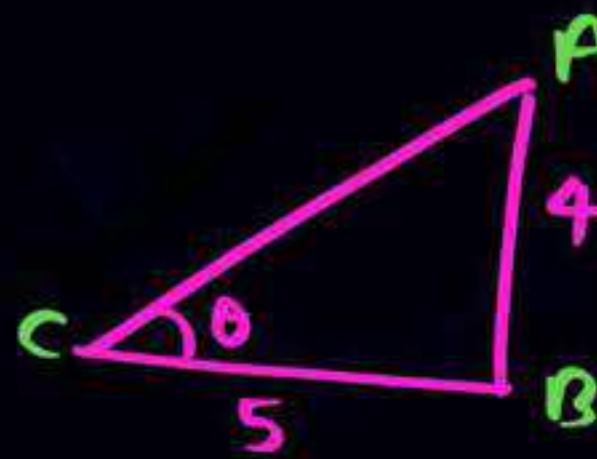
# Vector & Matrices

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 १८<sup>th</sup> maths के only के topic पढ़ो / revise  
जैसे जिनकी जरूरत हो । ११<sup>th</sup> 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 जगह  
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  $2\pi$  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

 $120^\circ$ 

$$\frac{120\pi}{180} = \frac{2\pi}{3} \text{ rad}$$

 $240^\circ$ 

$$\frac{4\pi}{3} \text{ rad}$$

 $210^\circ$ 

$$\frac{210\pi}{180} = \frac{7\pi}{6} \text{ rad}$$

 $720^\circ$ 

$$4\pi \text{ rad}$$

 $750^\circ$ 

$$\frac{750\pi}{180} = \frac{25\pi}{6} \text{ rad}$$

 $150^\circ$ 

$$\frac{5\pi}{3} \text{ rad}$$

$$\textcircled{1} \quad \sin 2^\circ \approx 2 \times \frac{\pi}{180} \approx \frac{\pi}{90} = \frac{3.14}{90} \approx 0.03488$$

$$\textcircled{2} \quad \sin 3^\circ \approx 3 \frac{\pi}{180} = \frac{\pi}{60} = \frac{3.14}{60}$$

$$\textcircled{3} \quad \sin 4^\circ = 4 \frac{\pi}{180} = \frac{\pi}{45}$$

$$\textcircled{4} \quad \sin 8^\circ \approx \frac{8\pi}{180}$$

## 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  $\theta$  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  $\tan 5^\circ = \frac{5\pi}{180}$

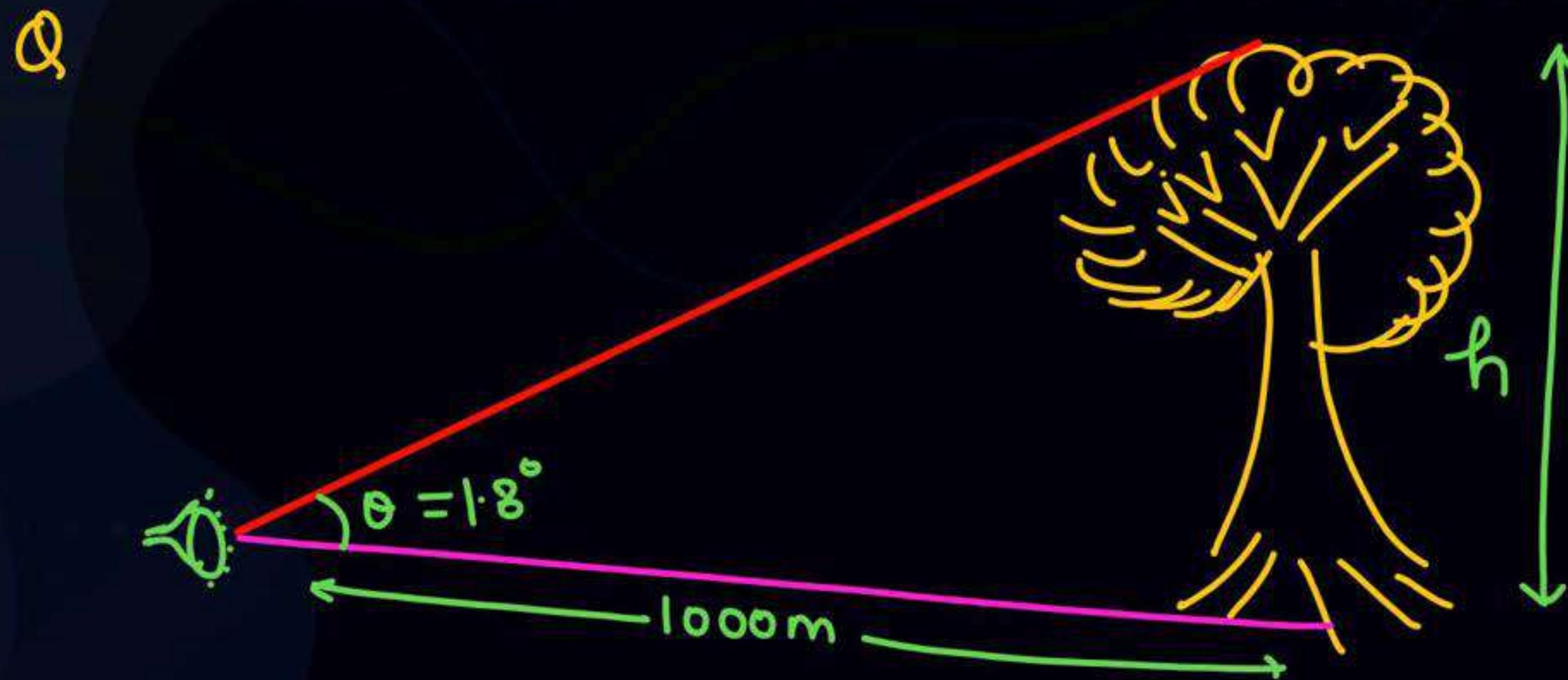
if  $\theta$  is very small

$\theta < 5^\circ$

$\cos \theta \rightarrow 1$

$\sin 2^\circ \approx \tan 2^\circ$

$\sin 5^\circ \approx \tan 5^\circ$



$$\tan 1.8^\circ = \frac{h}{1000}$$

$$\begin{aligned} h &= 1000 \cdot \tan 1.8^\circ = 1000 \times 1.8 \times \frac{\pi}{180} \\ &= 10\pi = \underline{31.4\text{ m}} \end{aligned}$$

$$\sin 2^\circ \approx \underline{.0348}^{99} (\text{calc})$$

$$\tan 2^\circ \approx \underline{.0349}$$

$$\sin 2^\circ \approx 2 \cdot \frac{\pi}{180} = \frac{\pi}{90} = \frac{3.14}{90} = .0348$$

$(\sin \theta \approx \theta)$

$$\sin 5^\circ \approx .0871$$

$$\tan 5^\circ = .0874$$

|||

Approx equal

$$\sin \theta \approx \theta \text{ rad}$$

$$\sin 2^\circ \approx 2 \cdot \frac{\pi}{180} = \frac{\pi}{90} = \frac{3.14}{90} = \underline{\underline{0.03488}}$$

$$\sin 3^\circ \approx 3 \cdot \frac{\pi}{180} = \frac{\pi}{60} = \frac{3.14}{60} = 0.0523$$

- \*  $\pi \text{ rad} = 180^\circ$
- \*  $1^\circ = 60' \text{ (minute)}$

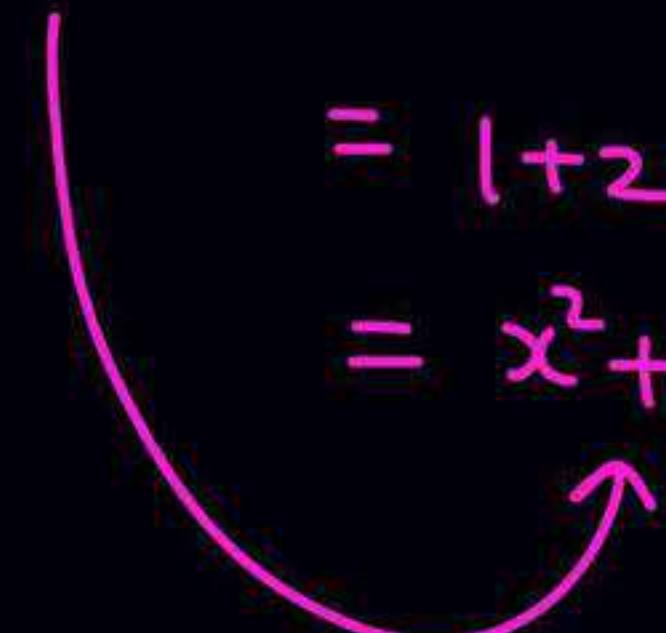
## Binomial Expansion

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

$$\begin{aligned}(1+x)^2 &= 1 + 2x + \frac{2 \cdot 1 \cdot x^2}{1 \cdot 2} + \dots \\ &= 1 + 2x + x^2 \\ &= x^2 + 1 + 2x\end{aligned}$$



$$(1+x)^n = 1 + nx +$$

$$\frac{n(n-1)x^2}{1 \times 2} + \dots$$

Neglect

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

$$\textcircled{1} \quad \frac{3\pi}{2} \longrightarrow \frac{3 \times 180}{2} = 270^\circ$$

$\theta$  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 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  $x \ll 1$

$$(1.007)^3 = 1.021$$

$$(1.009)^{\frac{1}{3}} \approx 1 + \frac{1}{3} \times 0.009 = 1.003$$

$$(1.008)^{\frac{1}{2}} \approx (1+0.008)^{\frac{1}{2}} = 1.004$$

$$\sqrt{1.006} \approx (1+0.006)^{\frac{1}{2}} \approx 1 + \frac{1}{2} \times 0.006 \\ = \underline{1.003}$$

$$\frac{1}{1.006} \approx (1.006)^{-1} \\ = (1+0.006)^{-1} \\ = 1 - 0.006 = 0.994$$

$$\frac{1}{0.998} \approx (0.998)^{-1} = (-0.002)^{-1}$$

$$\left(\frac{1}{0.997}\right)^2 \approx (0.997)^{-2} = (1-0.003)^{-2} \\ = 1+0.006 \\ = \underline{1.006}$$

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 ✓  
उम्मीद से follow करेंगे.

$$\sin (90^\circ + 30^\circ) = +\cos 30^\circ = +\frac{\sqrt{3}}{2} = \text{झूर रही}$$

$90^\circ, 270^\circ$  में तोड़े  
ती

$$\sin \rightleftharpoons \cos$$

$$\tan \rightleftharpoons \cot$$

$180^\circ, 360^\circ$  में  
तोड़ रही हो तो  
सम Change करी

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  $\sin 210^\circ = \sin(180^\circ + 30^\circ) = -\sin 30^\circ = -\frac{1}{2}$

→  $\sin(270^\circ - 60^\circ) = -\cos 60^\circ = -\frac{1}{2}$

$$\textcircled{3} \quad \sin 240^\circ = \sin(180^\circ + 60^\circ) = -\sin 60^\circ = -\frac{\sqrt{3}}{2}$$

$$\hookrightarrow \sin(270^\circ - 30^\circ) = -\cos 30^\circ = -\frac{\sqrt{3}}{2}$$

$$\textcircled{4} \quad \cos 240^\circ = \cos(180^\circ + 60^\circ) = -\cos 60^\circ = -\frac{1}{2}$$

$$\hookrightarrow \cos(270^\circ - 30^\circ) = -\sin 30^\circ = -\frac{1}{2}$$

$$\textcircled{3} \quad \tan 240^\circ = \tan(180^\circ + 60^\circ) = +\tan 60^\circ = \sqrt{3}$$

$$\hookrightarrow \tan(270^\circ - 30^\circ) = +\cot 30^\circ = \sqrt{3}$$

$$\textcircled{4} \quad \cos 300^\circ = \cos(360^\circ - 60^\circ) = +\cos 60^\circ = \frac{1}{2}$$

$$\hookrightarrow \cos(270^\circ + 30^\circ) = +\sin 30^\circ = \frac{1}{2}$$

$$\textcircled{5} \quad \sin 300^\circ = \sin(360^\circ - 60^\circ) = -\frac{\sqrt{3}}{2}$$

$$\hookrightarrow \sin(270^\circ + 30^\circ) = -\cos 30^\circ = -\frac{\sqrt{3}}{2}$$

$\sin(90^\circ - \theta) = \cos \theta$   
 $\cos(90^\circ - \theta) = \sin \theta$   
 $\tan(90^\circ - \theta) = \cot \theta$   
 $\cot(90^\circ - \theta) = \tan \theta$

10<sup>th</sup> 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



$\Rightarrow \text{311d} \in \uparrow$

Q2

$$\text{Displacement} = \vec{d} = 3\hat{i} + 4\hat{j}$$

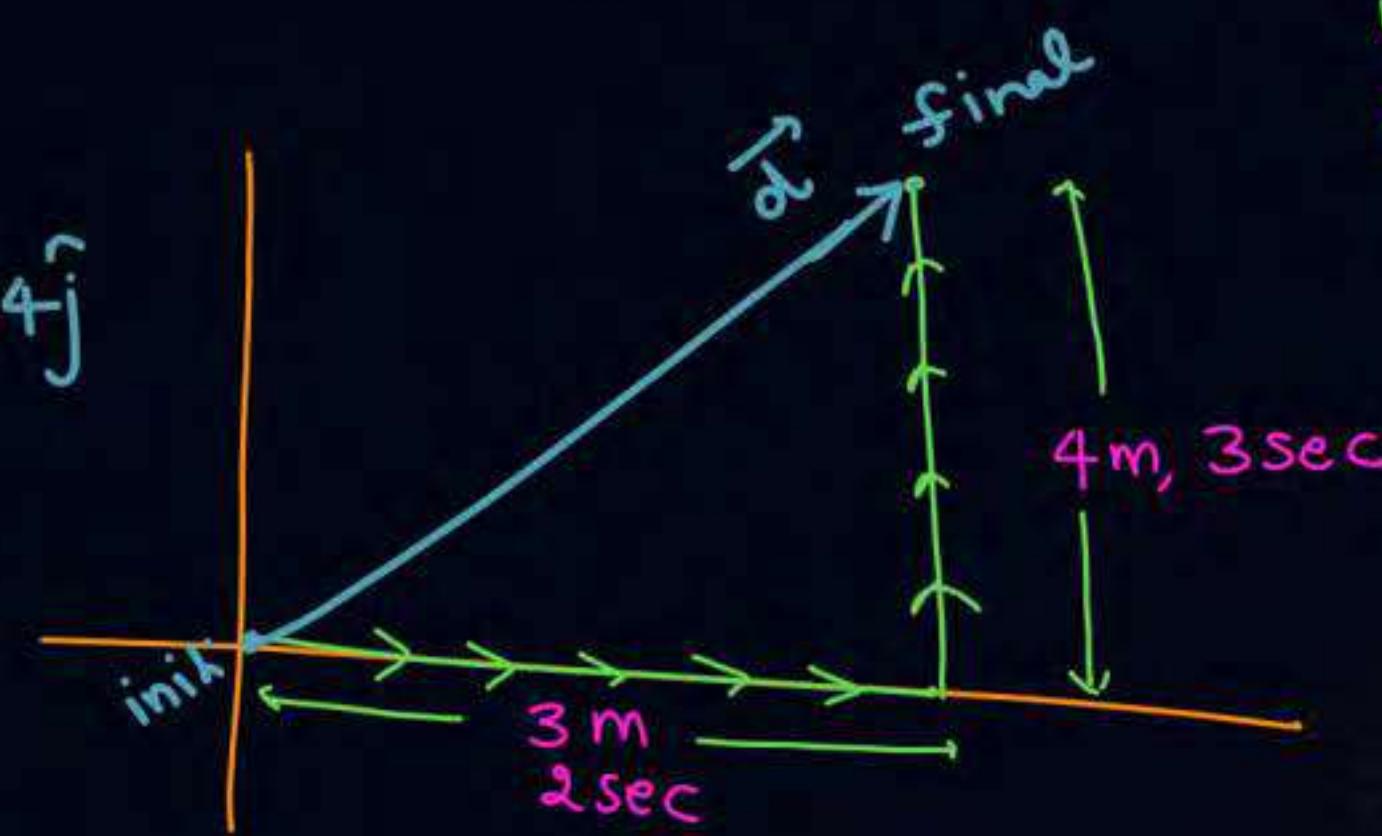
$$\text{Average Velocity} = \frac{3\hat{i} + 4\hat{j}}{2+3}$$

$$= \frac{3\hat{i} + 4\hat{j}}{5}$$

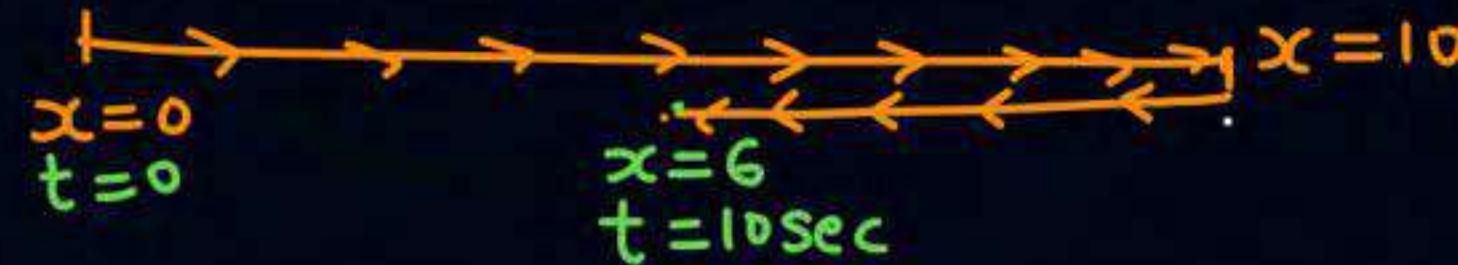
magnitude  $\Rightarrow$  Displacement = 5

time =  $2+3 = 5 \text{ sec}$

$$\text{Avg velocity} = \frac{5}{5} = 1 \text{ m/s}$$



if displacement = 0  
Avg velocity = 0

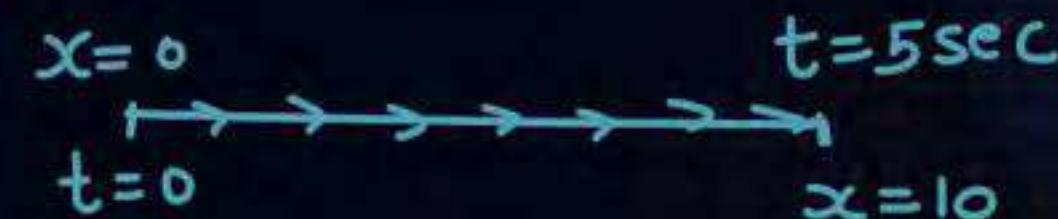
Q<sub>1</sub>

$$\text{Displacement} = 6$$

$$\text{Avg Velocity} = \frac{6}{10}$$

$$\text{Distance} = 10 + 4 \\ = 14$$

$$\text{Avg speed} = \frac{14}{10}$$

Q<sub>2</sub>

$$\text{distance} = 10$$

$$\text{displacement} = 10 \text{ (magnitude)}$$

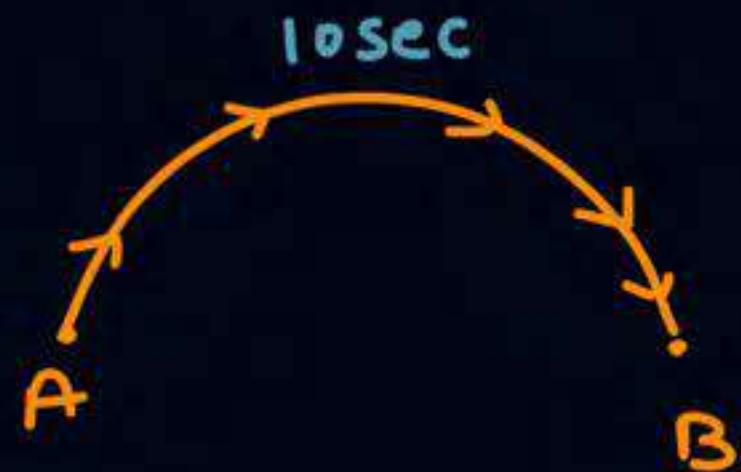
$$\text{Avg velocity} = \frac{10}{5} \text{ (magnitude)}$$

$$\text{Avg speed} = \frac{10}{5}$$

Q

$$\text{Avg. Speed} = \frac{\pi R}{10}$$

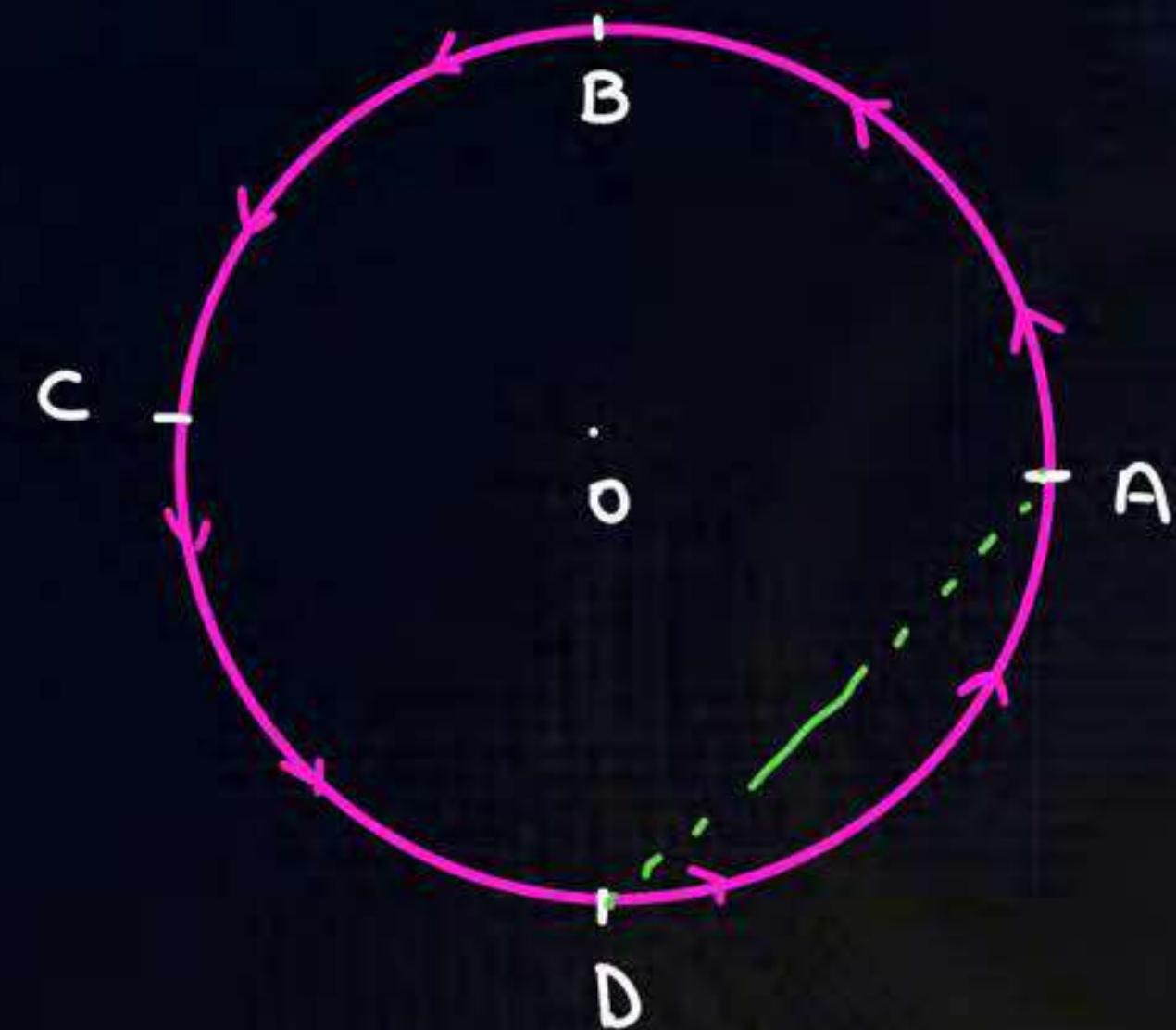
$$\text{Avg Velocity (magnitude)} = \frac{2R}{10} = \frac{R}{5}$$



Q

A particle is performing Uniform circular motion with  
 const speed  $v$ , having time period  $T$  anticlockwise.

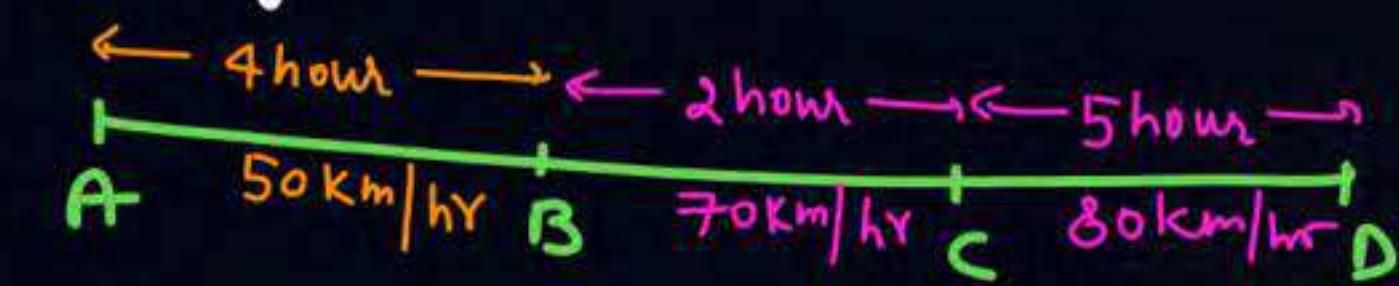
	Avg Speed	Avg Velocity
$A \rightarrow B$	$\frac{2\pi R/4}{T/4} = \frac{2\pi R}{T}$	$\frac{R\sqrt{2}}{T/4}$
$A \rightarrow B \rightarrow C$	$\frac{\pi R}{T/2} = \frac{2\pi R}{T}$	$\frac{2R}{T/2}$
$A \rightarrow B \rightarrow C \rightarrow D$	$\frac{\frac{3}{4}2\pi R}{3T/4} = \frac{2\pi R}{T}$	$\frac{R\sqrt{2}}{3T/4}$
$A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$	$\frac{2\pi R}{T}$	O



9th class

P  
W

Q A car is moving along  $+x$  axis, in 1<sup>st</sup> 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

$$\textcircled{1} \quad t=0 \longrightarrow t=2 \text{ sec}$$

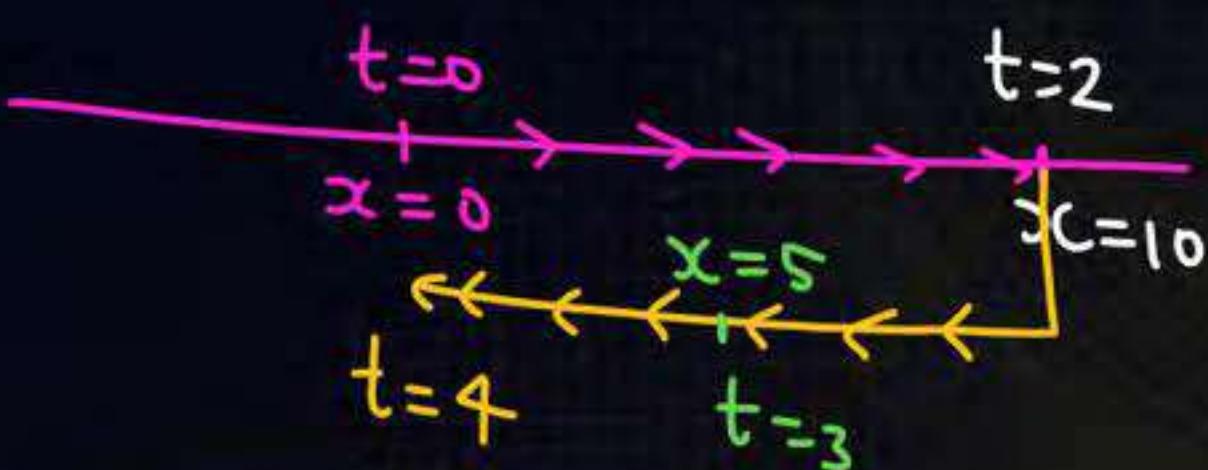
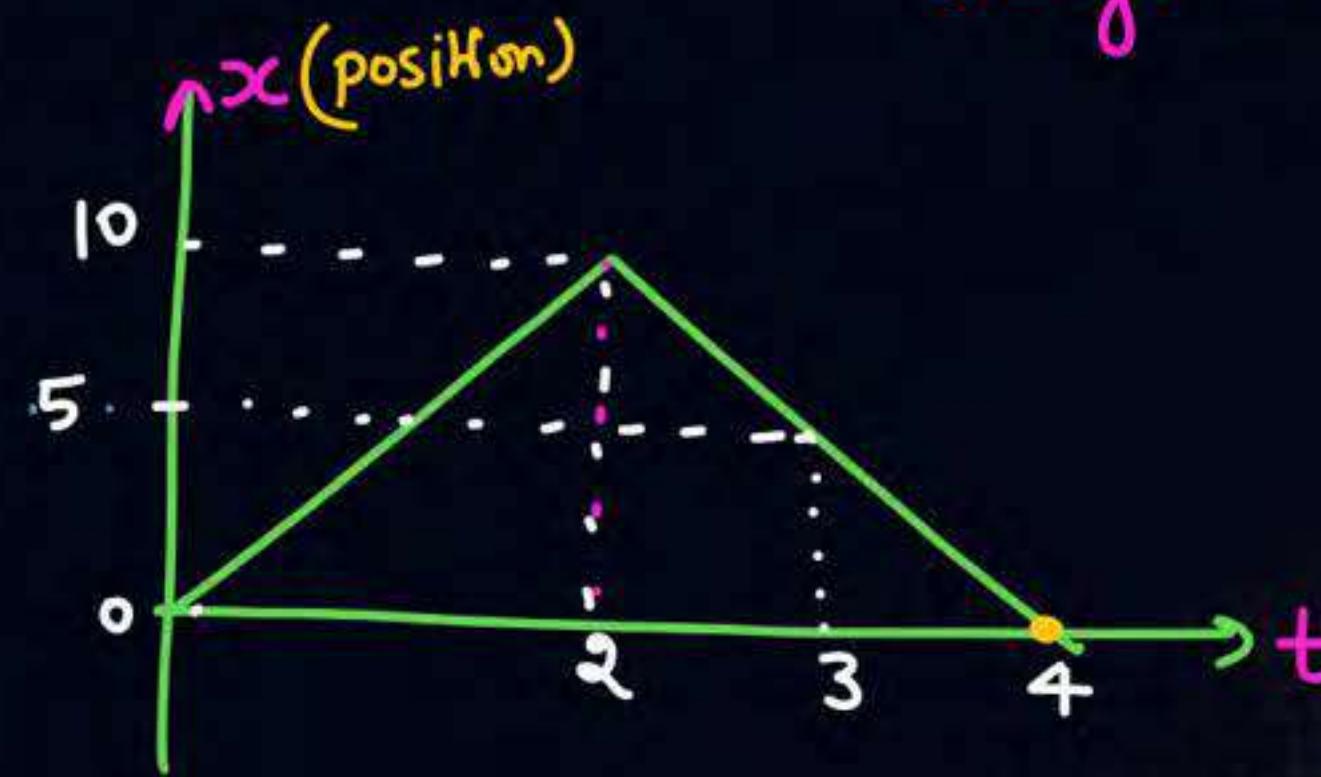
$$\text{Avg velocity} = \frac{10}{2} = 5$$

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{time}} = \frac{10 - 0}{2}$$

$$\textcircled{2} \quad t=0 \longrightarrow t=3$$

$$\text{Avg Velocity} = \frac{x_f - x_i}{\text{time}} = \frac{5 - 0}{3}$$

$$\text{Avg Speed} = \frac{15}{3} = 5$$

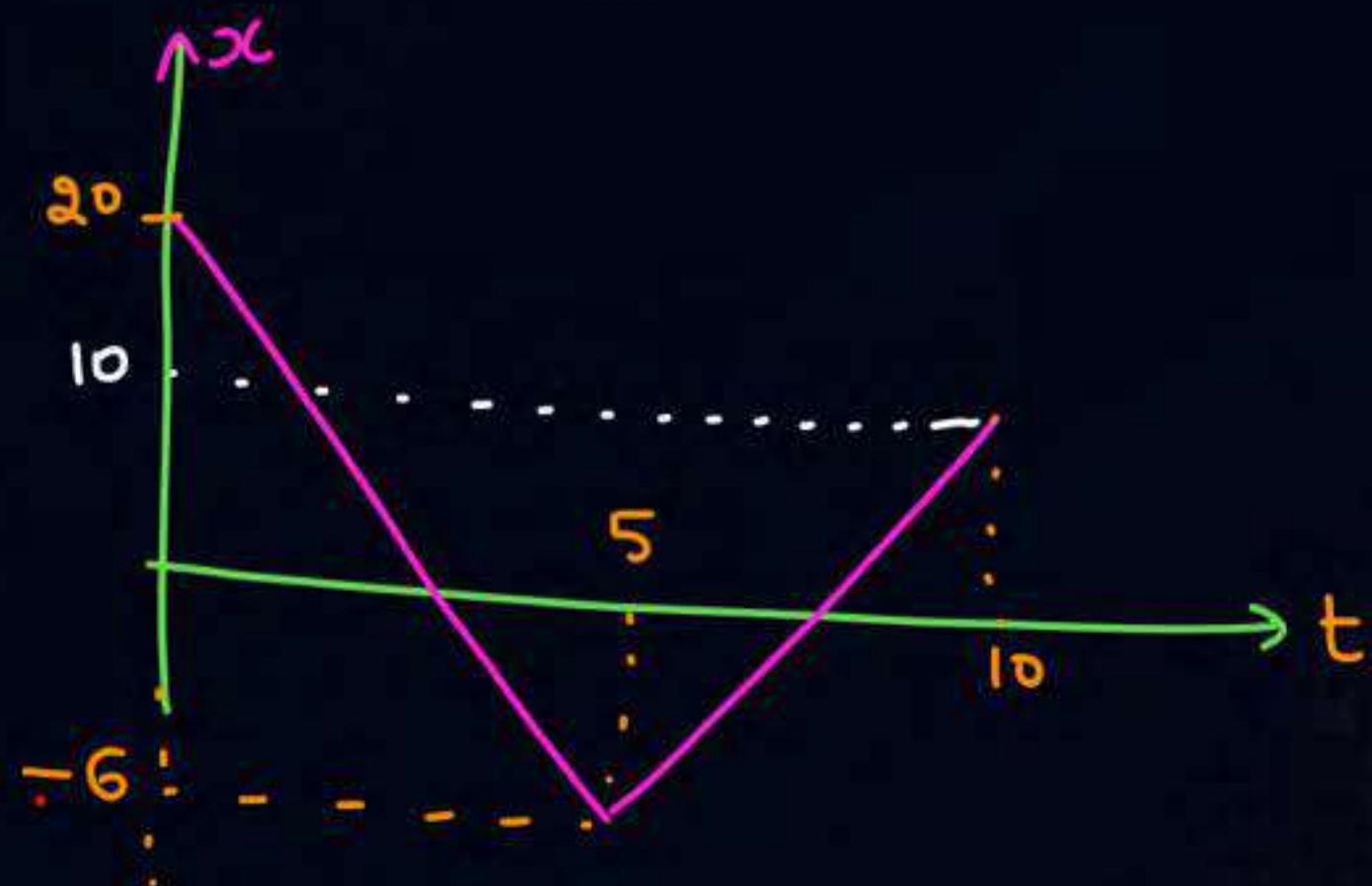


Q t = 0 → t = 5

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{time}}$$
$$= \frac{(-6) - (+20)}{5}$$
$$= -\frac{26}{5}$$

Q2 t = 0 → t = 10

$$\text{Avg velocity} = \frac{10 - 20}{10}$$



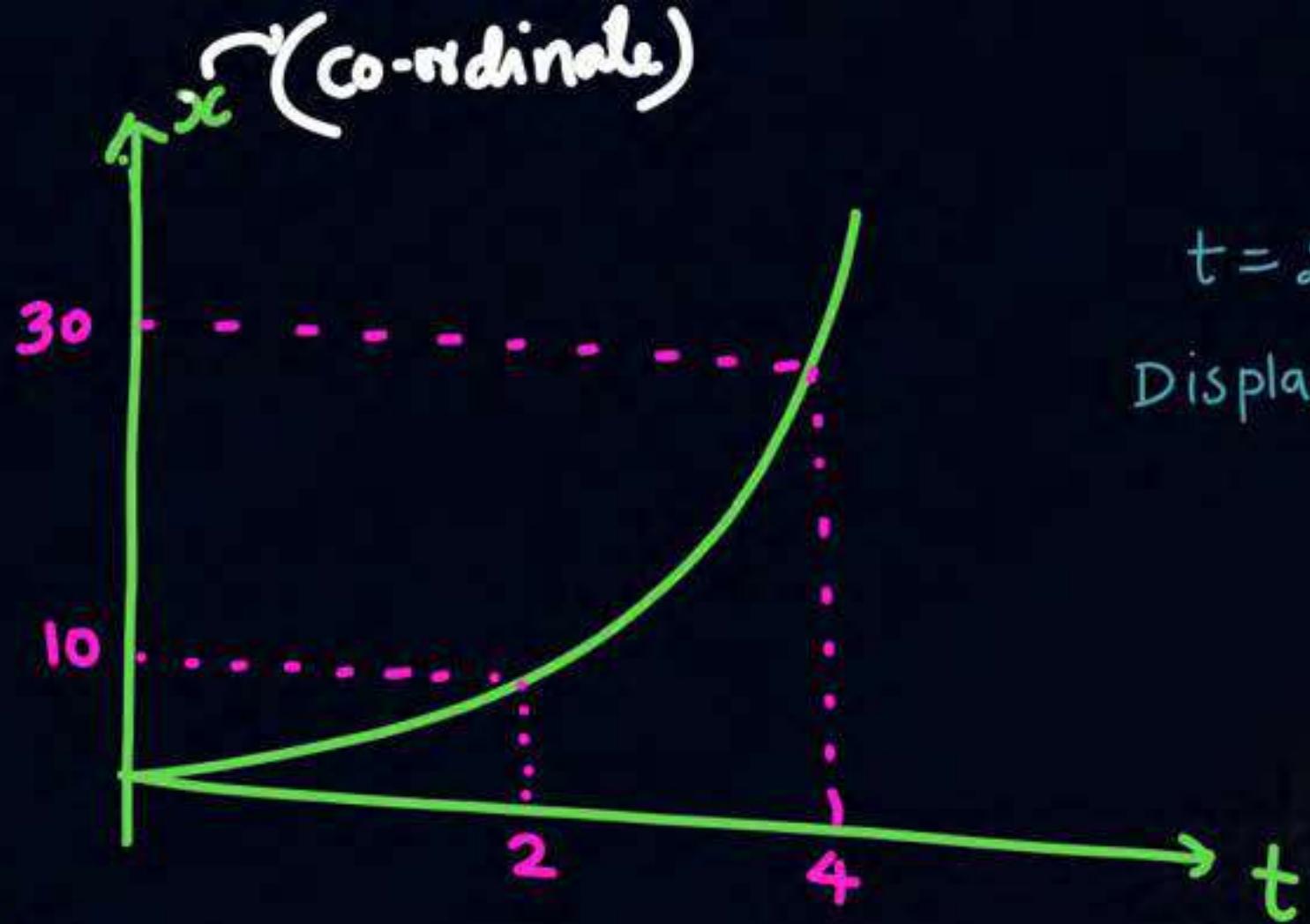
Q

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

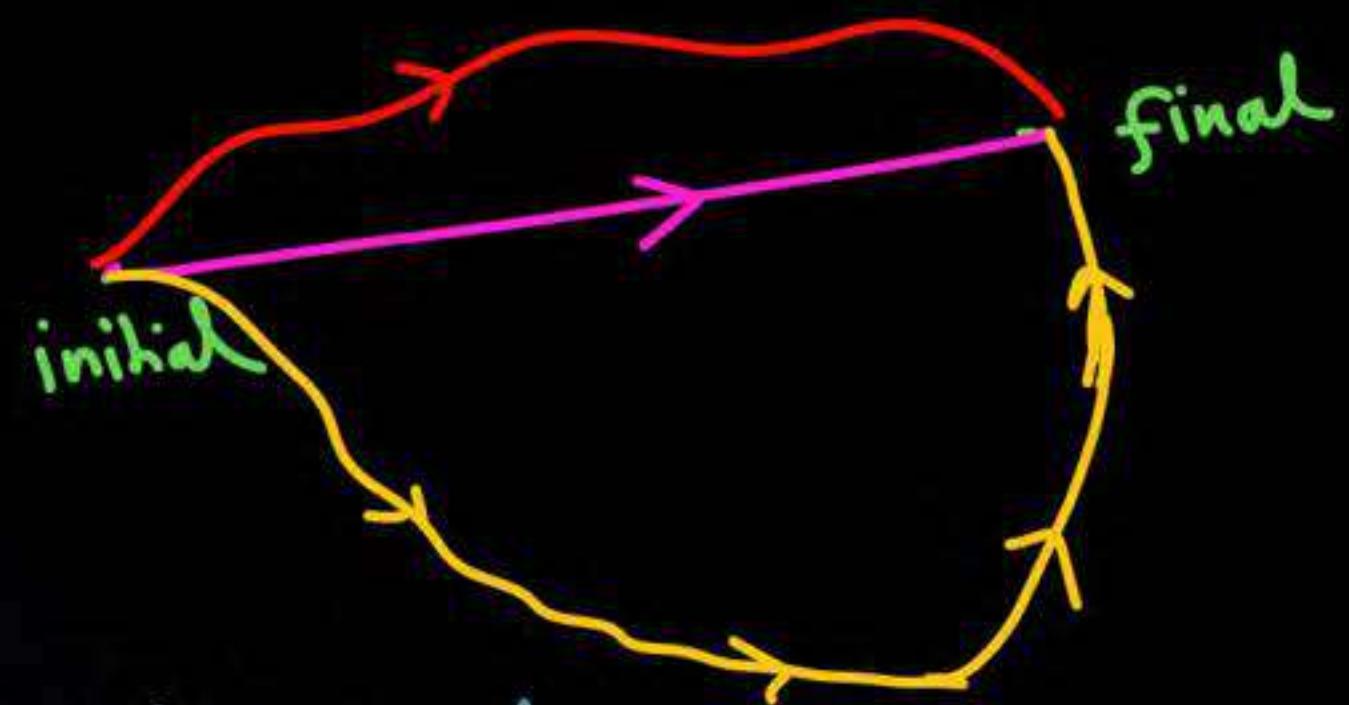
$$(-5, 0, 0)$$

initial

$$(0, 0, 0)$$

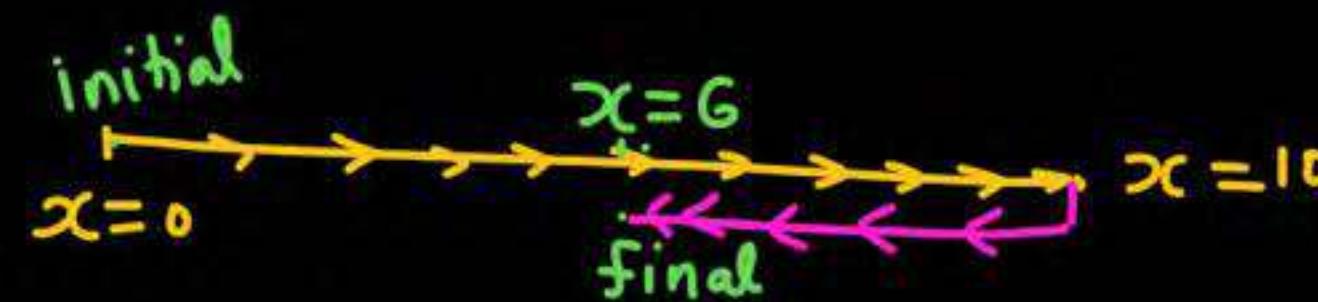
$$\text{Displacement} = -5\hat{i}$$

Q



- Displacement  $\rightarrow$  Same
- Distance  $\rightarrow$   $\overline{314159} = \text{diff} \checkmark = \text{depends on path.}$

Q

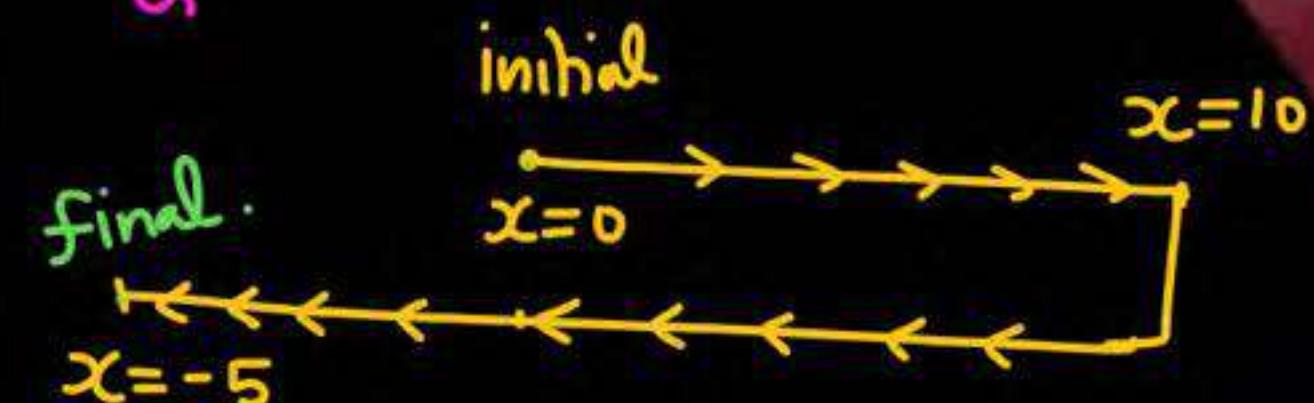


$$\text{Distance travelled} = 10 + 4 = 14$$

$$\text{Displacement} = 6 \text{ (magnitude)}$$

$$\text{Displacement (vector)} = 6\hat{i}$$

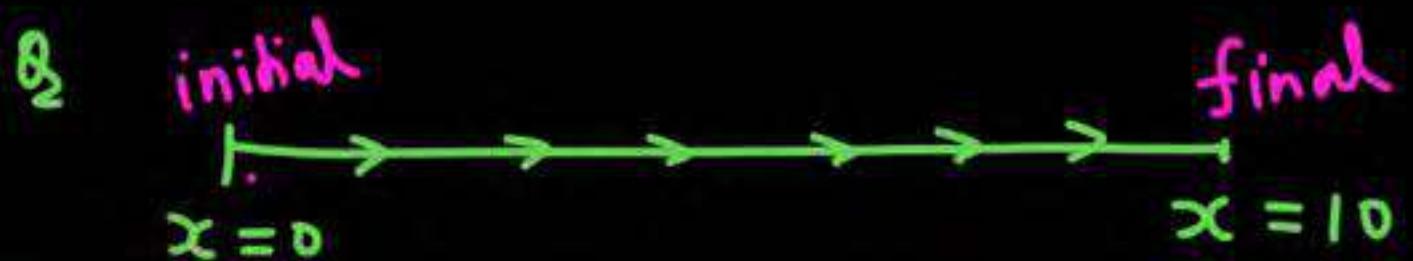
Q



$$\begin{aligned}\text{Distance} &= 10 + 10 + 5 \\ &= 25\end{aligned}$$

$$\text{Displacement} = -5\hat{i}$$





distance = 10

Displacement =  $10\hat{i}$



Distance = | Displacement |

Q<sub>2</sub>

$$\text{Distance} = 4 + 3 = 7 \text{ m}$$

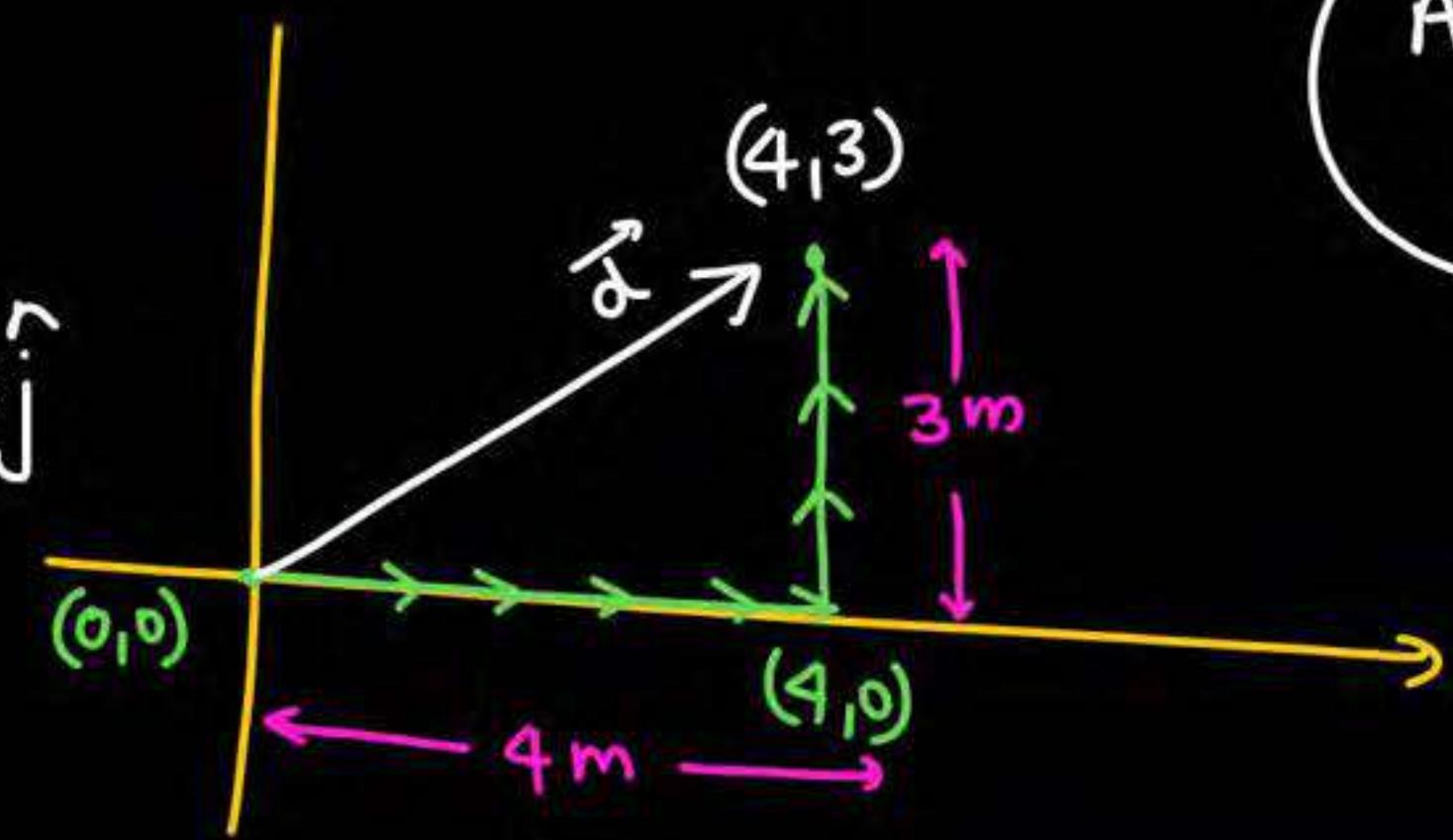
$$\text{Displacement} = \vec{d} = 4\hat{i} + 3\hat{j}$$

magnitude of

$$\begin{aligned}\text{displacement} &= \sqrt{4^2 + 3^2} \\ &= 5\end{aligned}$$

here

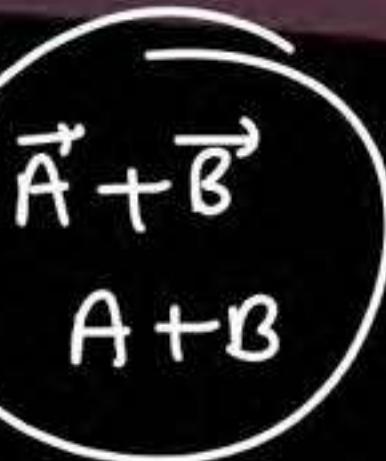
$$\text{Distance} > |\text{Displacement}|$$



$$\vec{d}_1 = 4\hat{i}$$

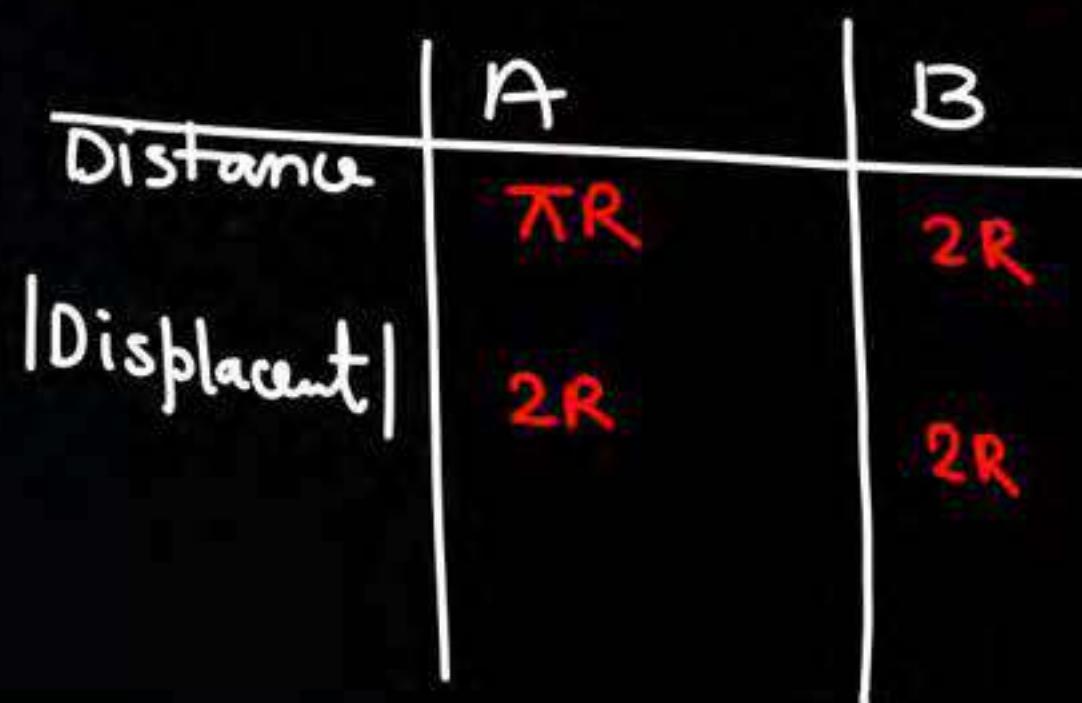
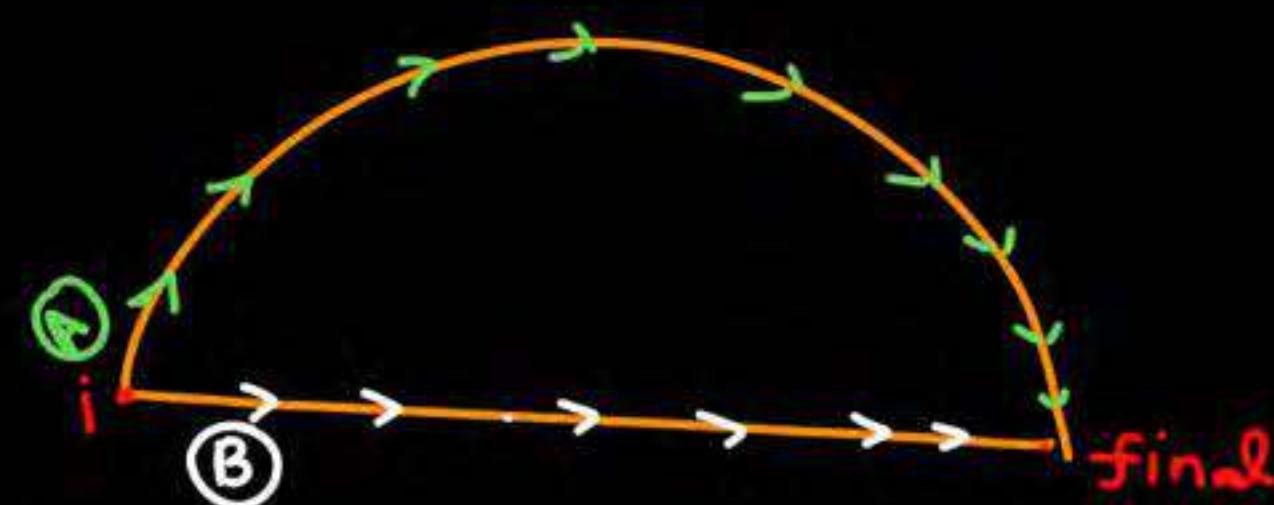
$$\vec{d}_2 = 3\hat{j}$$

$$\vec{d}_{\text{net}} = 4\hat{i} + 3\hat{j}$$



$\Omega$ 

- (A) → semicircle  
(B) → st. line



Q

A particle move 5m along east, then 6m along north and 10m in upward direction.

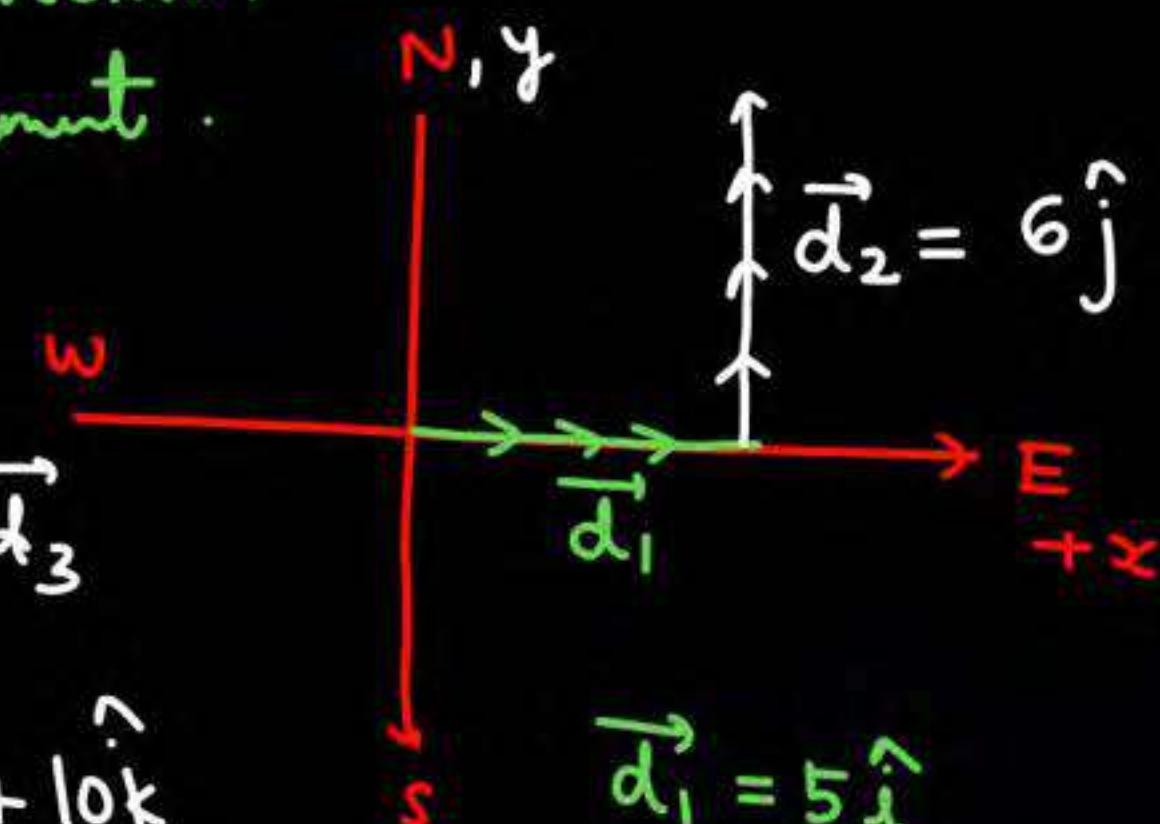
find distance & displacement.

$$\text{Distance} = 5 + 6 + 10 = 21$$

$$\text{Displacement} = \vec{d}_{\text{net}} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$$

$$= 5\hat{i} + 6\hat{j} + 10\hat{k}$$

$$\text{Magnitude} = \sqrt{5^2 + 6^2 + 10^2}$$

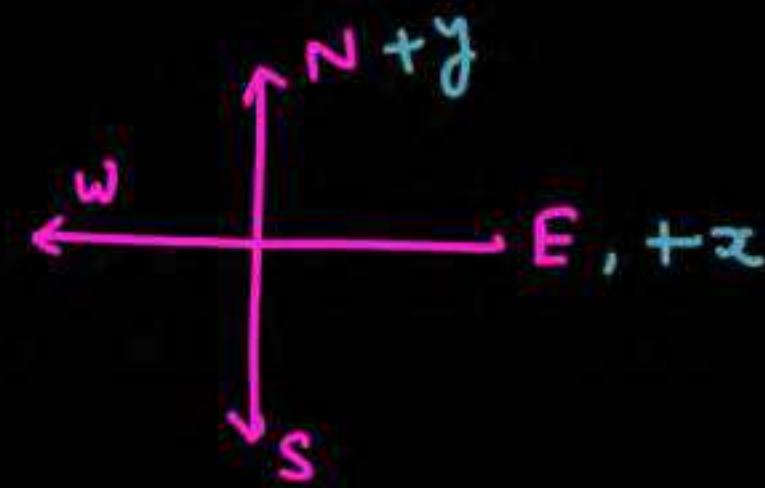


$$\vec{d}_1 = 5\hat{i}$$

$$\vec{d}_3 = 10\hat{k}$$

Q2 A particle moves

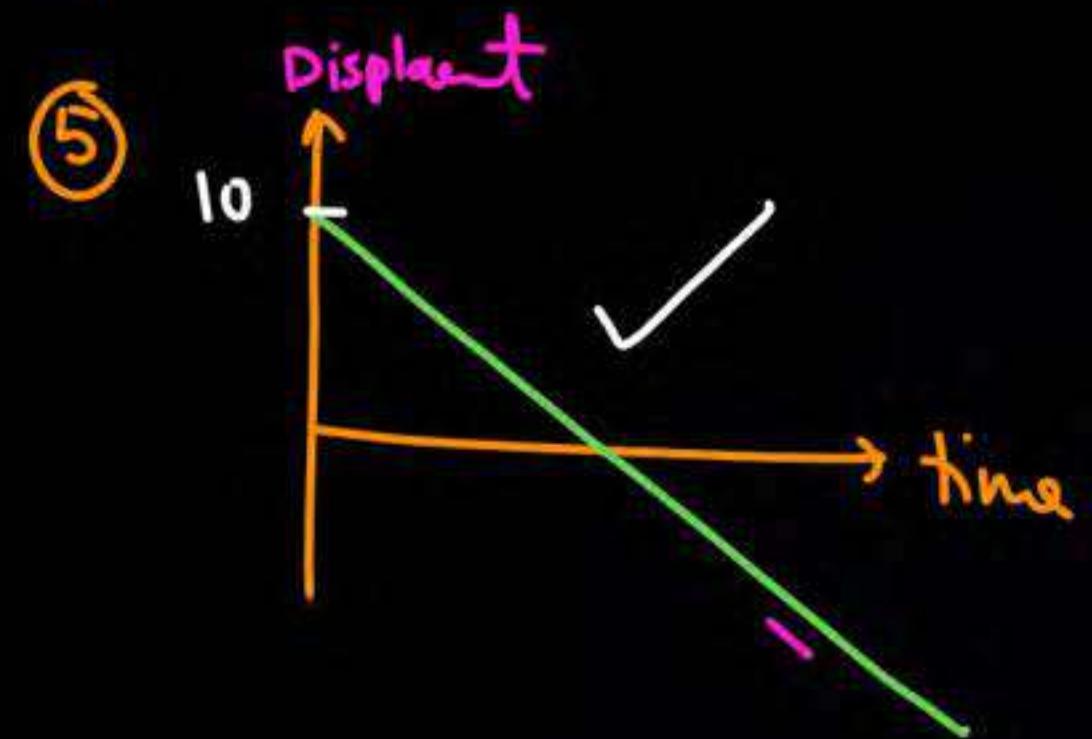
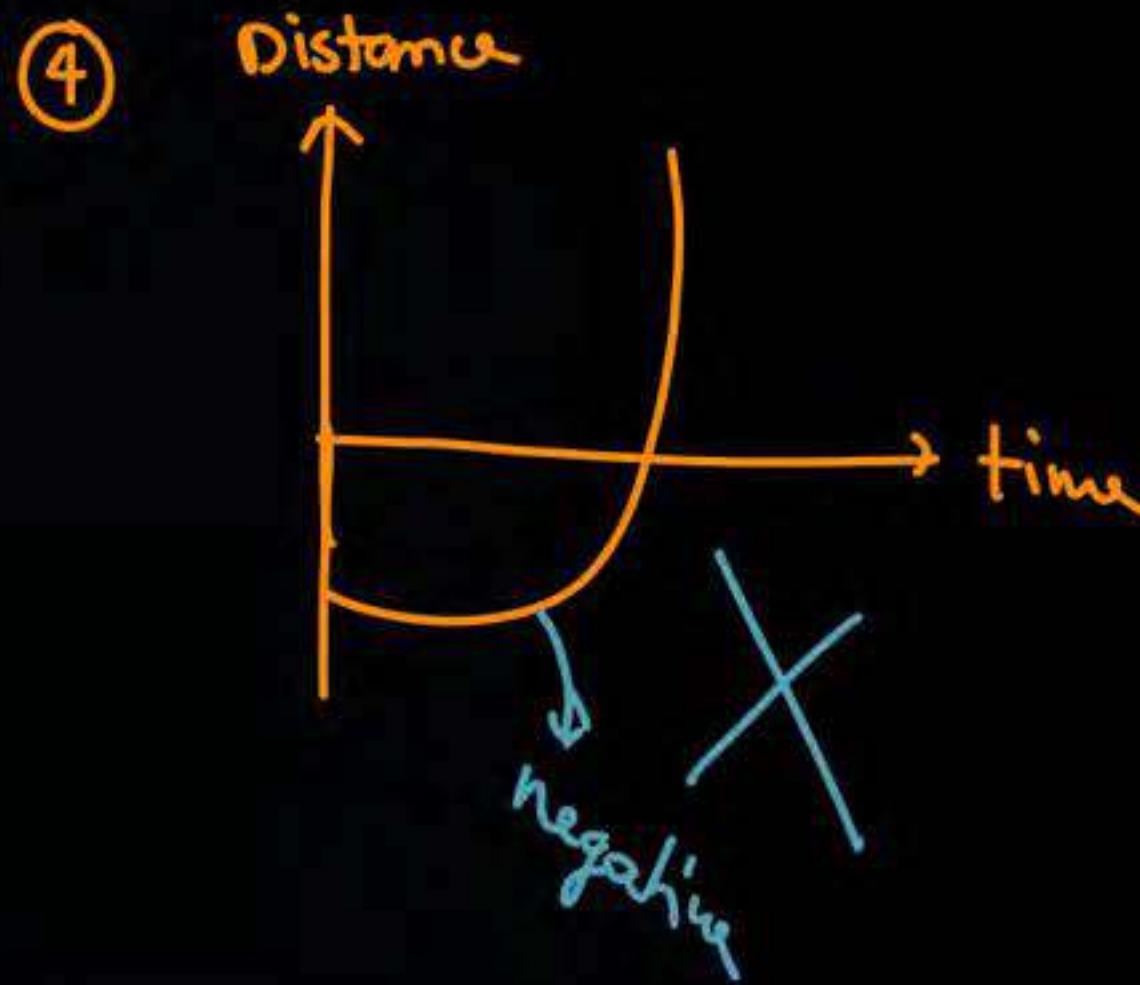
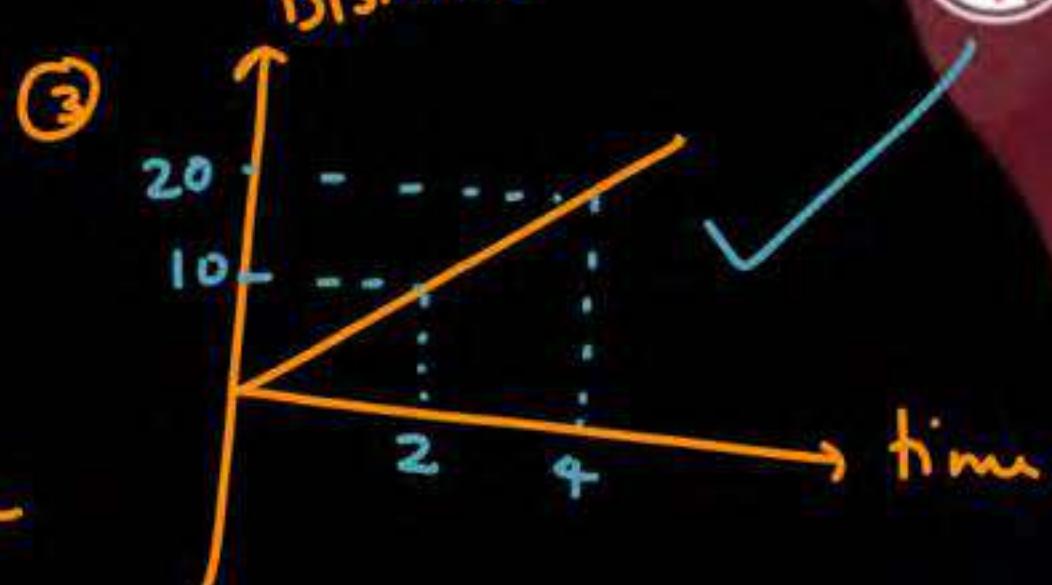
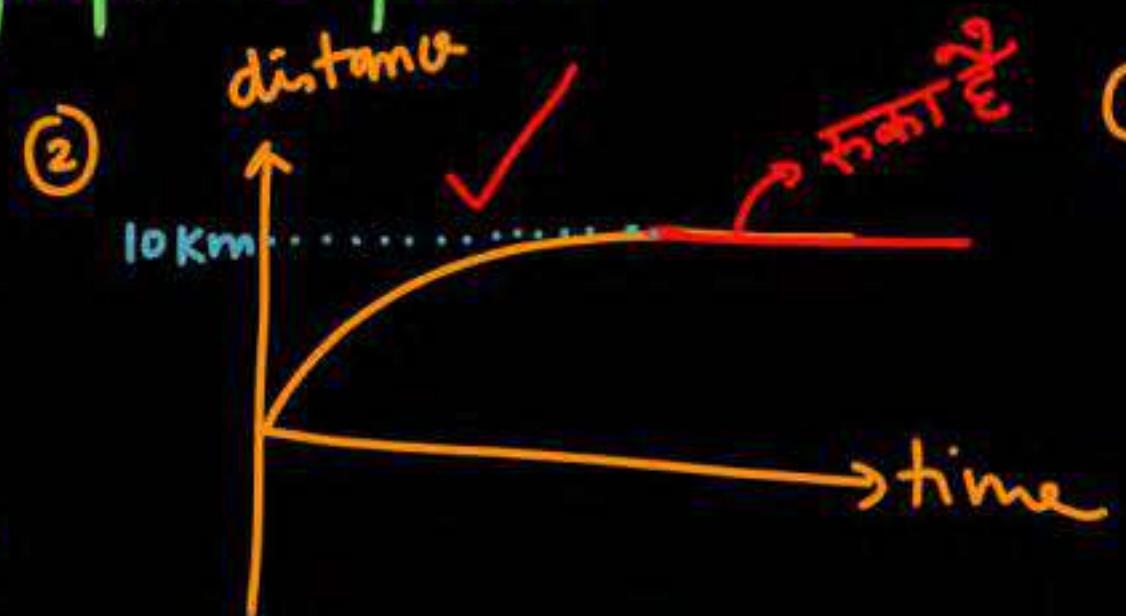
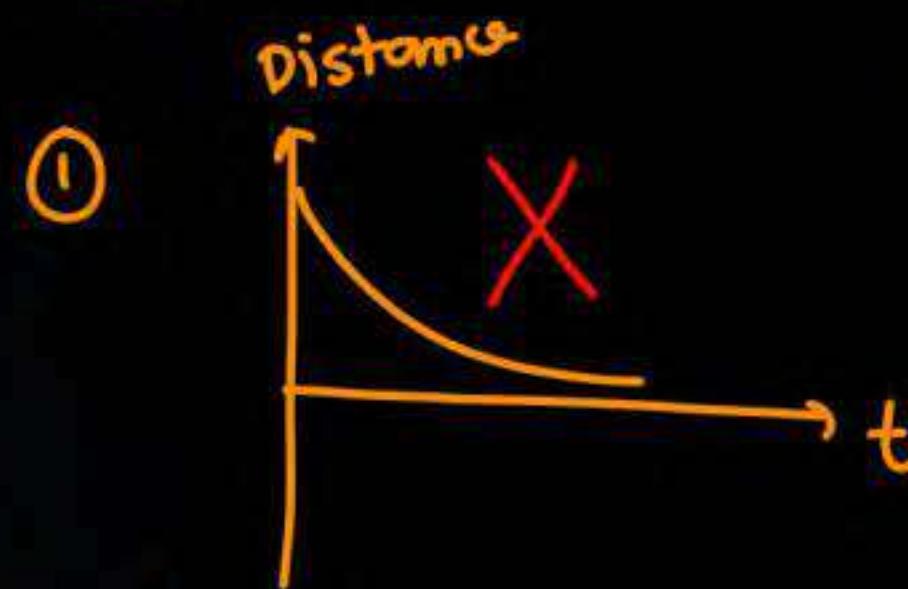
10m east  $\vec{d}_1 = 10\hat{i}$   
5m north  $\vec{d}_2 = 5\hat{j}$   
6m south  $\vec{d}_3 = -6\hat{j}$   
8m west  $\vec{d}_4 = -8\hat{i}$   
15m east  $\vec{d}_5 = 15\hat{i}$   
20m north  $\vec{d}_6 = 20\hat{j}$

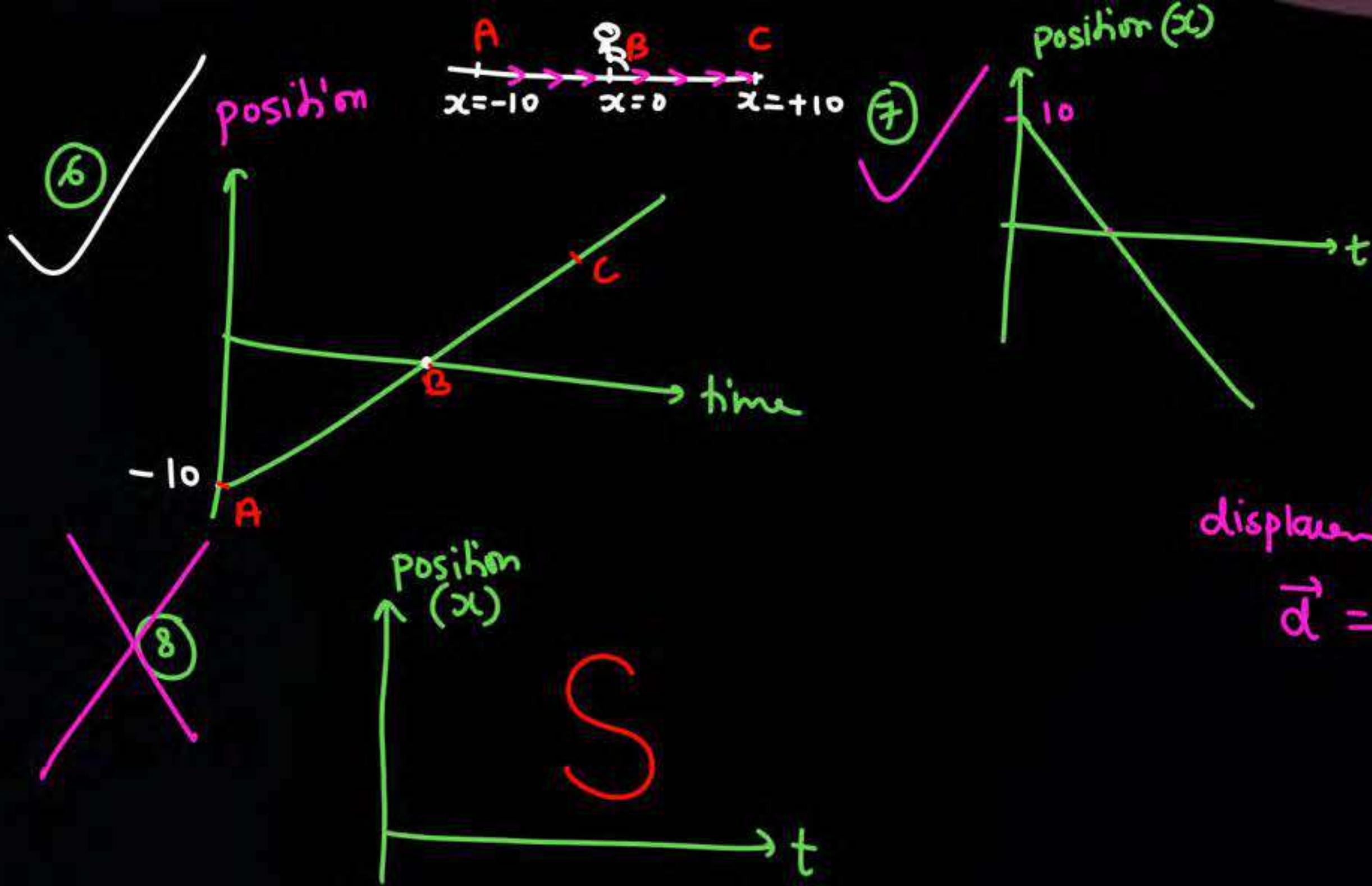


$$\begin{aligned}\vec{d}_{\text{net}} &= (\text{Add}) = (10 - 8 + 15)\hat{i} + (5 - 6 + 20)\hat{j} \\ &= 17\hat{i} + 19\hat{j}\end{aligned}$$

$$\text{distance} = 10 + 5 + 6 + 8 + 15 + 20$$

Q which of the graph is possible.

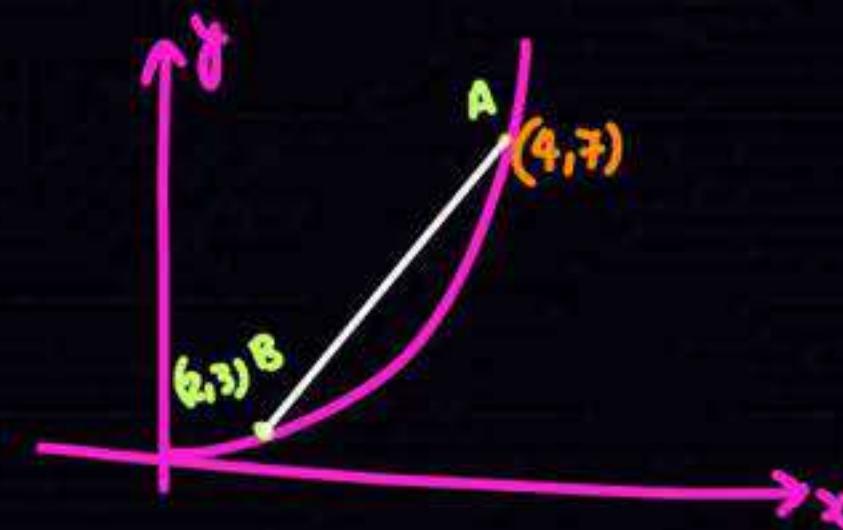




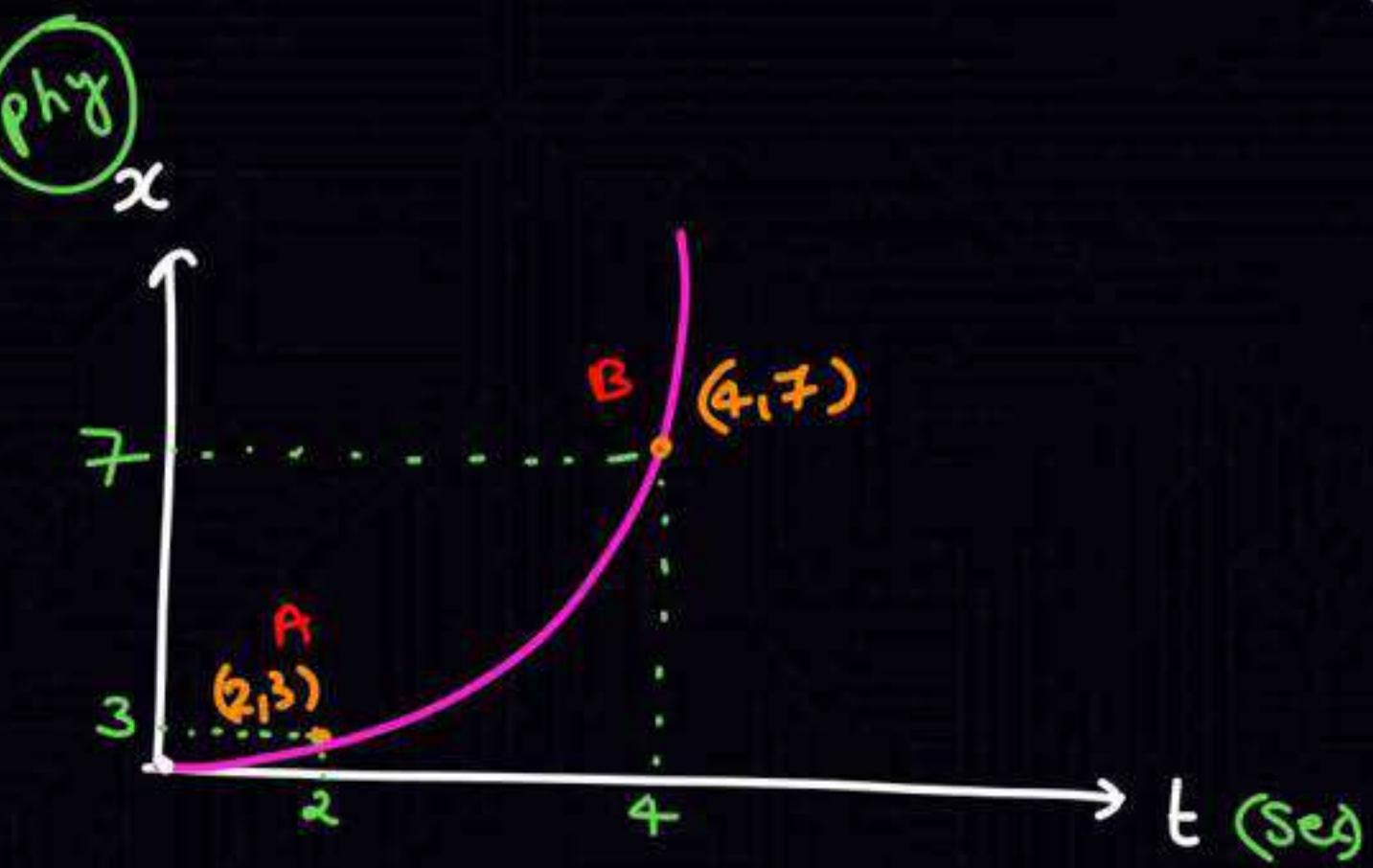
Slope

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

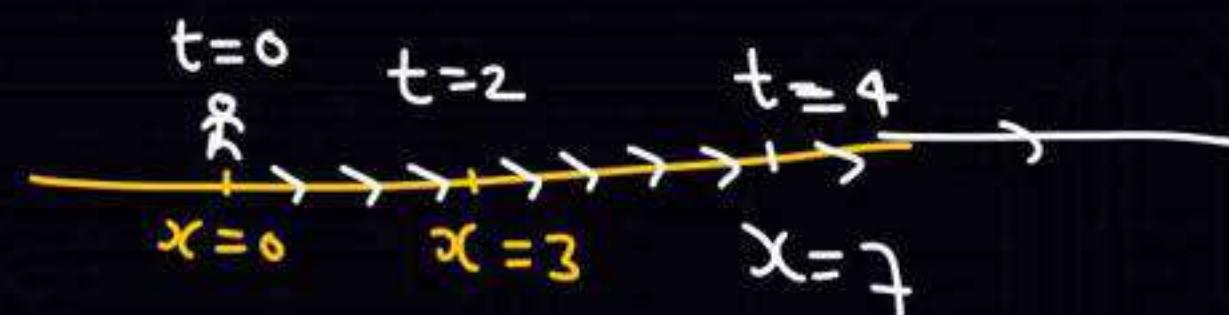
$$\text{Slope} = \frac{7-3}{4-2} = 2$$

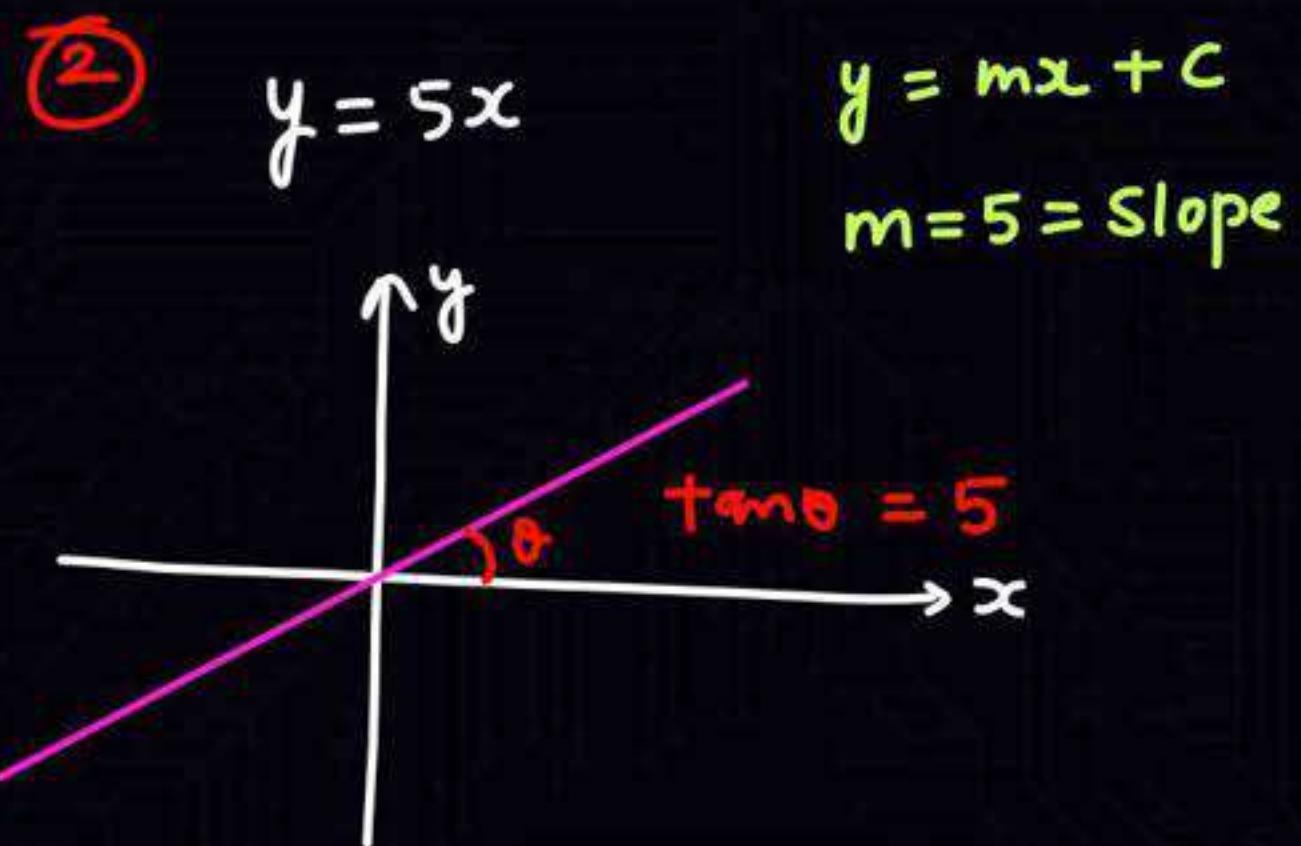
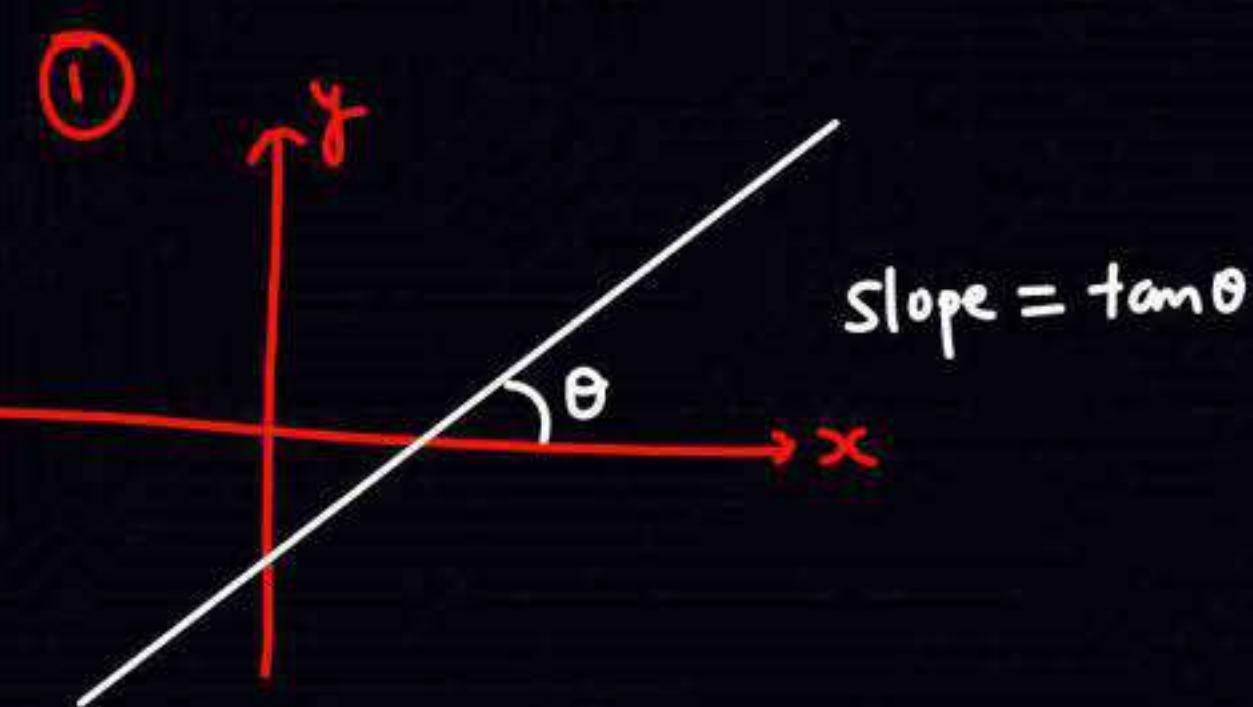


$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{change in } y}{\text{change in } x}$$



$$\text{Avg velocity } (A \rightarrow B) = \frac{x_f - x_i}{t_f - t_i} = \frac{7 - 3}{4 - 2} = 2$$





③

$$y = x\sqrt{3}$$



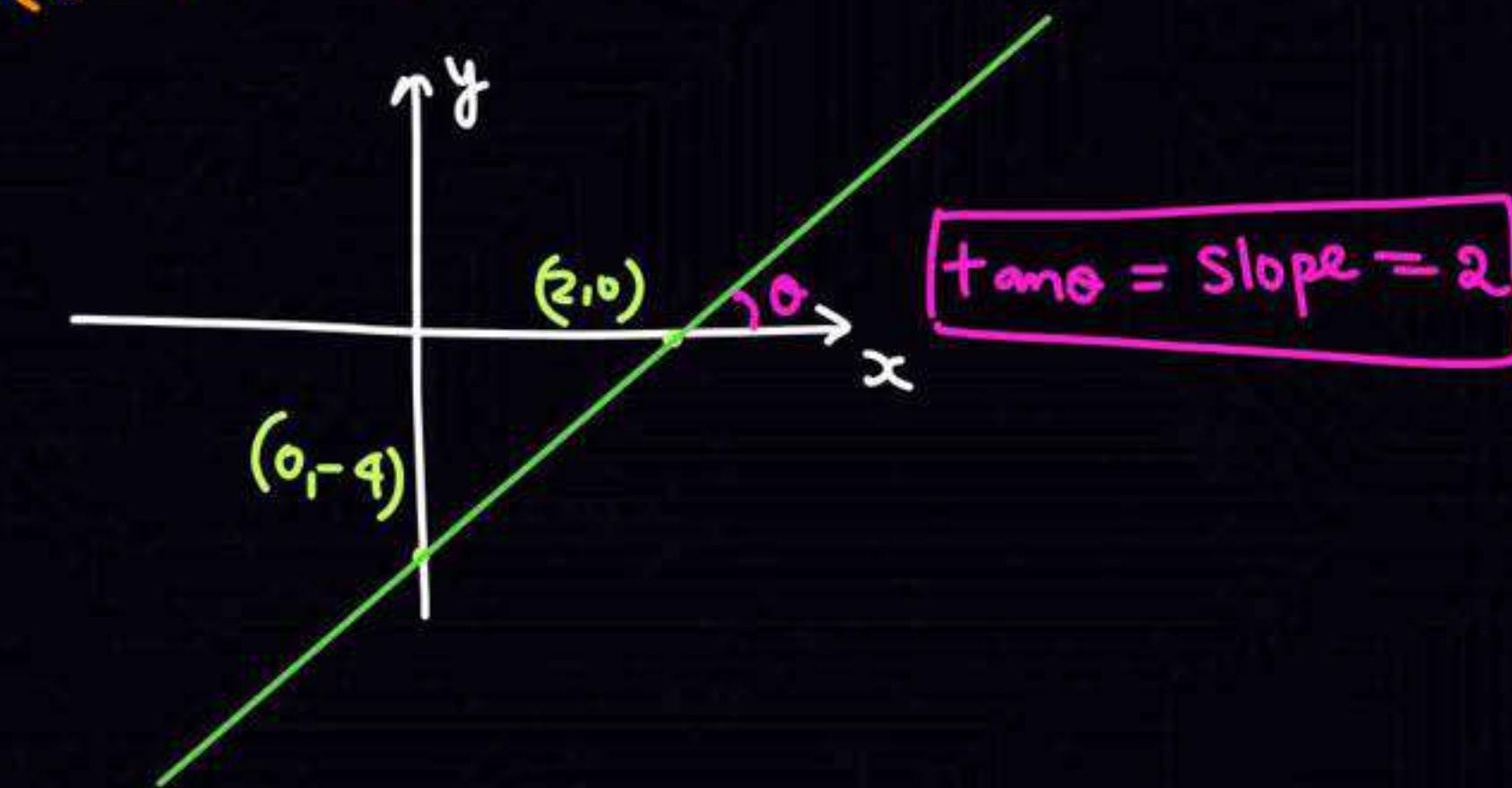
$$\text{Slope} = \sqrt{3} = \tan\theta$$

$$\theta = 60^\circ$$

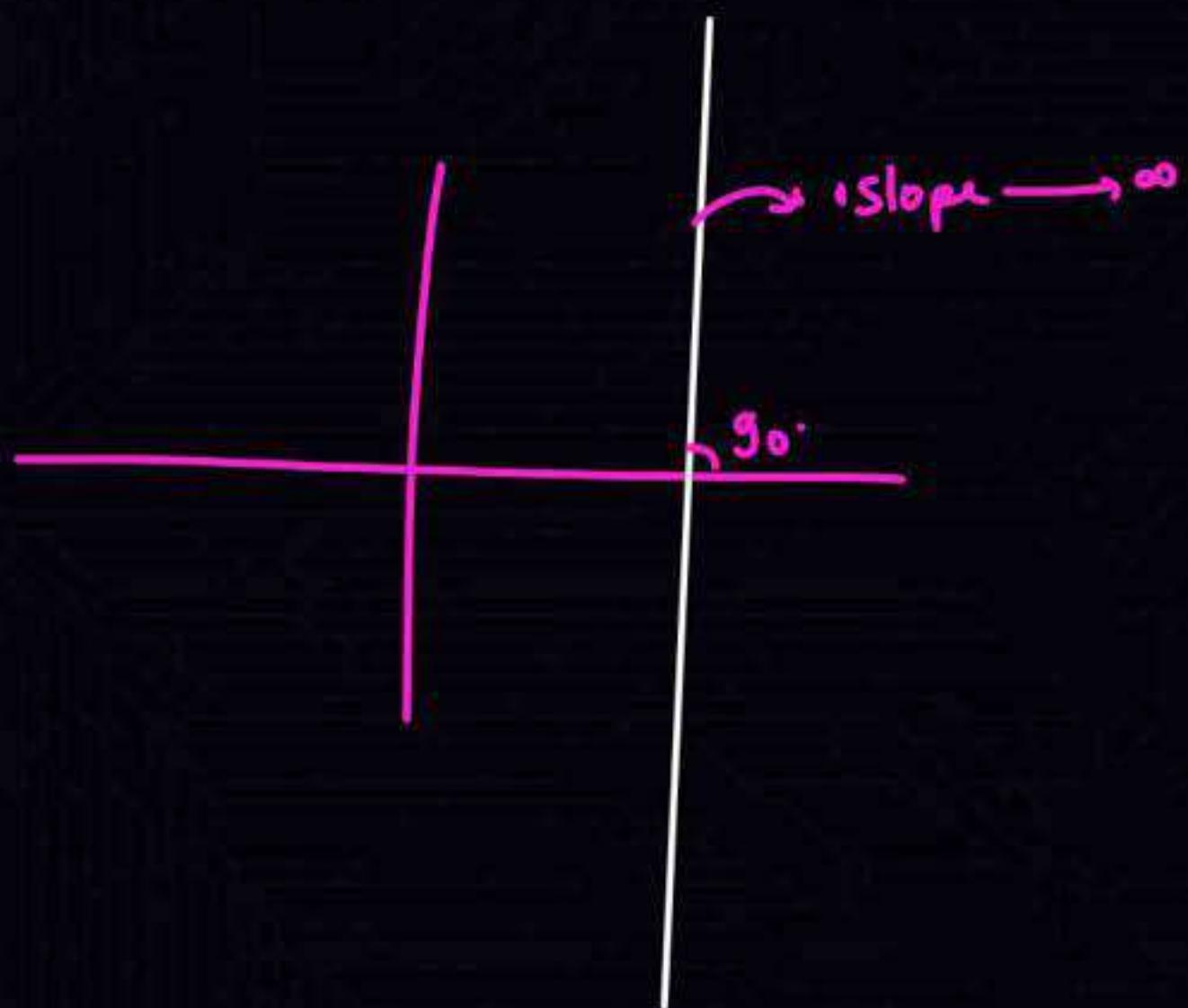
$$y = 2x - 4 \quad (\text{draw}) \rightarrow (\text{not imp in physics})$$

$$(x=0, y=-4) = (0_1, -4)$$
$$(y=0, x=2) = (2, 0)$$

Slope = 2  $\Rightarrow$  +ve



$$\tan\theta = \text{Slope} = 2$$

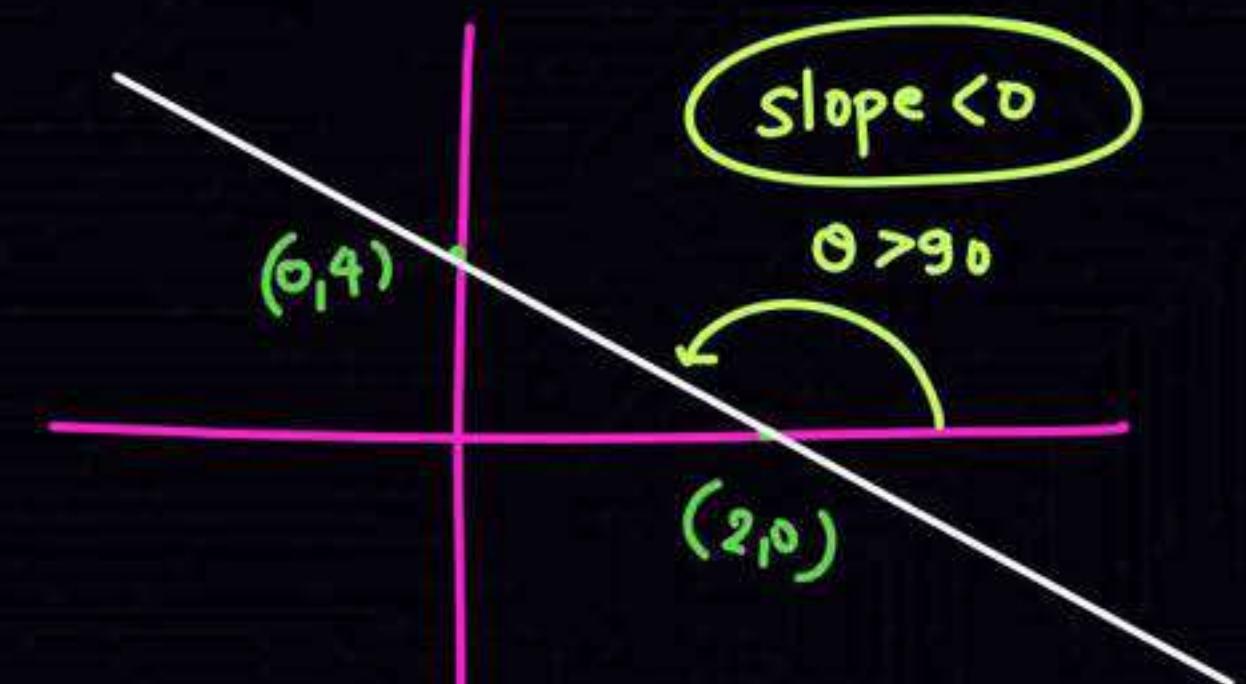


$$y = -2x + 4$$

$$\begin{aligned}x=0, \quad y &= 4 \\y=0, \quad x &= 2\end{aligned}$$

$$\text{Slope} = -2$$

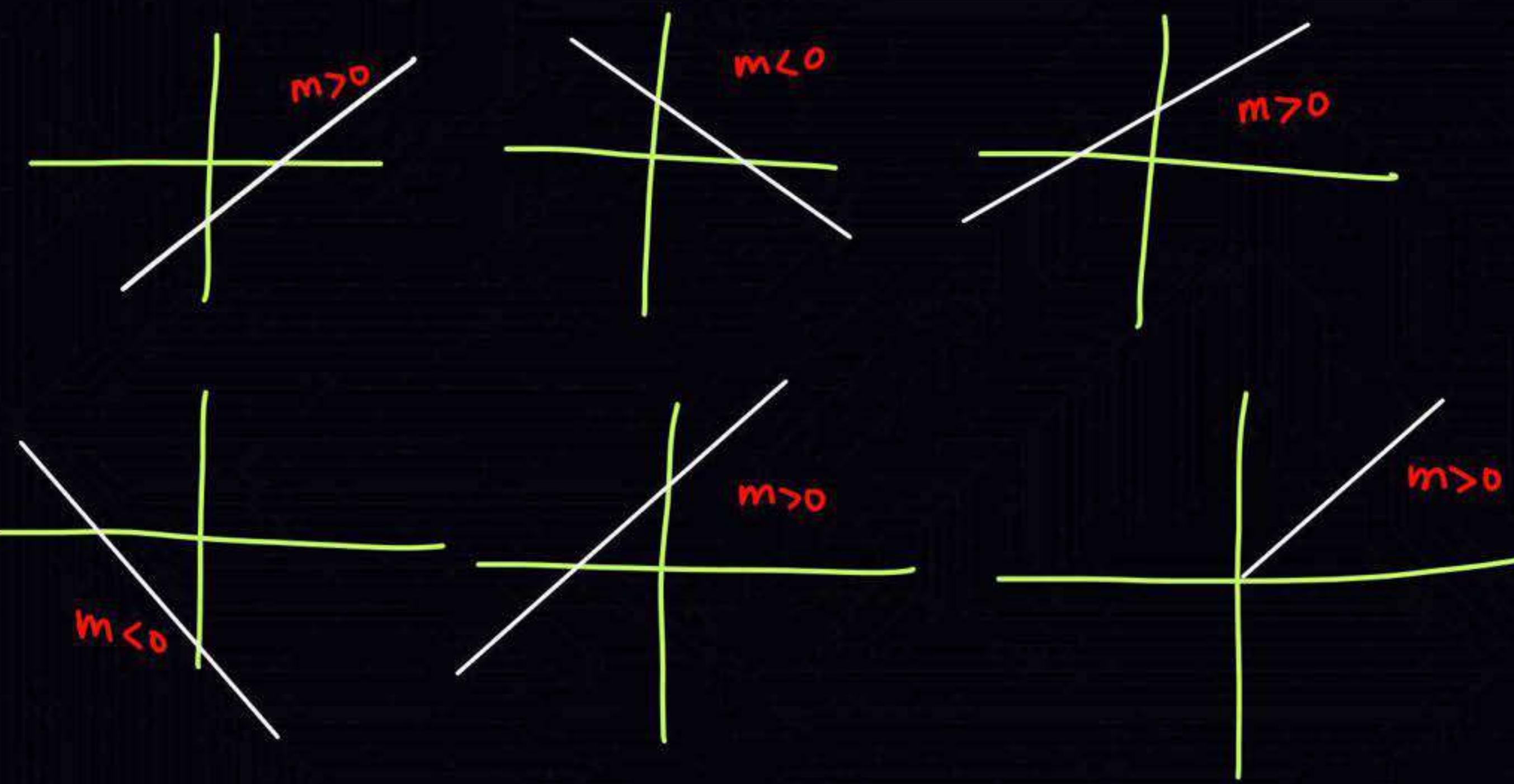
$$\tan \theta = -2$$



$$\begin{aligned}y &= mx + c \\2y &= 8x + 16\end{aligned}$$

$$\boxed{\text{Slope} = 8x}$$

$$\begin{aligned}y &= 4x + 8 \\ \text{Slope} &= 4\end{aligned}$$



$$y = x^n$$

$$\frac{dy}{dx} = nx^{n-1}$$

$$\textcircled{1} \quad y = x^3$$

$$\frac{dy}{dx} = 3x^{3-1} = 3x^2$$

$$\textcircled{2} \quad y = x^5$$

$$\frac{dy}{dx} = 5x^4$$

$$\textcircled{3} \quad y = x^7$$

$$\frac{dy}{dx} = 7x^6$$

$$\textcircled{4} \quad y = x^9$$

$$\frac{dy}{dx} = 9x^8$$

$$\textcircled{5} \quad y = 2x^5$$

$$\begin{aligned}\frac{dy}{dx} &= 2 \times 5x^4 \\ &= 10x^4\end{aligned}$$

$$\textcircled{6} \quad y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$\textcircled{7} \quad y = t^3$$

$$\frac{dy}{dt} = 3t^2$$

$$\textcircled{8} \quad x = t^3$$

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

$$\textcircled{9} \quad x = t^5$$

$$\frac{dx}{dt} = 5t^4$$

$$\textcircled{10} \quad x = t^7$$

$$\frac{dx}{dt} = 7t^6$$

$$\textcircled{1} \quad y = x^n$$

$$\frac{dy}{dx} = nx^{n-1}$$

$$\textcircled{2} \quad y = \sin x$$

$$\frac{dy}{dx} = \frac{d}{dx}(\sin x) = \cos x$$

↓  
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



$$Q \quad x = 3t^2 - 12t + 10$$

$$\textcircled{1} \quad t=0, \quad t=2, \quad t=3,$$

$$\begin{cases} \rightarrow v = 6t - 12 \\ \rightarrow a = 6 = \text{const} \end{cases}$$

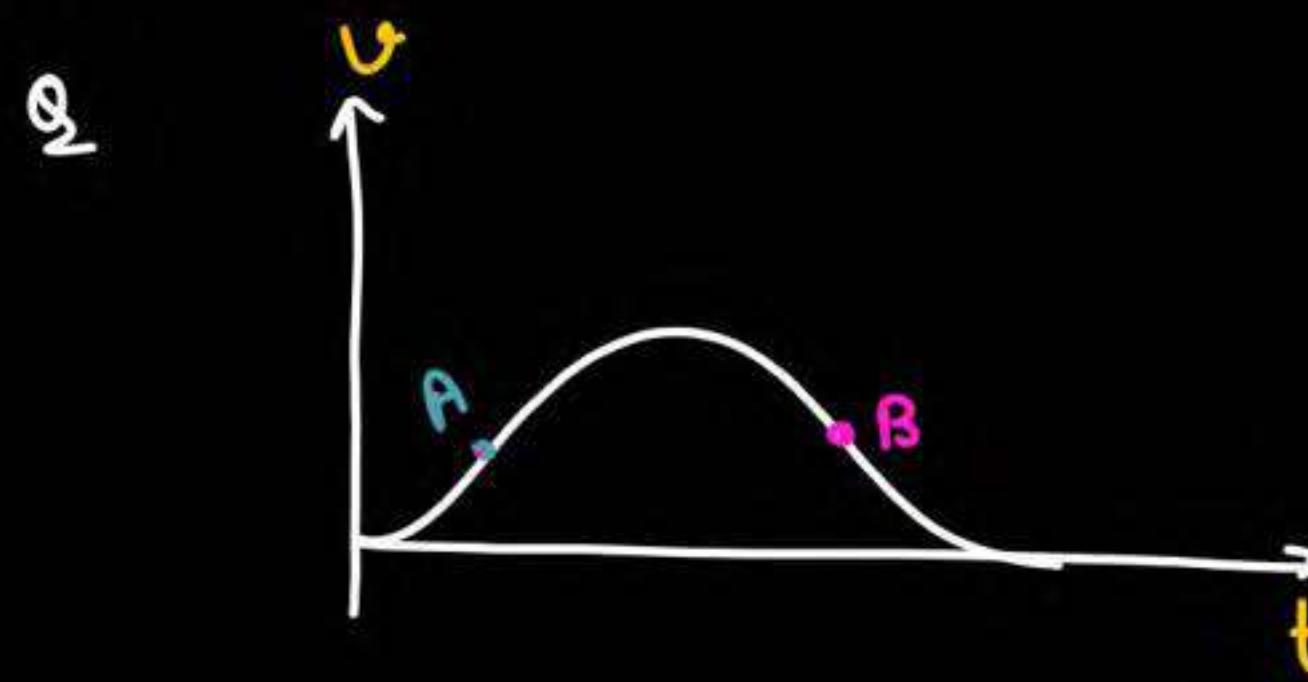
	$x$	$v$	$a$
$t=0$	10	-12	6
$t=2$	-2	0	6
$t=3$	+1	6	6

$\textcircled{2}$  find  $x$  &  $a$  when particle comes to at rest

$$v = 0, \quad v = 6t - 12 = 0$$

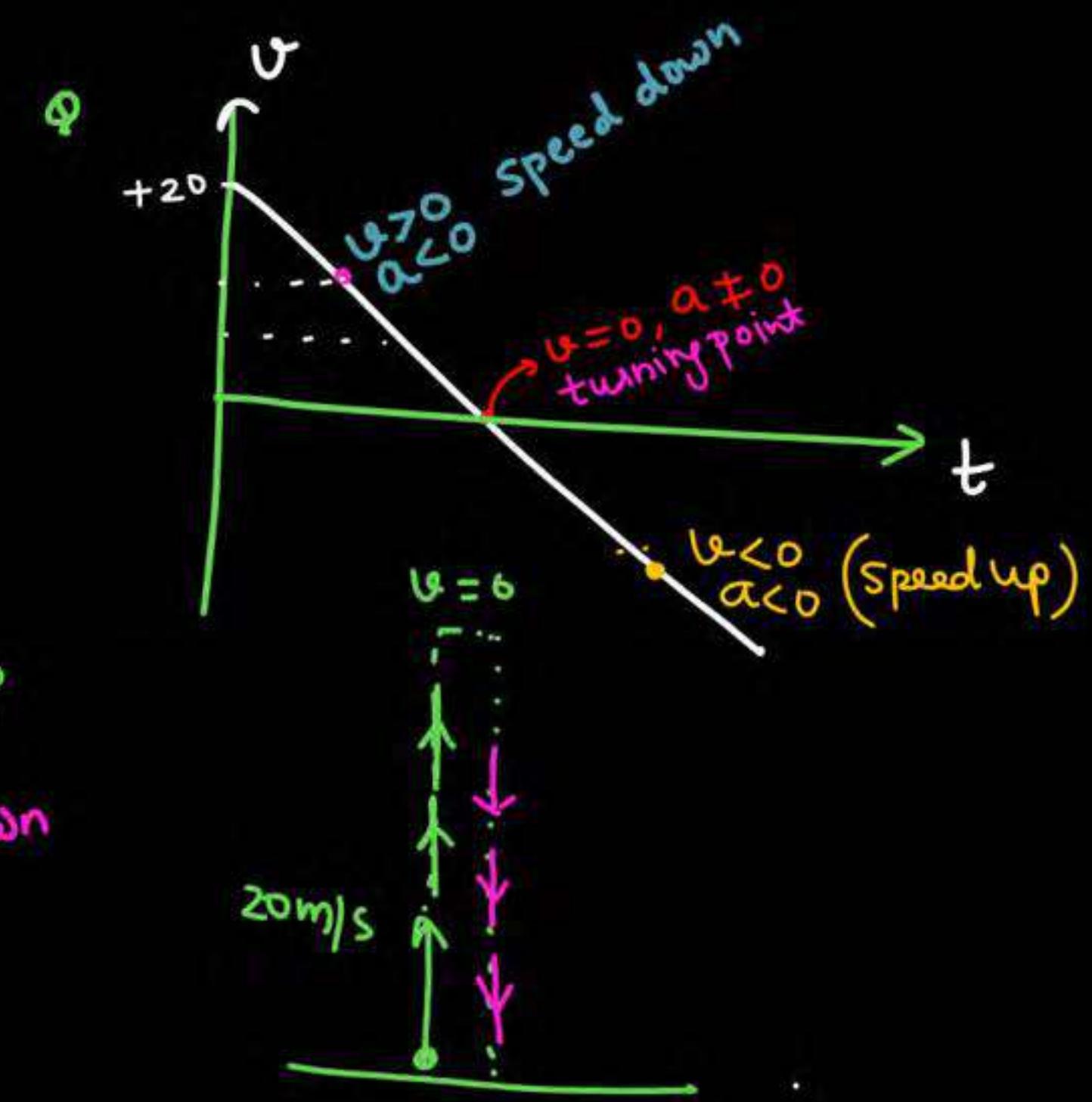
$$t = 2$$

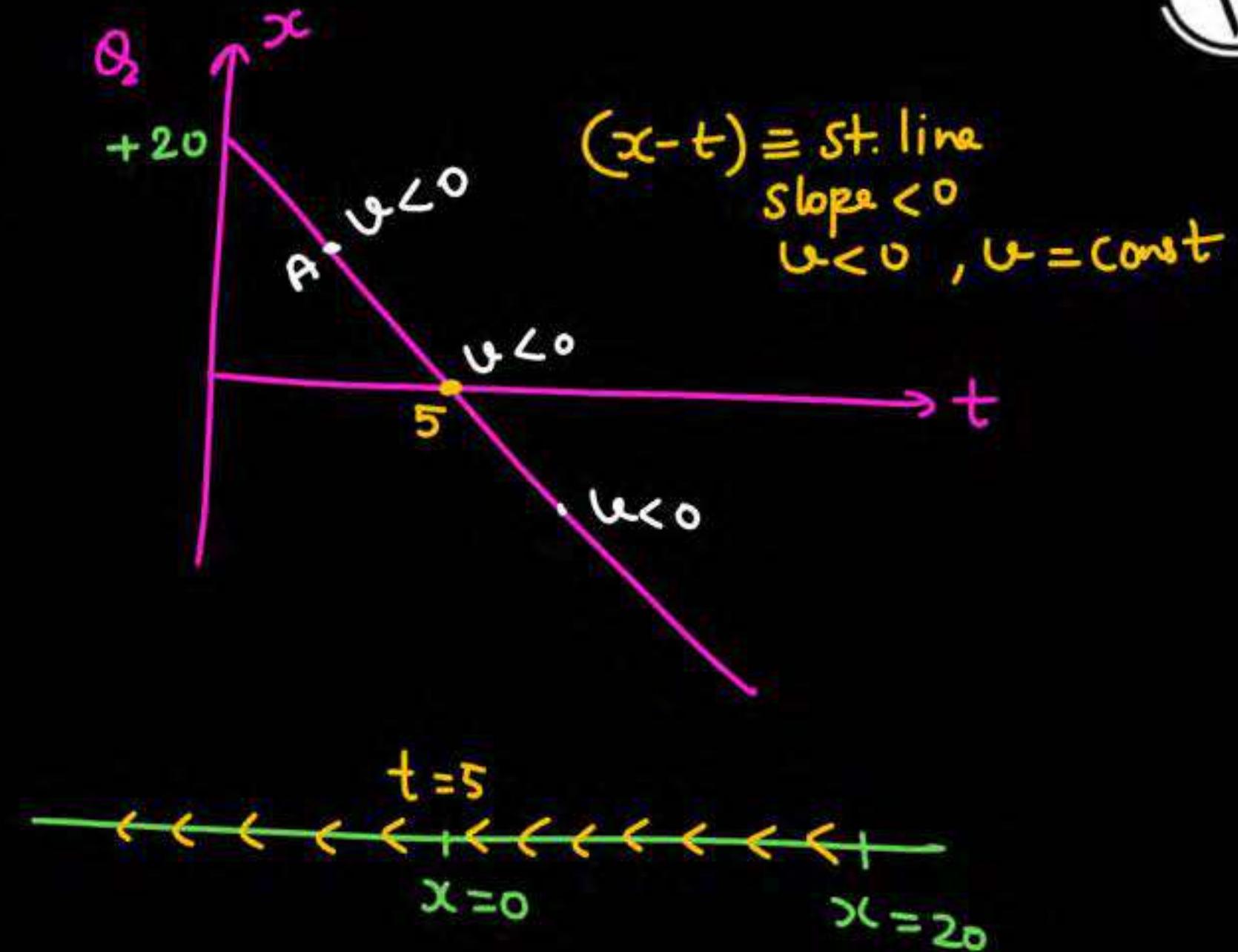
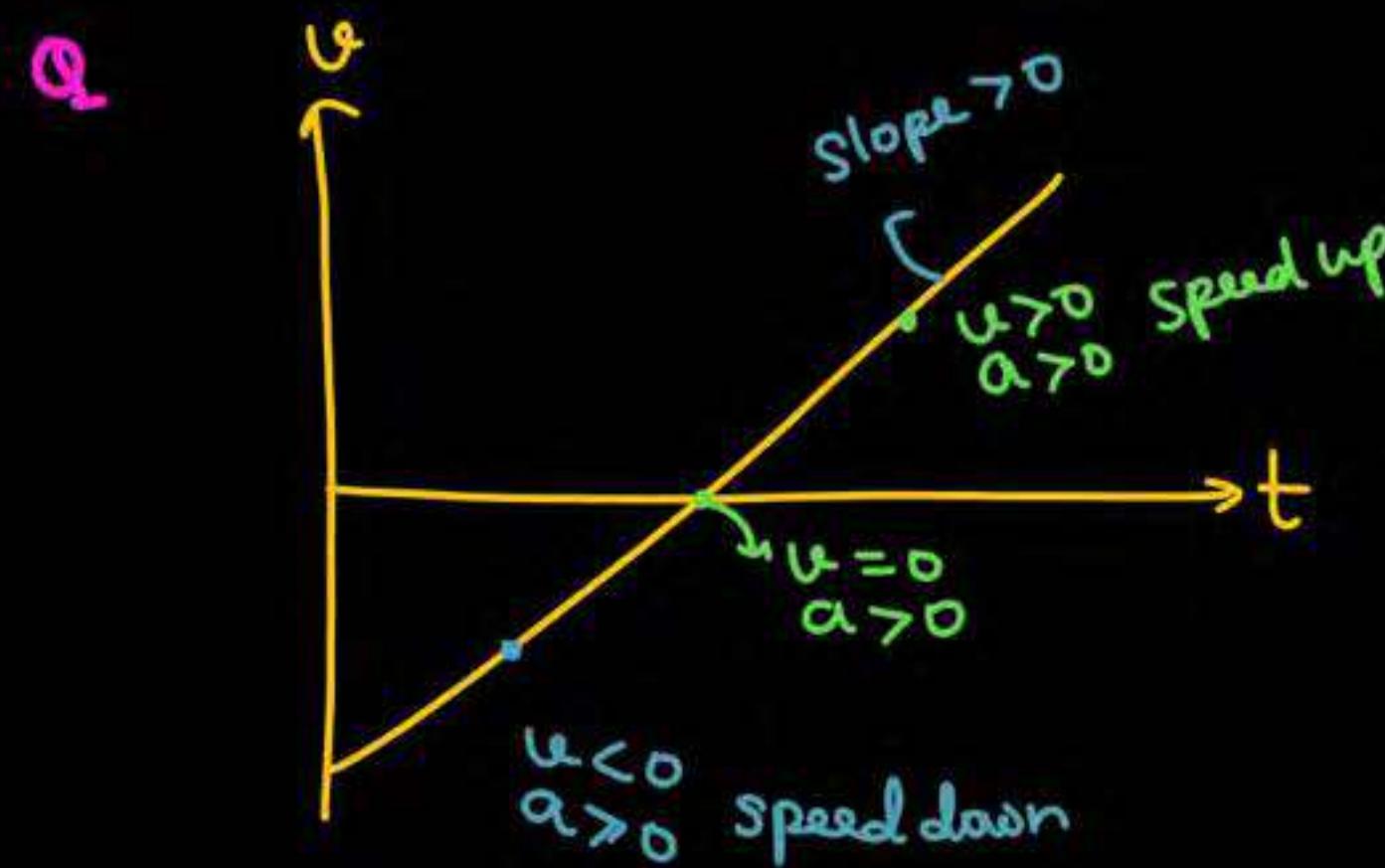
$$t = 2, \quad x = -2 \\ a = 6$$

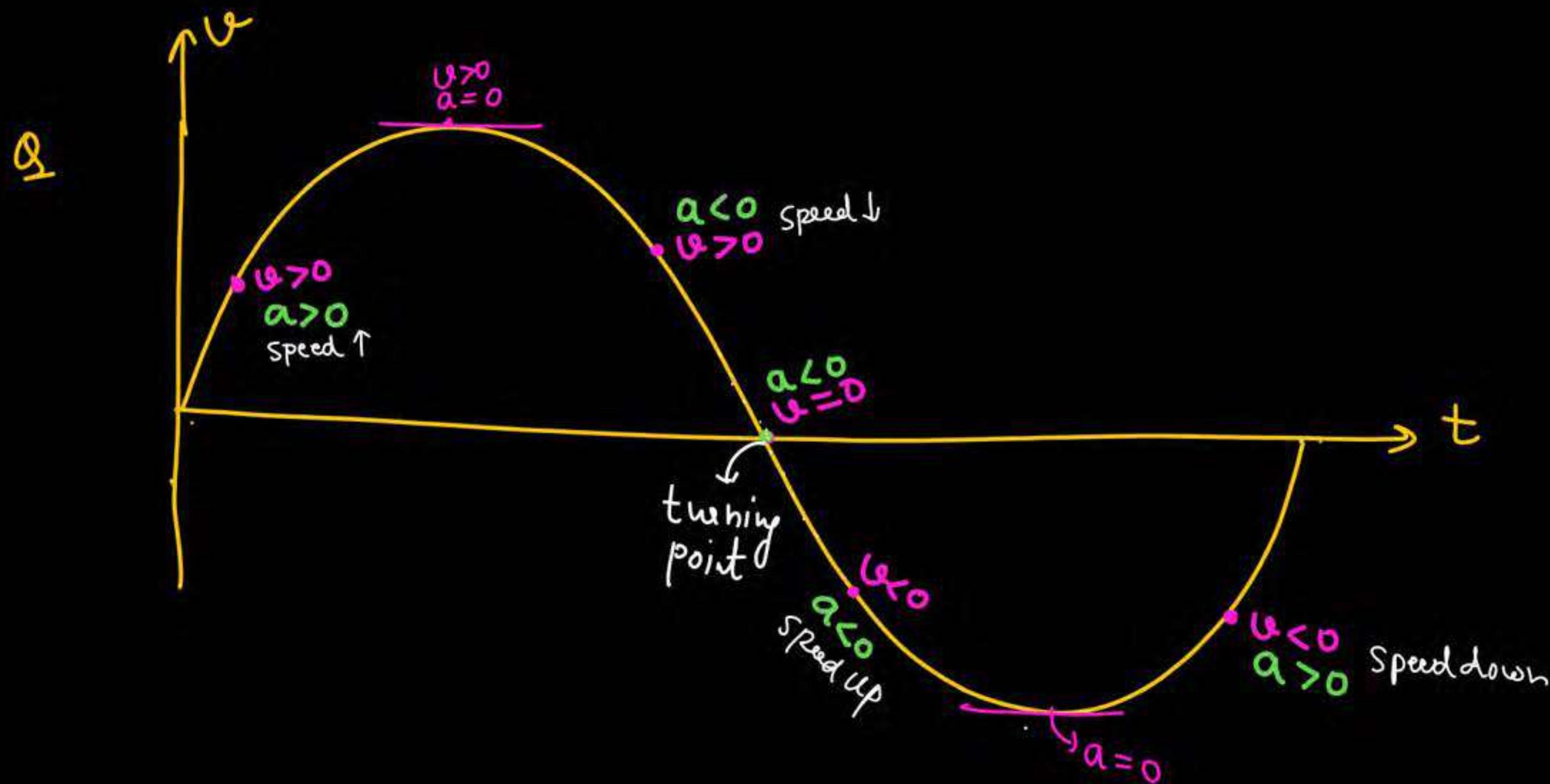


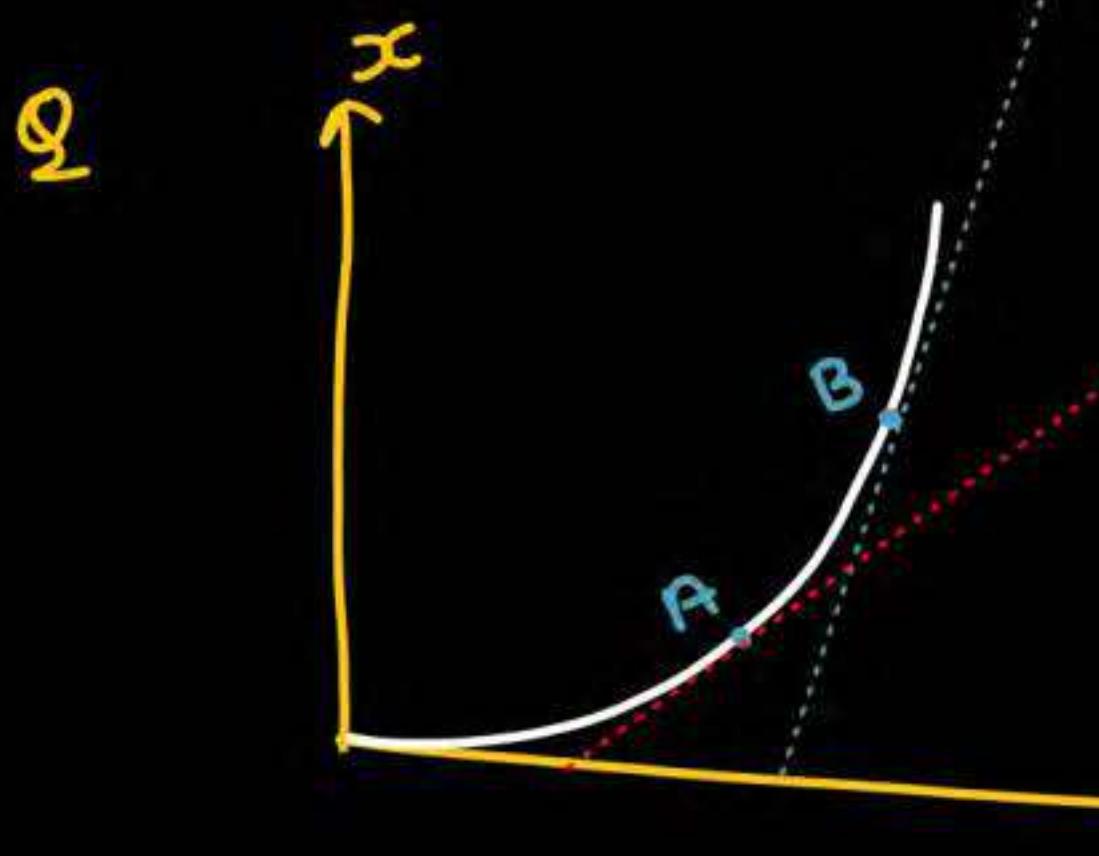
$v_A > 0, a_A > 0 \Rightarrow$  Speed up

$v_B > 0, a_B < 0 \Rightarrow$  Speed down









logical तरीका

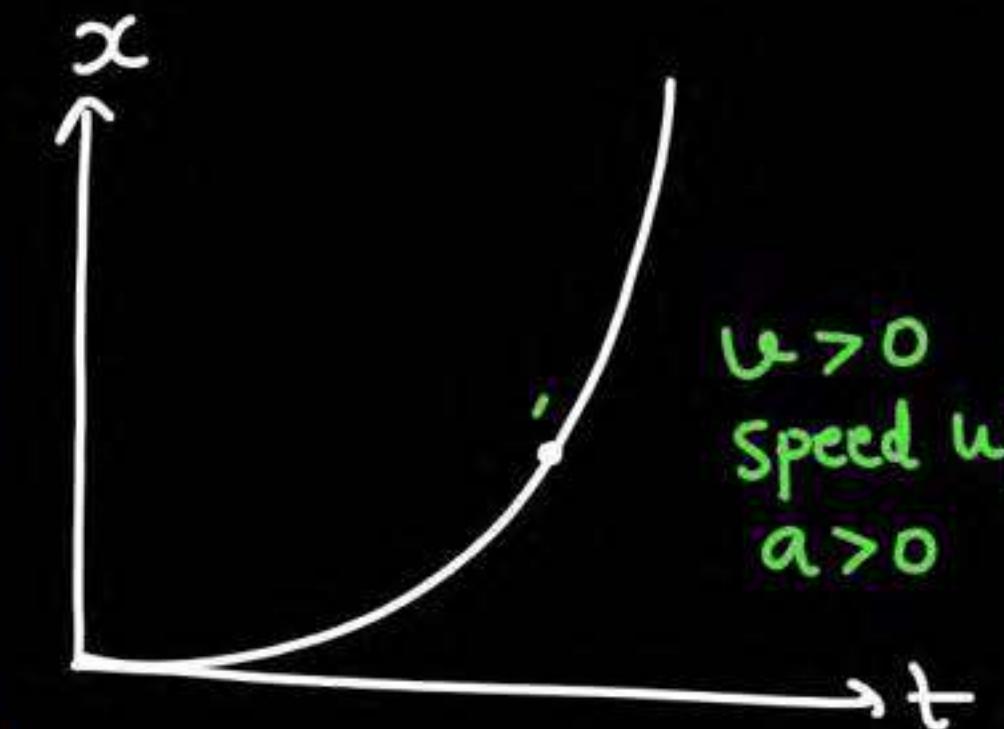
$$v_A > 0, v_B > 0$$

$(\text{slope})_{\text{at } B} > (\text{slope})_{\text{at } A}$

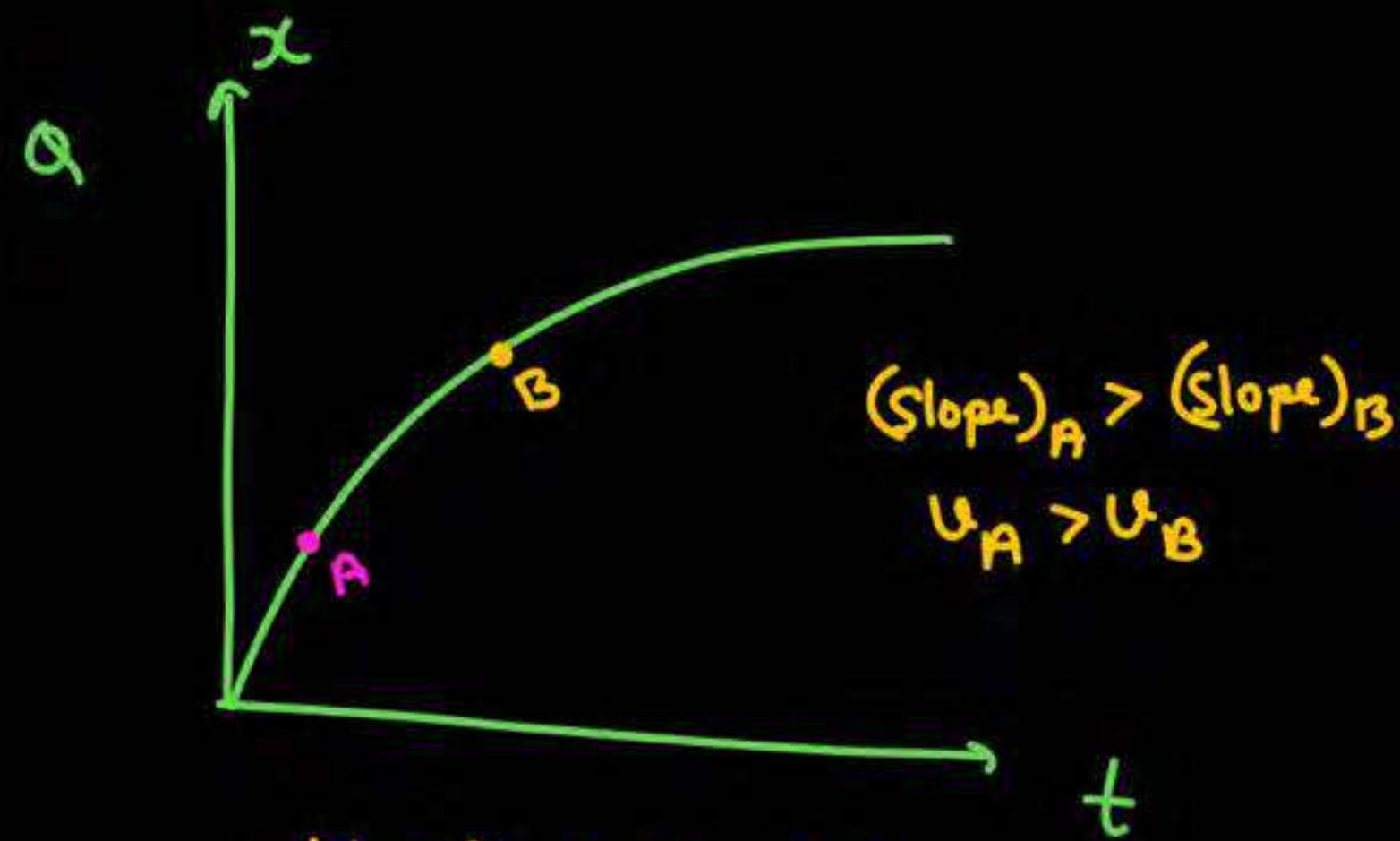
$$v_B > v_A$$

speed up

$$v > 0 \quad a > 0$$



$v > 0$   
Speed up  
 $a > 0$

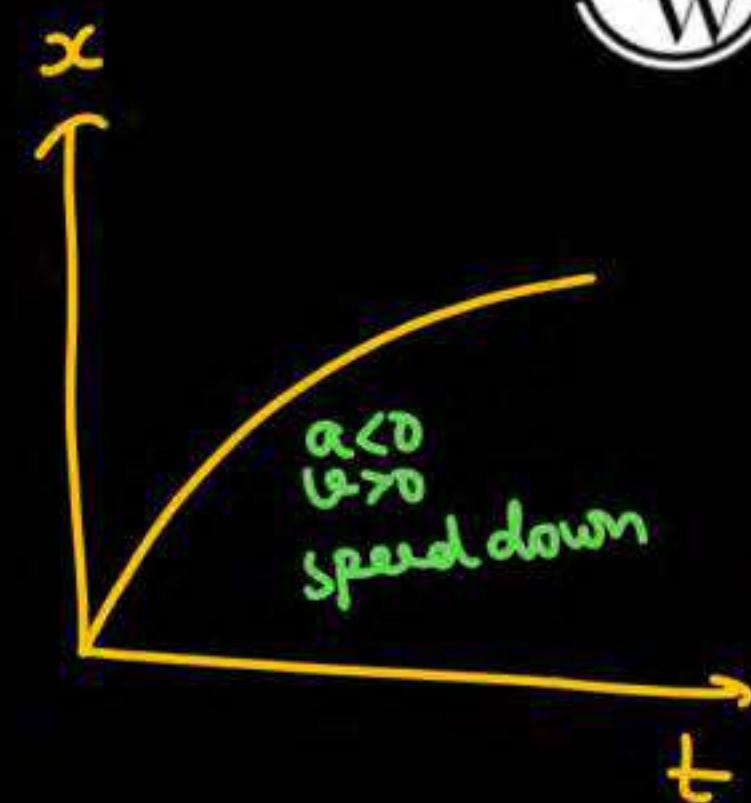
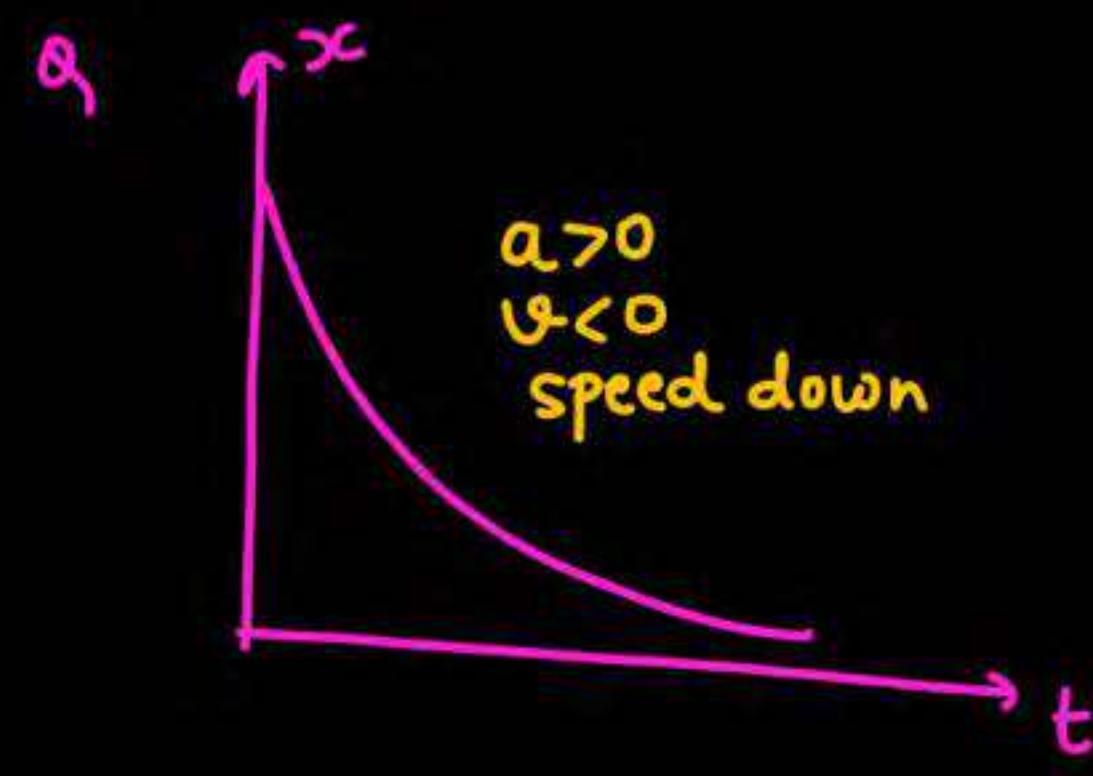
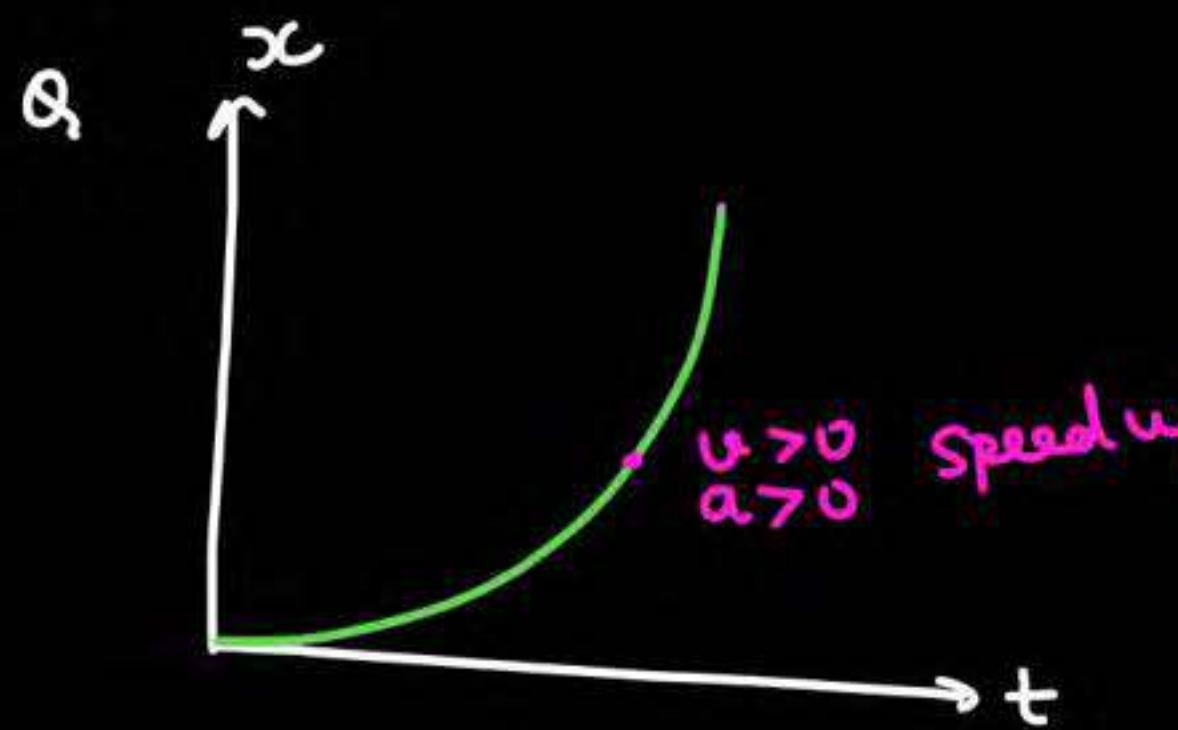


$$(\text{slope})_A > (\text{slope})_B$$

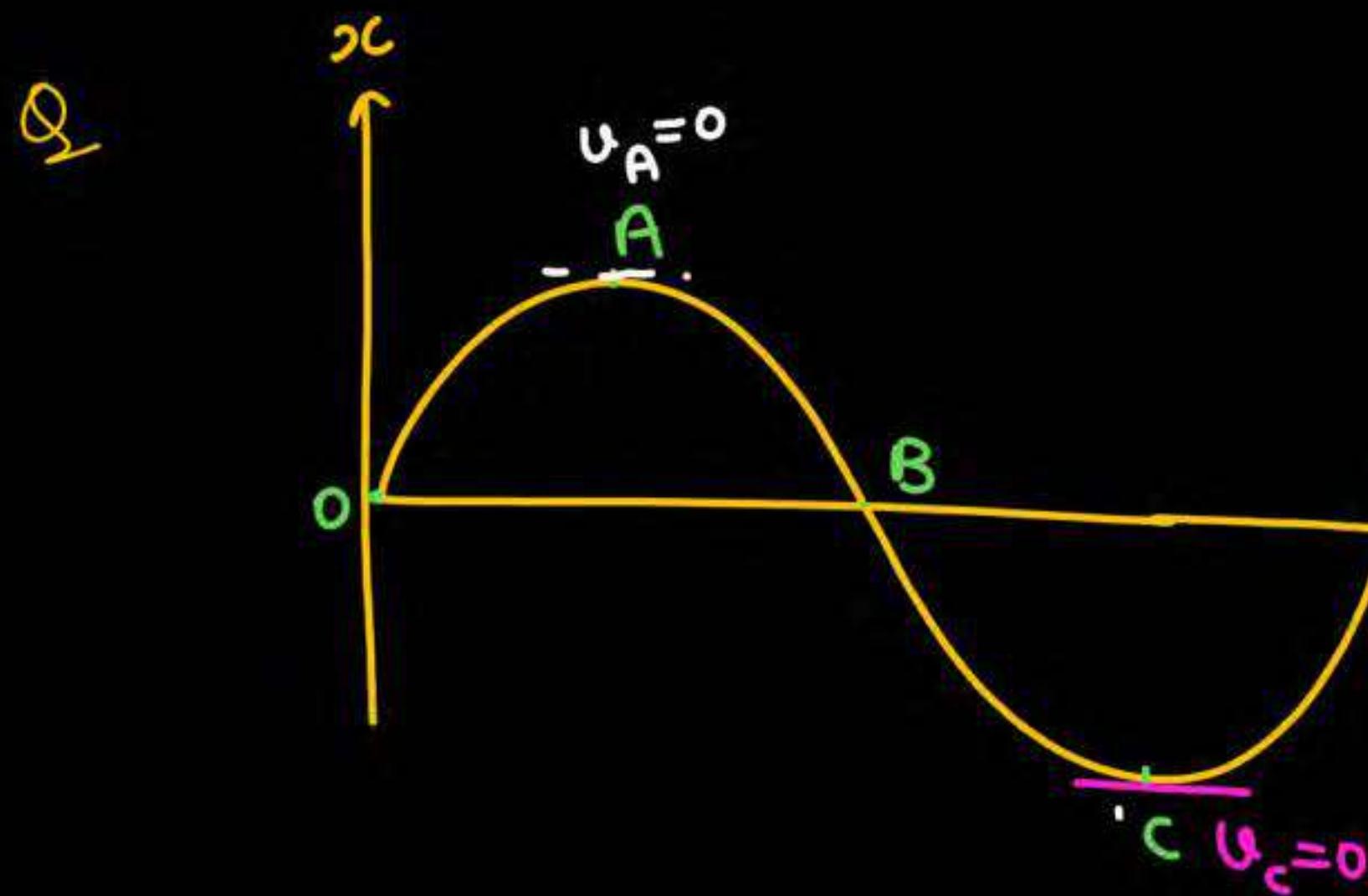
$$v_A > v_B$$

time  $\uparrow \Rightarrow$  Speed  $\downarrow$

$$v > 0, a < 0$$



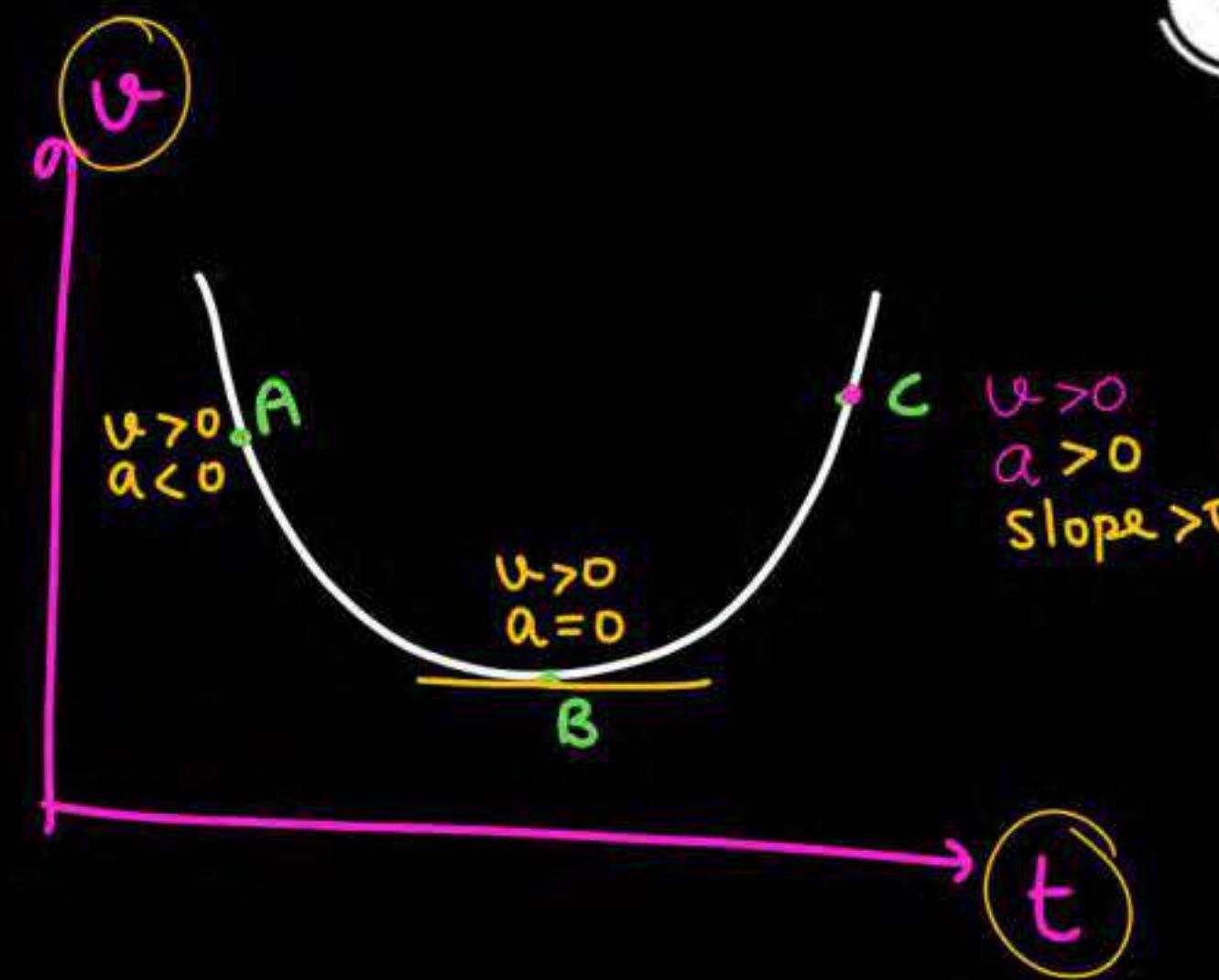
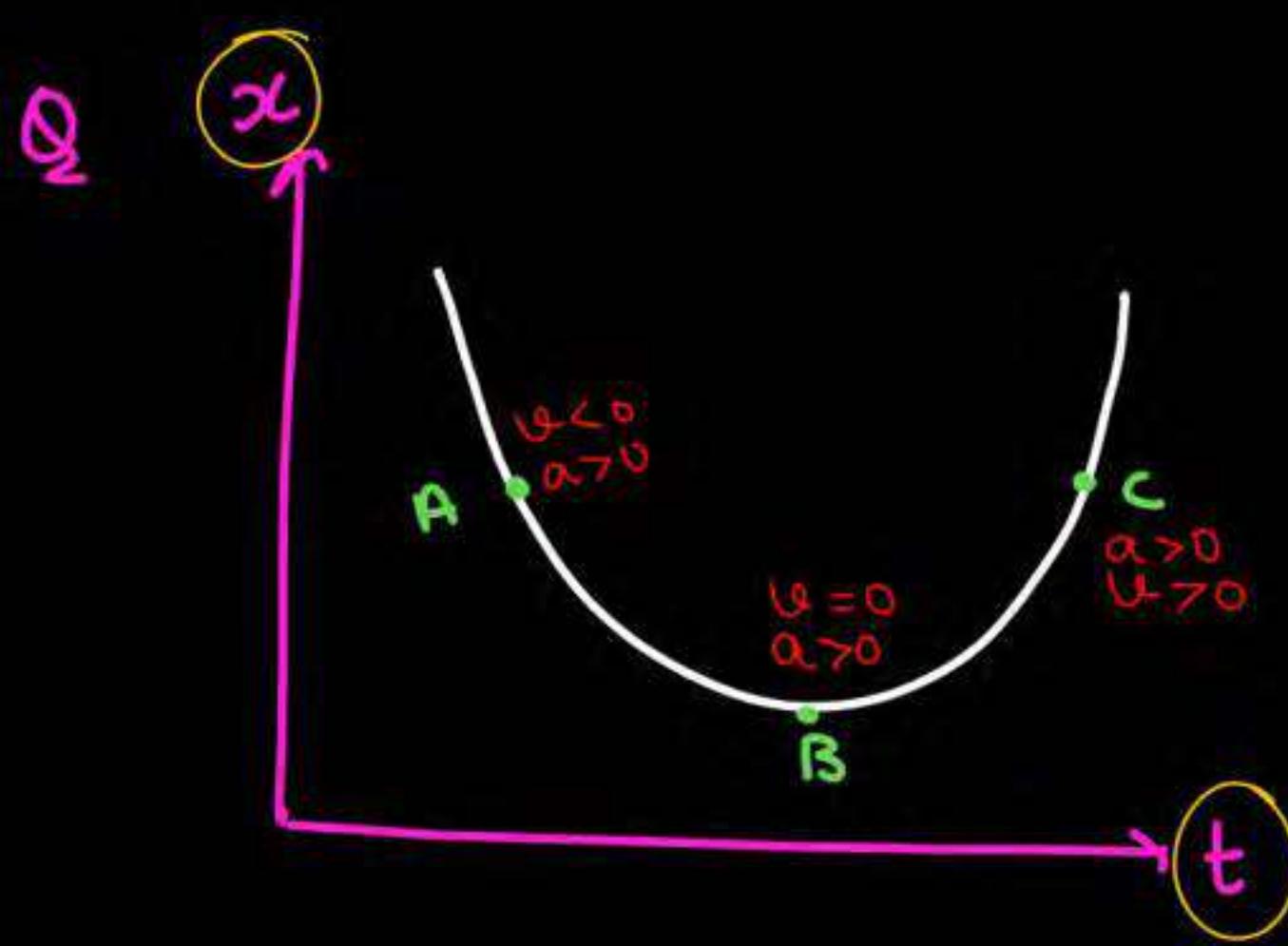
P  
W

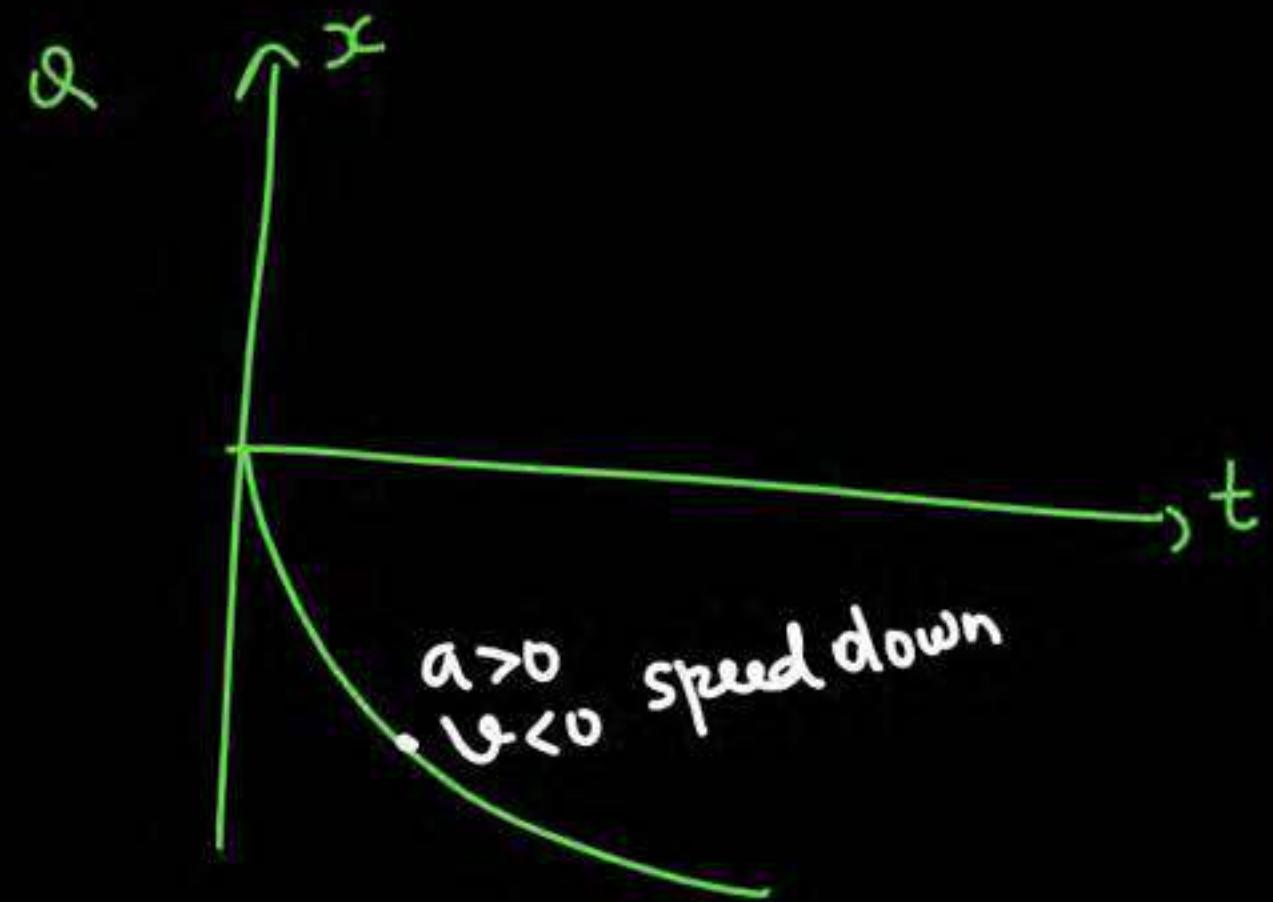
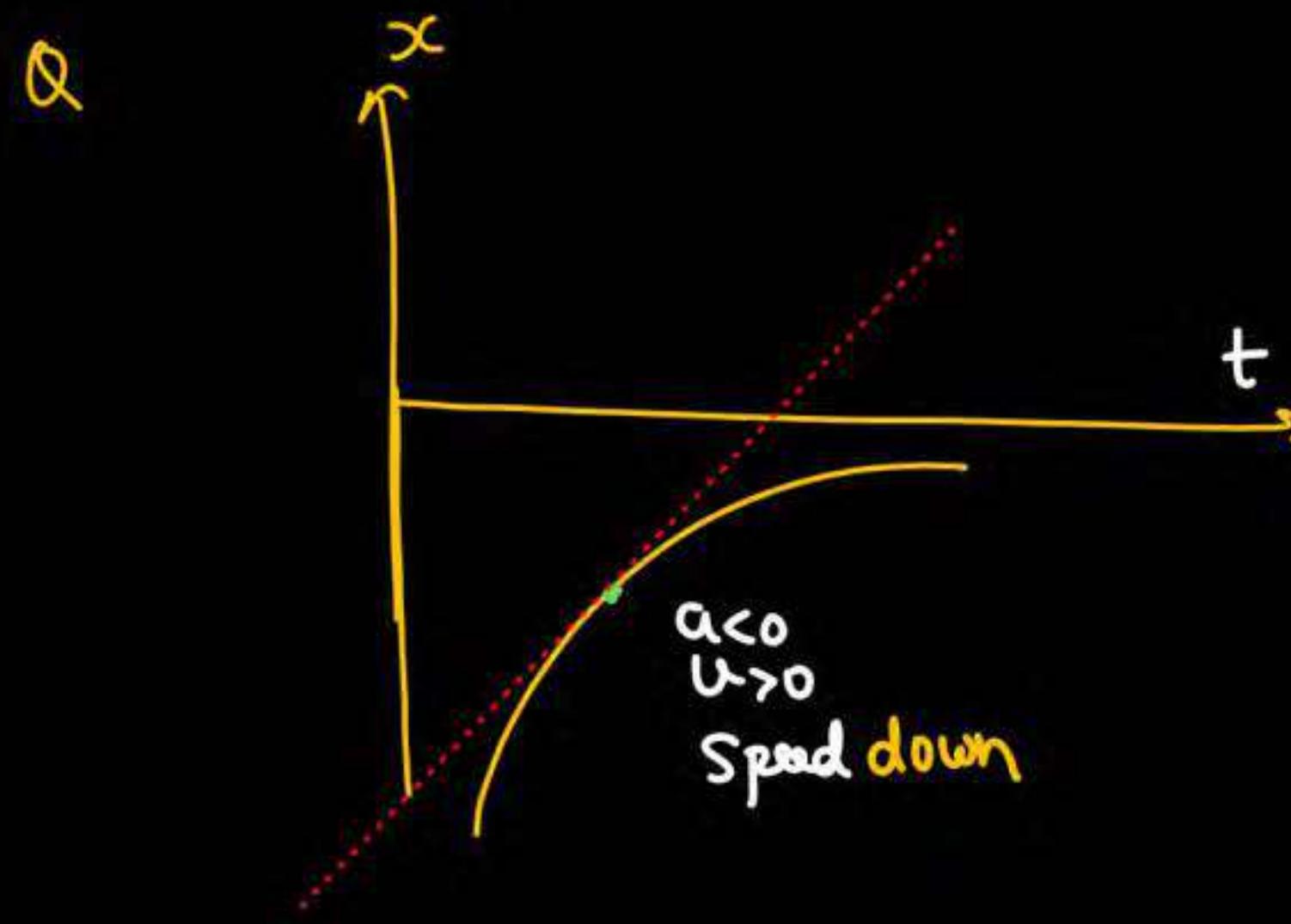


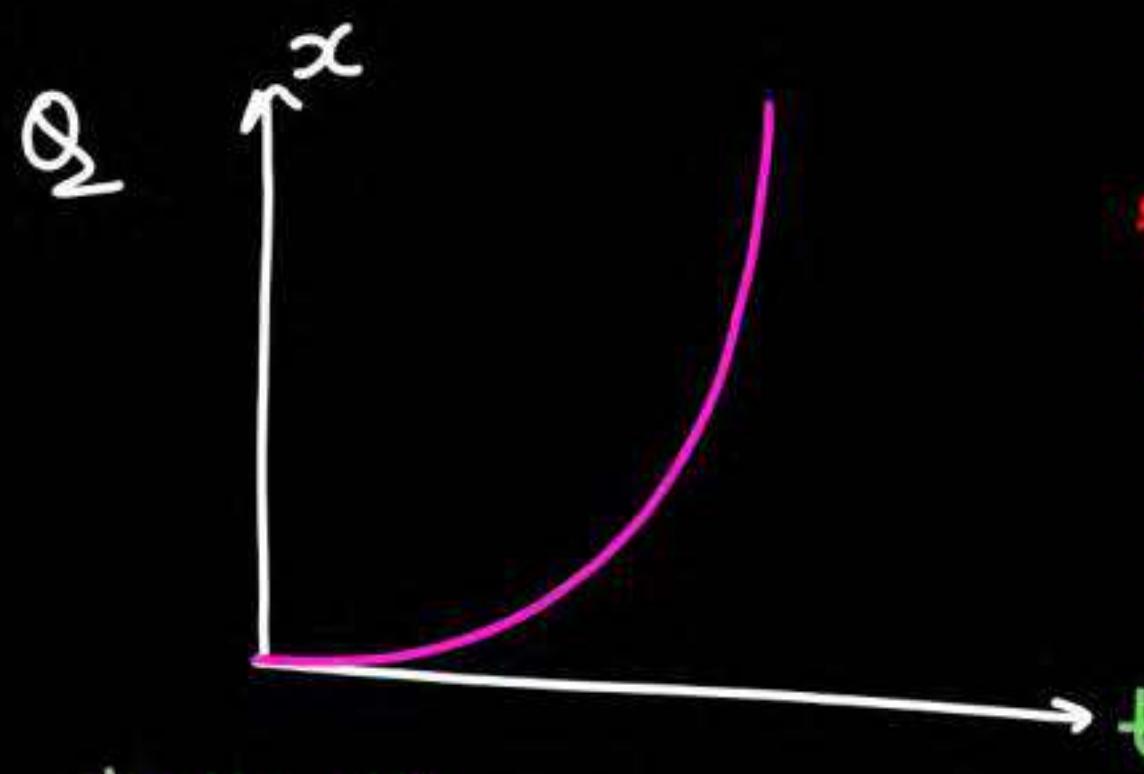
$\omega$	$a$	
+	-	Speed $\uparrow \downarrow$
-	-	Speed $\downarrow$
-	+	Speed $\uparrow$
+	+	Speed $\downarrow$
+	+	Speed up

Arrows indicate the direction of motion:  $O \rightarrow A$ ,  $A \rightarrow B$ ,  $B \rightarrow C$ , and  $C \rightarrow D$ .

P  
W



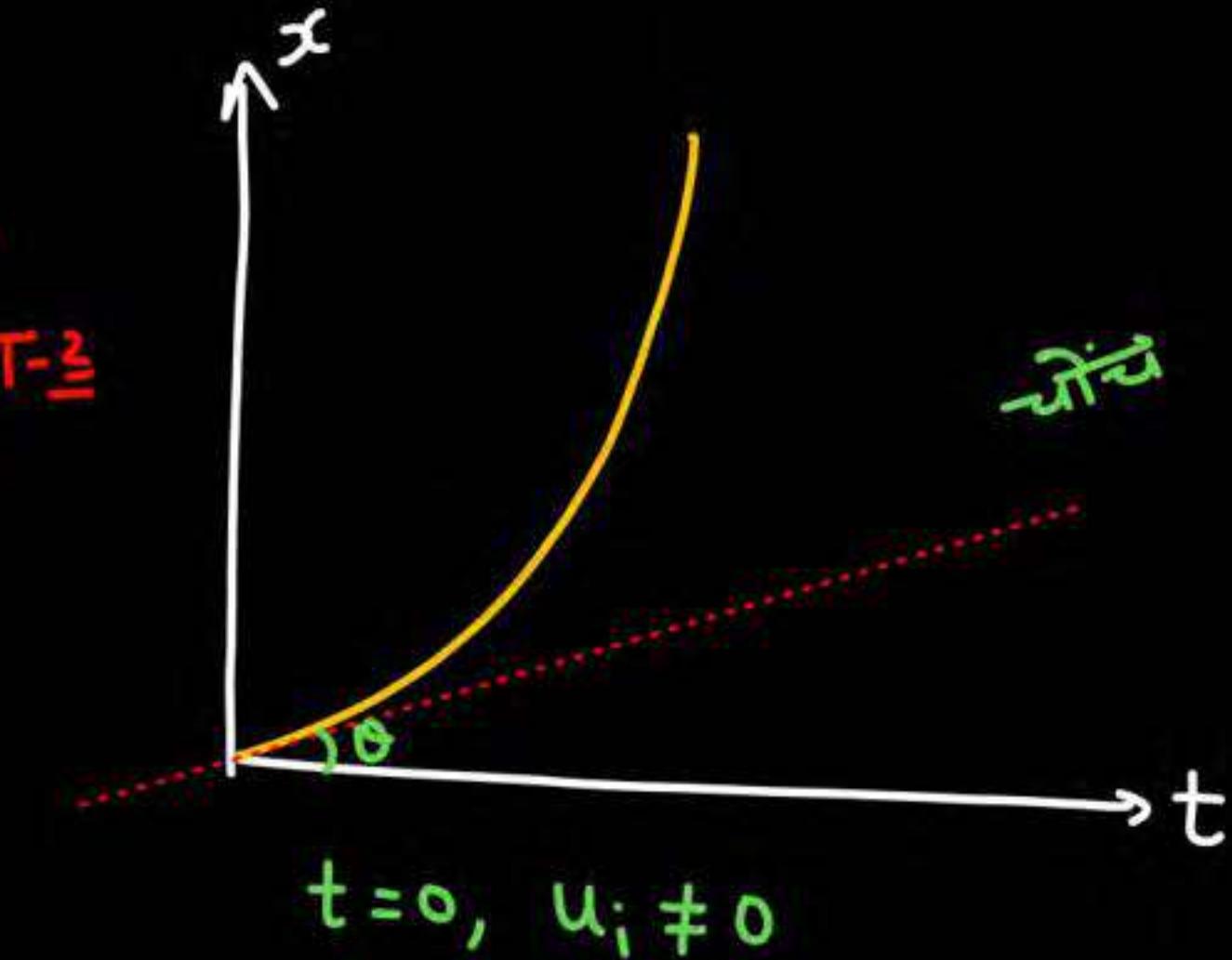




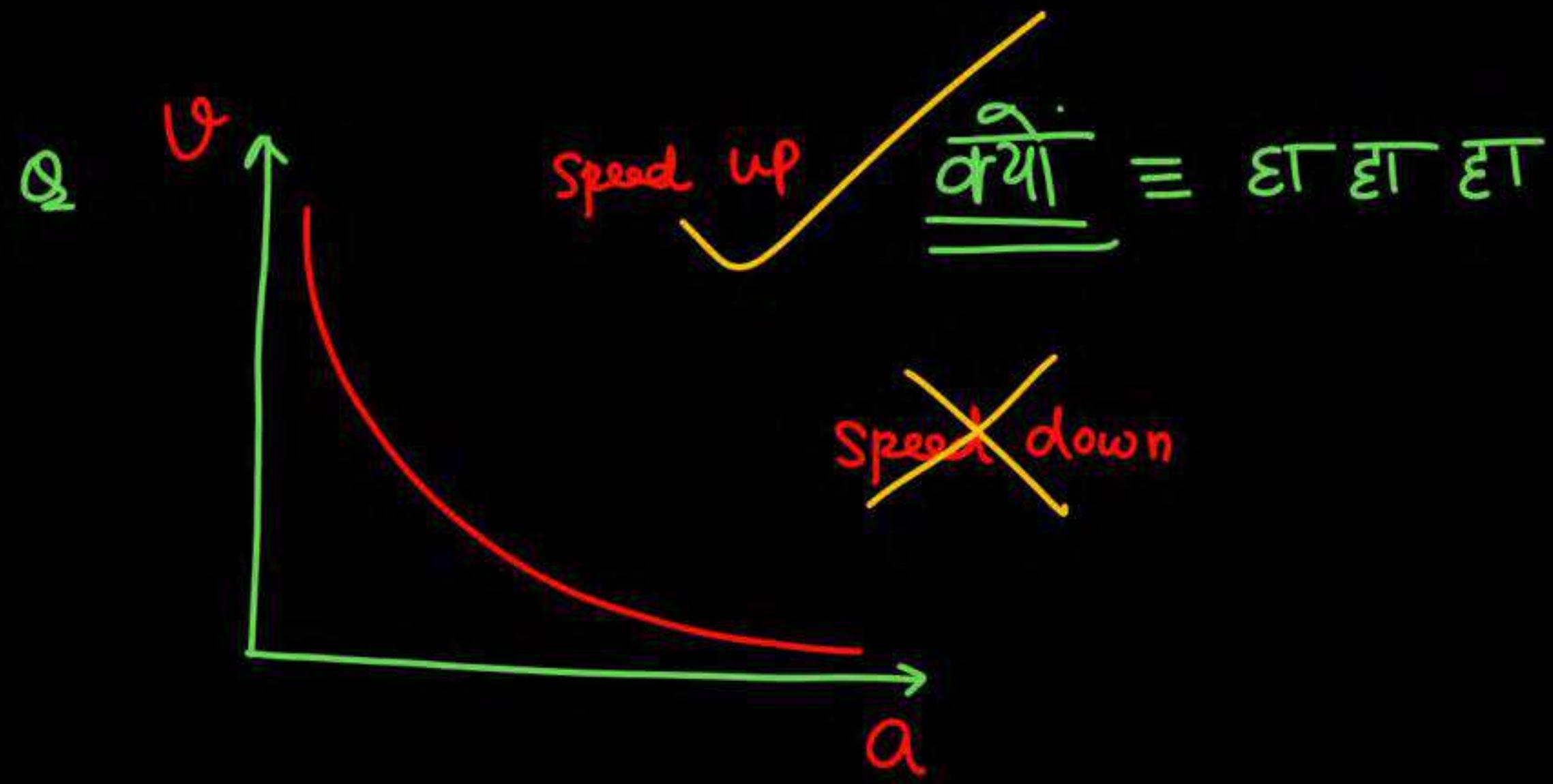
$$t=0, \text{ Slope}=0 \\ v=0$$

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

$$\textcircled{1} \quad t=0, x_i = 5$$

$$t=4, x_f = 5$$

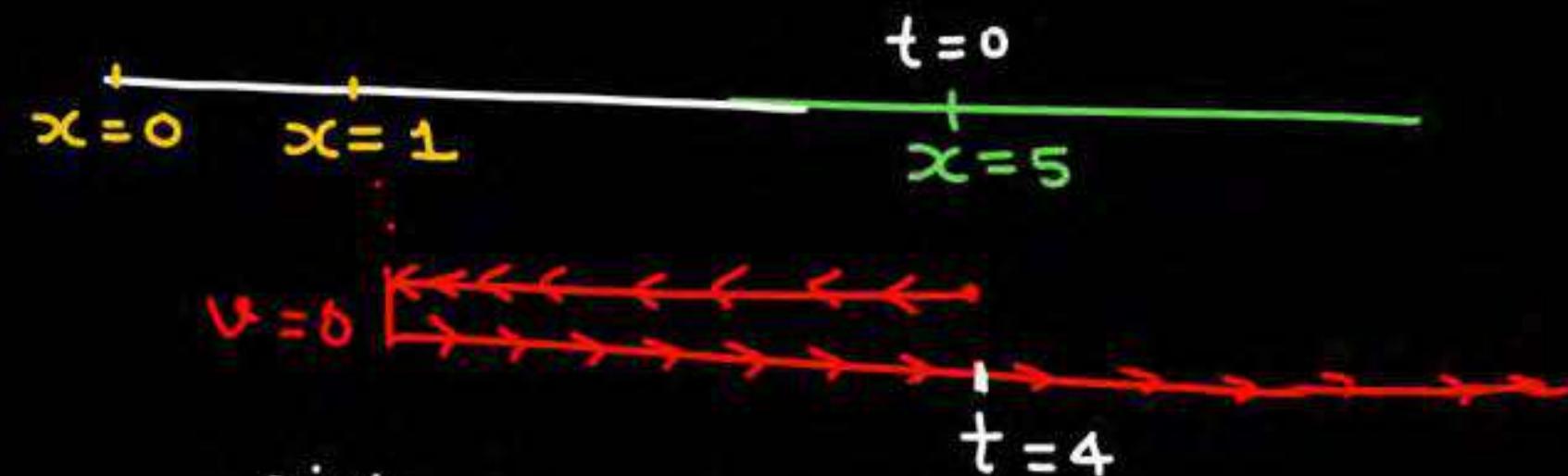
$$\textcircled{2} \quad \text{turning point} \equiv ?$$

$$v = 0$$

$$v = 2t - 4 = 0$$

$$\boxed{t = 2 \text{ sec}}$$

$$\begin{aligned} t = 2, x &= 2^2 - 4 \times 2 + 5 \\ &= 1 \end{aligned}$$



$$\text{Distance } t=0 \rightarrow t=4 = 4 + 4$$

$$\text{Average speed} = \frac{8}{4} = 2$$

Q  $x = t^2 - 2t + 10$

find average speed from  $t=0 \rightarrow t=3$  sec

Sol<sup>n</sup>

$$t=0, x_i = 10$$

$$t=3, x_f = 9 - 6 + 10 = 13$$

$$v = 2t - 2 = 0$$

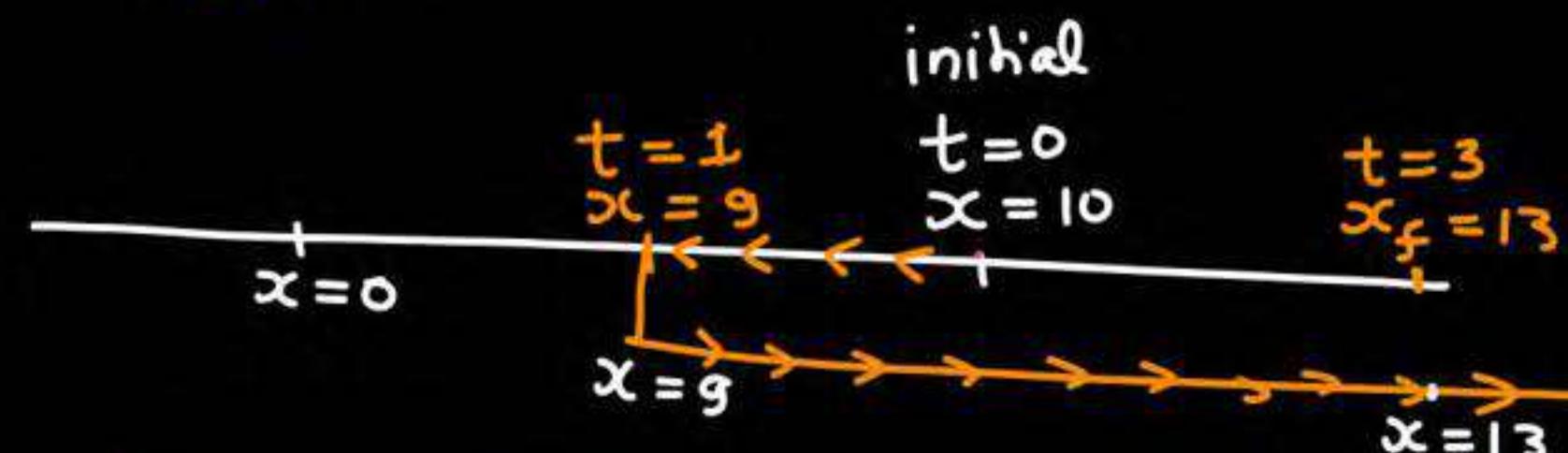
$$2t = 2$$

$$\boxed{t=1}$$

$\approx$  turning point

$$t=1, x = 1^2 - 2 \times 1 + 10$$

$$x = 9$$



Average speed =  $\frac{1+4}{3} = \frac{5}{3}$

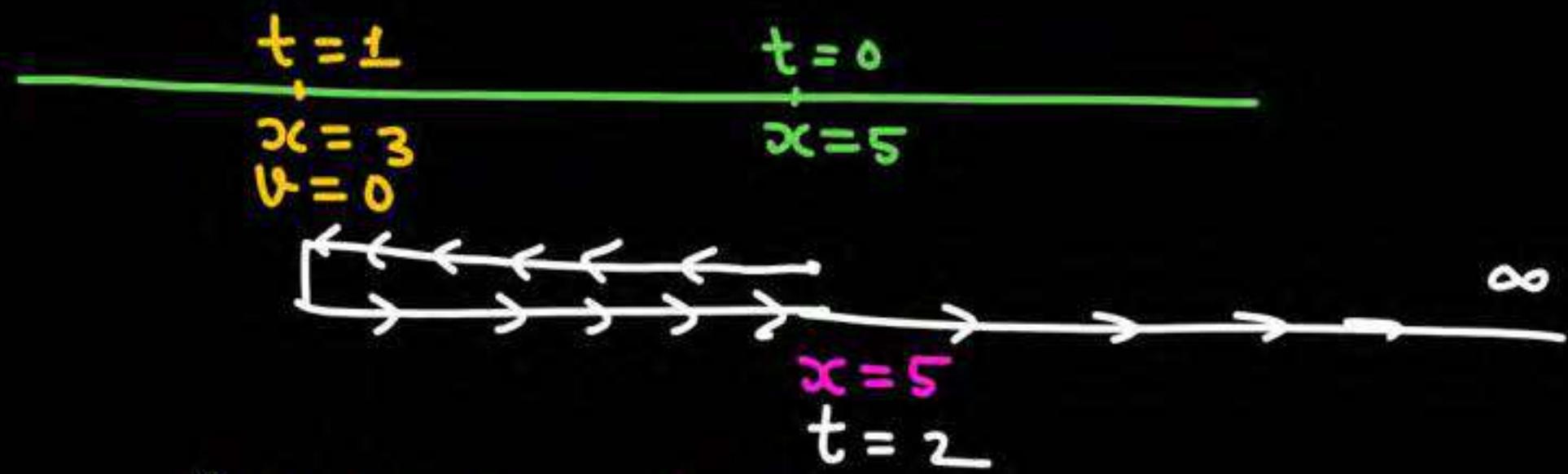
$$\text{Q. } x = 2t^2 - 4t + 5$$

$t=0 \longrightarrow t=2$  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

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

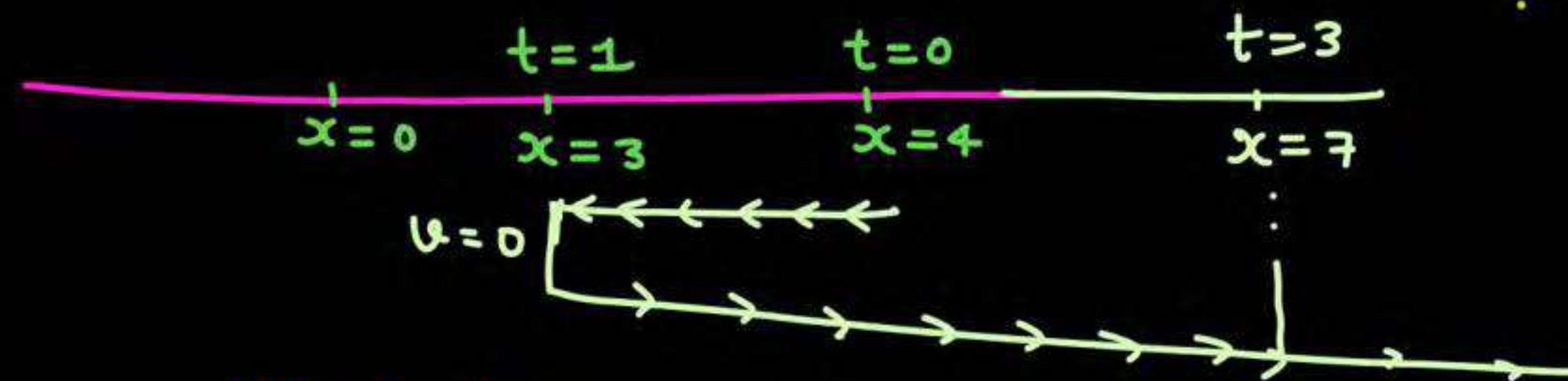
$$x = 9 - 6 + 4 = 7$$

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

$$v = 4t - 4$$

$$\underline{Q} \quad x = 2t^2 - 4t + 2$$

$$t=0 \longrightarrow t=3$$

$$\text{Average Speed} = \frac{2+8}{3} = \frac{10}{3}$$

$$t=0, x=2$$

$$v = 4t - 4 = 0$$

$$(t=1)$$

$$x = 2 - 4 + 2 = 0$$

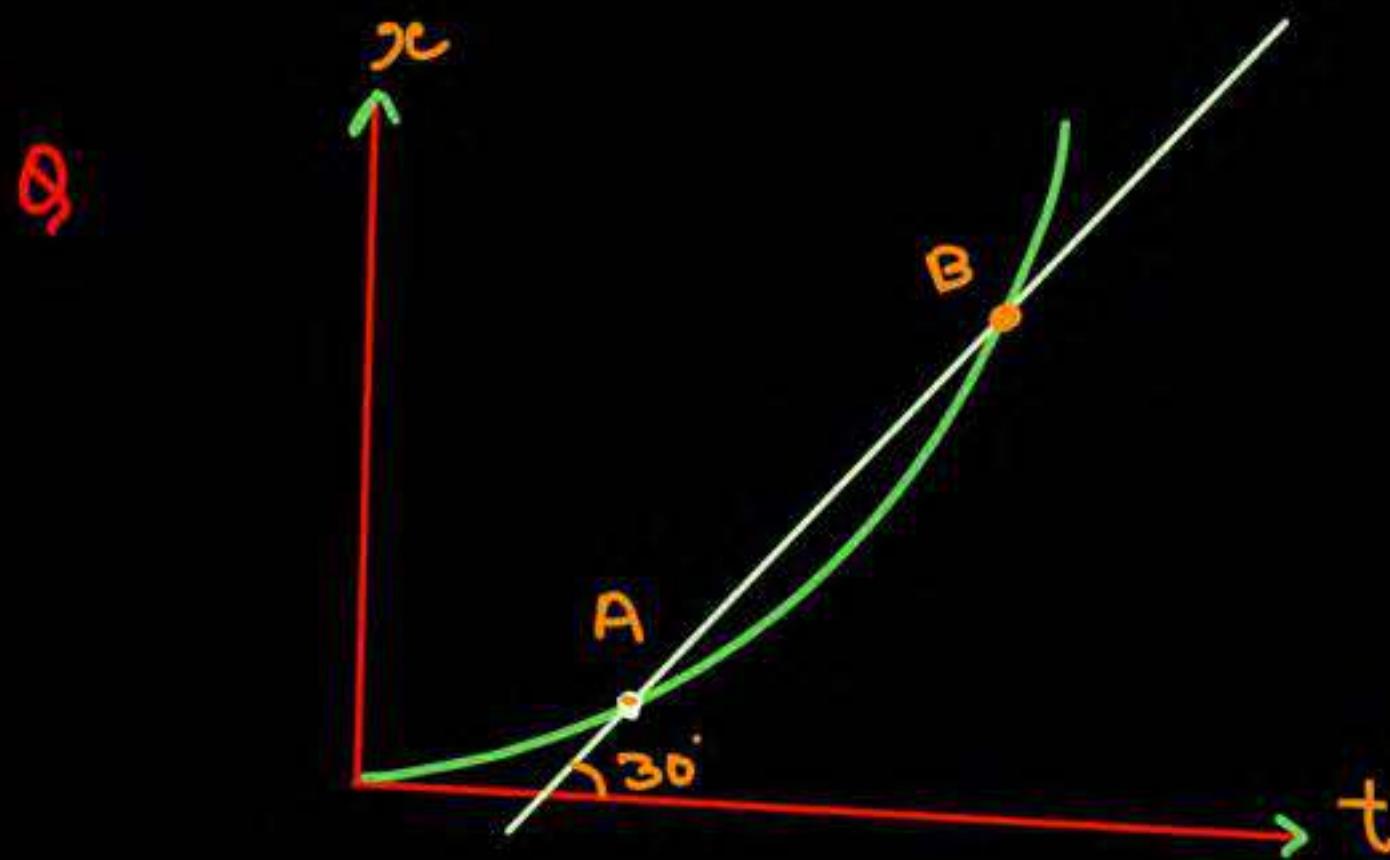
$$t=3 \quad x = 18 - 12 + 2 = 8$$

$$t=1 \\ x=0$$

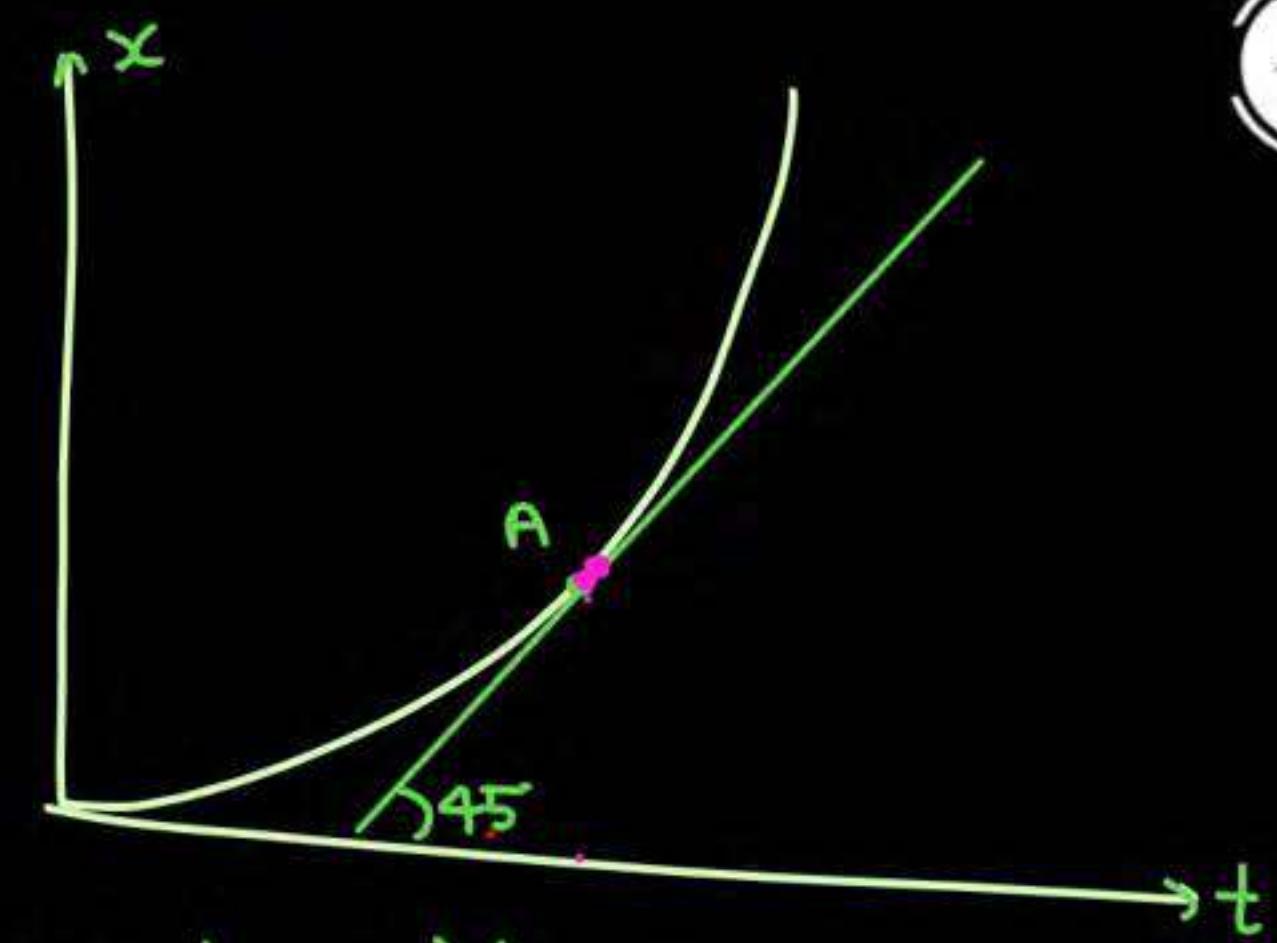
$$t=0 \\ x=2$$

$$t=3 \\ x=8$$



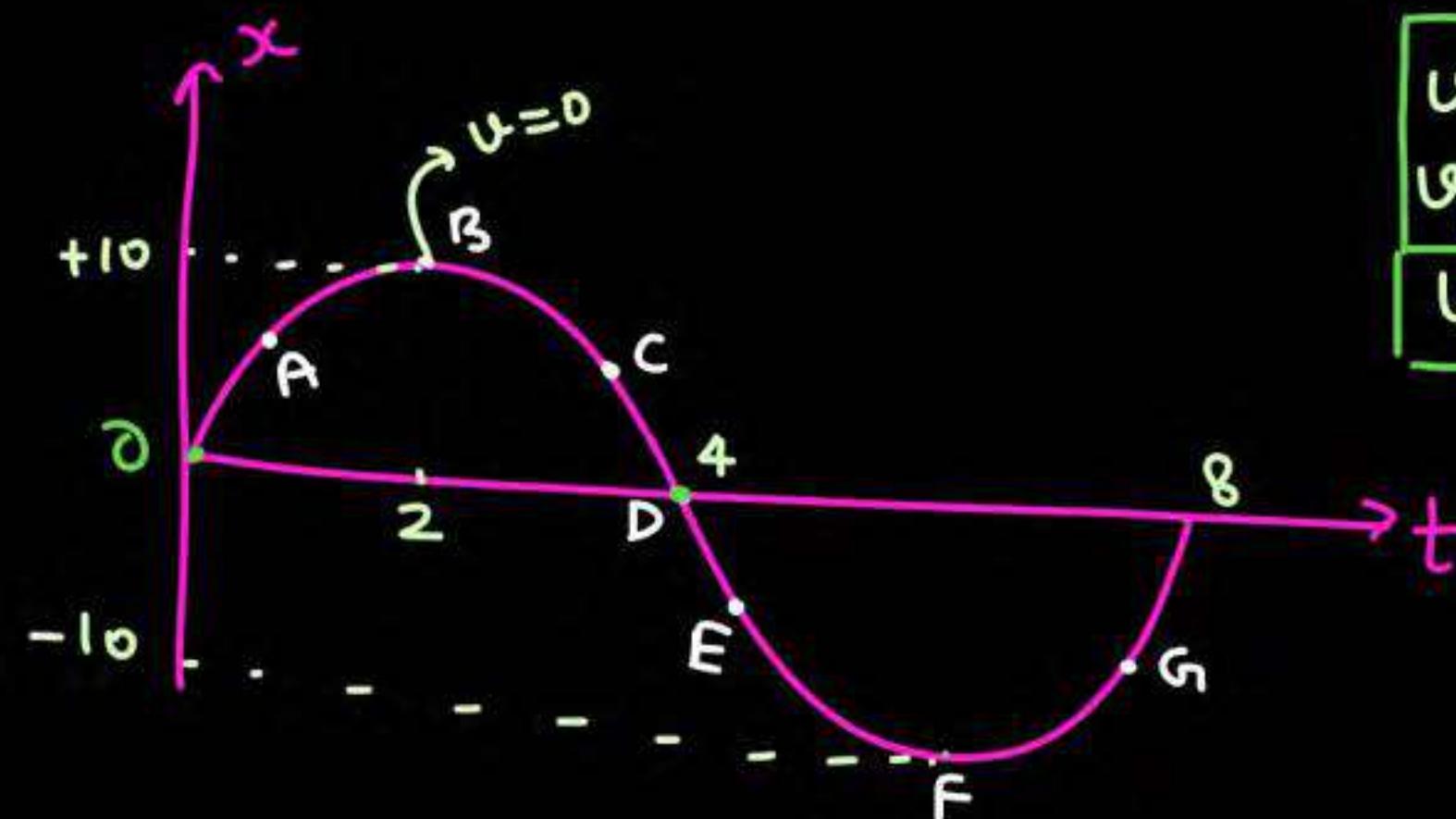


Average velocity = Slope of line AB  
b/w A & B =  $\tan 30^\circ$



Velocity at 'A' =  $\tan 45^\circ = 1$

(4)



$$v_A > 0, v_G > 0$$

$$v_B = 0, v_F = 0$$

$$v_C, v_D, v_E = -v_e$$

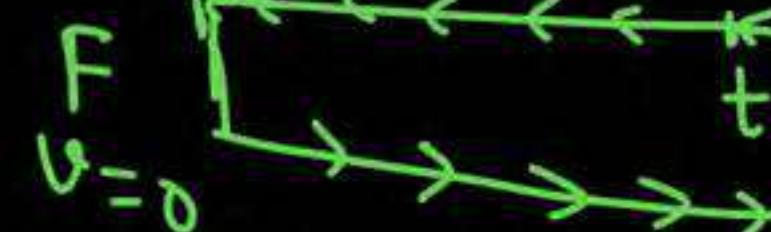
$$t = 0$$

$$x = 0$$

$$x = +10$$

$$t = 2$$

$$v = 0$$



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  $x=2$

Sol<sup>n</sup>

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$\text{at } x=2, \quad \frac{dy}{dx} = 3 \times 2^2$$

$$= 12 \quad \text{Ans}$$

Similarly  
find  $\Rightarrow$

$$Q \quad y = t^2$$

find  $\frac{dy}{dt}$  at  $t=10 \text{ sec}$

$$\frac{dx}{dt} = 2t \Rightarrow \frac{dy}{dt} = 2 \times 10 = 20 \checkmark$$



$$x = t^2 + 2t$$

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

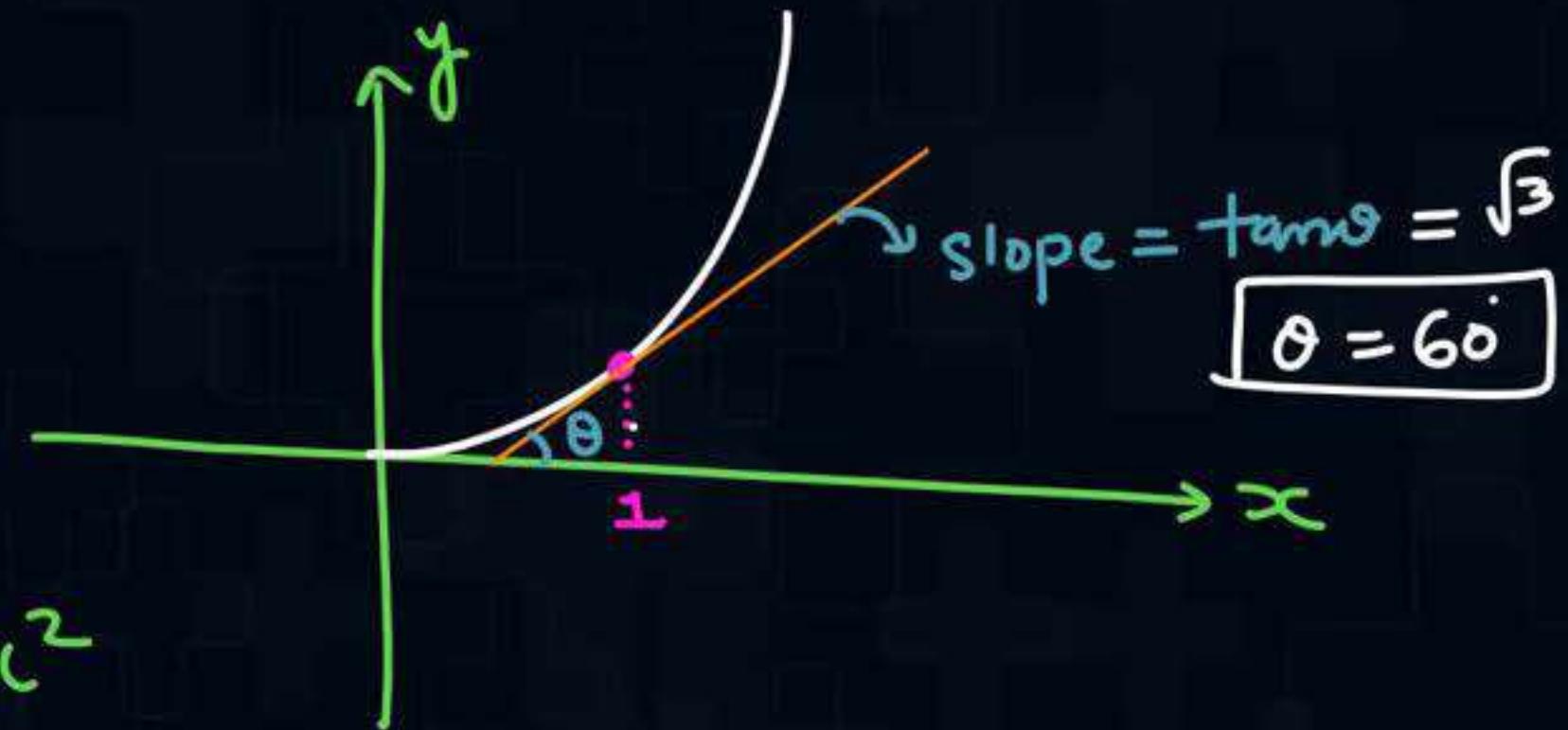
$$\text{Q} \quad y = \frac{x^3}{\sqrt{3}}$$

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

$$\begin{aligned}y &= K \frac{d(x^3)}{dx} \\y &= Kx(3x^2)\end{aligned}$$

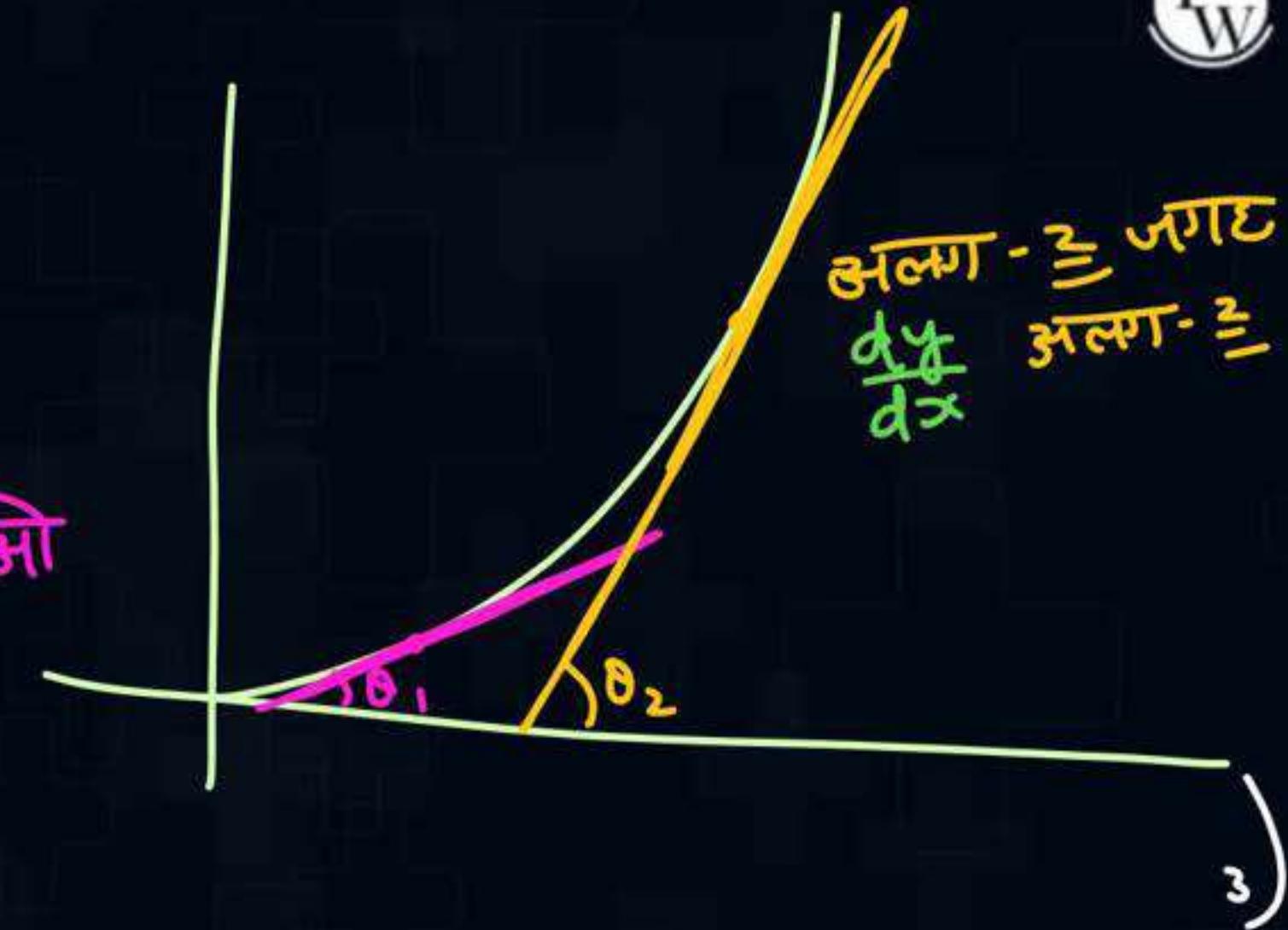
$$\textcircled{3} \quad y = \pi x^3$$
$$\frac{dy}{dx} = \pi \cdot 3x^2$$
$$\textcircled{4} \quad y = \pi + x^3$$
$$\frac{dy}{dx} = 0 + 3x^2$$

$$Q \quad y = \frac{x^3}{\sqrt{3}}$$

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 vol<sup>n</sup> 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  $t = 0$

$$v = 2t - 4$$

$$t=0, v = 0 - 4 = -4$$

$$\text{Q} \quad x = t^2 - 6t + 10$$

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

$$t=0, x_i = 5$$

$$t=4, x_f = \cancel{t^2} - 4 \times 4 + 5 = 5$$

$$\text{Avg velocity} = \frac{x_f - x_i}{\text{duration}} = \frac{5-5}{4} = 0$$

$$\textcircled{1} \quad y = x^n$$

$$\frac{dy}{dx} = \frac{d x^n}{dx} = n x^{n-1}$$

$$\textcircled{3} \quad y = x^{-5}$$

$$\frac{dy}{dx} = -5 x^{-5-1} = -5 \cdot x^{-6}$$

$$\frac{dy}{dx} = \frac{-5}{x^6}$$

$$\textcircled{1} \quad y = x^5$$

$$\frac{dy}{dx} = 5 x^{5-1} = 5 x^4$$

$$\textcircled{2} \quad y = x^7$$

$$\frac{dy}{dx} = 7 x^6$$

$$\textcircled{4} \quad y = \frac{1}{x^2} = x^{-2}$$

$$\frac{dy}{dx} = -2x^{-2-1} = \frac{-2}{x^3}$$

$$f(x) = g(x) \pm h(x)$$

$$\frac{d}{dx} f(x) = \frac{d}{dx} g(x) \pm \frac{d}{dx} h(x)$$

$$\textcircled{5} \quad y = x^2 + x^5$$

$$\frac{dy}{dx} = 2x + 5x^4$$

$$\textcircled{6} \quad y = x^7 + x^8$$

$$\frac{dy}{dx} = 7x^6 + 8x^7$$

$$\textcircled{6} \quad y = x^3 - x^4$$

$$\frac{dy}{dx} = 3x^2 - 4x^3$$

$$\textcircled{1} \quad y = x^9 + \frac{1}{x^5}$$

$$\frac{dy}{dx} = 9x^8 - \frac{5}{x^6}$$

#  $y = x^6$

$\frac{dy}{dx} = 6x^5$

$y'$  

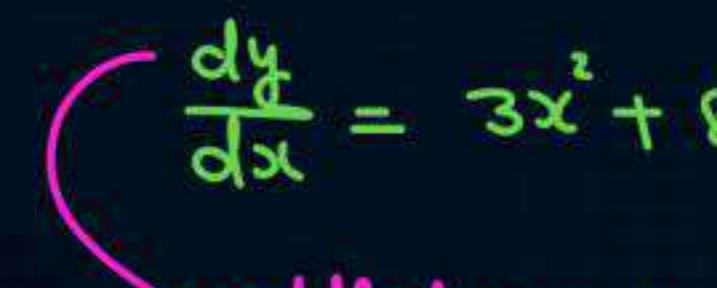
$$y = x^8$$

$$y' = \frac{dy}{dx} = 8x^7$$

$y = u \pm v$
$y' = u' \pm v'$

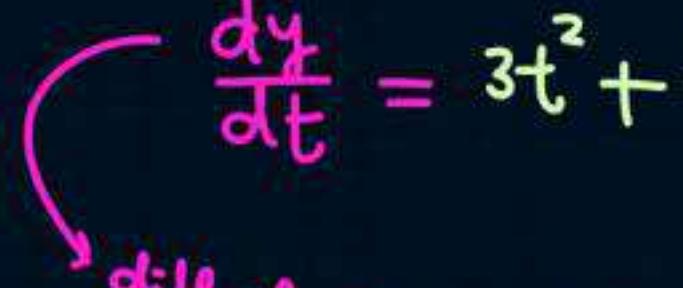
Q  $y = x^3 + x^8$

$\frac{dy}{dx} = 3x^2 + 8x^7$

 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

$$\underline{Q} \quad y = \pi x^2$$
$$\frac{dy}{dx} =$$

$$\underline{Q} \quad A = \pi r^2$$
$$\frac{dA}{dr} =$$

$$\underline{Q} \quad y = \pi x^3$$
$$\frac{dy}{dx} =$$

$$\underline{Q} \quad V = \frac{4}{3}\pi r^3$$

$$\frac{dV}{dr} =$$

$$\underline{\text{Q}} \quad y = t^2 - 4t + 10$$

$$\frac{dy}{dt} =$$

$$\frac{d^2y}{dt^2} =$$

$$\underline{\text{Q}} \quad y = t^3 - 4t^2 + 10$$

$$\frac{dy}{dt} =$$

$$\frac{d^2y}{dt^2} =$$

$$\underline{\text{Q}} \quad x = t^2 - 4t + 10$$

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

$$\frac{d^2x}{dt^2} =$$

$$\underline{\text{Q}} \quad x = t^3 - 4t^2 + 10$$

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

$$\frac{d^2x}{dt^2} =$$

$$\text{Q } y = \sin x$$

$$\frac{dy}{dx} =$$

$$\frac{d^2y}{dx^2} =$$

$$\text{Q } P = \ln t$$

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  $t=2 \text{ sec}$

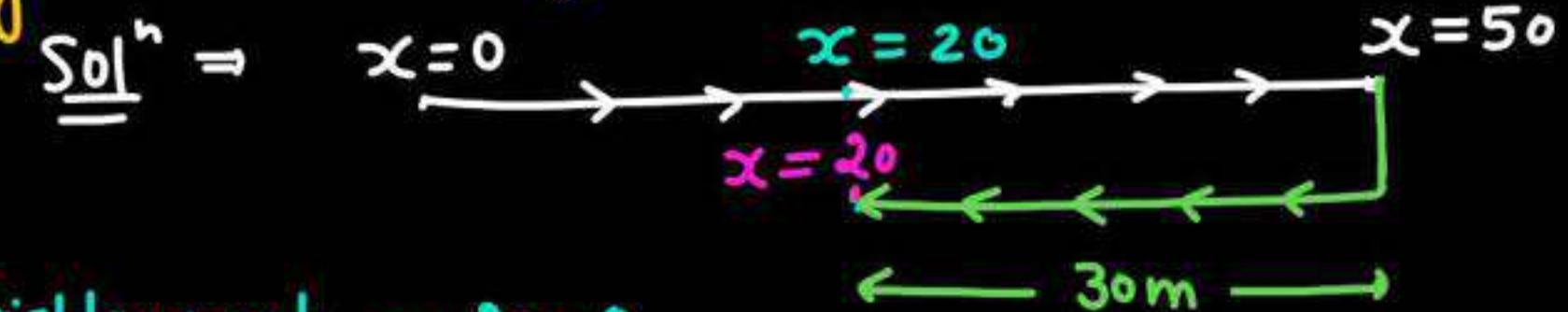
Q

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  $-10 \text{ m/s}$  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



$$\text{Displacement} = 20 - 0 \\ = 20$$

$$\text{Distance} = 50 + 30 = 80$$

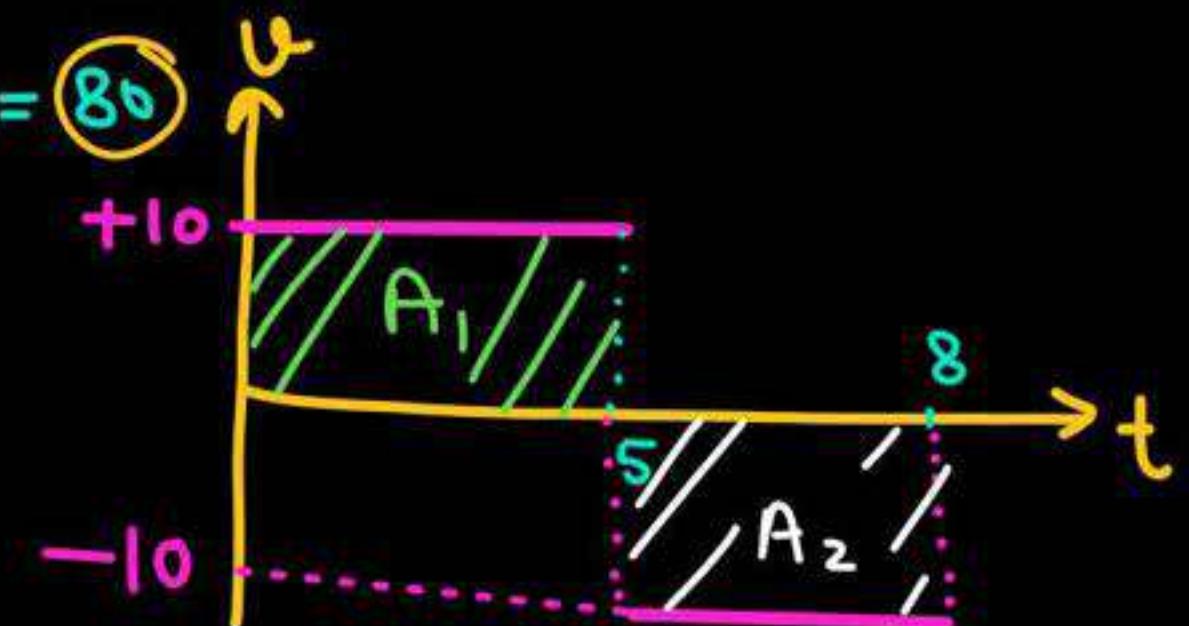
$$A_1 = 5 \times 10 = 50$$

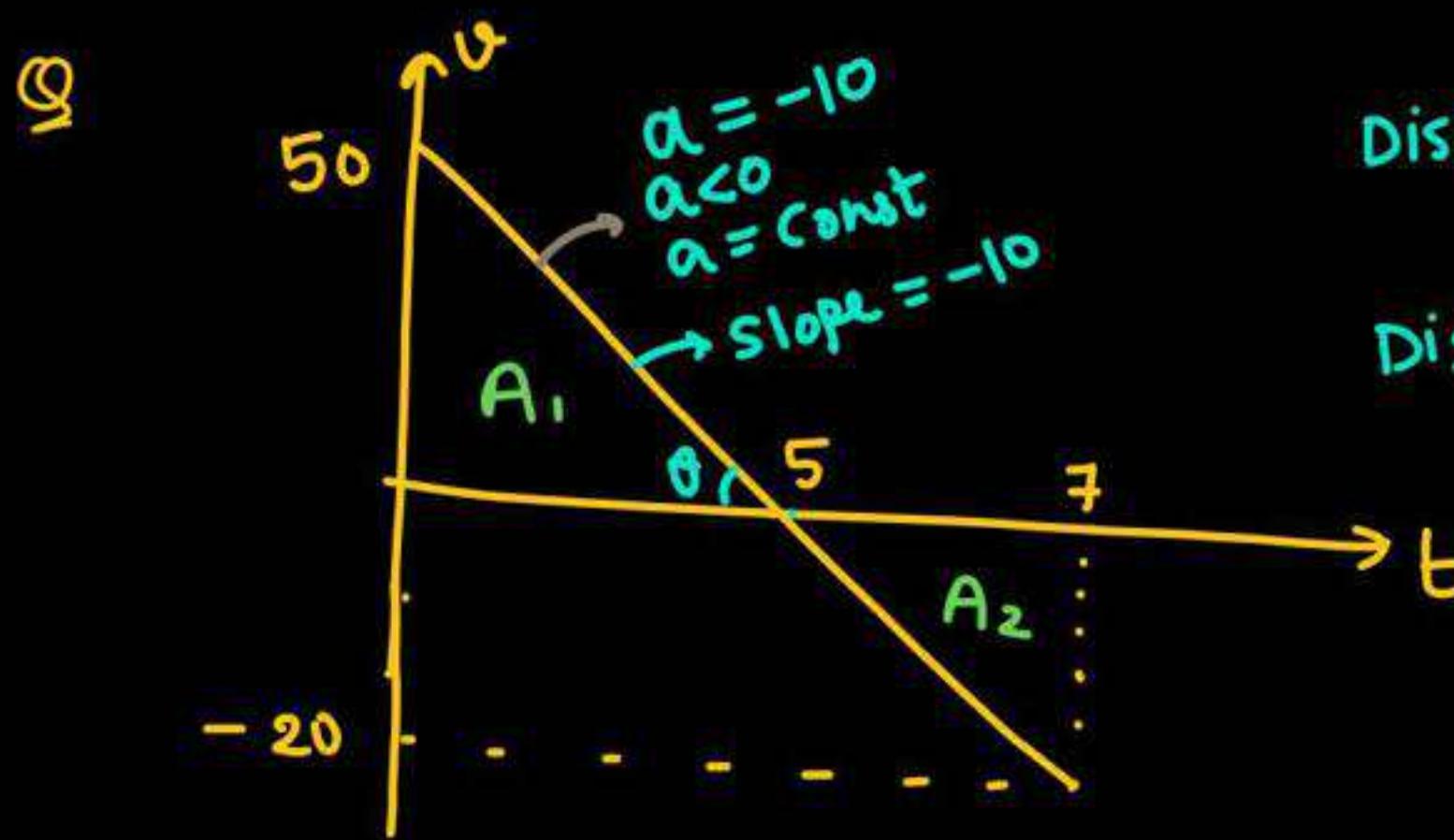
$$A_2 = 3 \times 10 = 30$$

$$\text{Displacement} = A_1 - A_2$$

$$= 50 - 30 = 20$$

$$\text{Distance} = A_1 + A_2 = 50 + 30 = 80$$





$$\text{Displacement} = 125 - 20 = 105$$

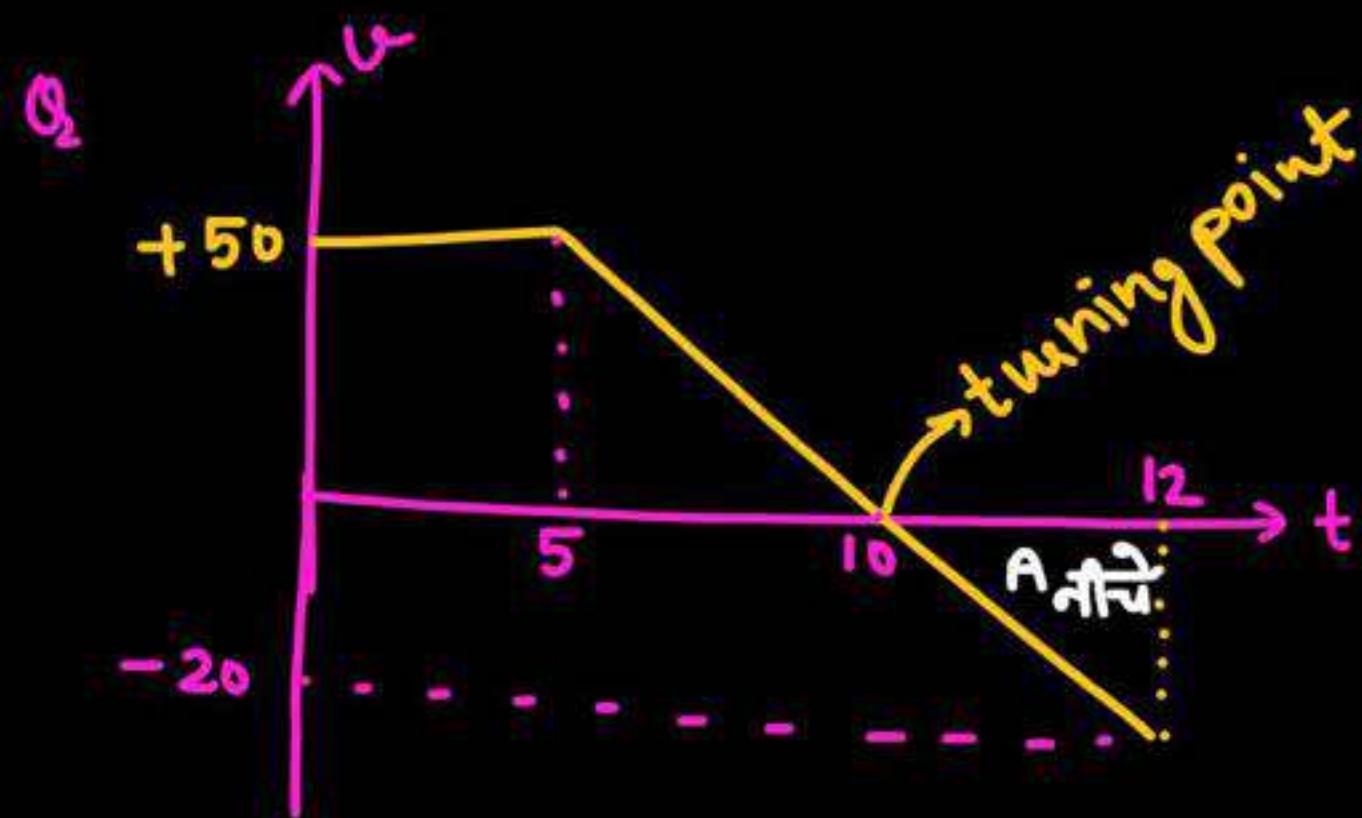
$$\text{Distance} = 125 + 20 = 145$$

$$\text{Average velocity} = \frac{105}{7}$$

$$\text{Avg. Speed} = \frac{145}{7}$$

$$A_1 = \frac{1}{2} \times 5 \times 50 = 125$$

$$A_2 = \frac{1}{2} \times 2 \times 20 = 20$$



$$\begin{aligned}
 \text{Displacement} &= A_{\text{upper}} - A_{\text{नीचे वाला}} \\
 &= \frac{1}{2} (5+10) \times 50 - \frac{1}{2} \times 2 \times 20 \\
 &= \frac{750}{2} - \frac{40}{2} = 375 - 20 = 355 \\
 \text{Distance} &= 375 + 20 = 395
 \end{aligned}$$

Q2

$$v = 10t + 20$$

Slope = 10 = const

$$a = 10$$

$$\rightarrow a = \frac{dv}{dt} = 10 + 0$$

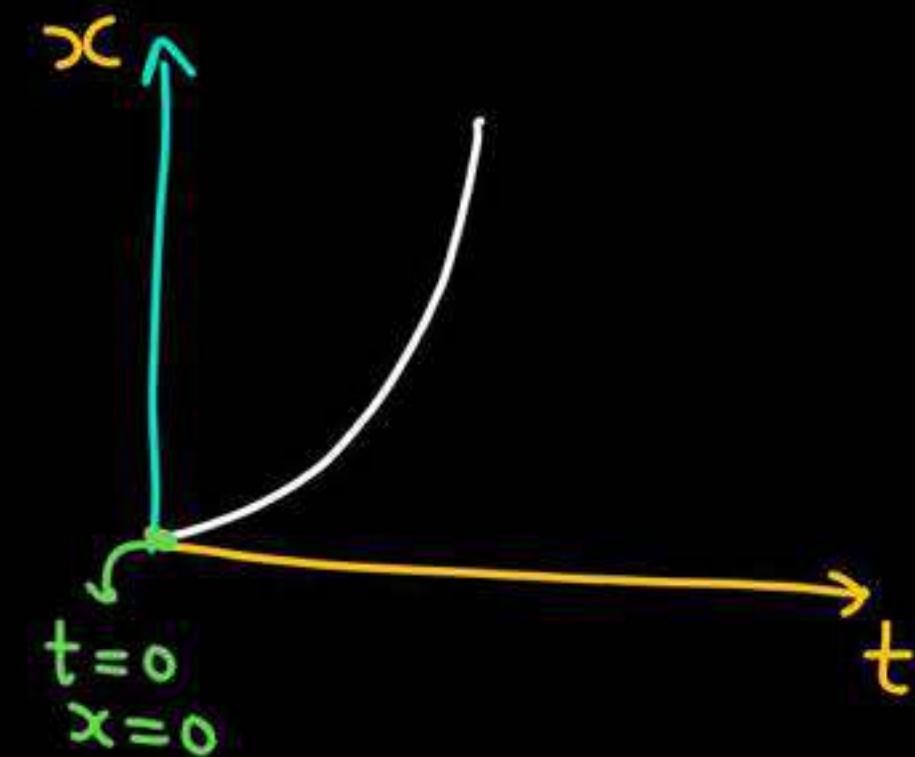
Q

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

$$a = +10$$

$$\frac{dv}{dt} = 10$$

$$\int dv = \int 10 dt$$

$$v = 10t + C$$

$$\text{at } t=0, 0 = 0 + C$$

$$\boxed{C=0}$$

$$t = 0, x = 0 \\ v = 0$$

$$v = 10t$$

$$\frac{dx}{dt} = 10t$$

$$\int dx = \int 10t dt$$

$$x = 10 \frac{t^2}{2} + C$$

$$x = 5t^2 + C$$

$$t = 0, x = 0 \Rightarrow 0 = 0 + C$$

$$\boxed{C=0}$$

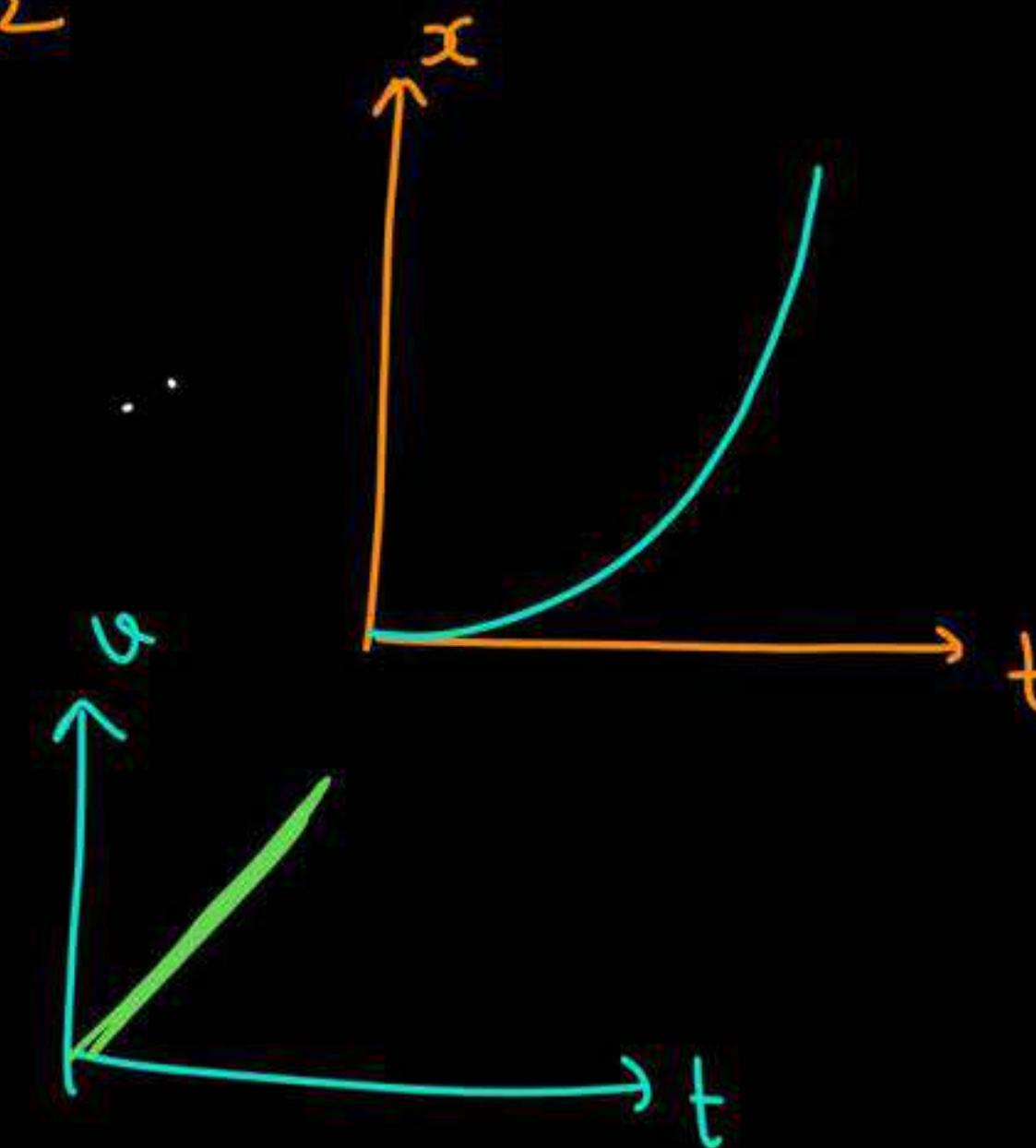
$$x = 5t^2$$

111  
(Parabola)

~~Q&W~~

$$x = 5t^2$$

$$v = 10t$$

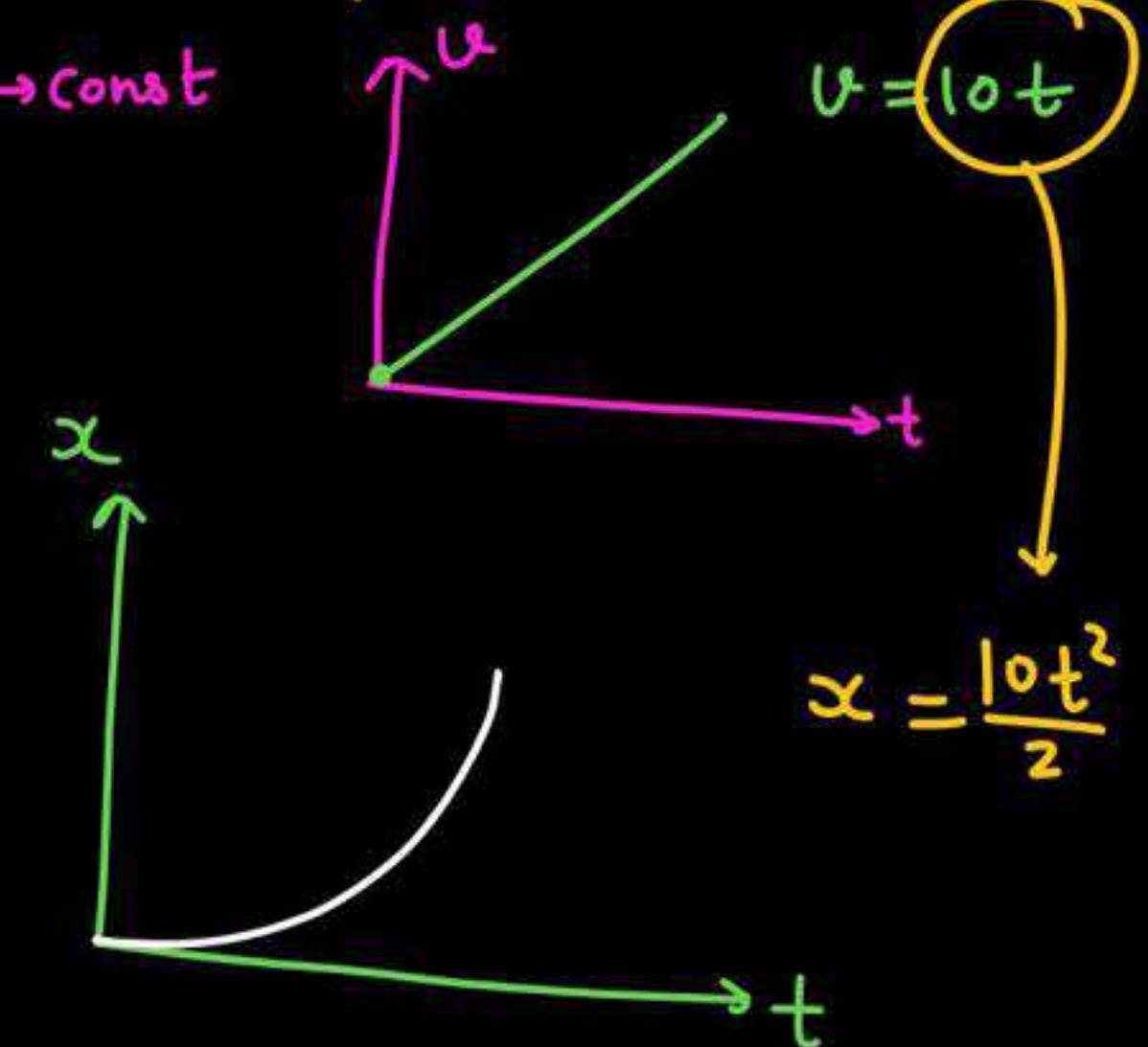


Q

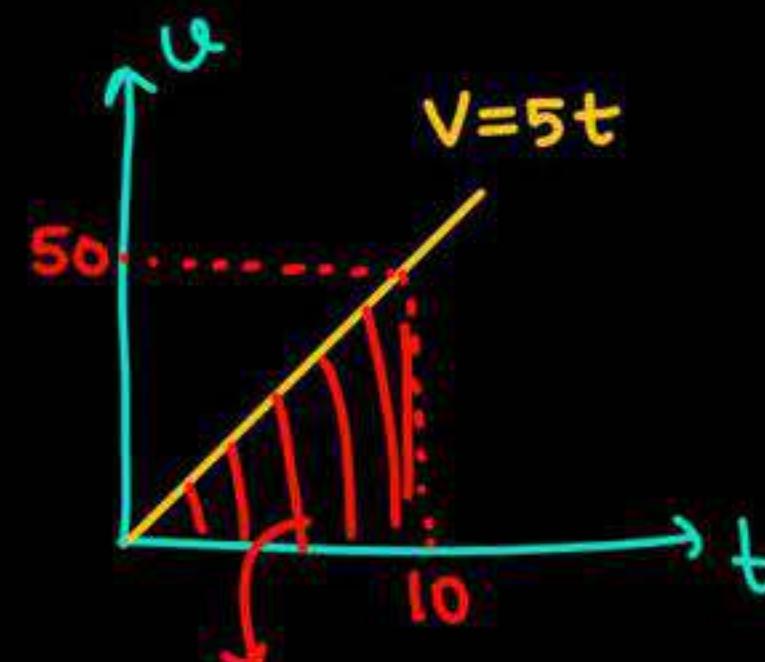
particle start from rest  
from origin at  $t=0$ , having  
acc  $+10 \text{ m/s}^2$ .

P  
W

$a \rightarrow \text{const}$

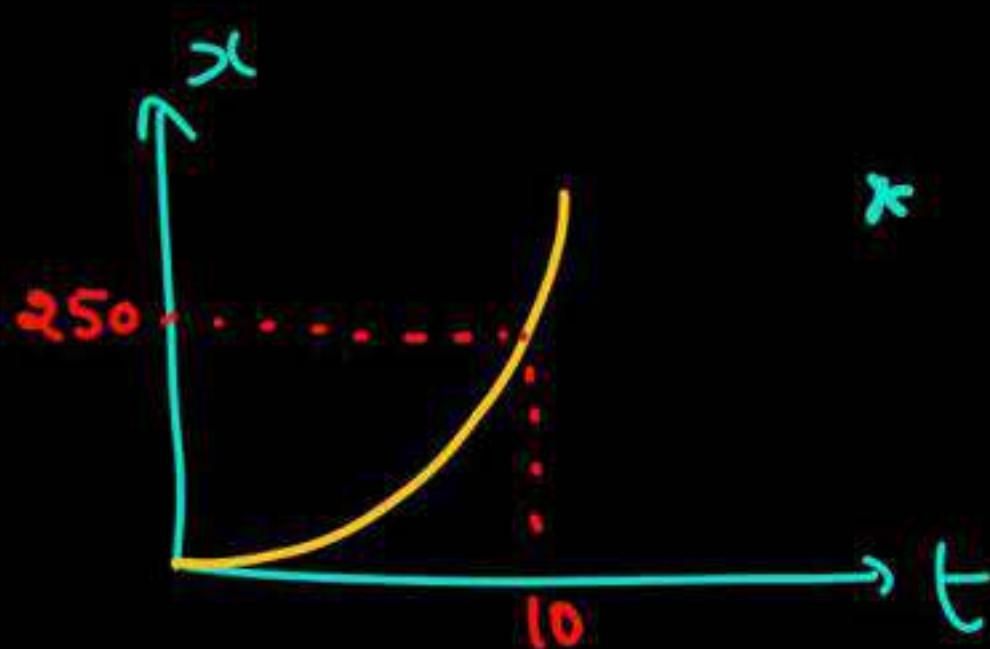


Q1 Particle start from rest from origin having acc  $a = +5 = \text{const}$



$$\text{Area} = \frac{1}{2} \times 50 \times 10 = 250$$

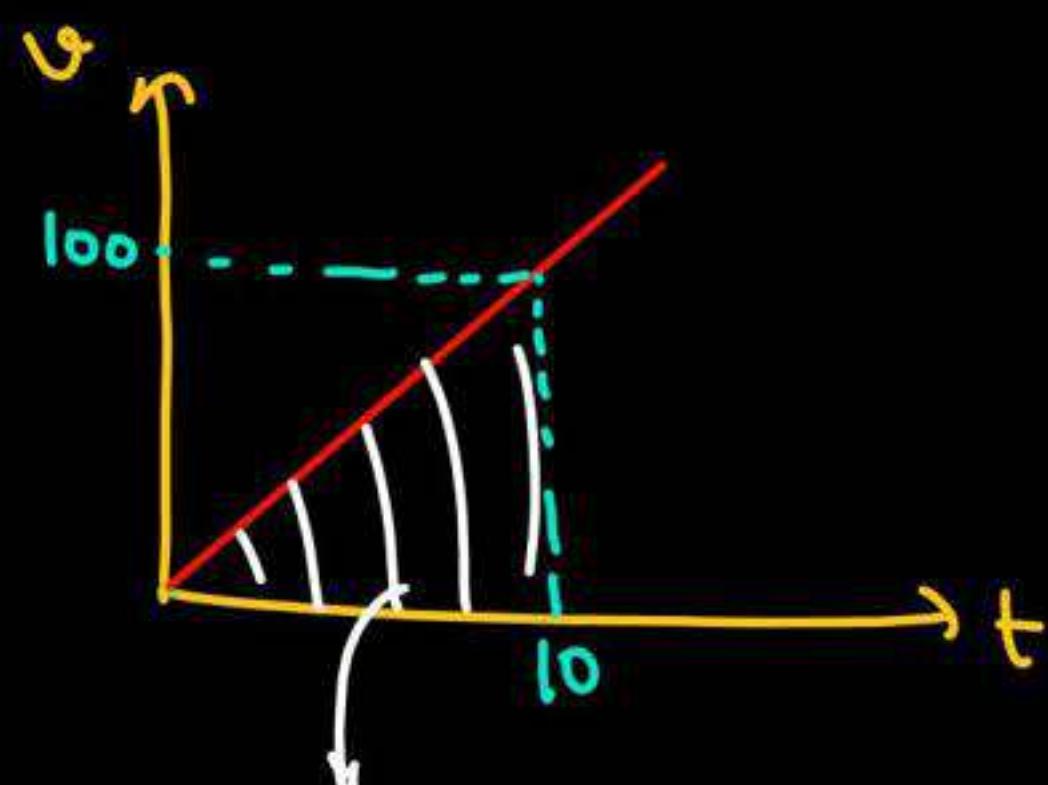
$$\begin{aligned} * & V = u + at \\ & = 0 + 5 \times 10 \\ & V = 50 \end{aligned}$$



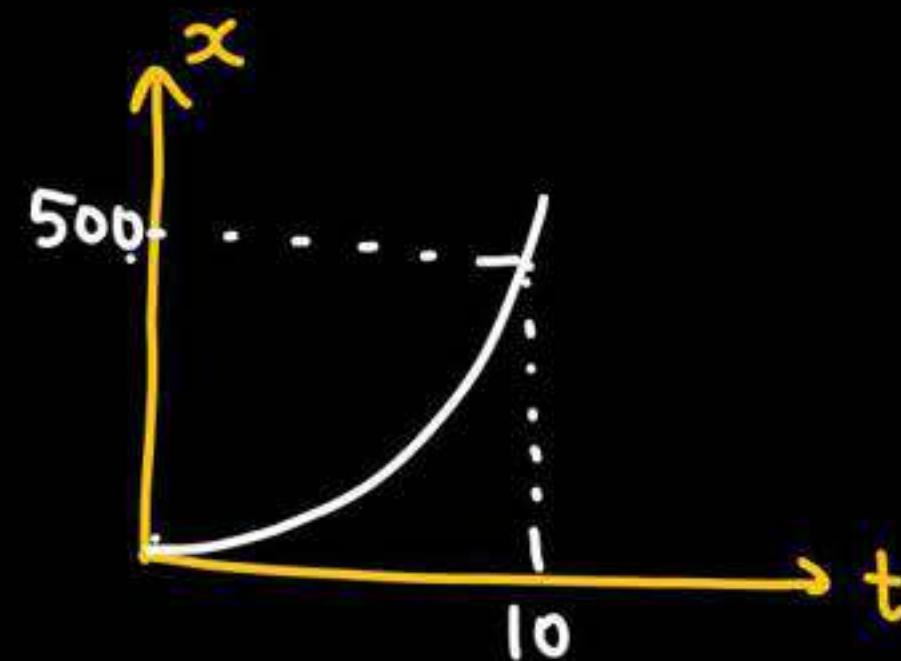
$$\begin{aligned} * & S = ut + \frac{1}{2}at^2 \\ & = 0 + \frac{1}{2} \times 5 \times 10^2 \\ & = 250 \end{aligned}$$

Q. Particle start from rest from origin having acc = +10m/s.

$t=0 \longrightarrow t=10$  तक  $(v-t)$ ,  $(x-t)$  draw



$$A_{\text{req}} = \frac{1}{2} \times 10 \times 100 = 500$$



$$u = 0$$

$$a = +10$$

$$v = u + at$$

$$v = 0 + 10 \times 10$$

$$v = 100$$

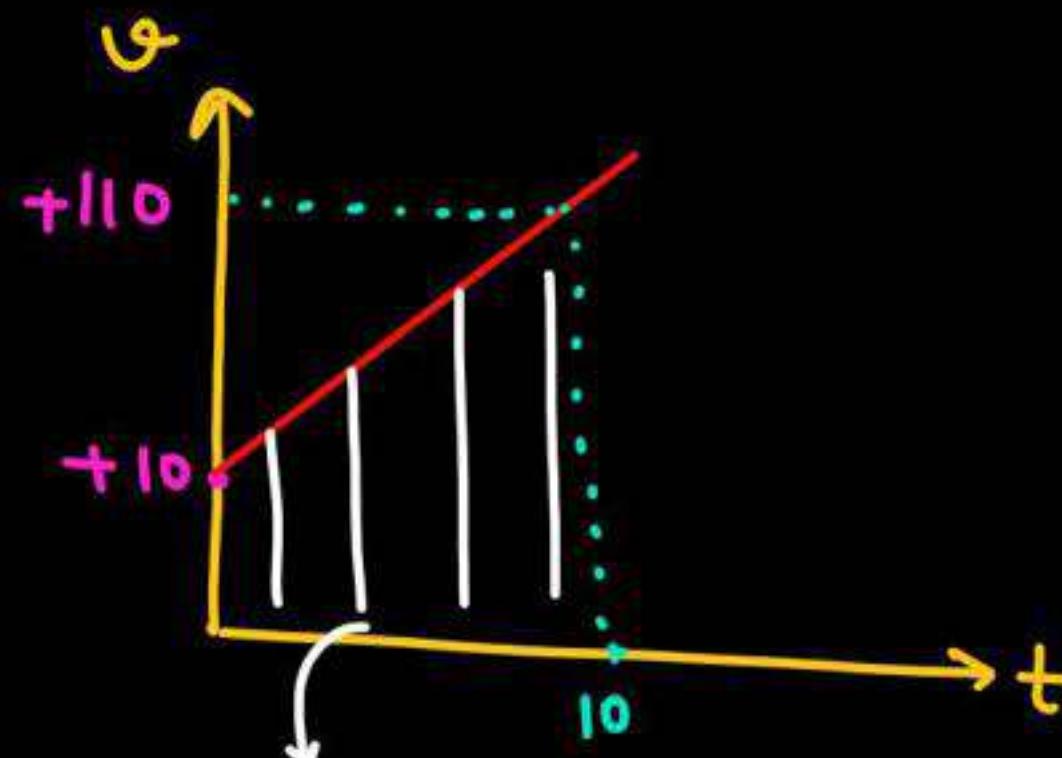
$$s = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2} \times 10 \times 10^2$$

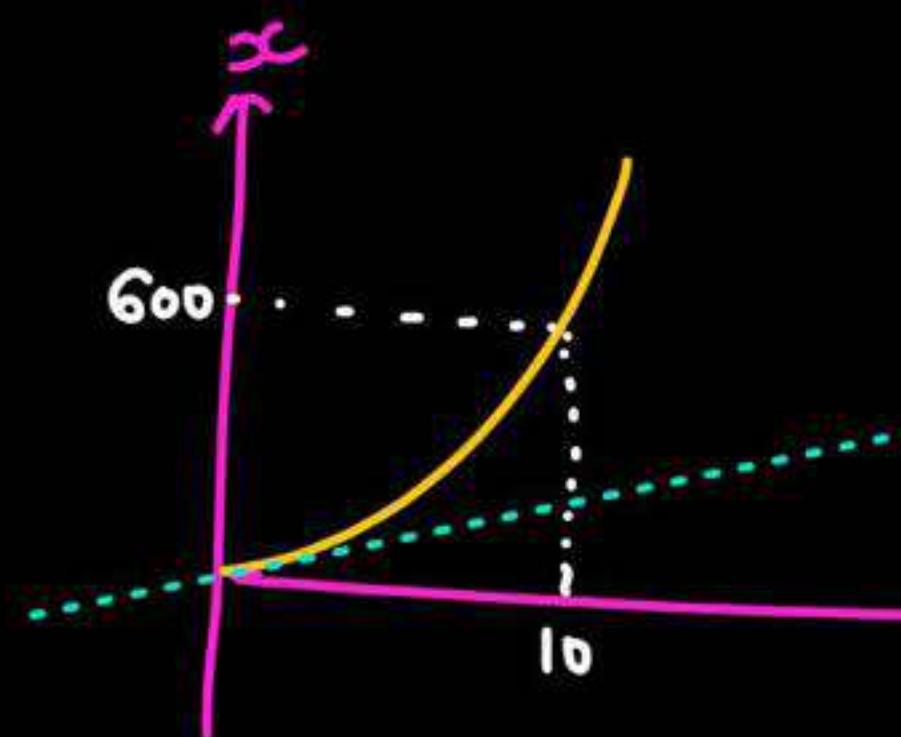
$$= 500$$

Q A particle starts motion having initial velocity +10m/s

and acc = +10m/s<sup>2</sup>.



$$\text{Area} = \frac{1}{2} \times (10 + 110) \times 10 \\ = 600$$



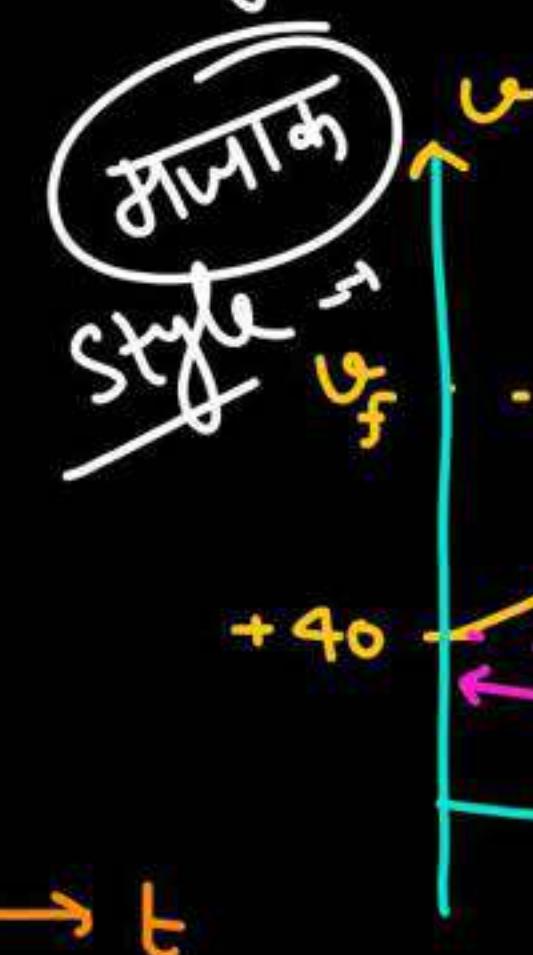
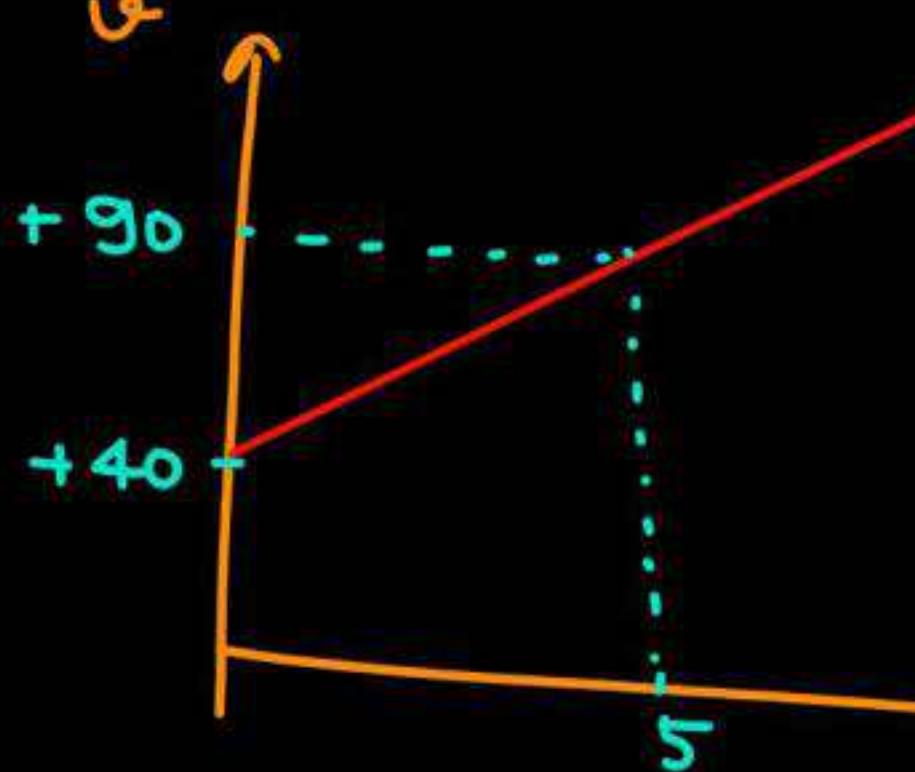
$$\begin{aligned} u &= +10 \\ a &= +10 \\ t &= 10 \text{ sec} \\ v &= u + at \\ &= 10 + 10 \times 10 \\ &= 10 + 100 \\ &\underline{\underline{v = 110}} \end{aligned}$$

$$\begin{aligned} S &= ut + \frac{1}{2}at^2 \\ &= 10 \times 10 + \frac{1}{2} \times 10 \times 10^2 \\ &= 100 + 500 = 600 \end{aligned}$$

Q A particle starts motion having initial velocity  $+40 \text{ m/s}^2$

and  $\text{acc} = +10 \text{ m/s}^2$ .

\*



$$\tan \theta = \text{Slope} = \frac{v_f - 40}{5} = 10$$

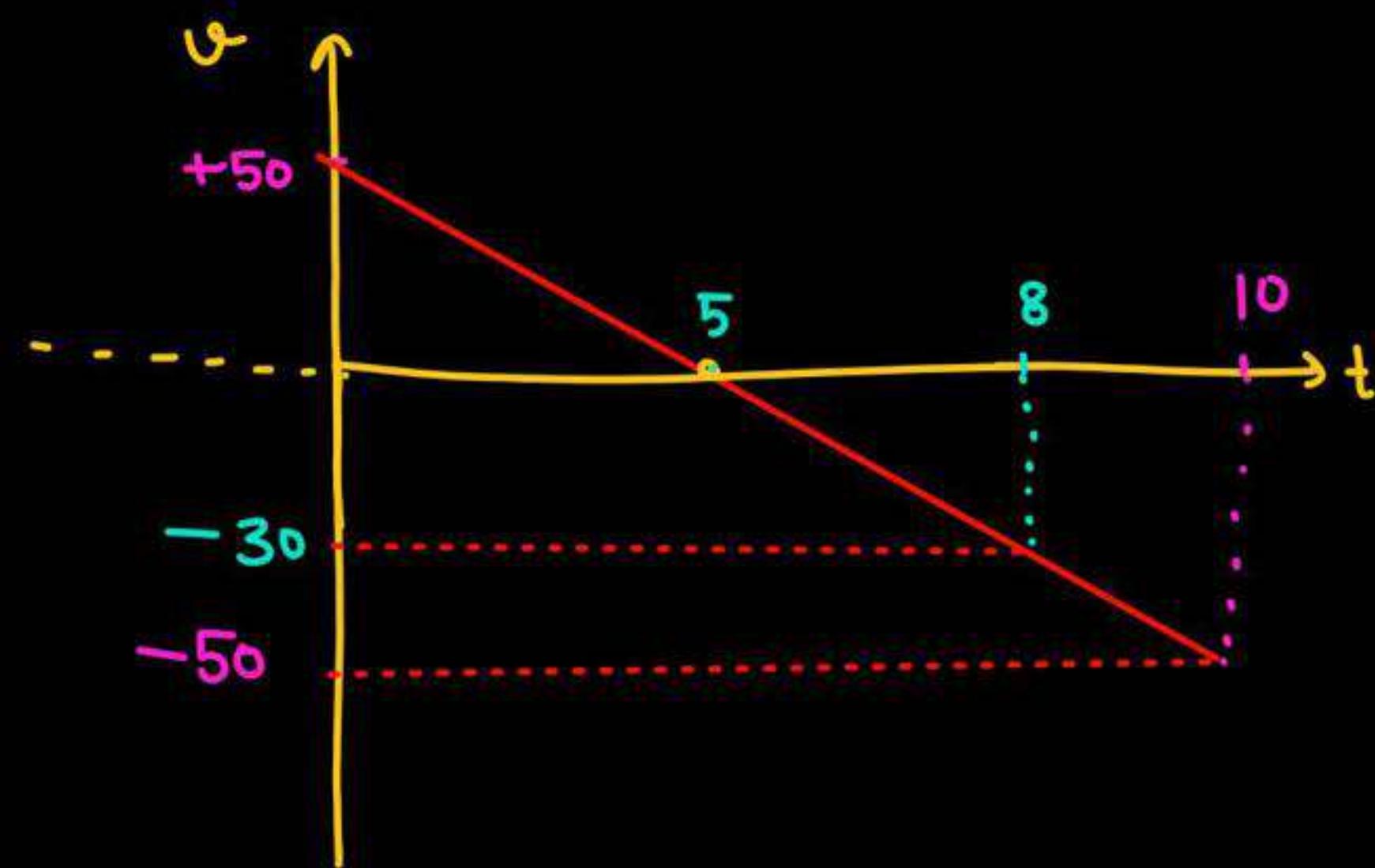
$$v_f - 40 = 50$$

$$v_f = 90$$

Q A particle starts motion having initial velocity +50 m/s and acc = -10 m/s<sup>2</sup>.  $a < 0$

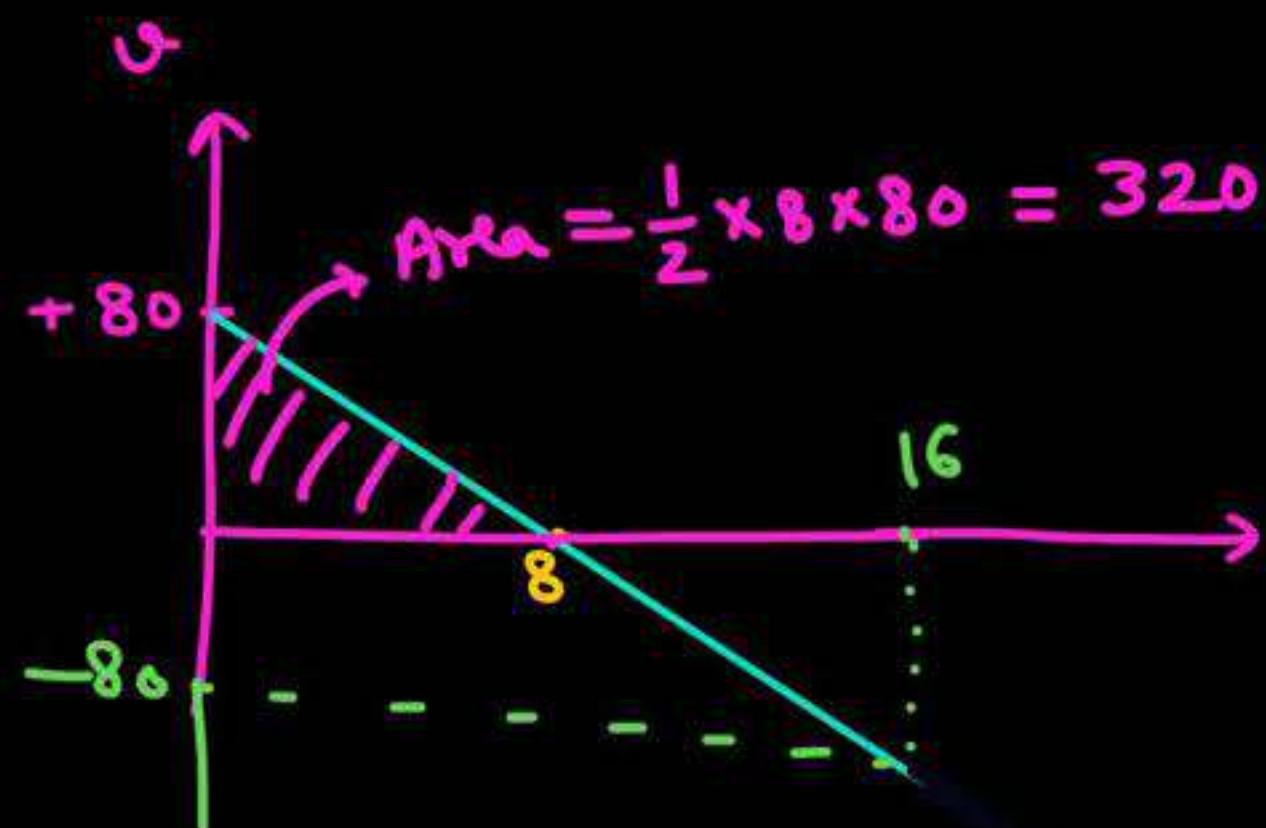
$$50 - 80 = -30$$

10



Q A particle starts motion having initial velocity  $+80 \text{ m/s}$

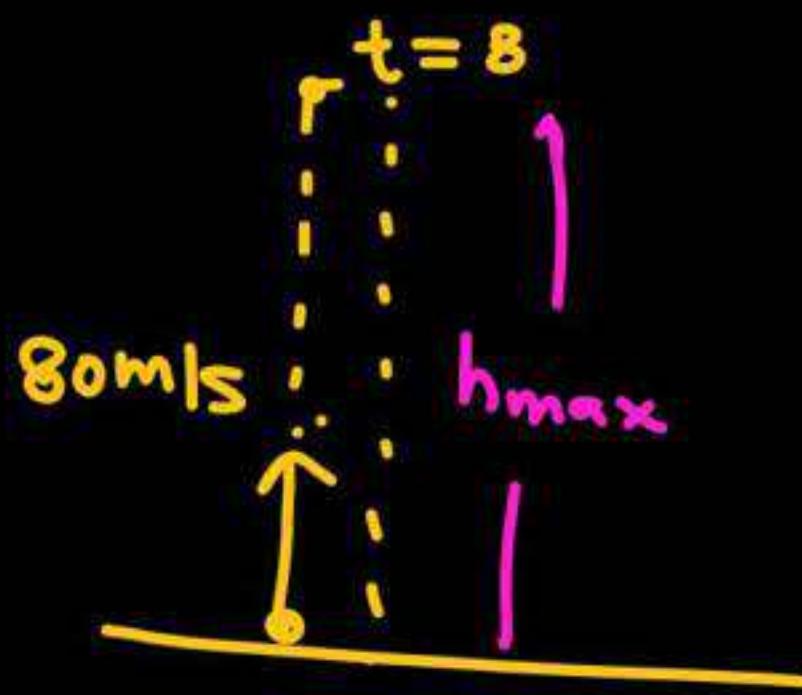
and  $\text{acc} = -10 \text{ m/s}^2$



$$t = 10 \text{ sec}$$

$$v = 80 - 100 = -20 \text{ m/s}$$

$$\begin{aligned} v &= u + at = 80 + (-10) 10 \\ &= -20 \end{aligned}$$

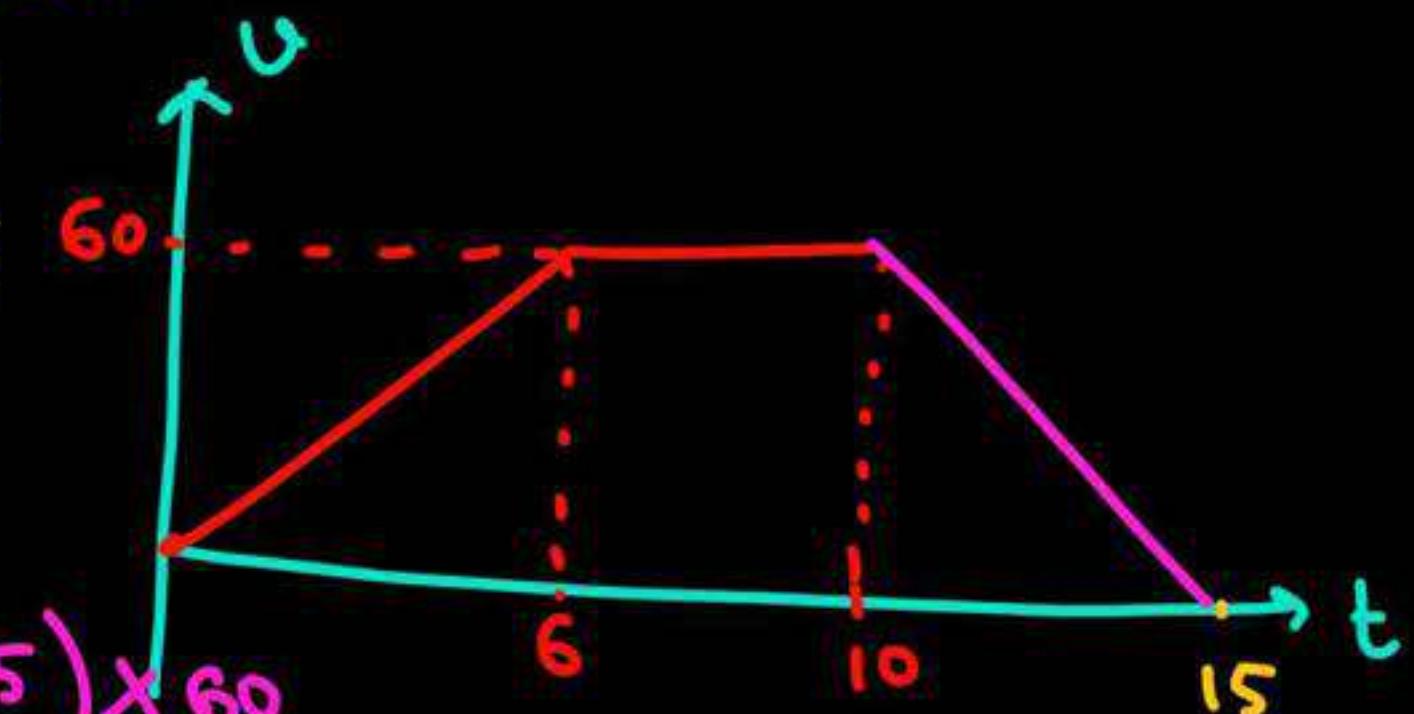


Q A particle starts motion from rest, having acc  $+10 \text{ m/s}^2$  for 6 sec. after that it moves with constant velocity for next four second. In last part of journey particle comes to rest & took 5 sec. having const acc.

① find acc in last part of journey

② Distance travelled, Displacement

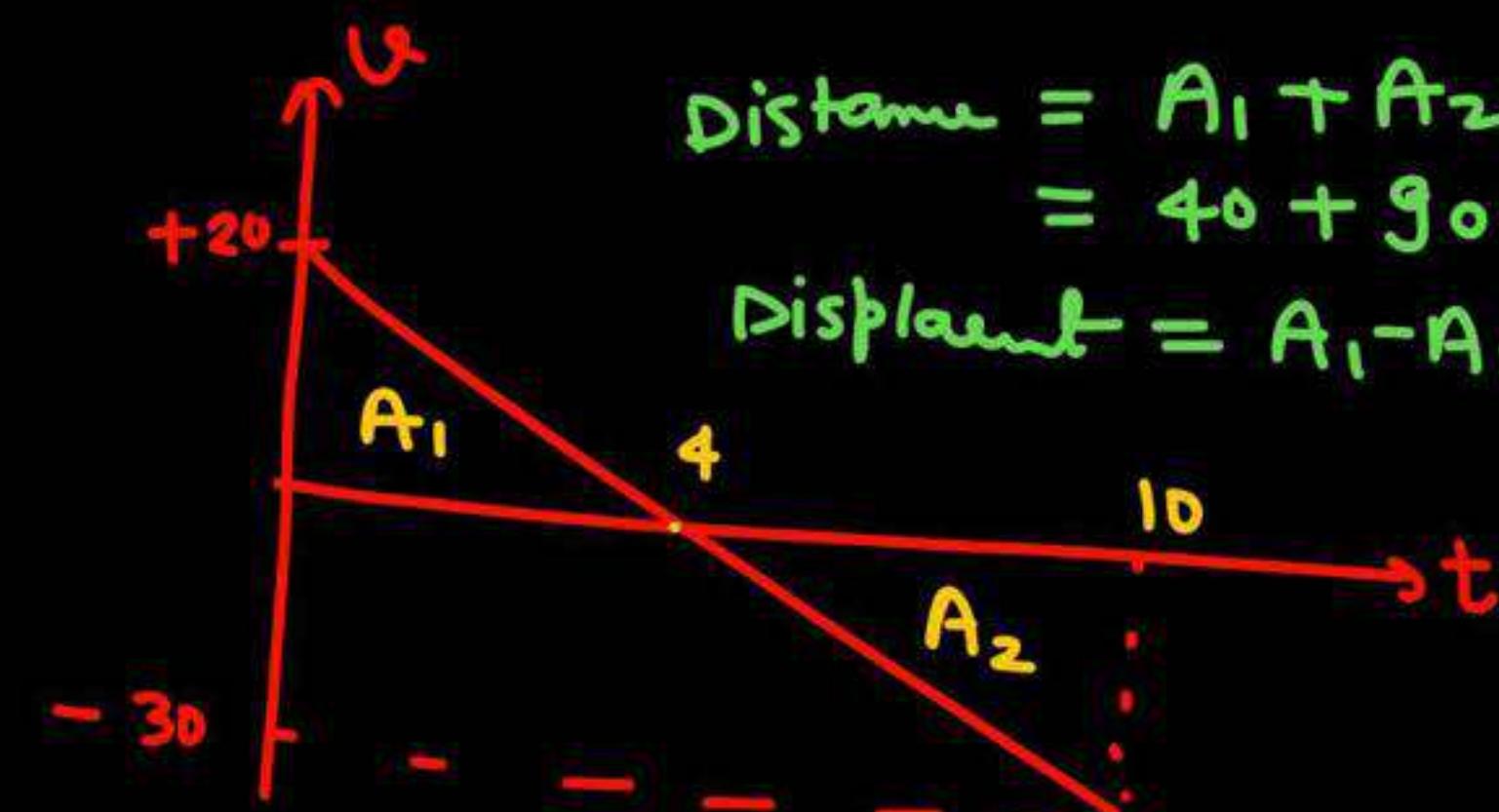
$$\therefore \text{Displ.} = \text{Area} = \frac{1}{2} \times (4 + 15) \times 60$$



Question

Q particle is moving with initial velocity +20 m/s having acceleration -5 m/s<sup>2</sup>. Find distance travelled by particle in 10 sec.

~~$u = +20$   
 $a = -5$   
 $s = ut + \frac{1}{2}at^2$   
 Displ. =  $20 \times 10 - \frac{1}{2} \times 5 \times 10^2$   
 $= 200 - 250$   
 $= -50$~~



$$\begin{aligned}
 \text{Distance} &= A_1 + A_2 \\
 &= 40 + 90 = 130
 \end{aligned}$$

$$\begin{aligned}
 \text{Displacement} &= A_1 - A_2 = 40 - 90 \\
 &= -50
 \end{aligned}$$

~~H/W~~

P  
W

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. After that particle moves with const acc of  $-20 \text{ m/s}^2$  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

$$Q \int_0^{\pi/2} \cos x dx = \sin x \Big|_0^{\pi/2} = (\sin \pi/2) - \sin 0 = 1 - 0 = 1$$

$$Q \quad \int_{x=1}^{x=4} 2x \, dx = 2 \cdot \frac{x^2}{2} \Big|_1^4 = x^2 \Big|_1^4 = 4^2 - 1^2 = 15$$

$$Q \quad \int_0^1 7x^6 \, dx = x^7 \Big|_0^1 = 1^7 - 0^7 = 1$$

$$Q \quad \int_2^3 e^x \, dx = e^x \Big|_2^3 = e^3 - e^2$$

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  $y = x^3$

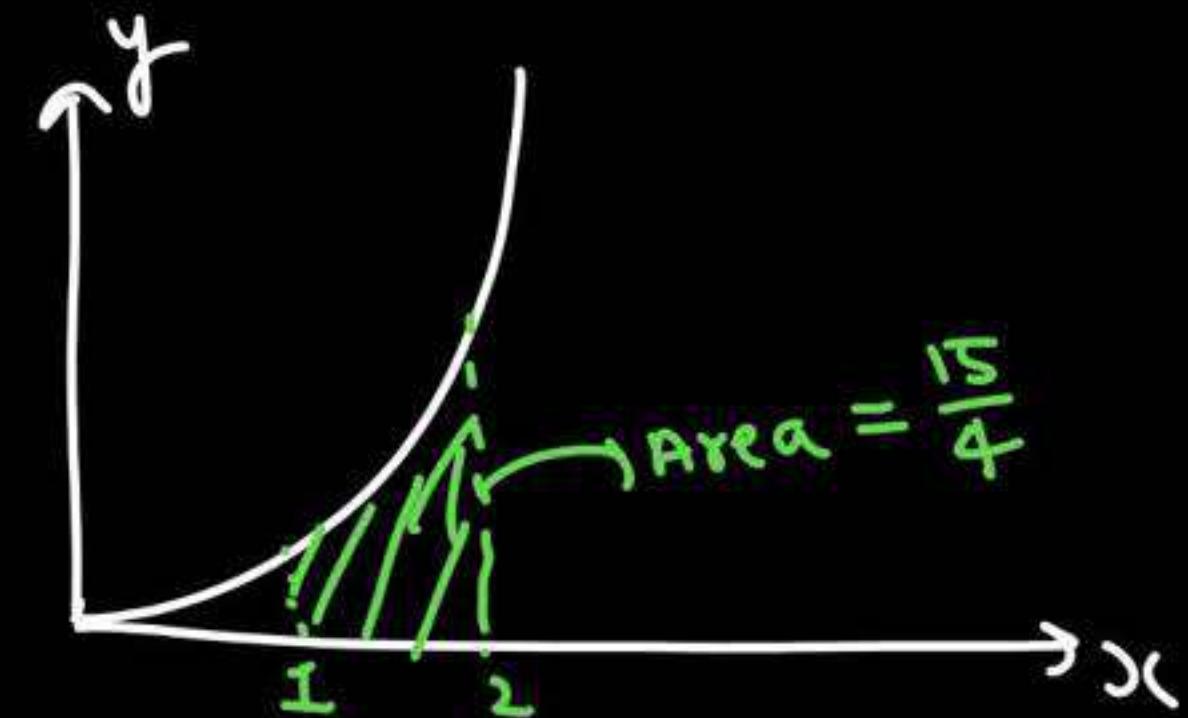
find area under curve (blw curve & x-axis)  
from  $x = 1$  to  $x = 2$

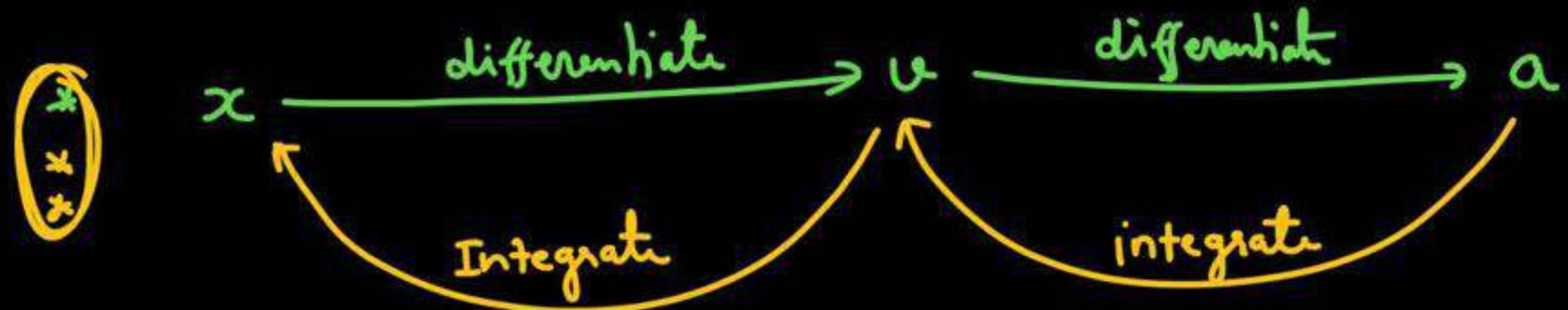
Sol

$$\text{Area} = \int y \, dx = \int x^3 \, dx$$

$$\text{Area} = \frac{x^4}{4} \Big|_{x=1}^{x=2}$$

$$= \frac{1}{4} [2^4 - 1] = \frac{15}{4}$$





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

$$\textcircled{2} \quad x = f(t)$$

$$x = \int v dt = \int (3t^2 + 2t) dt = t^3 + t^2 + C$$

$$\text{at } t=0, x=10$$

$$10 = 0 + 0 + C \Rightarrow \textcircled{C=10}$$

$$x = t^3 + t^2 + C$$

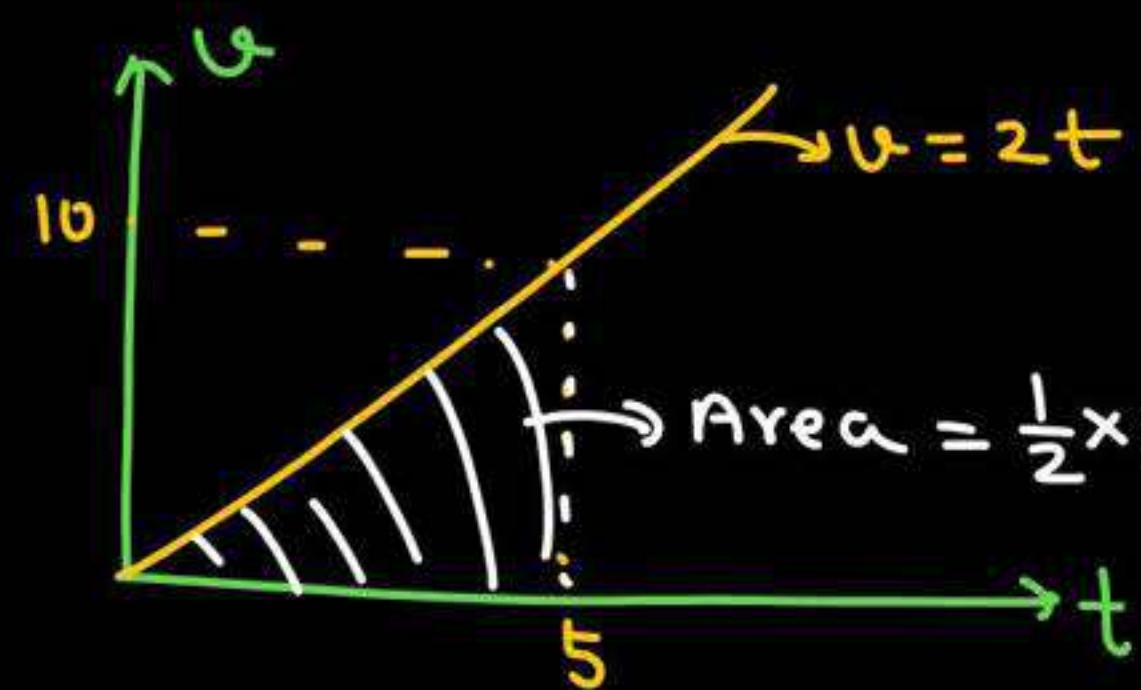
$$x = t^3 + t^2 + 10$$

Q A particle is moving along x-axis s.t its velocity vs time relation is given as

Displacement  
from  $t=0 \rightarrow t=5$

Sol<sup>n</sup> Area =  $\frac{1}{2} \times 5 \times 10$   
= 25

Area =  $\frac{1}{2} \times 5 \times 10 = \text{Displacement}$



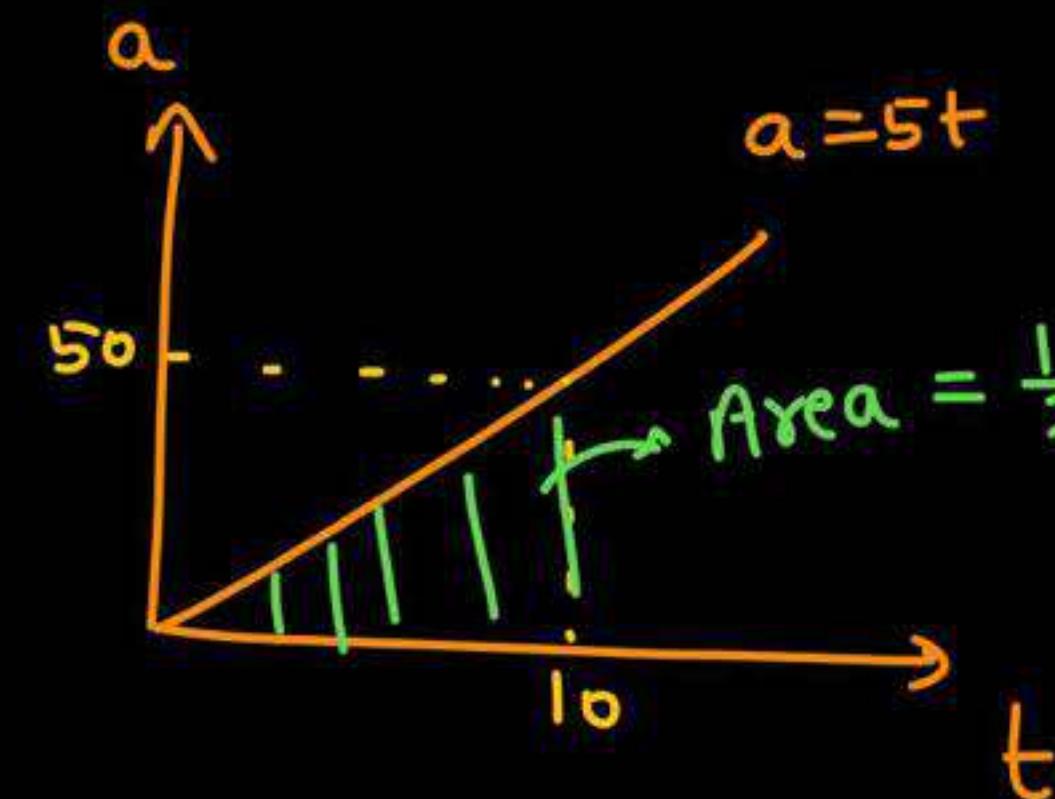
Q A particle starts motion from rest such that its  $a-t$  graph is given as

find velocity at  $t=10\text{ sec}$ ,

$$\text{Area} = \vec{V}_f - \vec{V}_i$$

$$\frac{1}{2} \times 10 \times 50 = V_f - 0$$

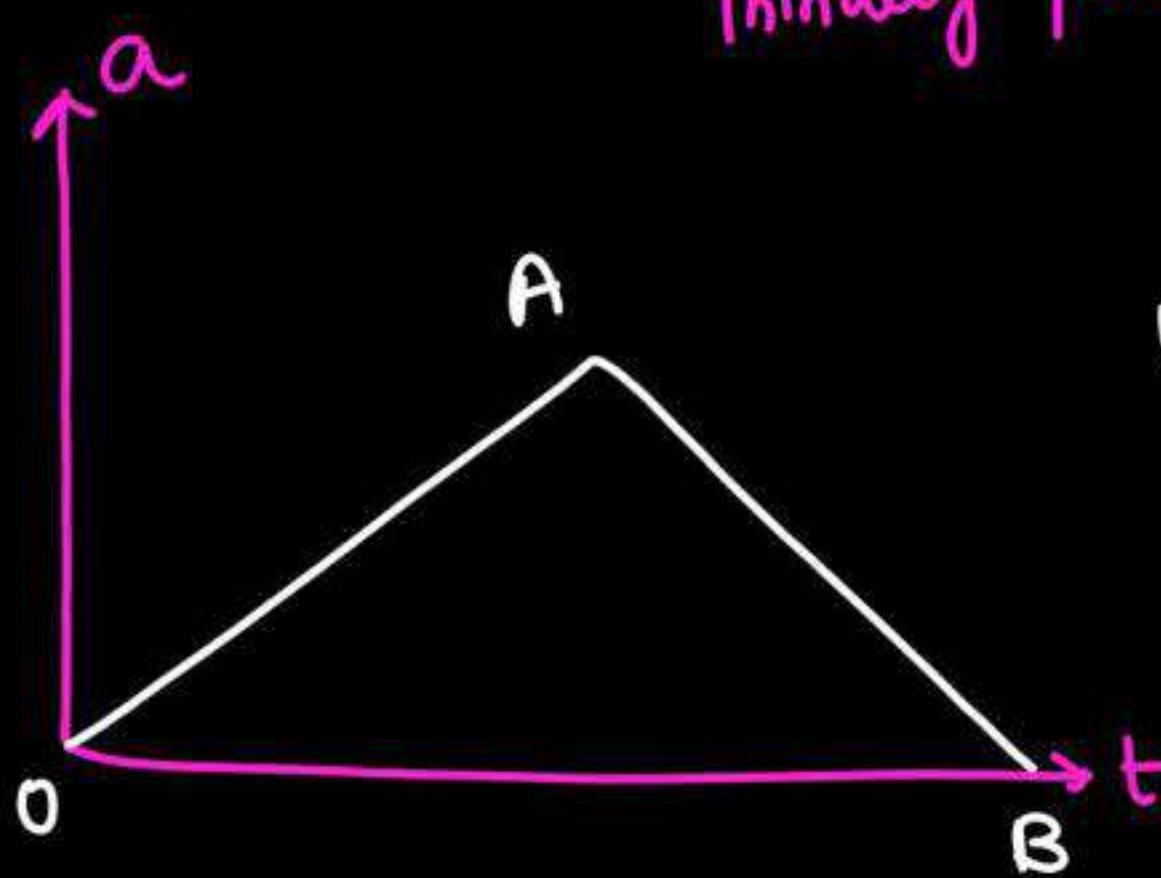
$$V_f = 250$$



$$a = 5t$$

$$\text{Area} = \frac{1}{2} \times 10 \times 50 =$$

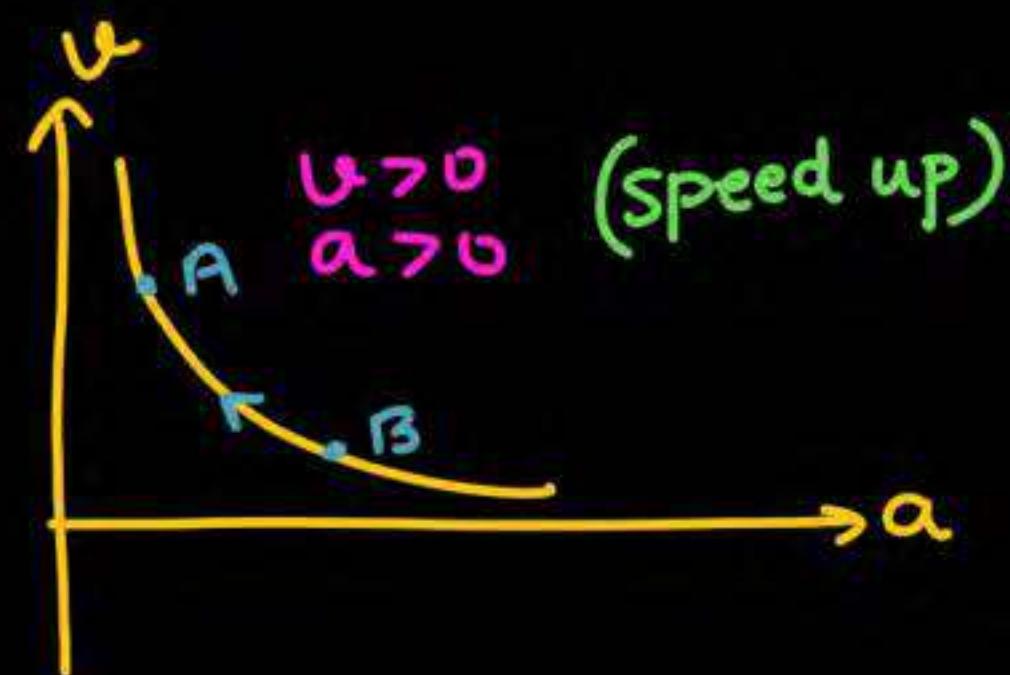
change in velocity  
 $= V_f - V_i$



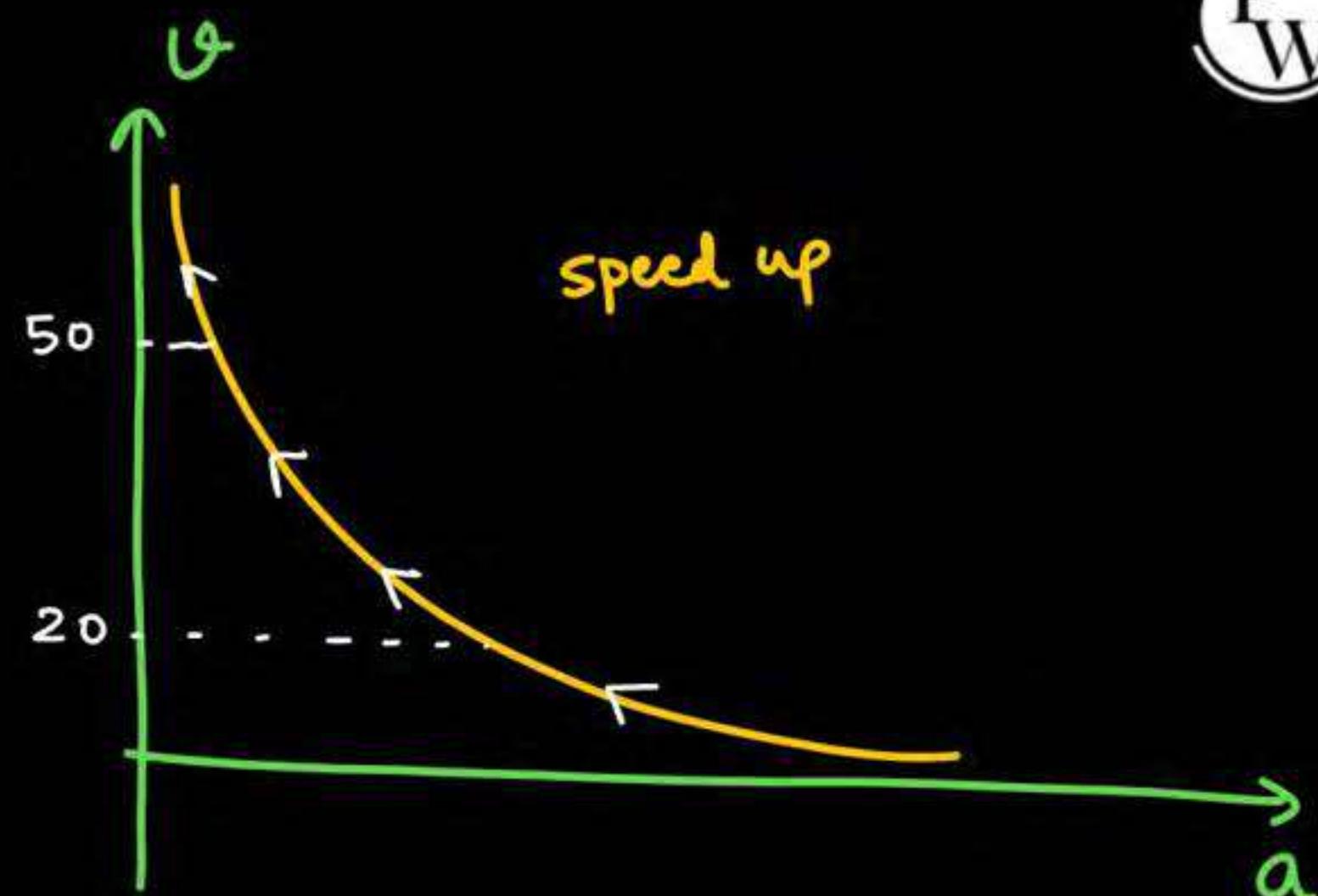
$v_{max}$  ~~on ET~~ ~~ET~~ A

~~A~~  $\equiv 35\%$   
~~B~~  $\equiv 45\%$   
C  $\equiv 0\%$

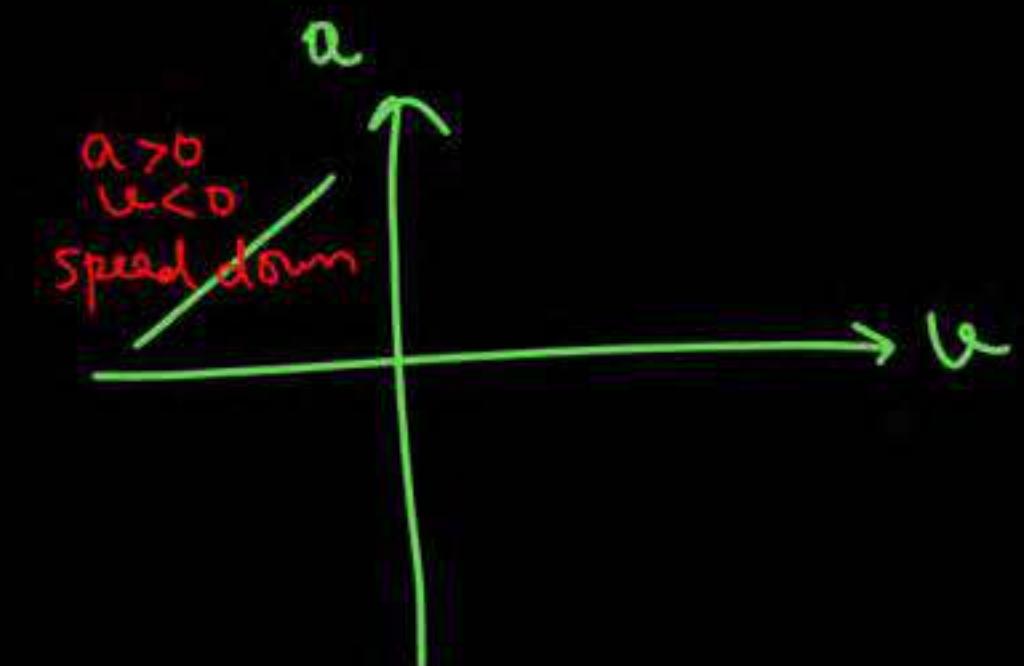
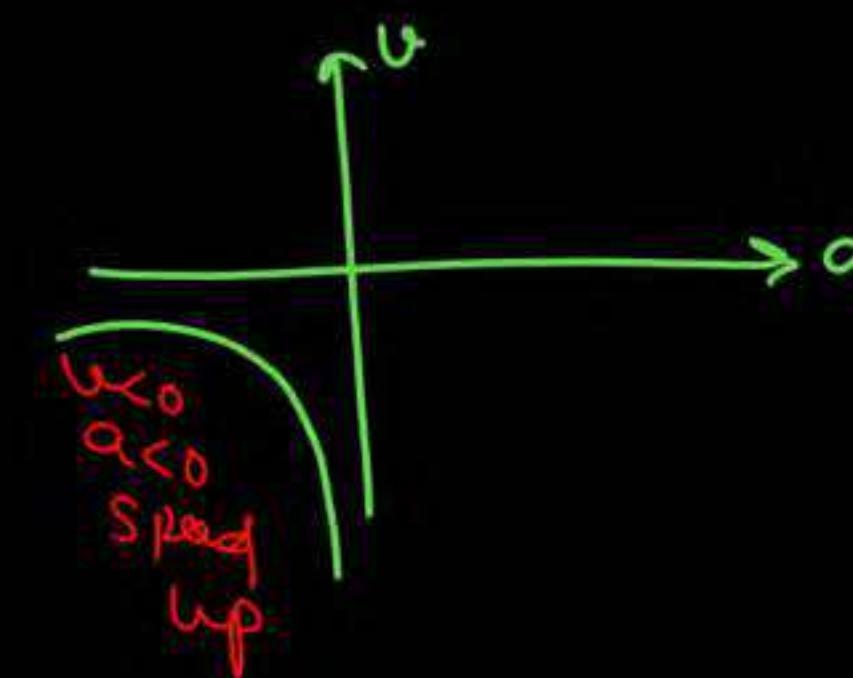
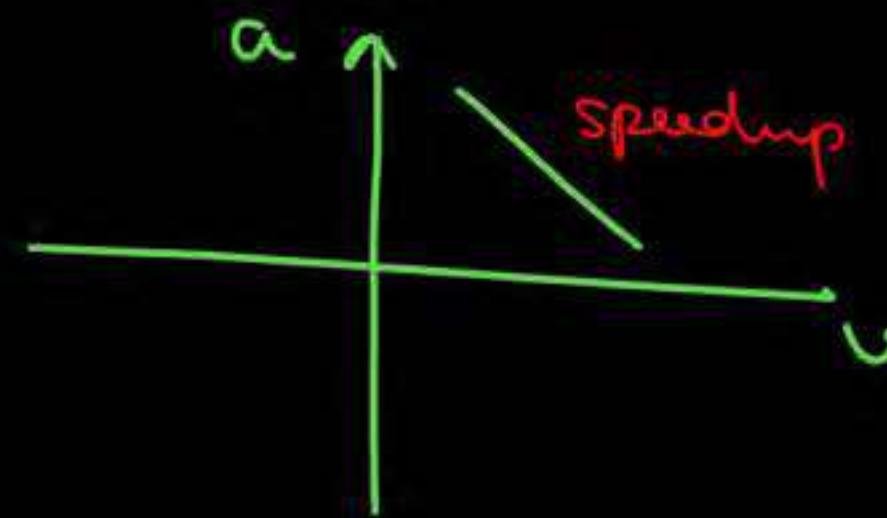
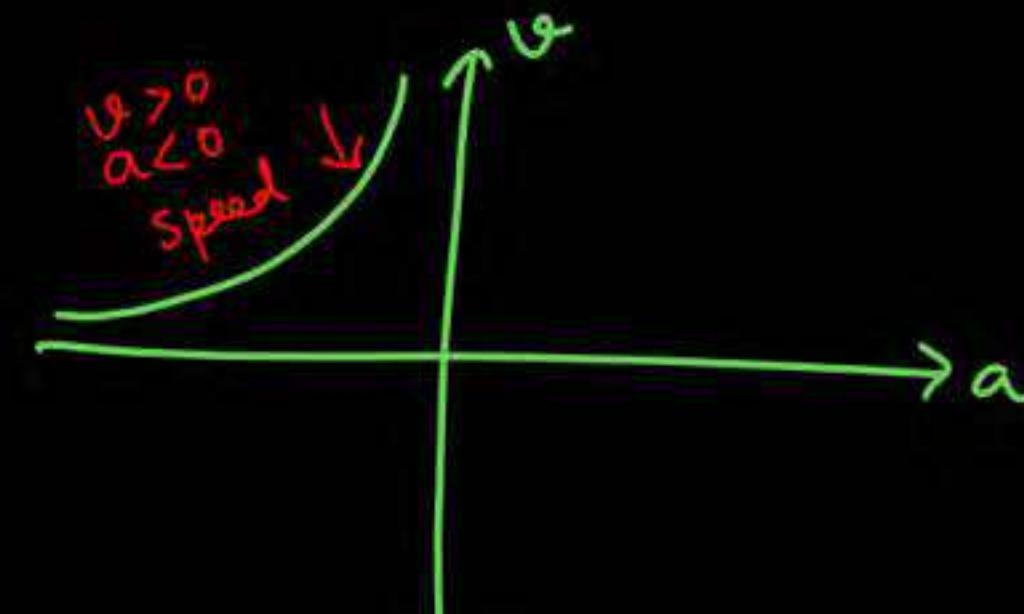
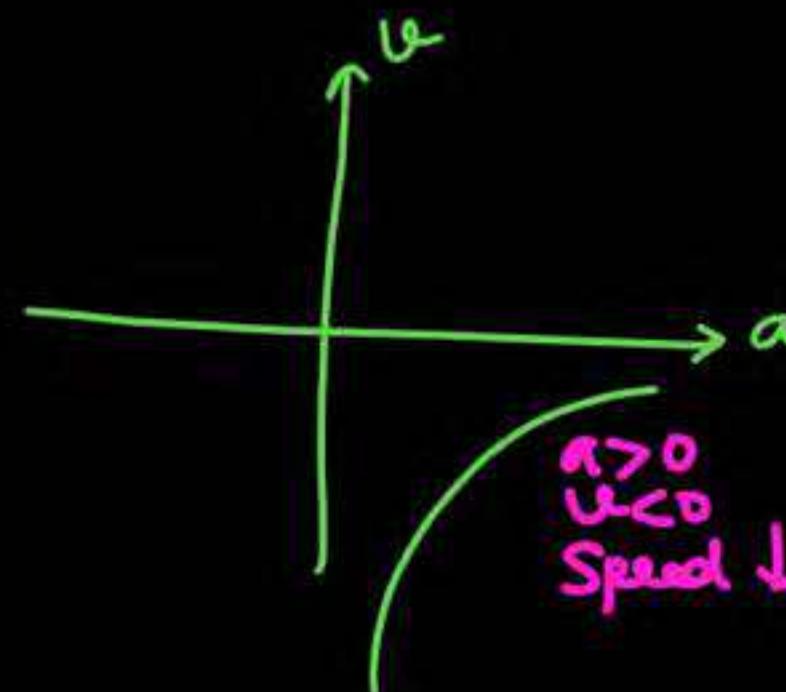
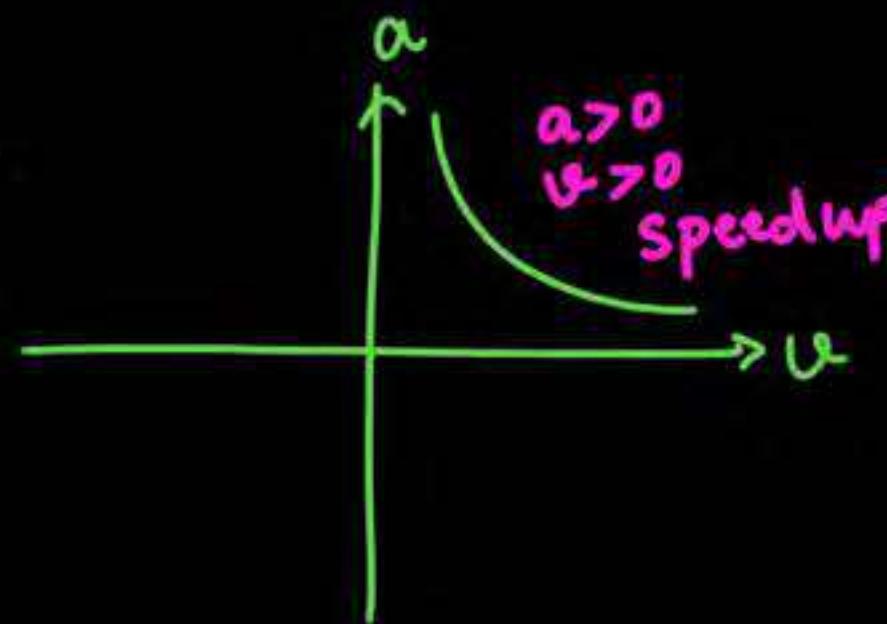
D  $\equiv$  ~~ET~~ ~~ET~~  $\eta$   $\approx 7\%$



- ① Velocity is decreasing X
- ② " increasing ✓
- ③ acc is increasing X
- \*④ acc is decreasing ✓

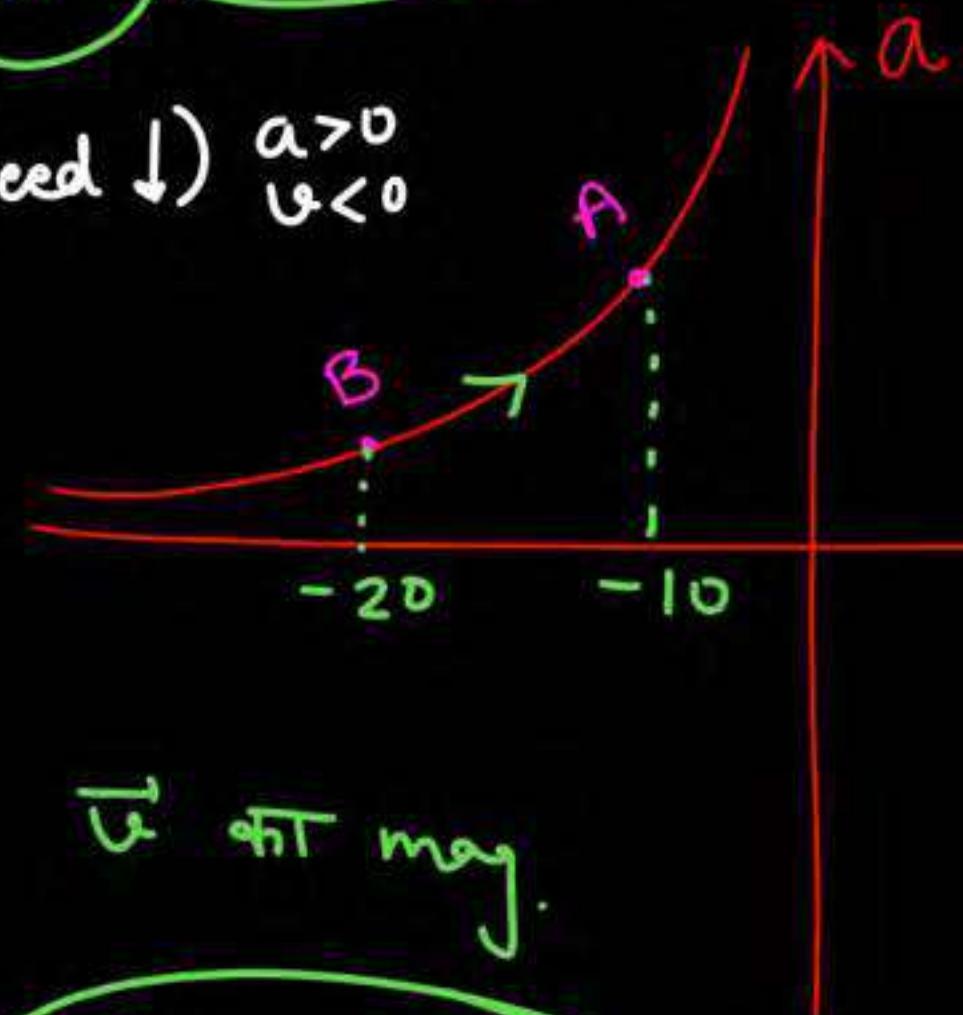


$\alpha$



Q HW next dn = Dis

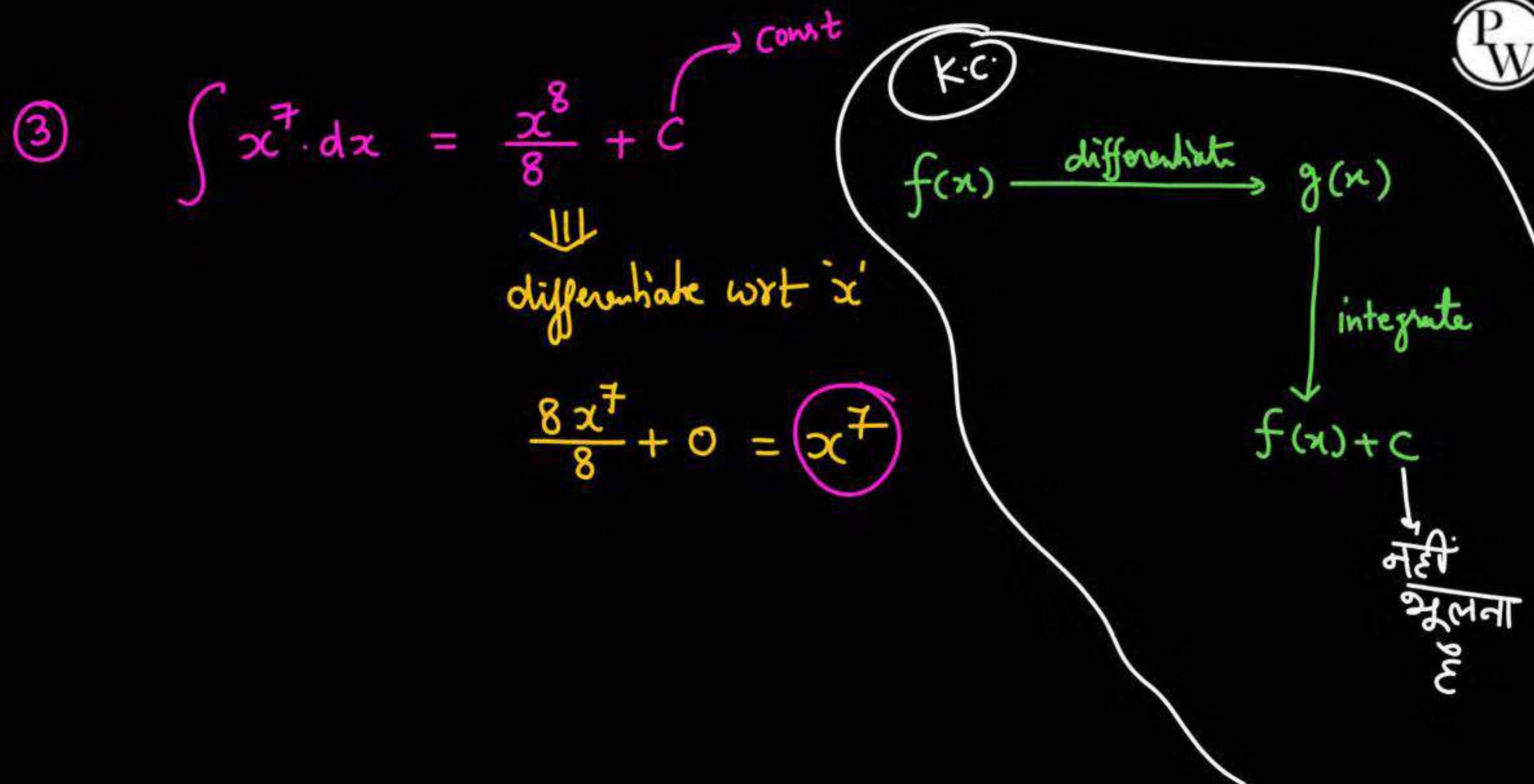
(Speed ↓)  $a > 0$   
 $v < 0$



$\vec{v}$  oft neg.

B → A

- ① acc is increasing
- ② " " decreasing  $\Rightarrow ?$
- ③  $v$  " increasing
- ④  $v$  is decreasing



Q

$$\textcircled{1} \quad x^3 \text{ का diff. wrt } x \Rightarrow 3x^2 \Rightarrow \int 3x^2 dx = 3 \int x^2 dx \\ = 3 \frac{x^3}{3} + C \\ = x^3 + C$$

$$\textcircled{2} \quad x^3 + 5 \text{ का differeniation wrt } x \Rightarrow 3x^2 + 0$$

$$\int 3x^2 \cdot dx = x^3 + C$$

$$\textcircled{3} \quad x^3 + 25 \text{ का diff. लेता हूँ } \Rightarrow 3x^2 + 0$$

$$\int 3x^2 dx = x^3 + C$$

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 ✓

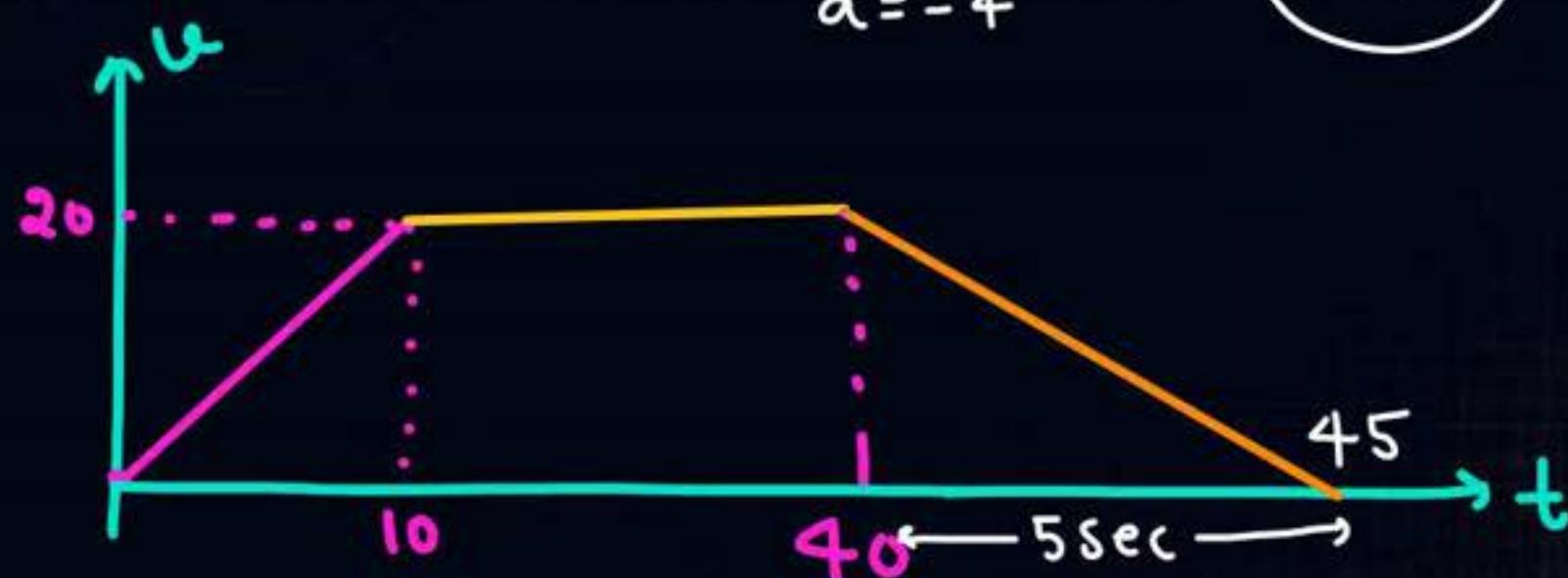
A particle starts from rest, accelerates at  $2 \text{ m/s}^2$  for 10 s and then goes at constant speed for 30 s and then decelerates at  $4 \text{ m/s}^2$  till it stops. What is the distance travelled by it?

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

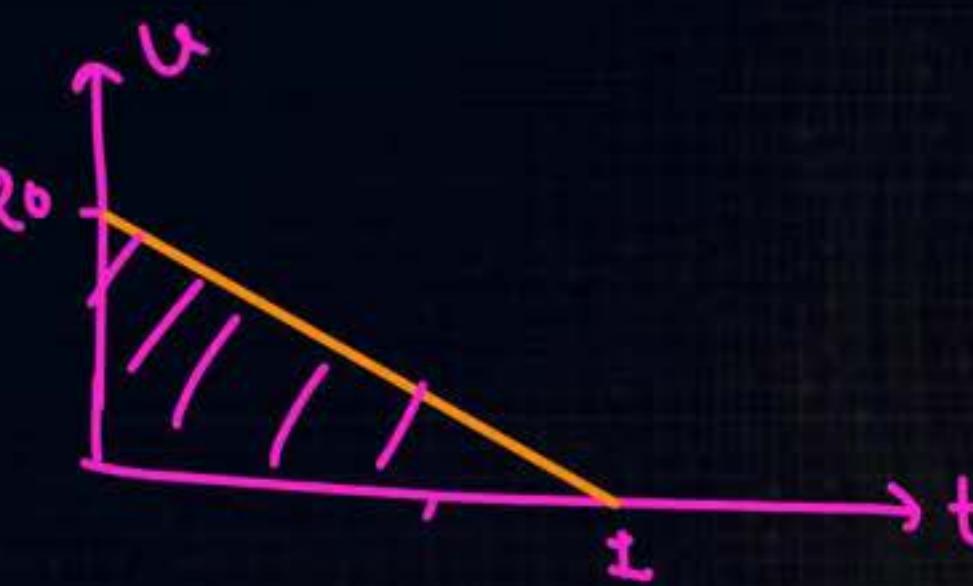
note X

The driver of a car which is moving on a straight horizontal road with a speed of  $72 \text{ kmh}^{-1}$  applies brakes. If the retardation produced is  $20 \text{ ms}^{-2}$ , 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 start motion having initial velocity 20 m/s and it moves with const acc of 10 m/s<sup>2</sup>.

① find velocity at t = 4 sec

② find displacement of particle from t = 0  $\longrightarrow$  t = 4 sec

③ find displacement in 4<sup>th</sup> sec

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

$$S_n = 20 + \frac{1}{2} \cdot (2 \times 4 - 1) \times 10$$

$$= 20 + 35 = 55$$

$$u = 20$$

$$a = 10$$

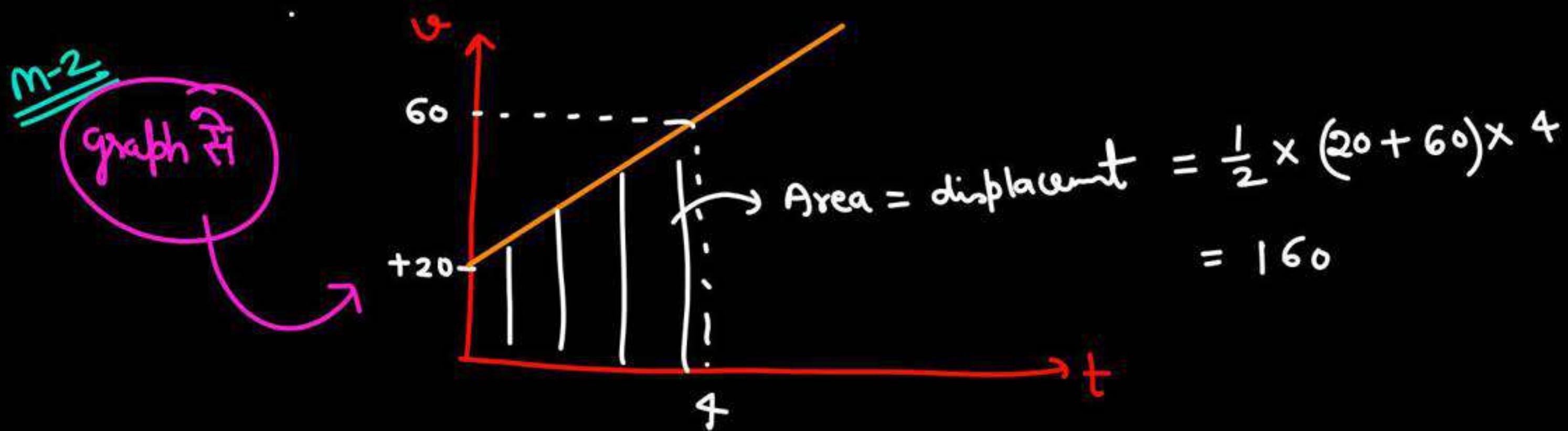
$$\textcircled{1} \quad t = 4, \Rightarrow v = u + at \\ = 20 + 10 \times 4$$

$$v = 60$$

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

$$= 20 \times 4 + \frac{1}{2} \times 10 \times 4^2 = 160$$

Q A particle starts motion having initial velocity  $20 \text{ m/s}$  and it moves with const acc of  $10 \text{ m/s}^2$ .

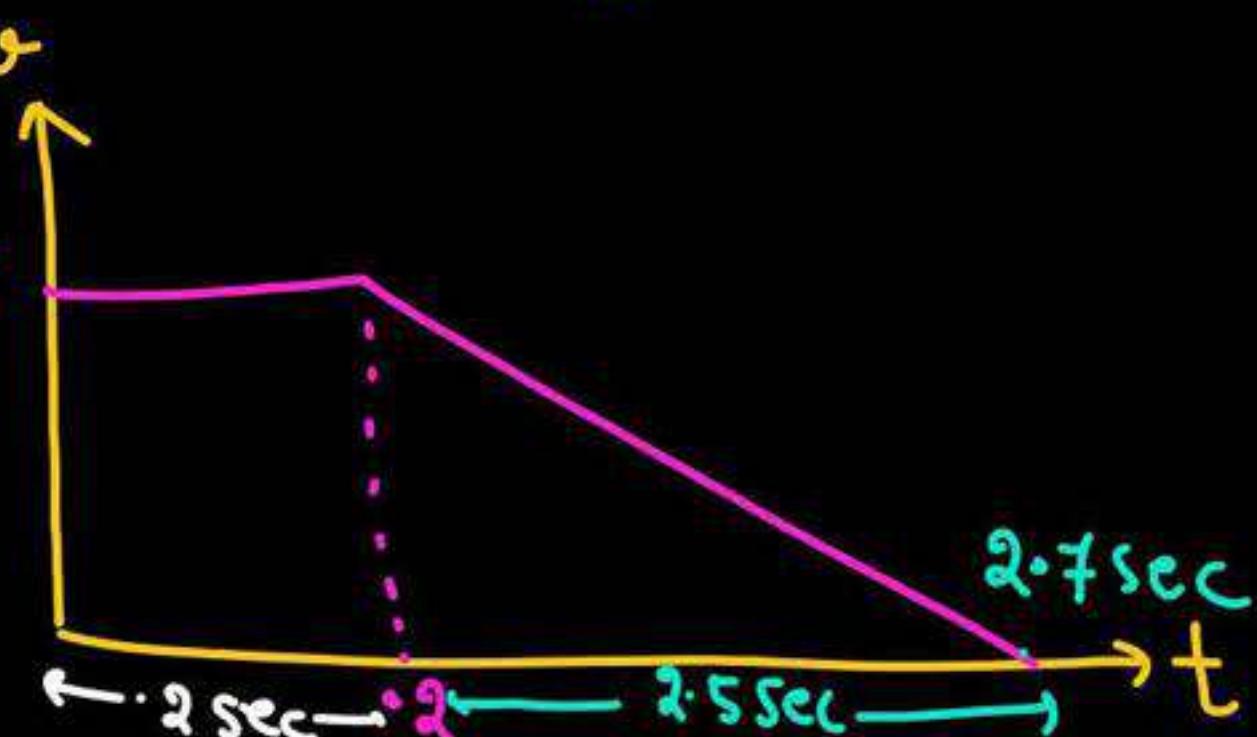


19. A driver takes 0.20 s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of  $6.0 \text{ m/s}^2$ , find the distance travelled by the car after he sees the need to put the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

HCV  
note  
find stopping distance.

$$54 \text{ km/hr} = 54 \times \frac{5}{18} = 15 \text{ m/s}$$

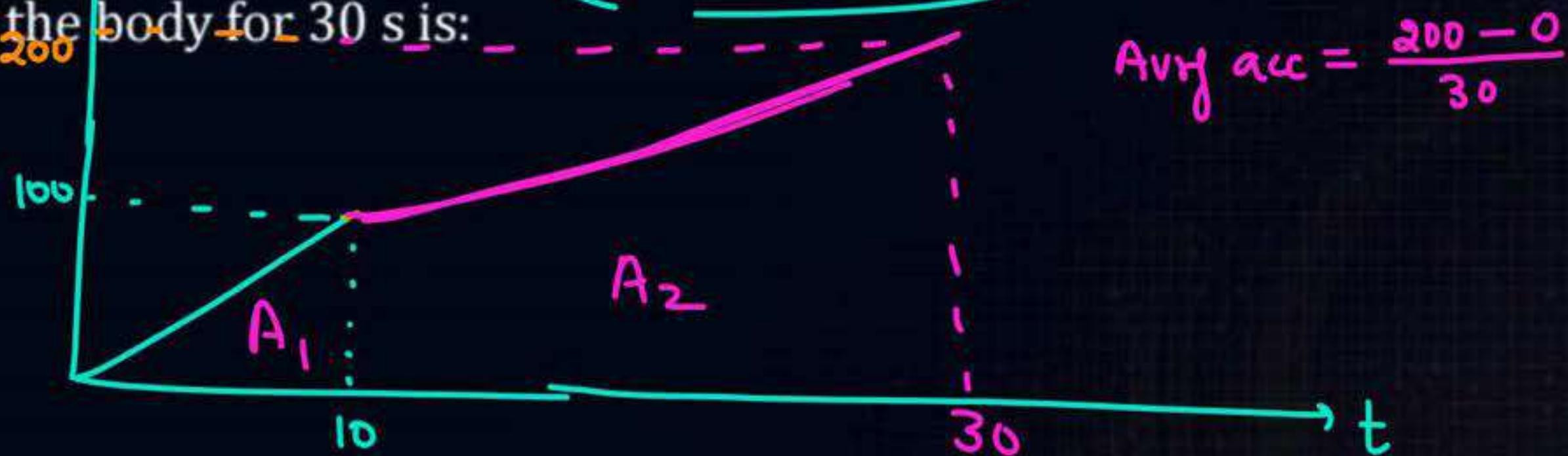
$$\begin{aligned}\text{Area} &= \frac{1}{2} \times (2 + 2.7) \times 15 \\ &= 21.75\end{aligned}$$



Question

Note X

If a body starting from the rest travels with a uniform acceleration of  $10 \text{ ms}^{-2}$  for first 10 second and with uniform acceleration  $5 \text{ ms}^{-2}$  for next 20 seconds, then average acceleration of the body for 30 s is:



- A  $15 \text{ ms}^{-2}$
- B  $10 \text{ ms}^{-2}$
- C  $20 \text{ ms}^{-2}$
- 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  $-5 \text{ m/s}^2$
- B  $6 \text{ m/s}^2$
- C  $-6 \text{ m/s}^2$
- D ZERO

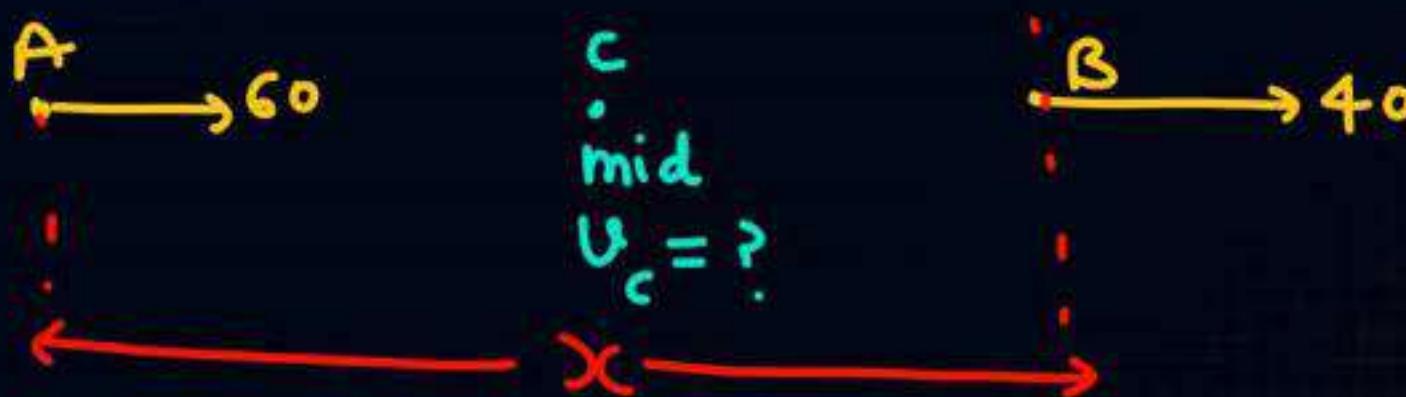
Ans : (C)

## 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  $5 \text{ ms}^{-2}$ , 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

$$S_{15} = 10 \times 15 + \frac{1}{2} 5 (15)^2$$

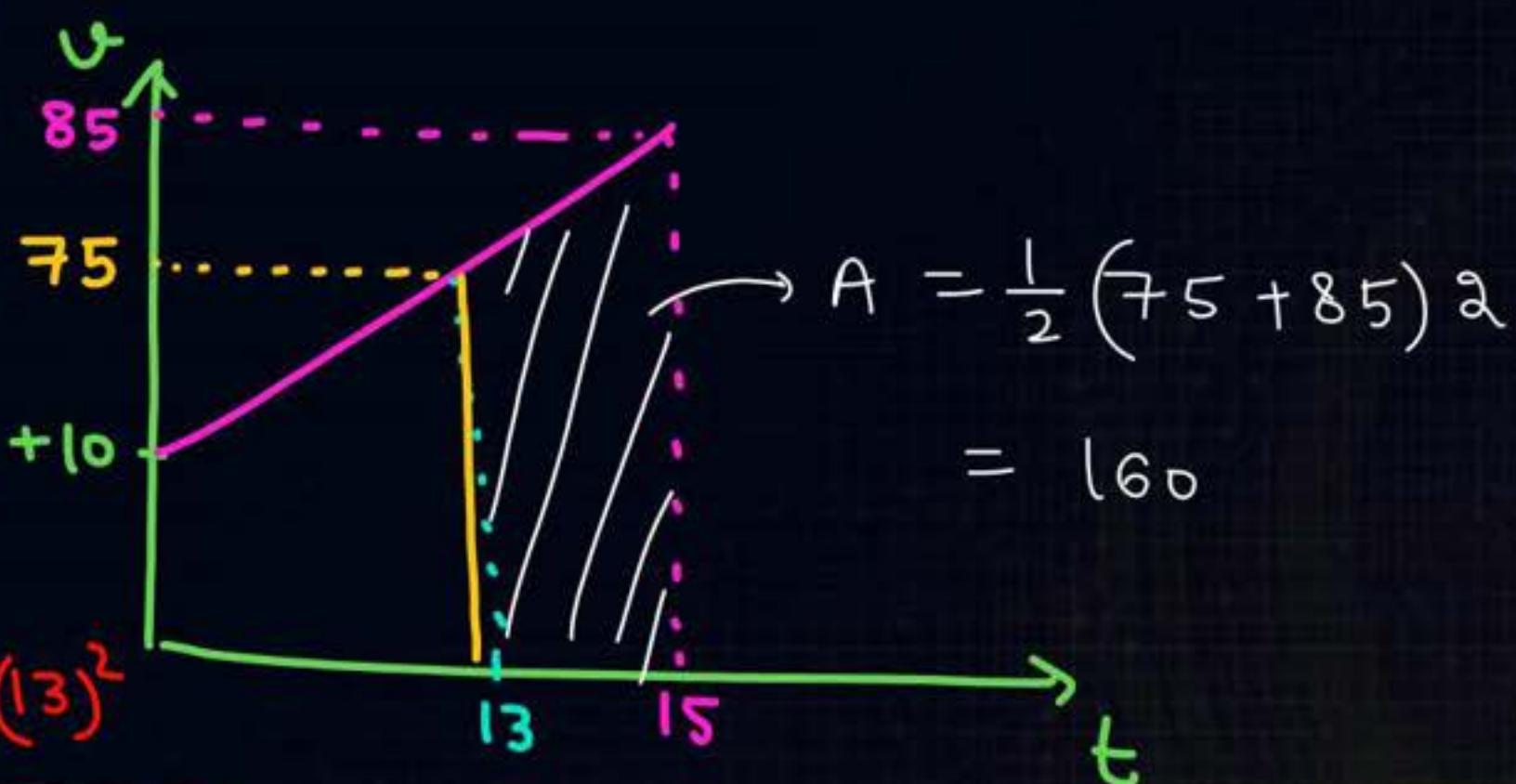
C 210 m

$$S_{13} = 10 \times 13 + \frac{1}{2} \times 5 \times (13)^2$$

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?

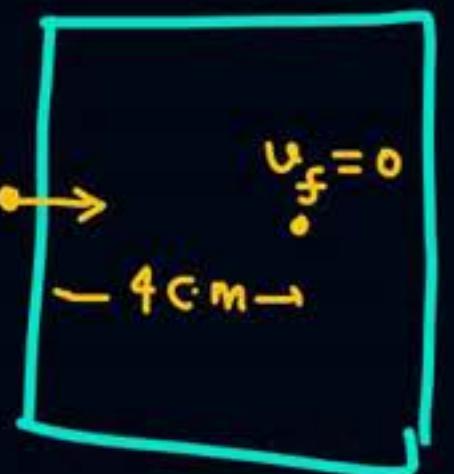
A 100 cm/s

B 136.2 cm/s

C 300 cm/s

D 250 cm/s

$u = 2$



$0^2 = 2^2 + 2a \times \frac{4}{100}$

$-4 = \frac{8}{100} a$

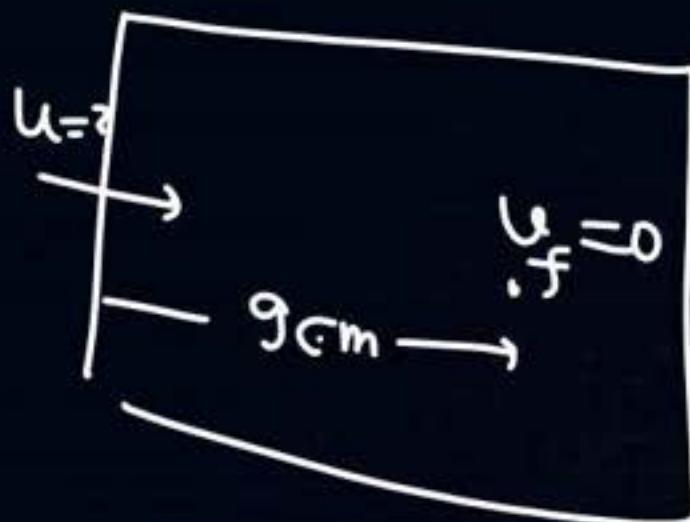
$a = -50$

$0^2 = u^2 + 2as$

$0 = u^2 + 2 \times (-50) \left( \frac{9}{100} \right)$

$u^2 = 9$

$u = 3$



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  $\rightarrow a = \text{const}$   $\rightarrow S = 20$

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  $350 \text{ m/s}$  enters a concrete wall and penetrates a distance of  $5.0 \text{ cm}$  before coming to rest. Find the deceleration.

*Rough*

$$v_f = 0 \quad a = ?$$

 $\frac{1}{2} \text{ min}$ 

$$\begin{array}{r} 35 \\ 35 \\ \hline 1225 \end{array}$$

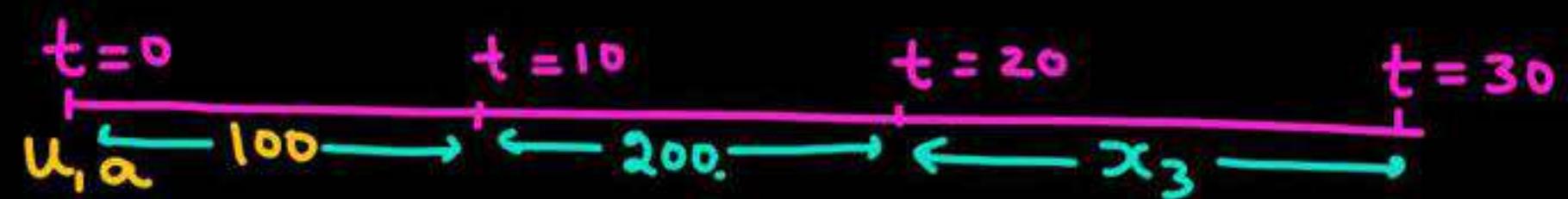
$$0^2 = (350)^2 + 2 \times a \times \frac{5}{100}$$

$$a = -(350)^2 \times 10$$

$$a = -1225000$$

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



$$t=0 \rightarrow t=10 \Rightarrow 100 = u \times 10 + \frac{1}{2} a \cdot 10^2$$

$$100 = 10u + 50a \quad \text{--- (1)}$$

$$\textcircled{1} - \textcircled{2}$$

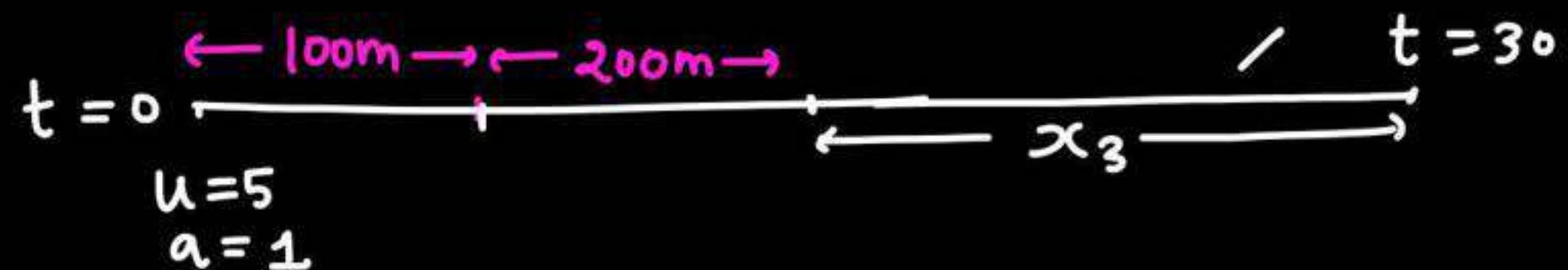
$$-50 = -50a$$

$$t=0 \rightarrow t=20 \Rightarrow 300 = u \cdot 20 + \frac{1}{2} \cdot a \cdot (20)^2$$

$$300 = 20u + 200a$$

$$150 = 10u + 100a \quad \text{--- (2)}$$

$a = 1$
$u = 5$



$$t = 0 \longrightarrow t = 30$$

$$300 + x_3 = ut + \frac{1}{2}at^2$$

$$300 + x_3 = 5 \times 30 + \frac{1}{2} \times 1 \times (30)^2$$

$$300 + x_3 = 150 + 450$$

$$x_3 = 300$$

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  $60\text{ m/s}$  and  $\text{const acc} = -10\text{ m/s}^2$

① When particle will come to at rest

$$t = 6$$

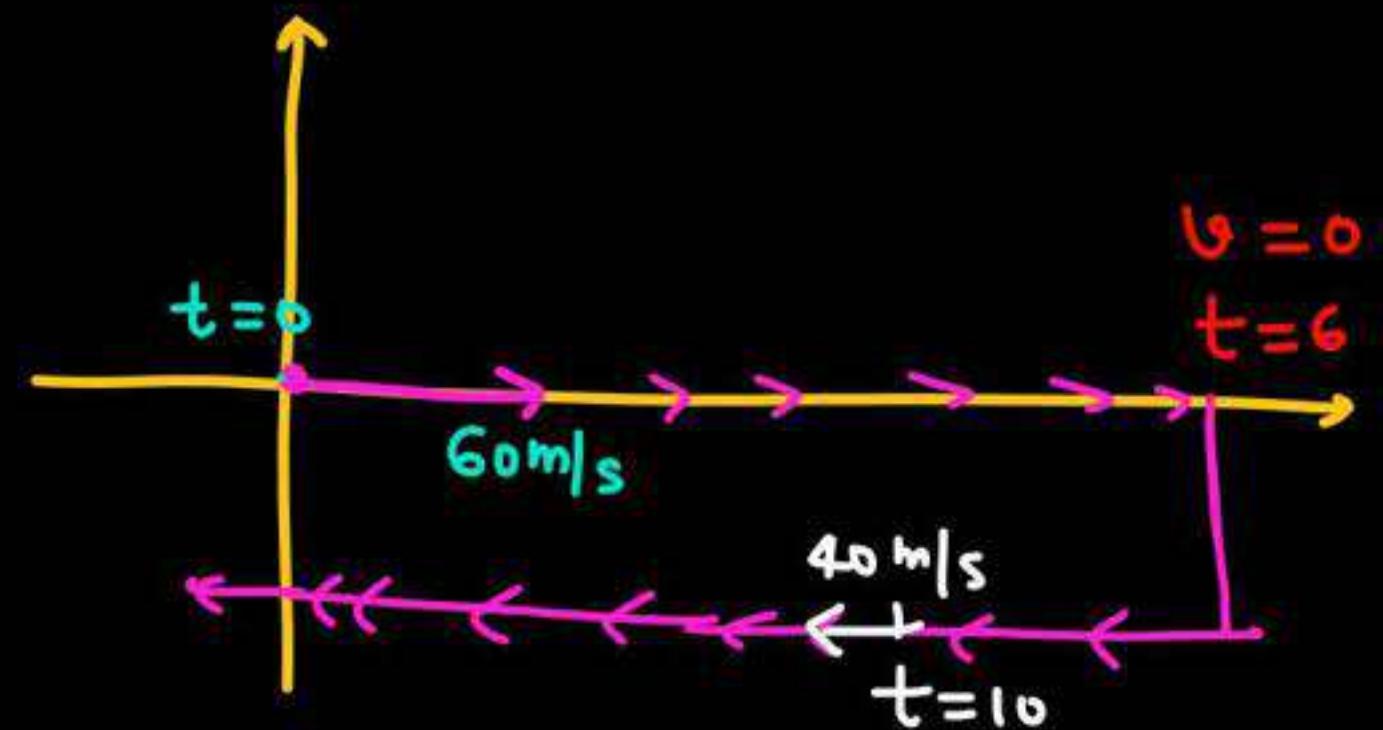
② find  $v$  at  $t = 2$ ,  $v = 40$

"  $v$  at  $t = 10\text{ sec}$

$$v = -40$$

③ Displacement in  $10\text{ sec}$

$$S = 60 \times 10 + \frac{1}{2} \times (-10) \times 10^2 = 600 - 500 = 100$$



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  $-4 \text{ m/s}^2$  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)  $4 \text{ m/s}^2$
- (b)  $200 \text{ m}$
- (c)  $1000 \text{ m}$

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  $10 \text{ m/s}^2$  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

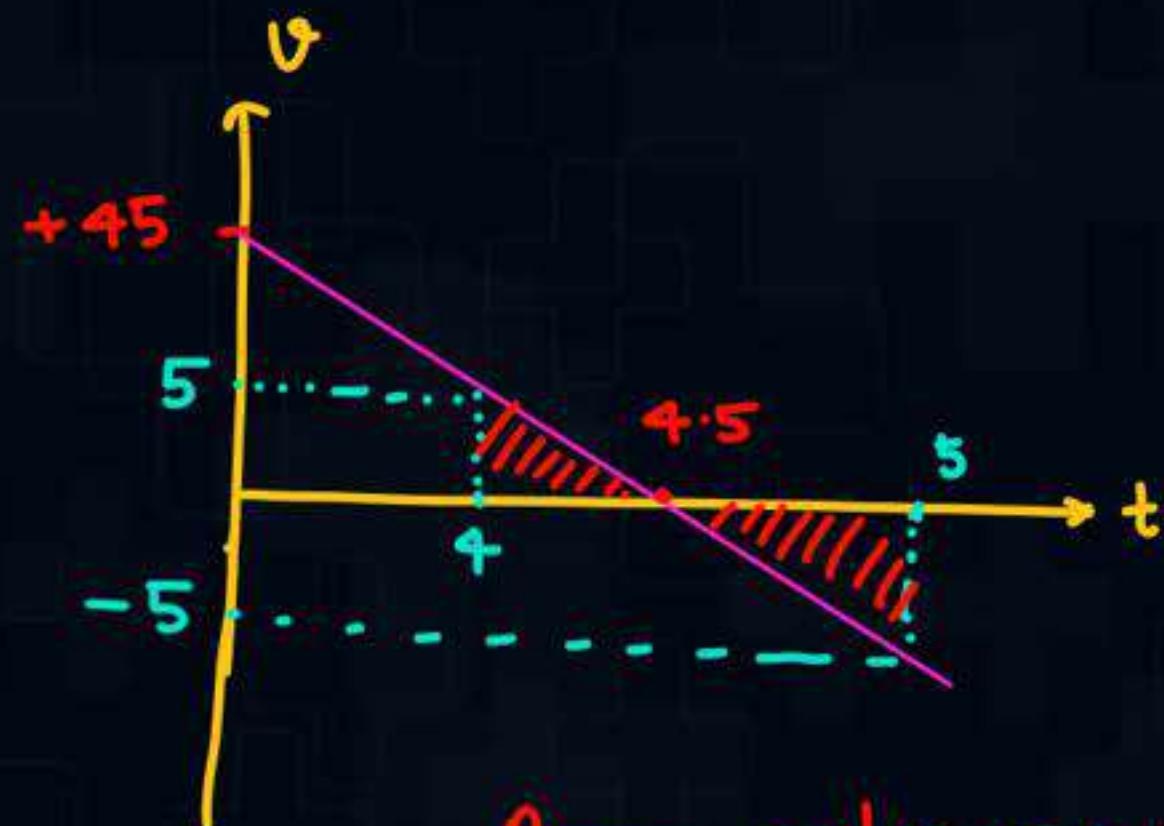
Q2

$$\begin{array}{l} u = 45 \text{ m/s} \\ \text{---} \\ a = -10 \end{array}$$

distance travelled in 5<sup>th</sup> sec.

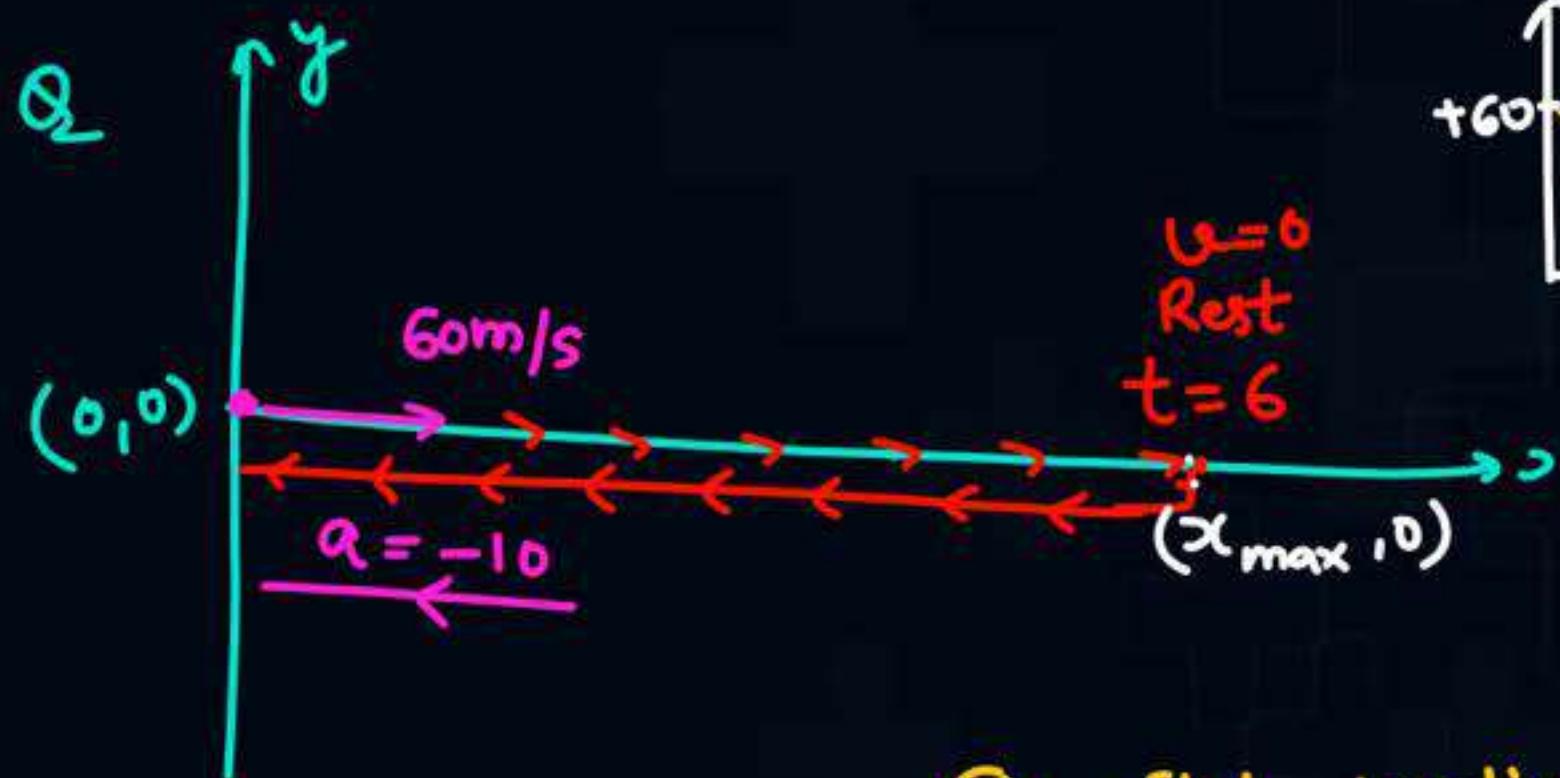
$$\text{Displacement} = A_{\text{अपर}} - A_{\text{तीव्र}} = 0$$

$$\begin{aligned} \text{Distance} &= A_{\text{अपर}} + A_{\text{तीव्र}} \\ &= \frac{25}{20} + \frac{25}{20} = \frac{50}{20} = \underline{\underline{2.5}} \end{aligned}$$



$$A_{\text{अपर}} = \frac{1}{2} \times 5 \times 5 = \frac{25}{20}$$

$$A_{\text{तीव्र}} = \frac{1}{2} \times 5 \times 5 = \frac{25}{20}$$



$$\textcircled{1} \quad t = 4, v = 20$$

$$\textcircled{2} \quad t = 6, v = 0$$

$$\textcircled{3} \quad t = 8, v = -20$$

$$\textcircled{4} \quad t = 10, v = -40$$

$$\textcircled{5} \quad t = 12, v = -60$$

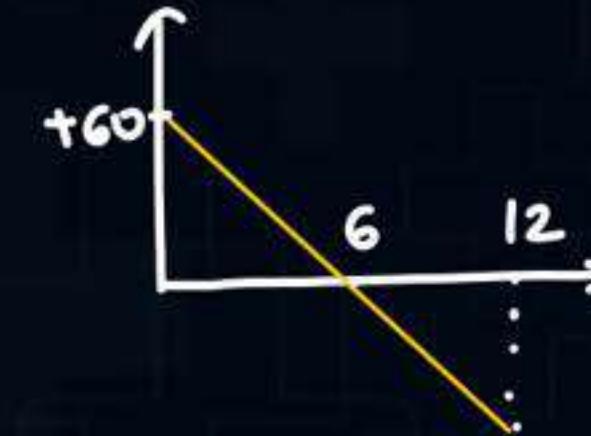
**⑥ find location of particle at  $t = 4 \text{ sec}$**

$$u = +60, a = -10$$

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

$$x = 60 \times 4 - \frac{1}{2} \times 10 \times 4^2$$

$$x = 240 - 80 = \underline{\underline{160}}$$



**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<sup>h</sup> (+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.

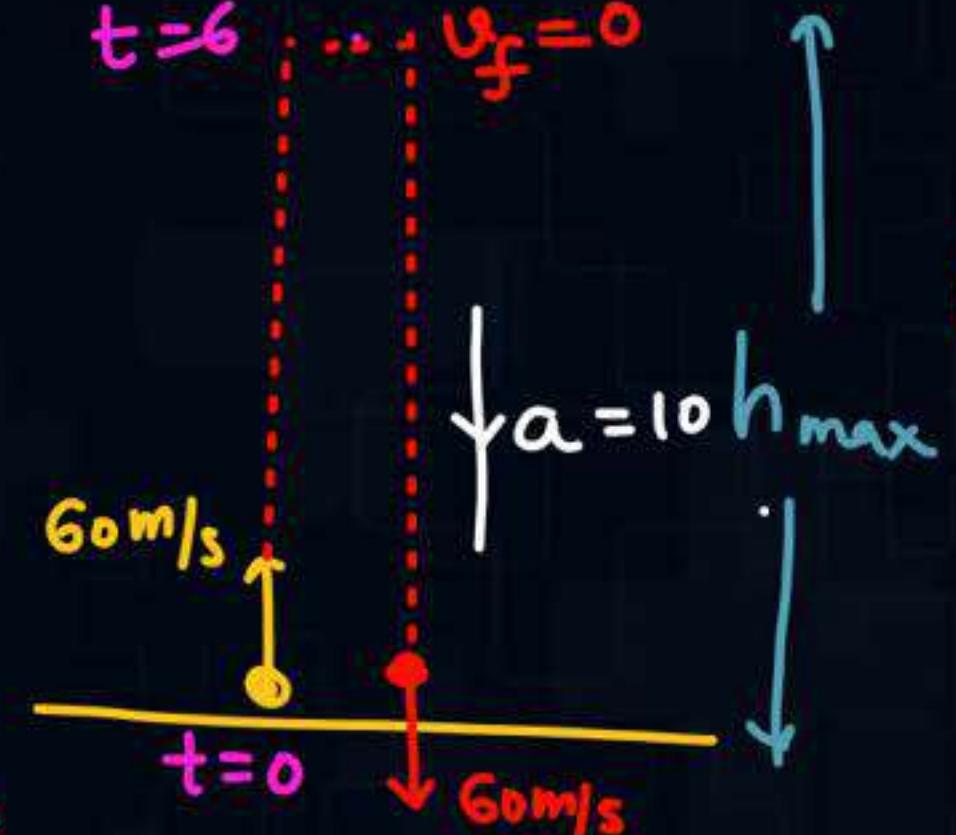
① find  $v$  at

$$t=4, v = 20$$

$$t=11, v = -50$$

② when particle will comes to at rest  $t=6$

③ find time of flight  $\Rightarrow 6+6 = 12 \text{ sec}$

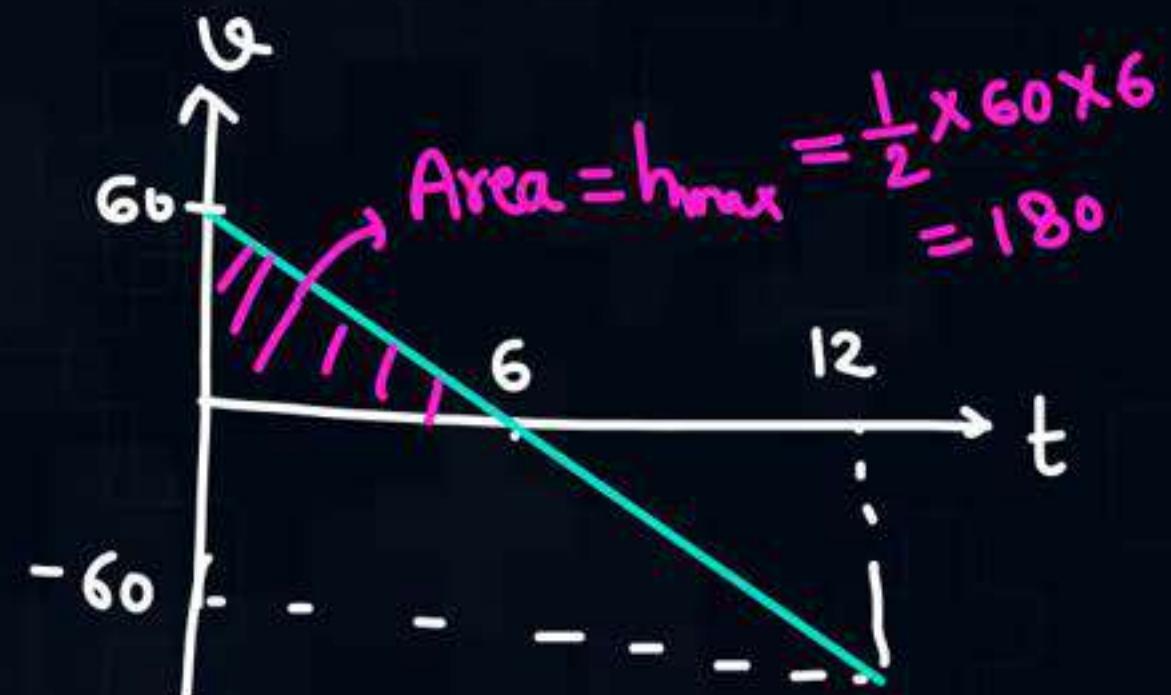


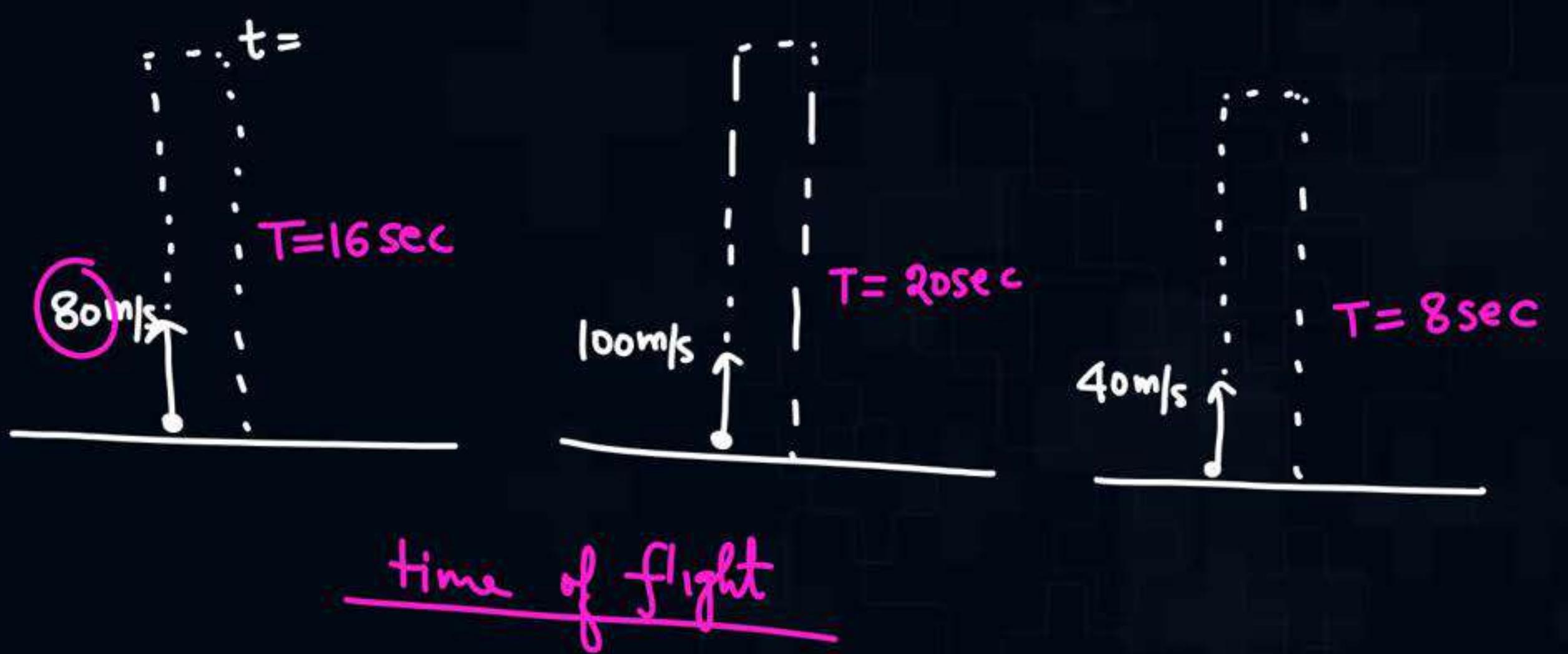
④

max height

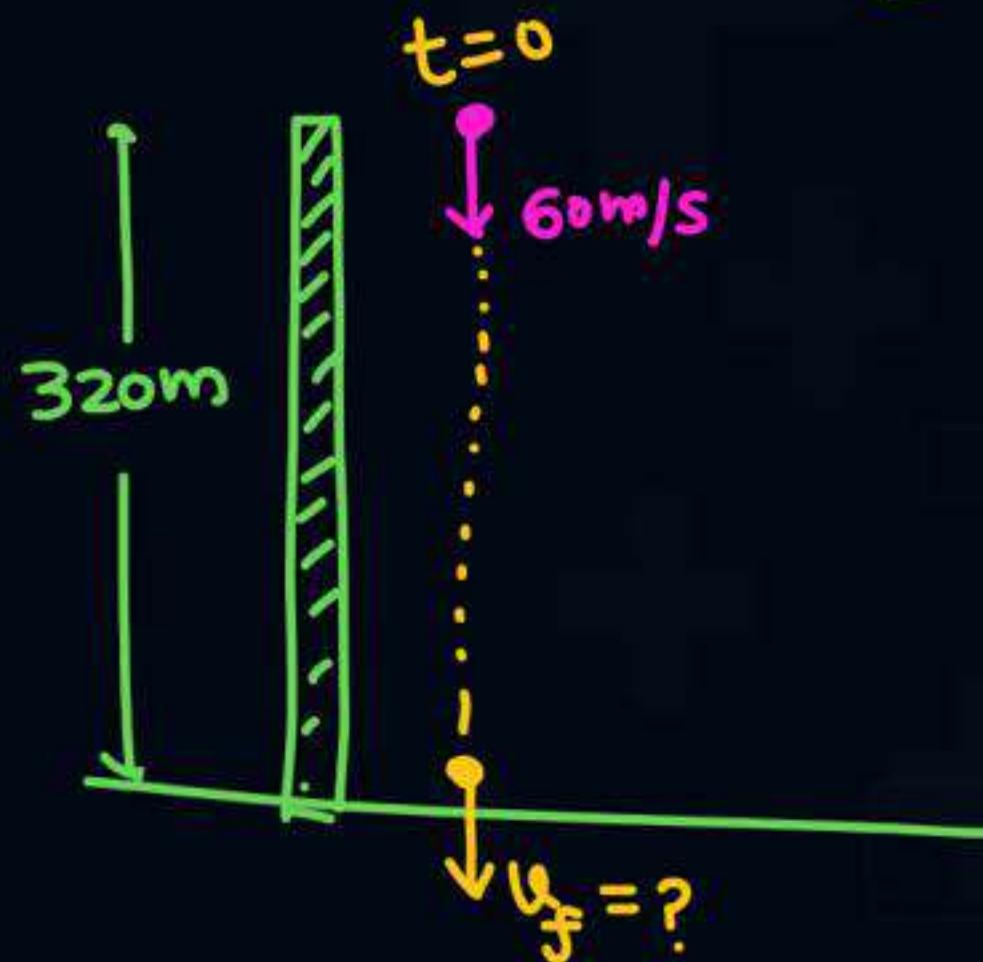
$$0^2 = 60^2 + 2 \times (-10) h_{\max}$$

$$h_{\max} = 180$$





Q



Q when particle will hit the ground  
& with what velocity.

नीचे  $\Rightarrow$  +ve (downward)

$$u = +60 \quad a = +10$$

$$\text{displacement} = s = \text{नीचे } 320 \\ s = +320$$

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

$$+320 = 60t + \frac{1}{2} \times 10 \times t^2$$

$$t^2 + 12t - 64 = 0$$

$$(t+16)(t-4) = 0$$

$$t = 4 \text{ sec}$$

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

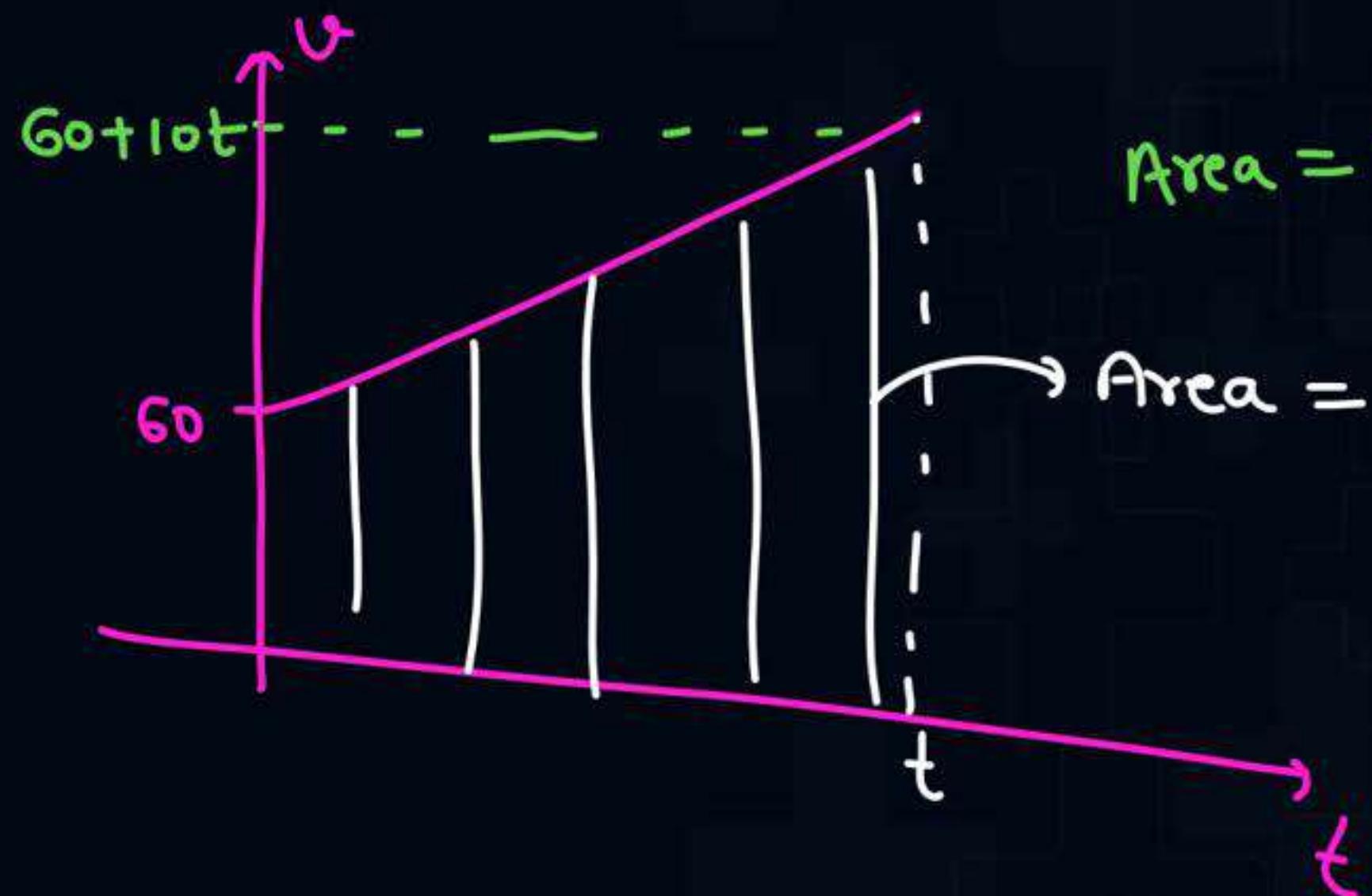
$$v^2 = 60^2 + 2 \times 10 \times 320$$

$$v^2 = 3600 + 6400$$

$$v^2 = 10000$$

$$v = 100 \text{ (नीचे)}$$

III  
(Common Sense)



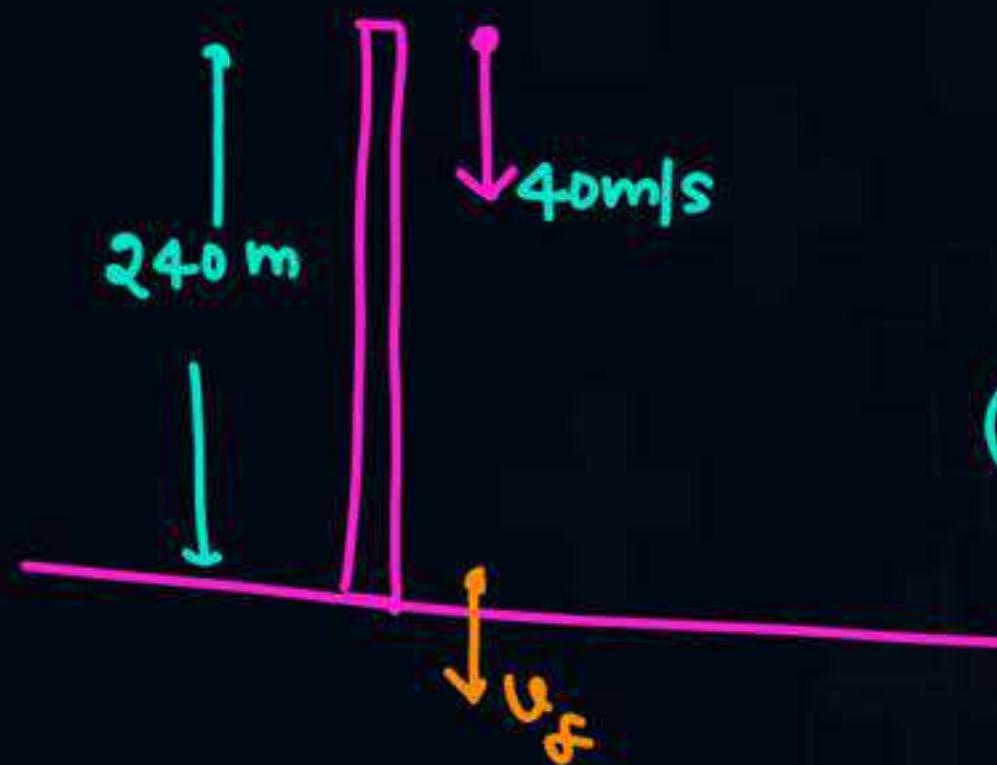
$$\text{Area} = \frac{1}{2}(60 + 60 + 10t) \times t = 320$$

$$(120 + 10t)t = 640$$

$$10t^2 + 120t = 640$$

$$t^2 + 12t - 64 = 0$$

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.

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

$$240 = 40t + \frac{1}{2} \times 10 \times t^2$$

$$5t^2 + 40t - 240 = 0$$

$$t^2 + 8t - 48 = 0$$

$$(t+12)(t-4) = 0$$

$$\boxed{t=4}$$

Q note ✓



when it will hit the ground

$$u = 0$$

$$a = +10$$

$$S = +500$$

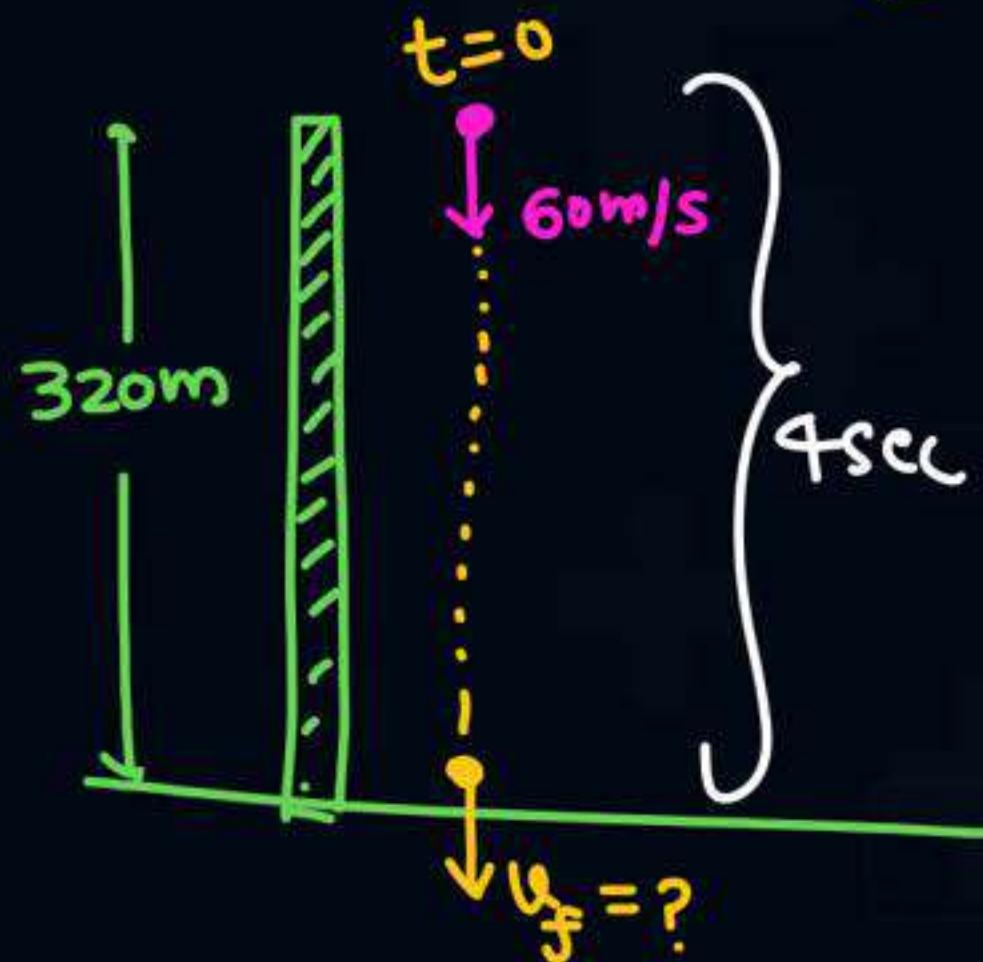
$$500 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$t = \sqrt{\frac{1000}{10}} = 10 \text{ sec}$$

$$v_f^2 = 0^2 + 2 \times 10 \times 500$$

$$v_f = 100$$

Q



Q when particle will hit the ground & with what velocity.

नीचे  $\Rightarrow$  +ve (downward)

$$u = +60 \quad a = +10$$

$$\text{displacement} = s = \text{नीचे } 320 \\ s = +320$$

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

$$+320 = 60t + \frac{1}{2} \times 10 \times t^2$$

$$t^2 + 12t - 64 = 0$$

$$(t+16)(t-4) = 0$$

$$t = 4 \text{ sec}$$

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

$$v^2 = 60^2 + 2 \times 10 \times 320$$

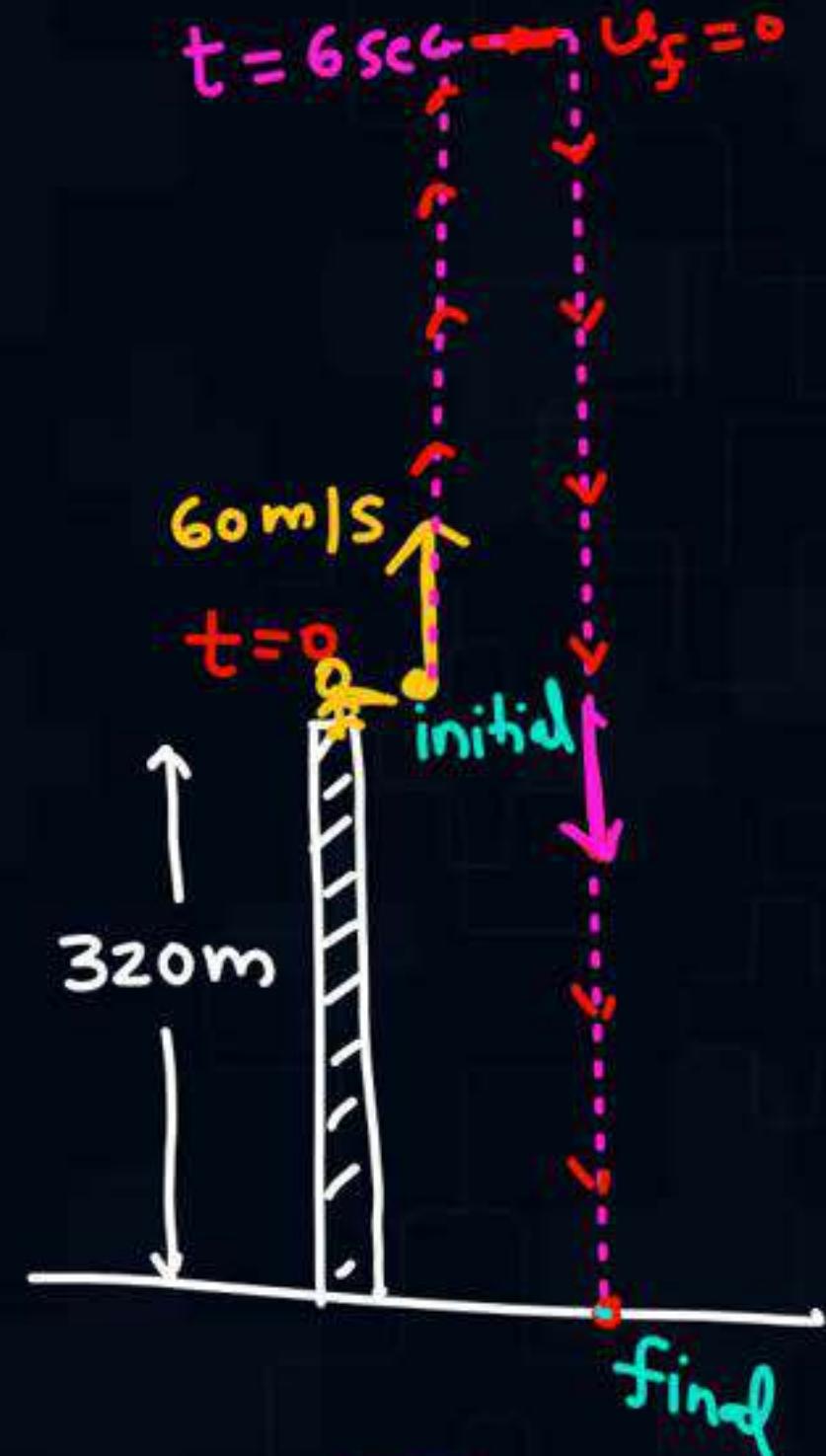
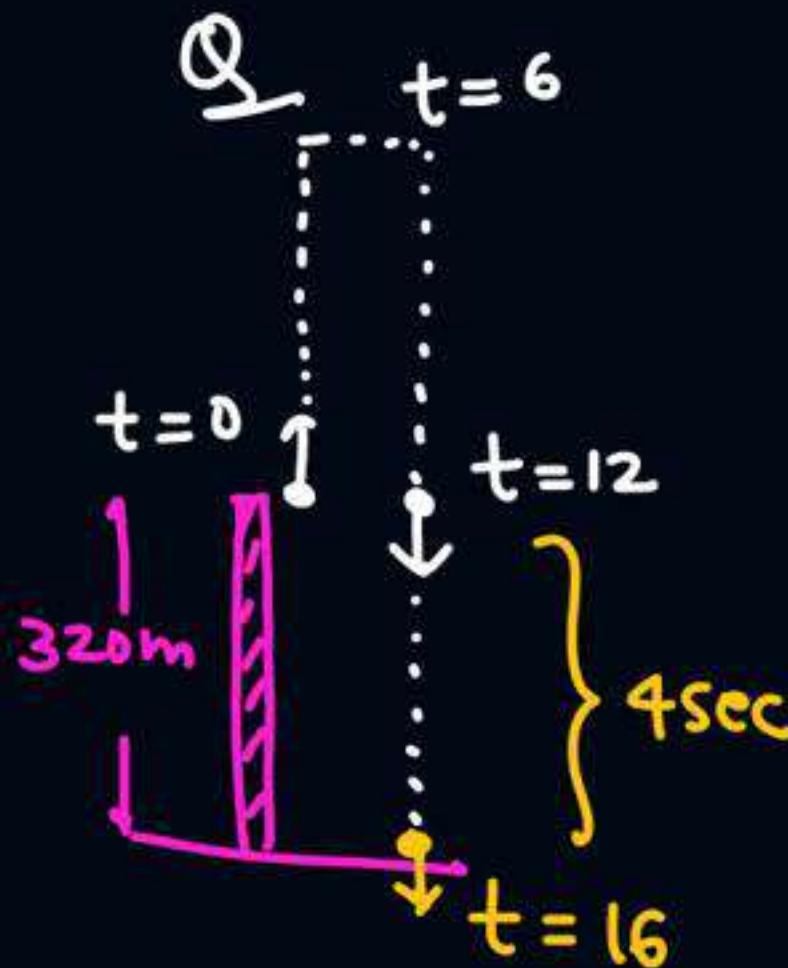
$$v^2 = 3600 + 6400$$

$$v^2 = 10000$$

$$v = 100 \text{ (नीचे)}$$

III  
(Common Sense)

$$t = 6 \text{ sec} \rightarrow v_f = 0$$



$$t = 16 \text{ sec}$$

when it will hit the ground.

उपर  $\rightarrow +ve$

$$u = \text{उपर } 60 = +60$$

$$a = \text{नीचे } g = -10$$

$$S = \text{नीचे } 320 = -320$$

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

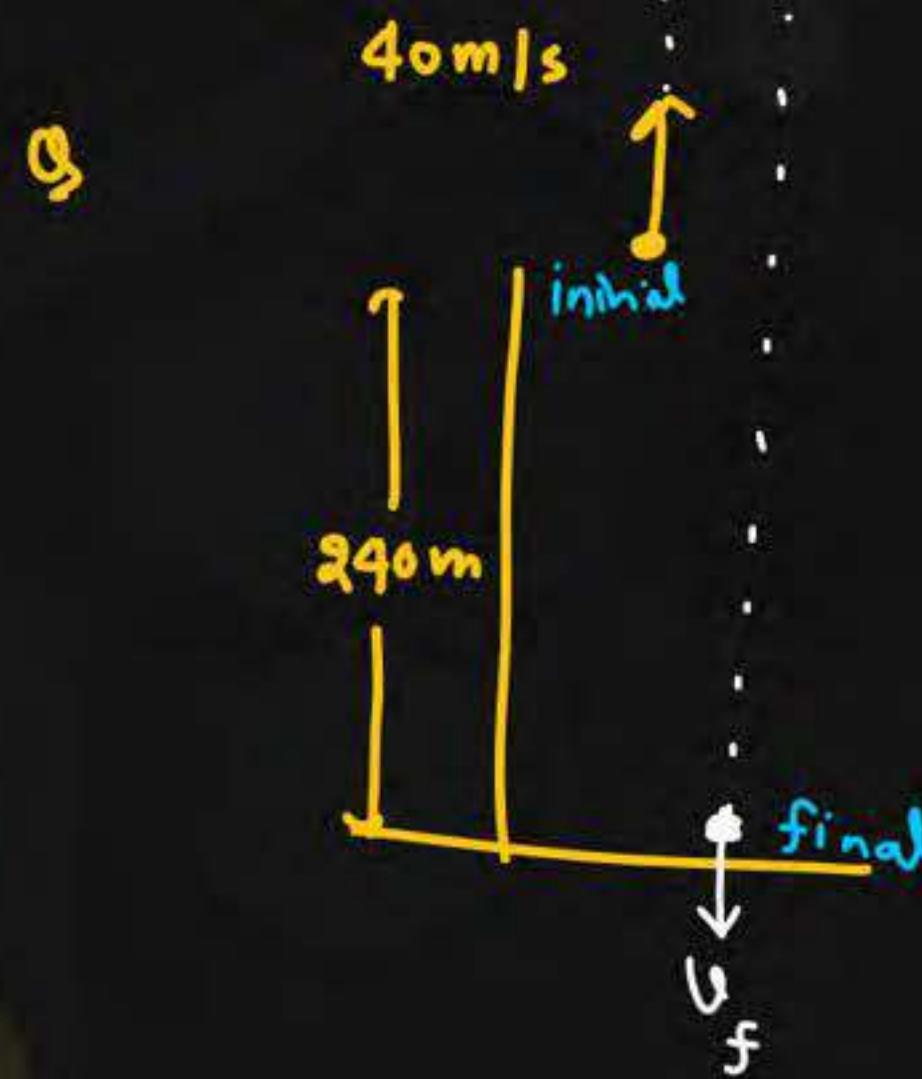
$$-320 = 60t - \frac{1}{2} \times 10 \times t^2$$

$$5t^2 - 60t - 320 = 0$$

$$t^2 - 12t - 64 = 0$$

$$(t-16)(t+4) = 0$$

on M practice



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

$$= (40)^2 + 2 \times (-10) \times (-240)$$

$v \approx 80$

- ① find the time when particle will hit the ground  
 ② " " velocity just before particle hit the ground

upward (positive)  $\sqrt{540}$  +ve

$$u = +40$$

$$a = -10$$

$$s = -240$$

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

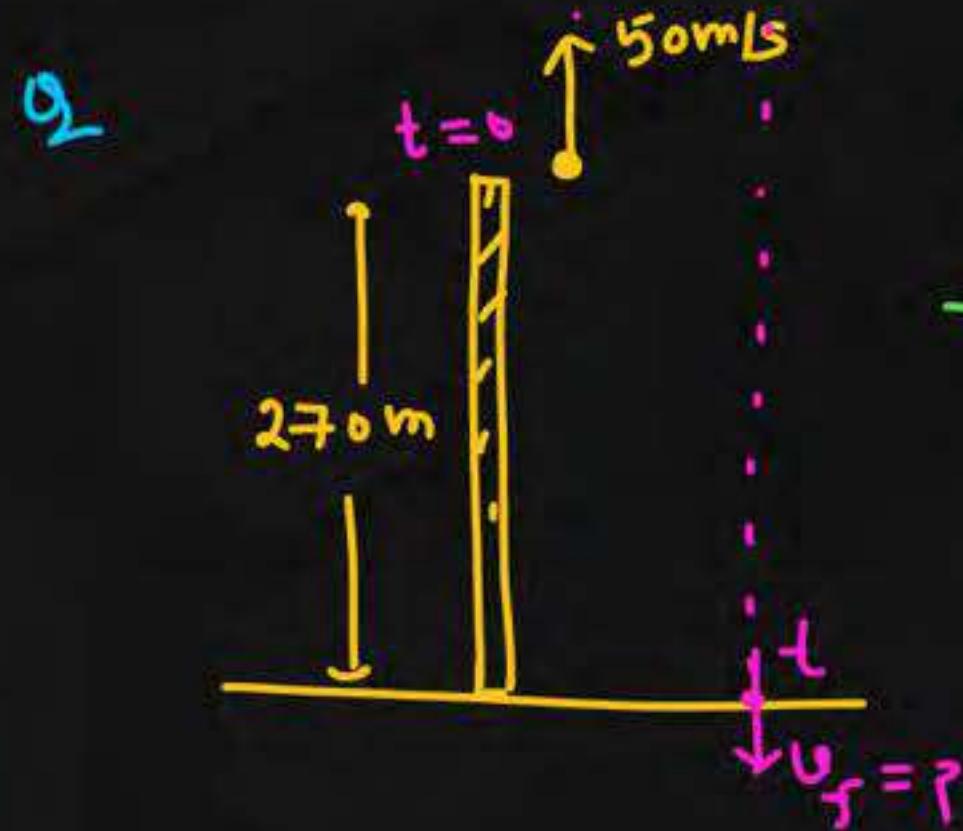
$$-240 = 40t + \frac{1}{2}(-10)t^2$$

$$5t^2 - 40t - 240 = 0$$

$$t^2 - 8t - 48 = 0$$

$$(t-12)(t+4) = 0$$

$t = 12$  Ans

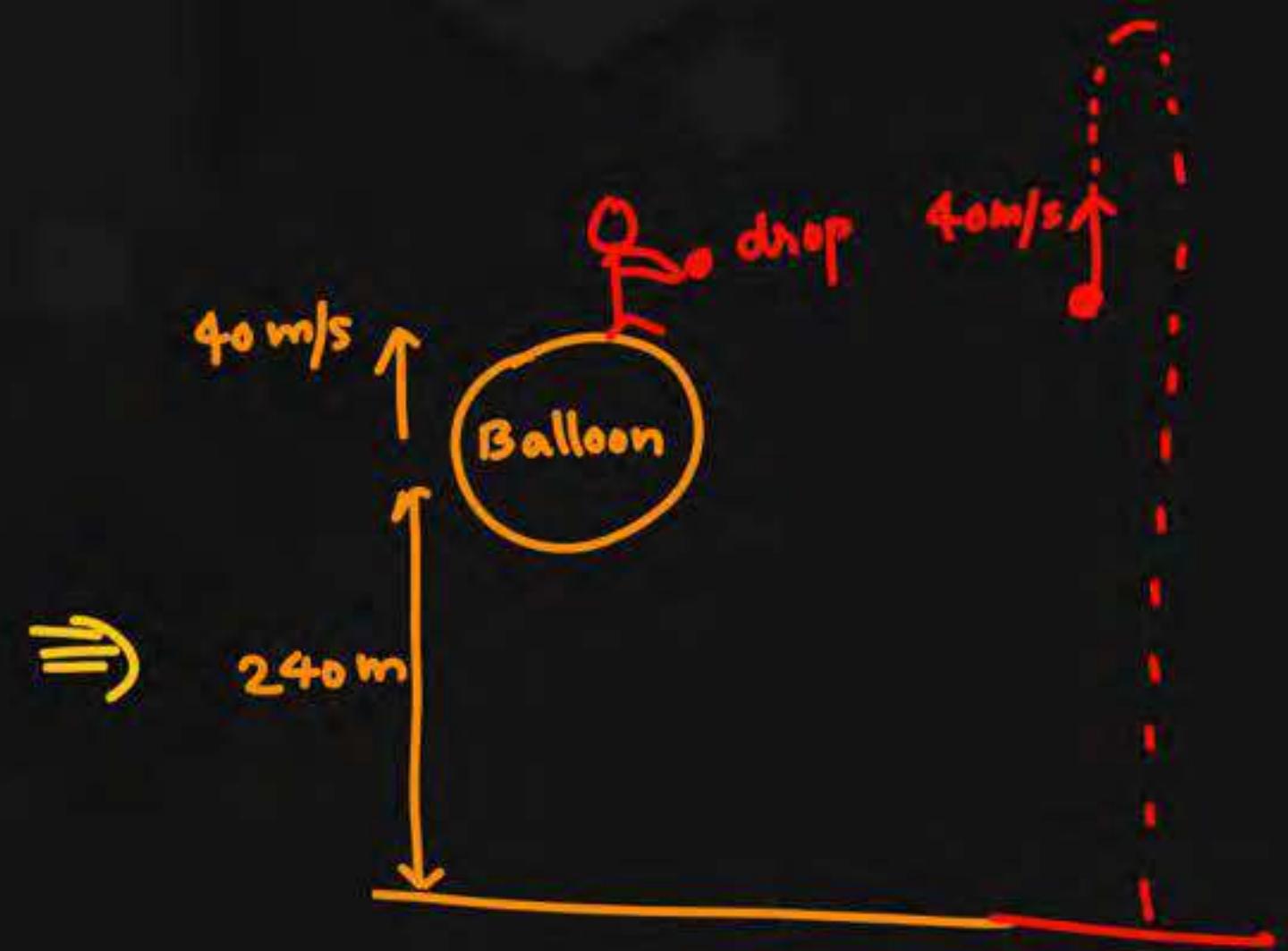
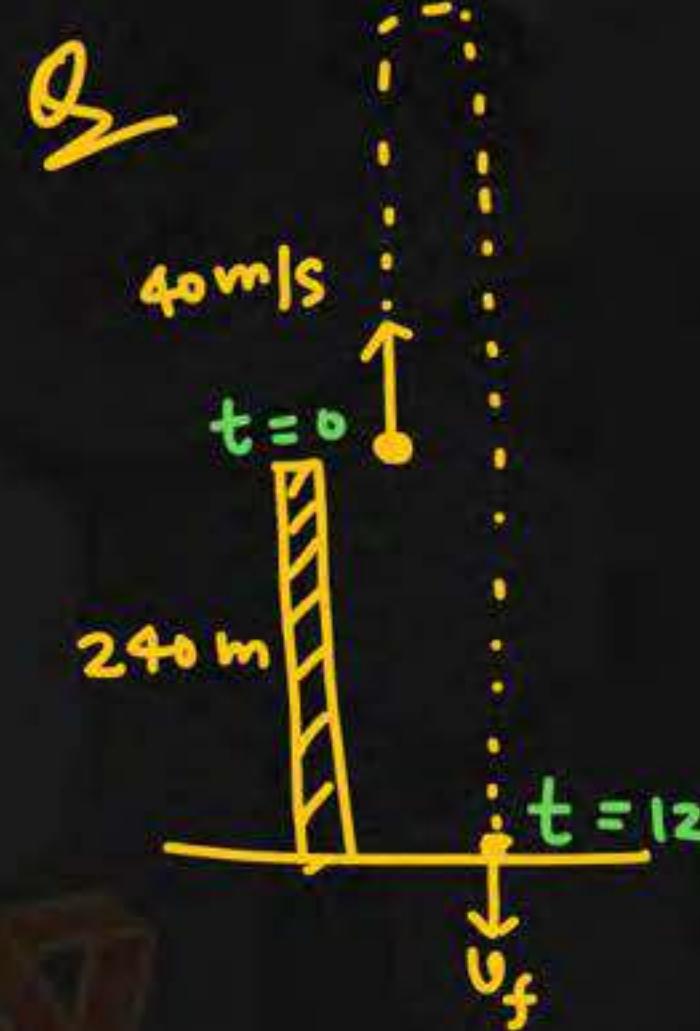


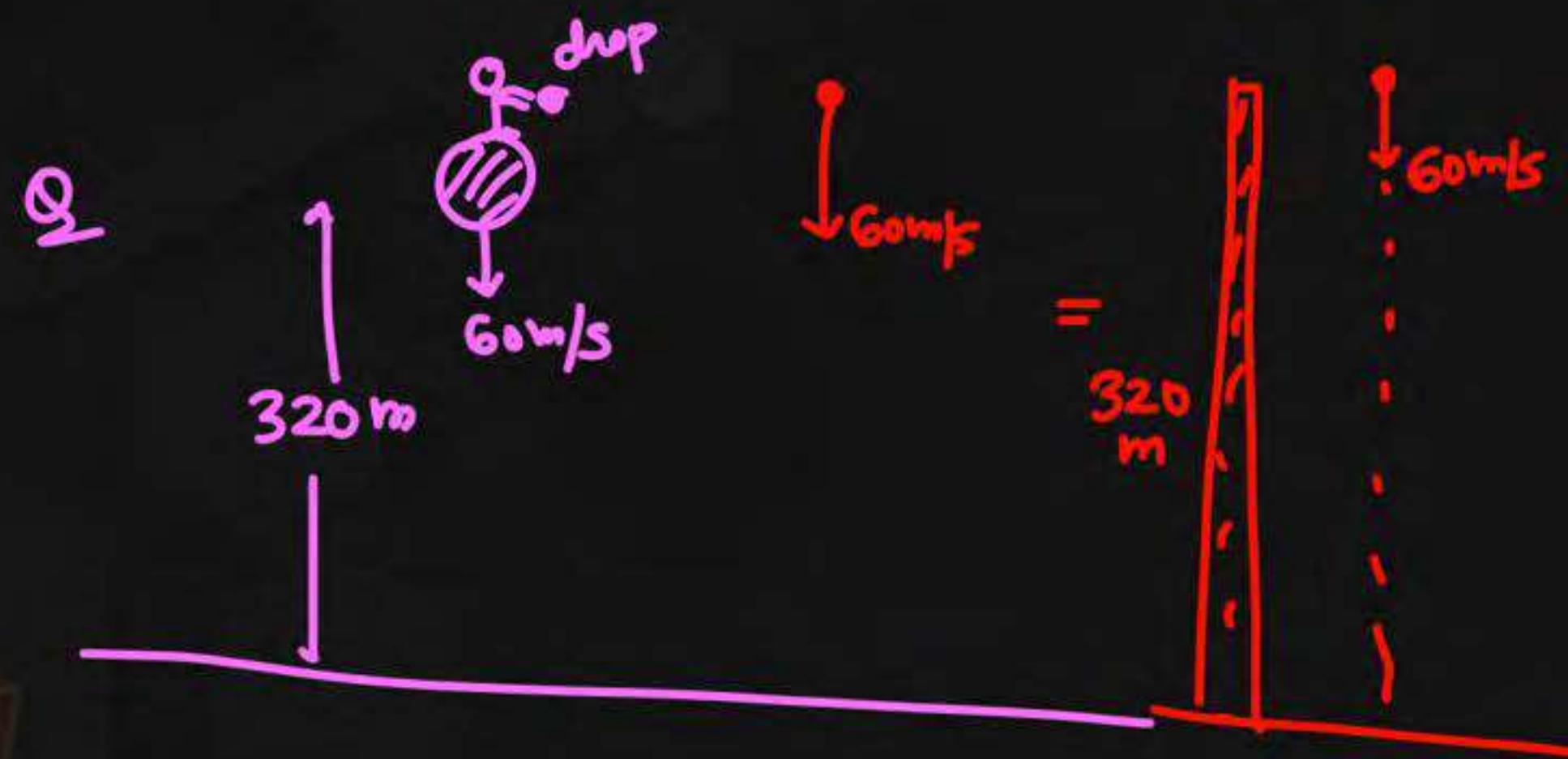
$$S = ut + \frac{1}{2}at^2$$

$$-270 = 50t - \frac{1}{2} \times 10 \times t^2$$

Solve quadratic ✓

$$U_f^2 = (50)^2 + 2(-10)(-270)$$



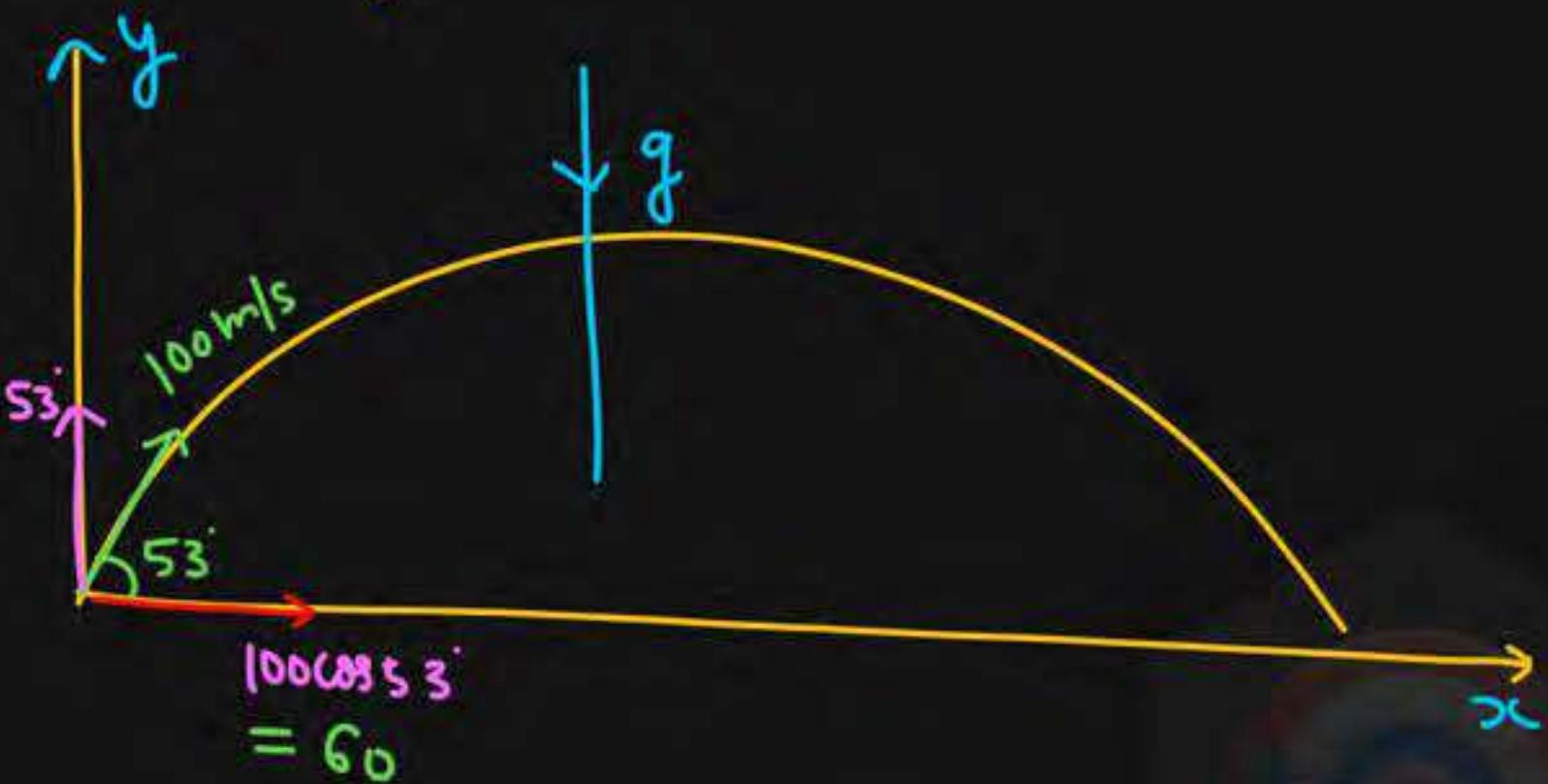


Q A particle is projected with velocity 100m/s at angle of  $53^\circ$  with the horizontal.

(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

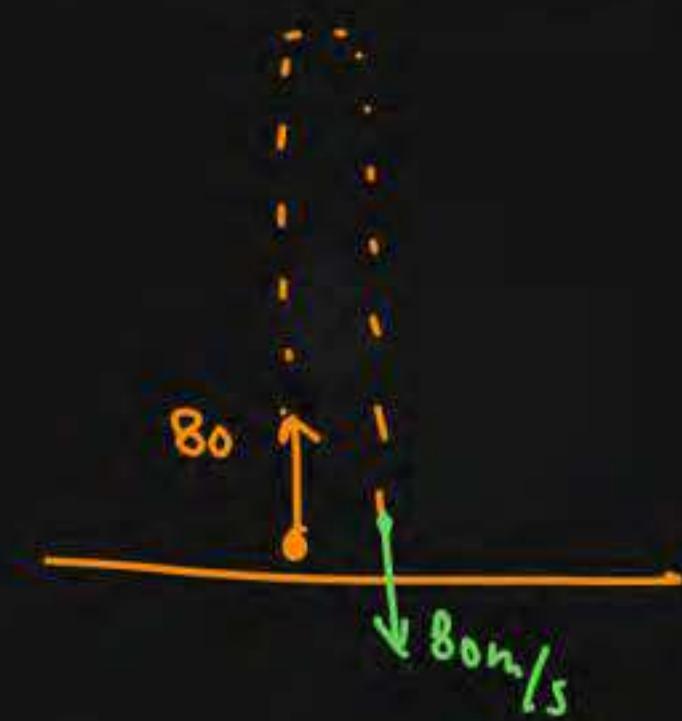
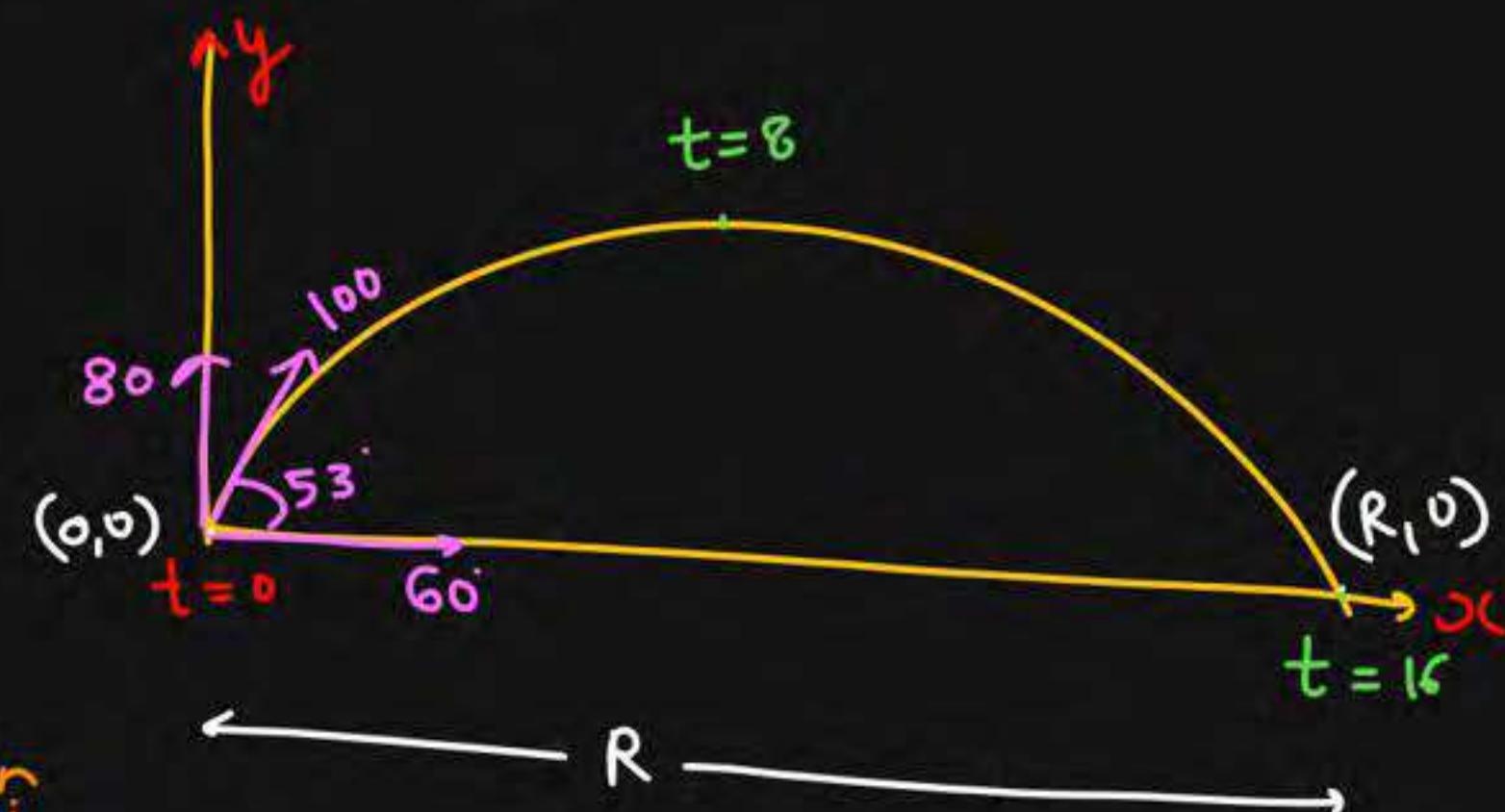
$$t = 2 \quad \vec{v} = 60\hat{i} + 60\hat{j}$$

$$t = 8 \quad \vec{v} = 60\hat{i} + 0\hat{j}$$

$$t = 10 \quad \vec{v} = 60\hat{i} - 20\hat{j}$$

~~$t = 16$~~   $\vec{v} = 60\hat{i} - 80\hat{j}$

just before it hit the ground



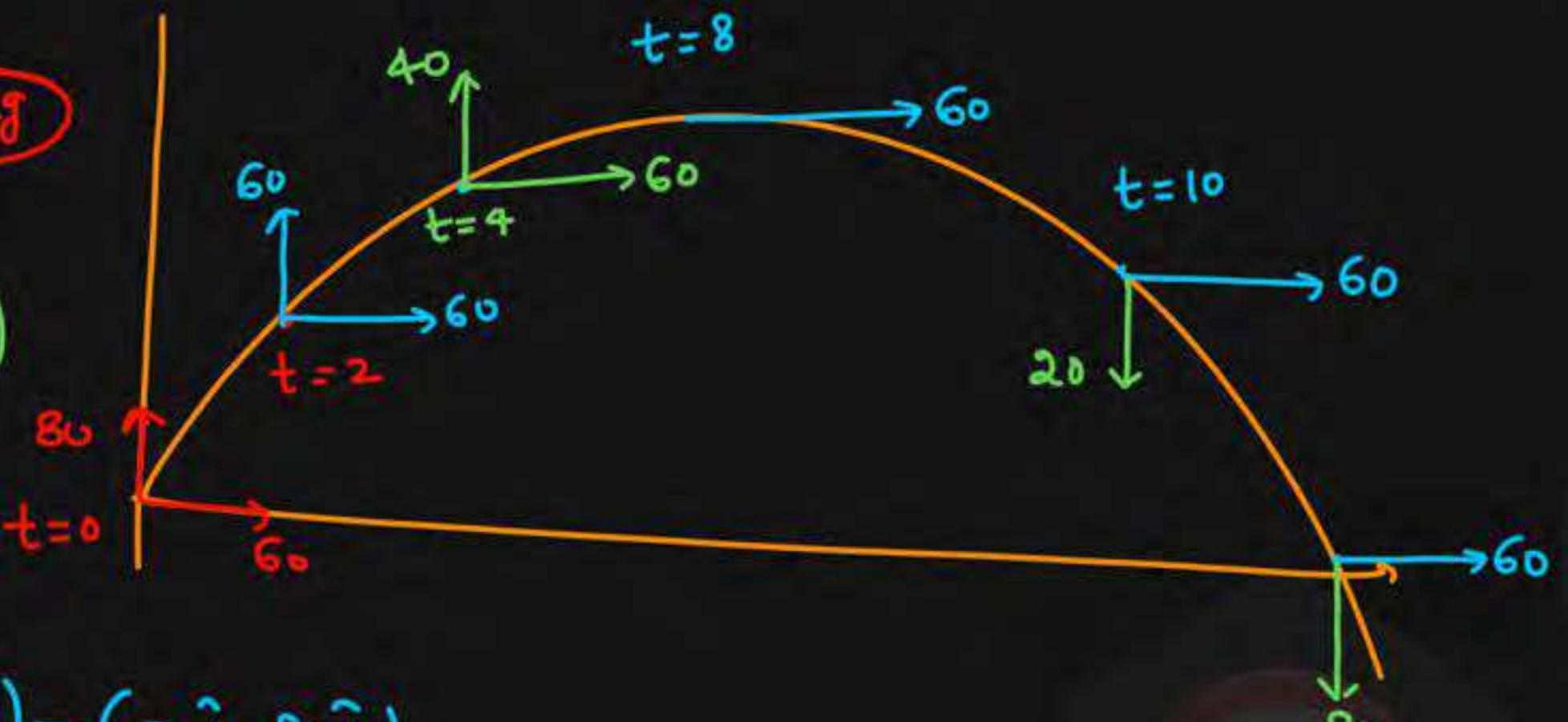
$$\vec{P} = \text{momentum} = m \vec{v}$$

f) find change in momentum  
for entire motion  $m = 1 \text{ kg}$

$$\Delta \vec{P} = \vec{P}_f - \vec{P}_i$$

$$\begin{aligned}\vec{P}_i &= m \vec{v}_i = 1(60\hat{i} + 80\hat{j}) \\ &= 60\hat{i} + 80\hat{j} \\ \vec{P}_f &= 60\hat{i} - 80\hat{j}\end{aligned}$$

$$\begin{aligned}\Delta \vec{P} &= \vec{P}_f - \vec{P}_i = (60\hat{i} - 80\hat{j}) - (60\hat{i} + 80\hat{j}) \\ &= -160\hat{j}\end{aligned}$$

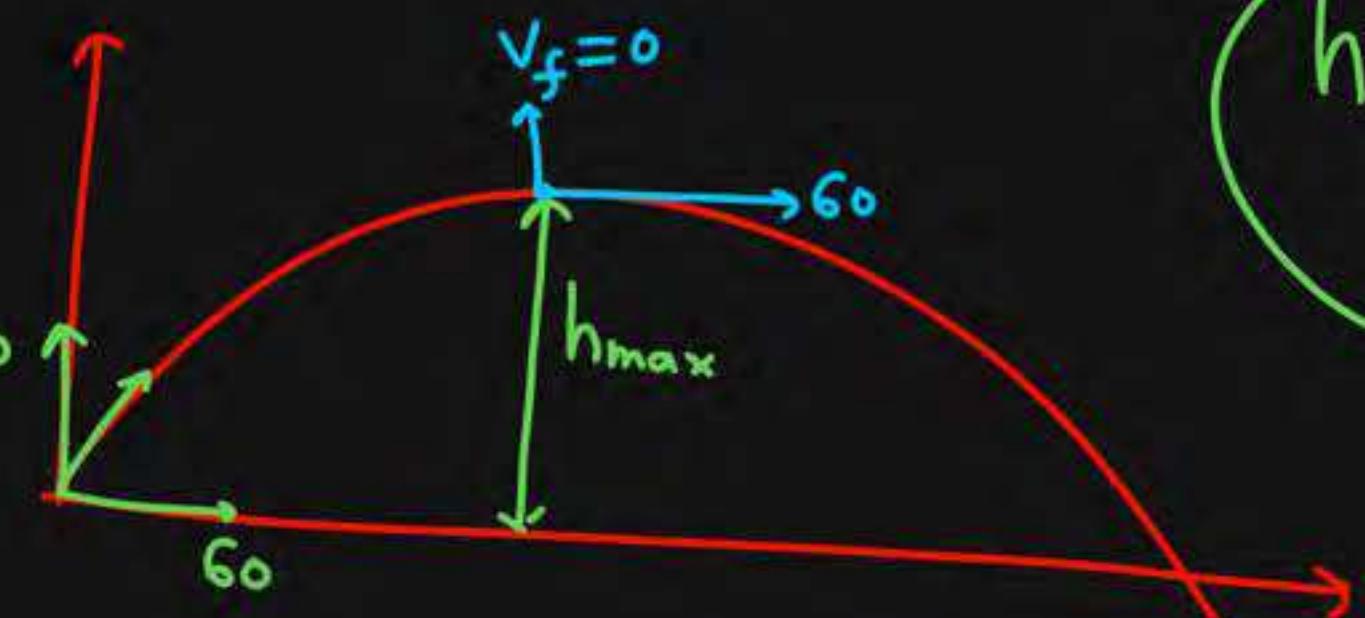


(g) find  $h_{\max}$

$$(g) v^2 = u^2 + 2as$$

$$0^2 = (80)^2 + 2(-10)(h_{\max})$$

$$h_{\max} = 320$$



$h_{\max}$  का तरीके  
3<sup>rd</sup> eqn of motion  
y में

(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  $\vec{a}$

$$\vec{v} \cdot \vec{a} = 0$$

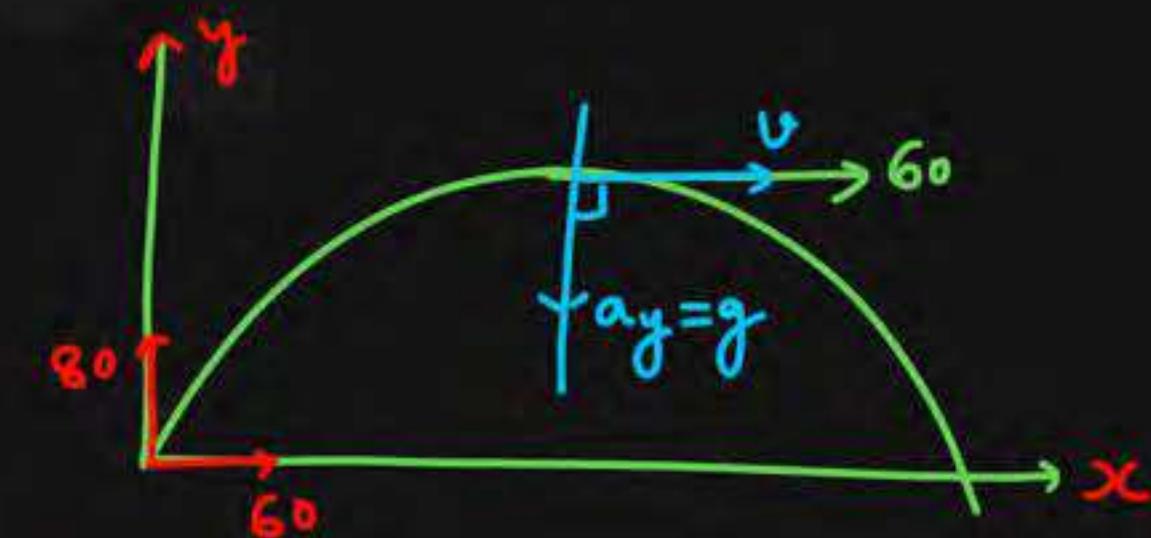
$$\vec{v} = 60\hat{i} + (80 - 10t)\hat{j}$$

$$\vec{a} = -10\hat{j}$$

---


$$\vec{v} \cdot \vec{a} = -10(80 - 10t) = 0$$

$$t = 8 \text{ sec}$$



(j)  $v = u + at$   
 $\vec{v}_y = 80 - 10t$

(j) find the time when velocity of particle become perpendicular to initial velocity.

$$\vec{u} = 60\hat{i} + 80\hat{j}$$

$$\vec{v}_f = 60\hat{i} + (80 - 10t)\hat{j}$$

$$\underline{\vec{v} \cdot \vec{u} = 0}$$

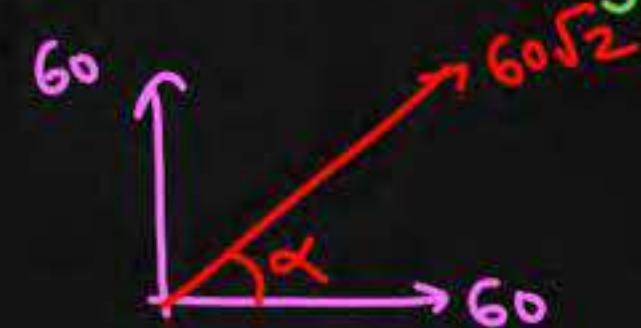
$$60 \times 60 + 80(80 - 10t) = 0$$

$$3600 + 6400 - 800t = 0$$

$$t = \frac{10000}{800} = \frac{100}{8} = 12.5$$

\*<sup>k</sup> 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

$$x = 60 \times 2 = 120$$

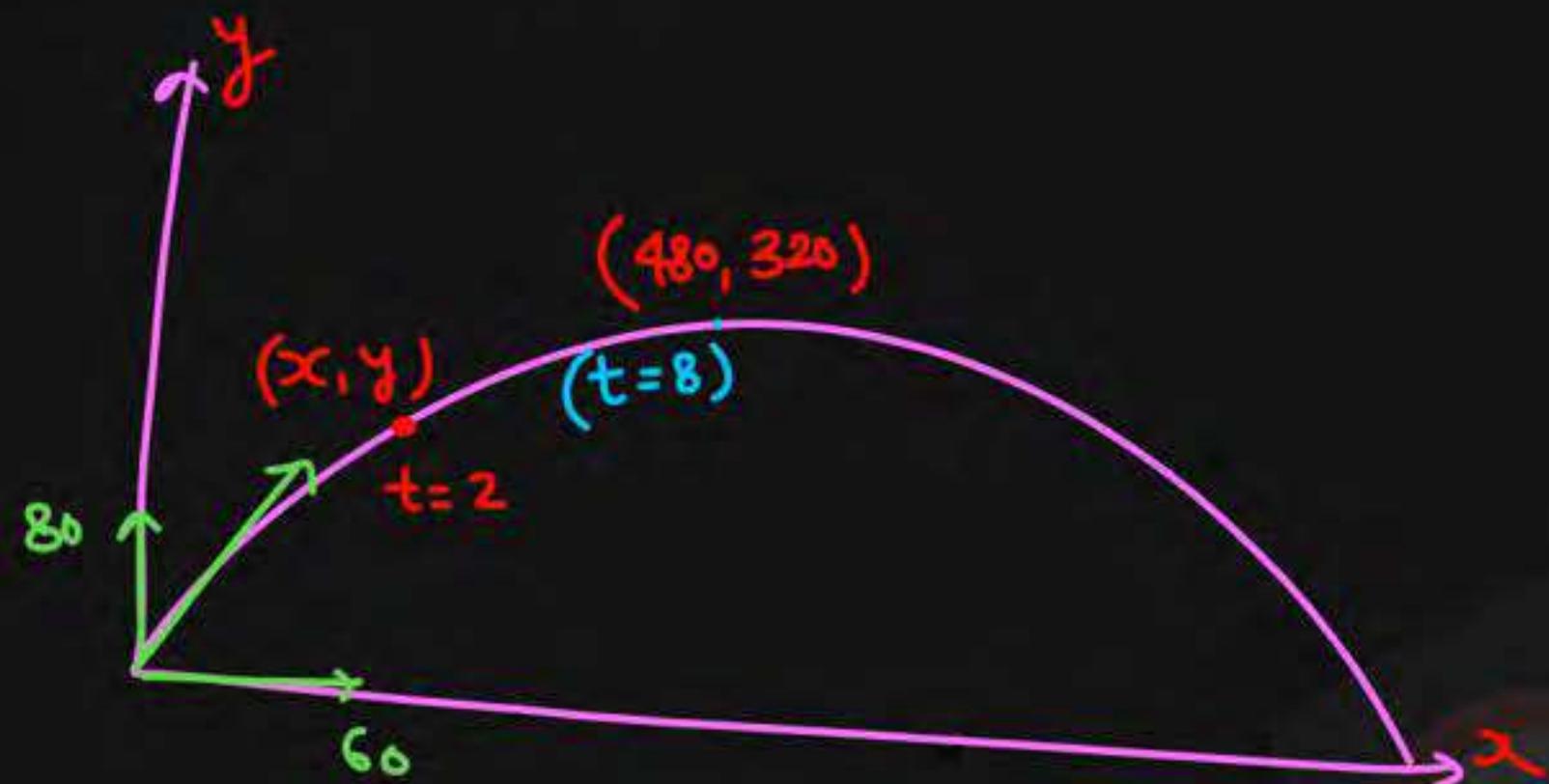
$$y = 80 \times 2 - \frac{1}{2} \times 10 \times 2^2 \\ = 160 - 20 = 140$$

$$(x, y) \Rightarrow (120, 140)$$

$$t = 8, \quad x = 60 \times 8 = 480$$

$$y = 80 \times 8 - \frac{1}{2} \times 10 \times 8^2 \\ = 640 - 320 = 320$$

$$(480, 320)$$



(m) If air start flowing such that it given horizontal acc of  $+5 \text{ m/s}^2$  to the particle (No air resistance) find

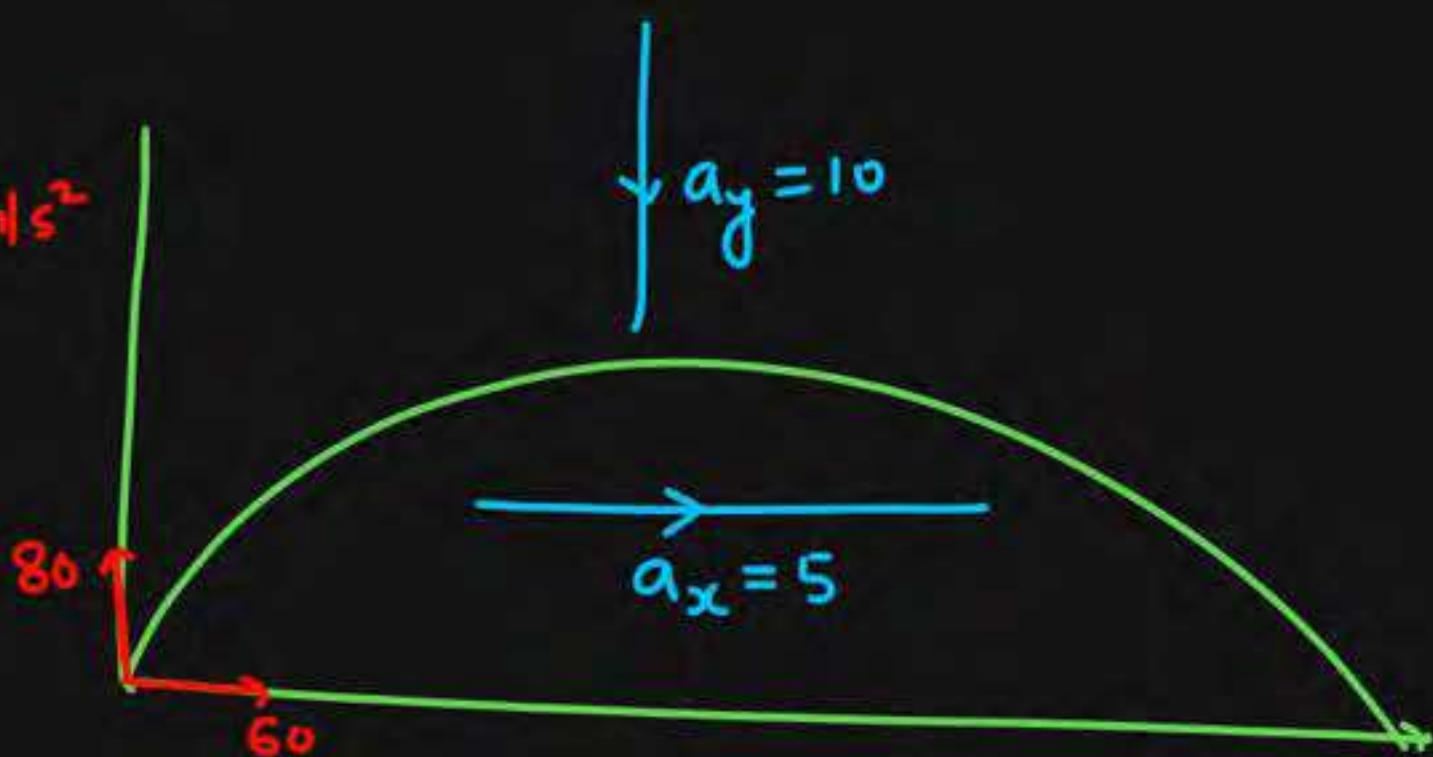
$$\textcircled{1} \quad T = 8 + 8 = 16 \text{ (Same)}$$

$T, H_{\max}$   $\longrightarrow$  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

$$\vec{u}_i = 40\hat{i} + 60\hat{j}$$

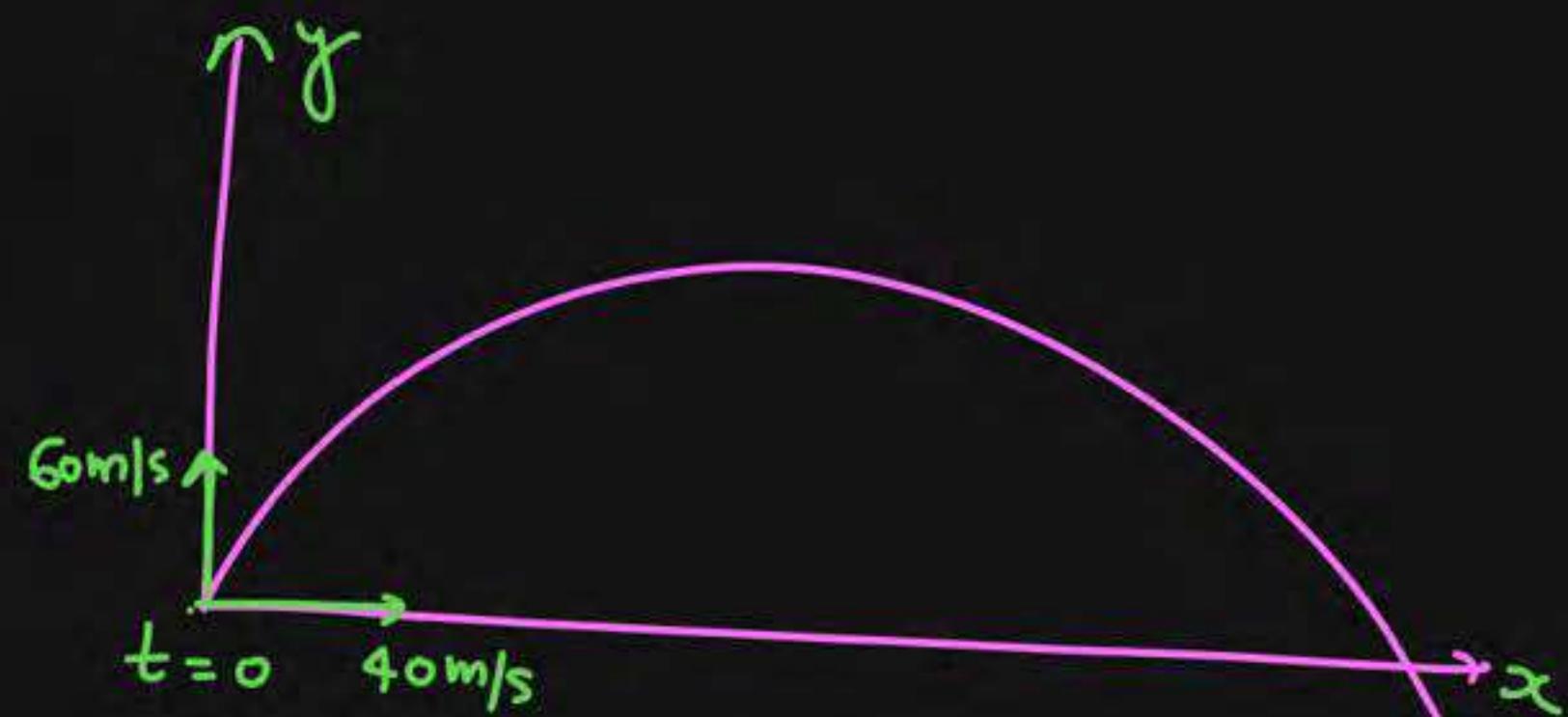
find

$$\textcircled{1} \quad T = 6 + 6 = 12$$

$$\textcircled{2} \quad R = 40 \times 12 = 480$$

$$\textcircled{3} \quad h_{max} = 180$$

$$\textcircled{4} \quad t=2, \vec{v} = 40\hat{i} + 40\hat{j}$$



$$\textcircled{3} \quad 0^2 = c_0^2 + 2 \times (-10) h_{max}$$

$$h_{max} = \frac{3600}{20}$$

Q2 find equation of trajectory

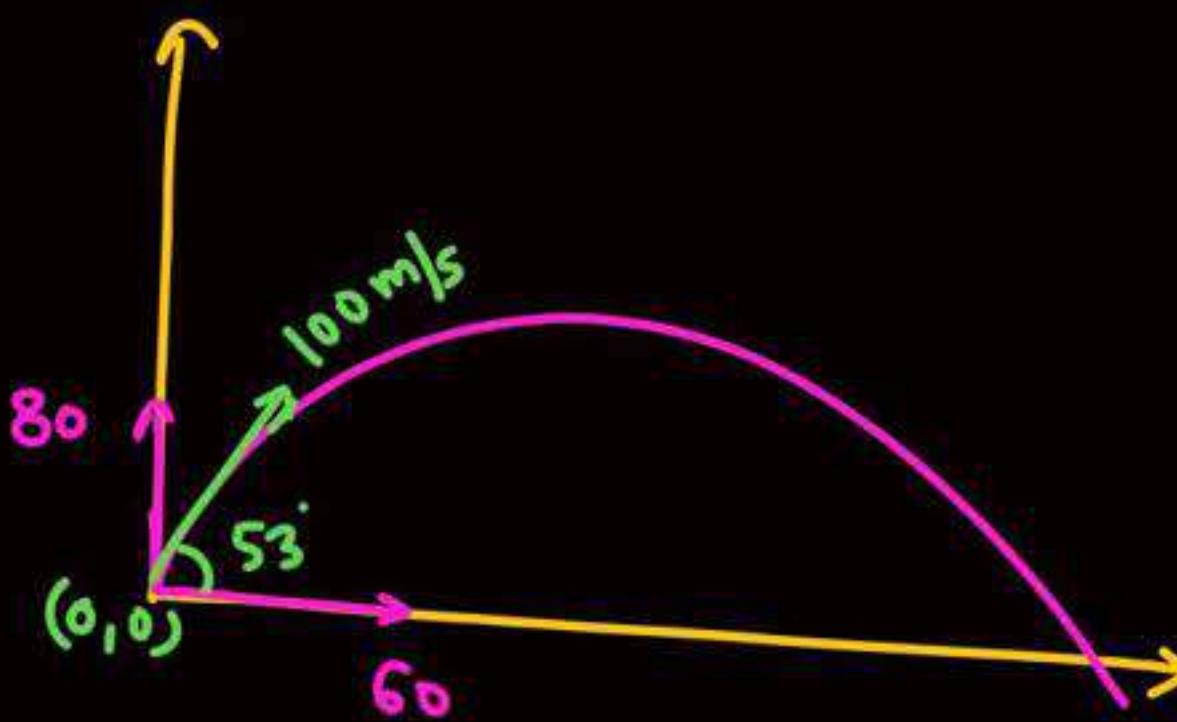
$$x = 60t \Rightarrow t = \frac{x}{60}$$

$$y = 80t - \frac{1}{2} \times 10 \times t^2$$

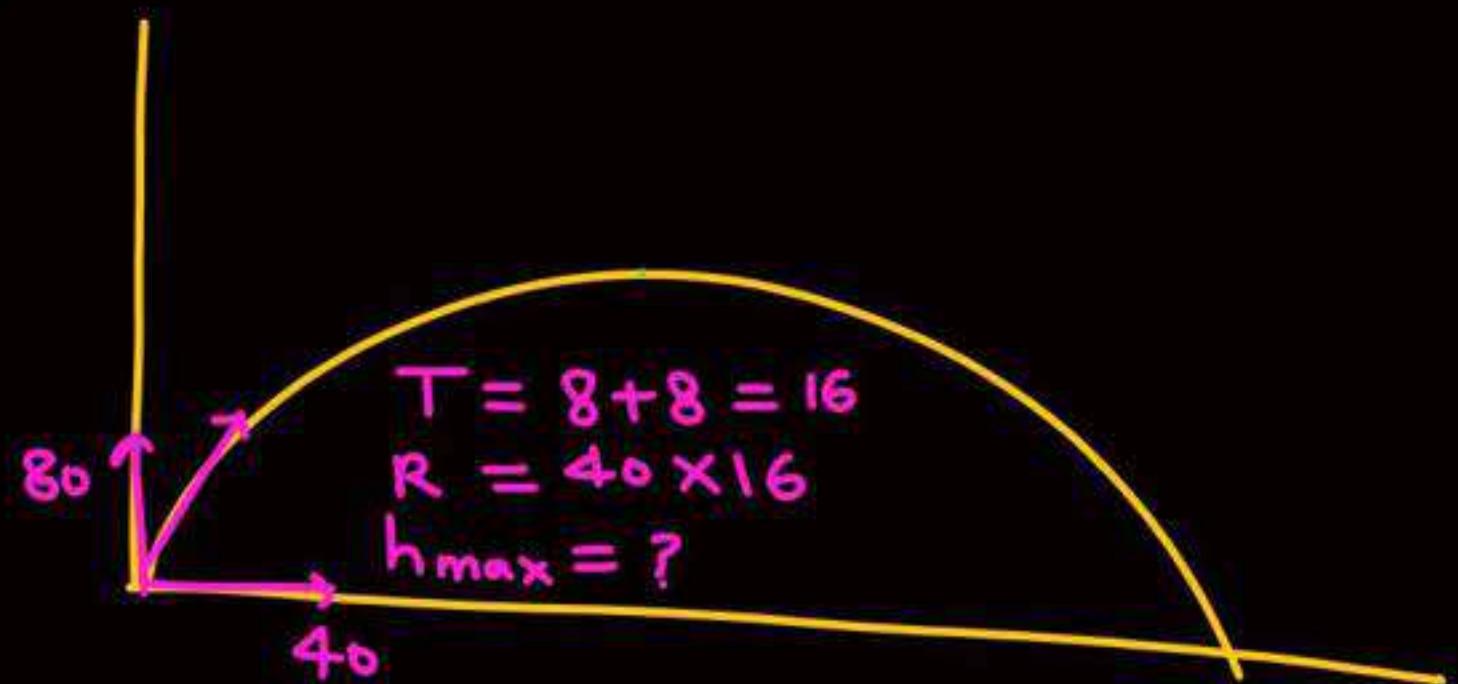
$$y = 80 \frac{x}{60} - \frac{1}{2} \times 10 \times \left(\frac{x}{60}\right)^2$$

$$\boxed{y = \frac{4x}{3} - \frac{x^2}{720}}$$

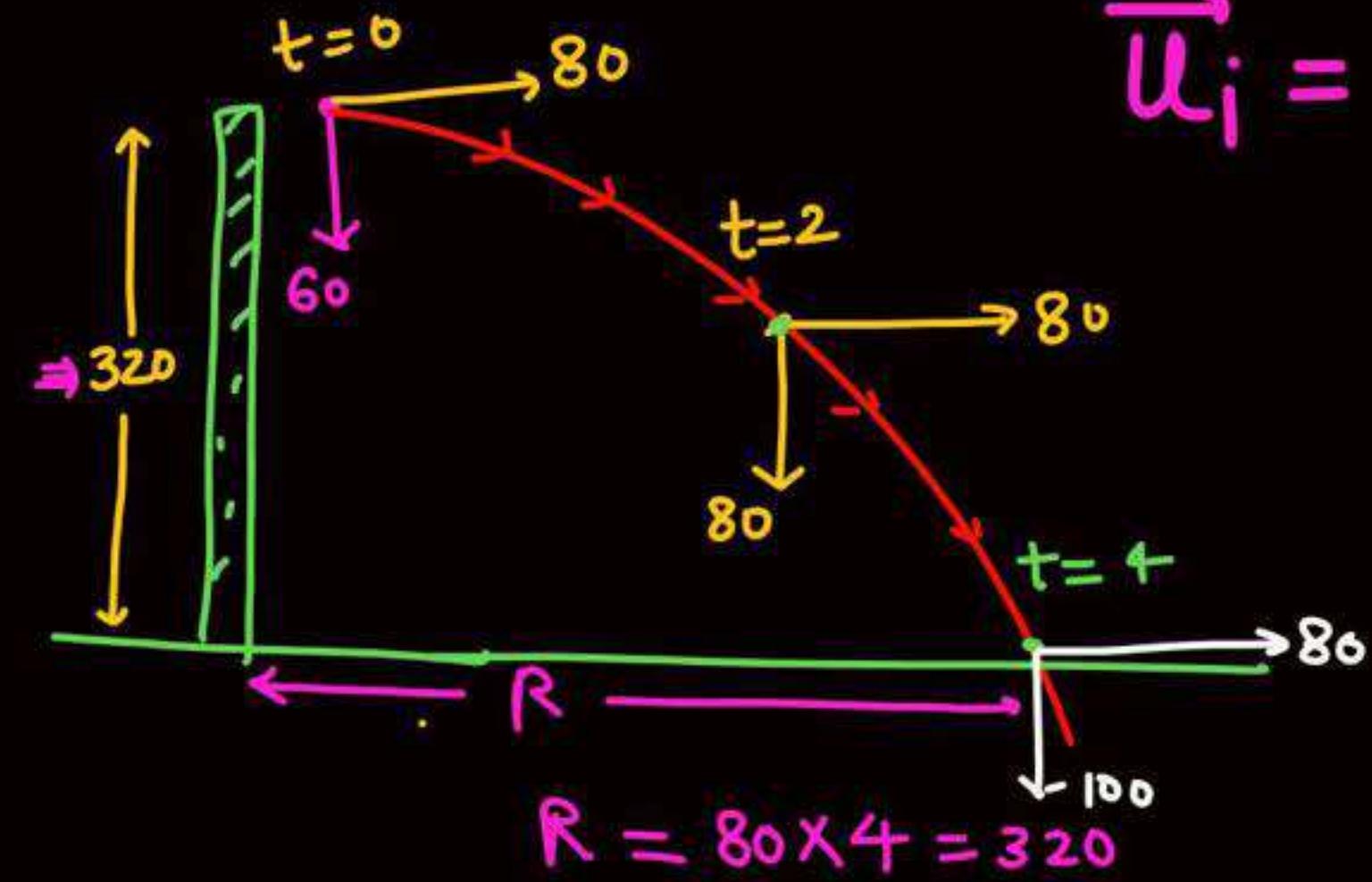
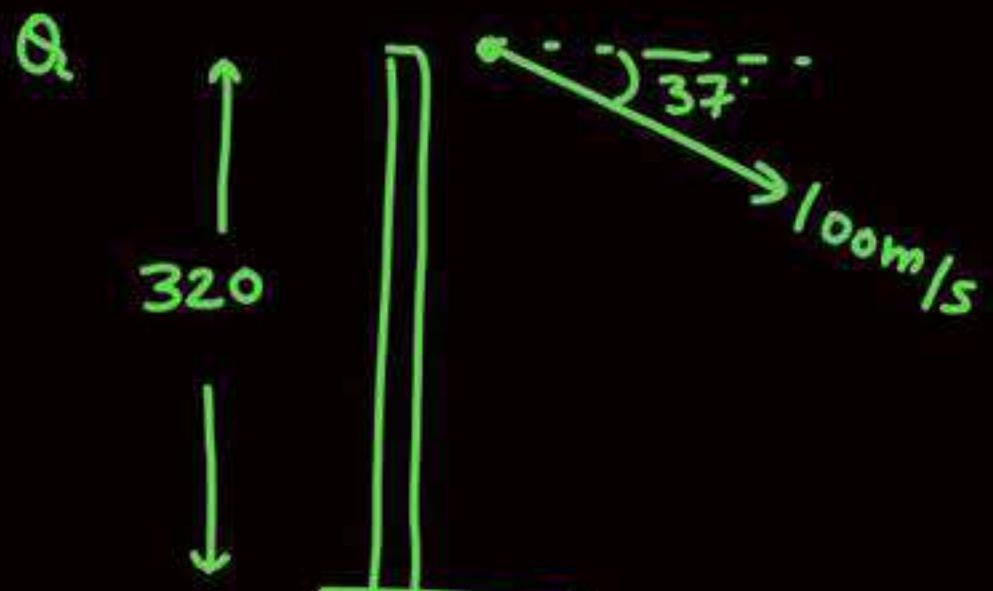
parabola



Q



$$0^2 = 80^2 - 2 \times 10 \times h_{\max}$$



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

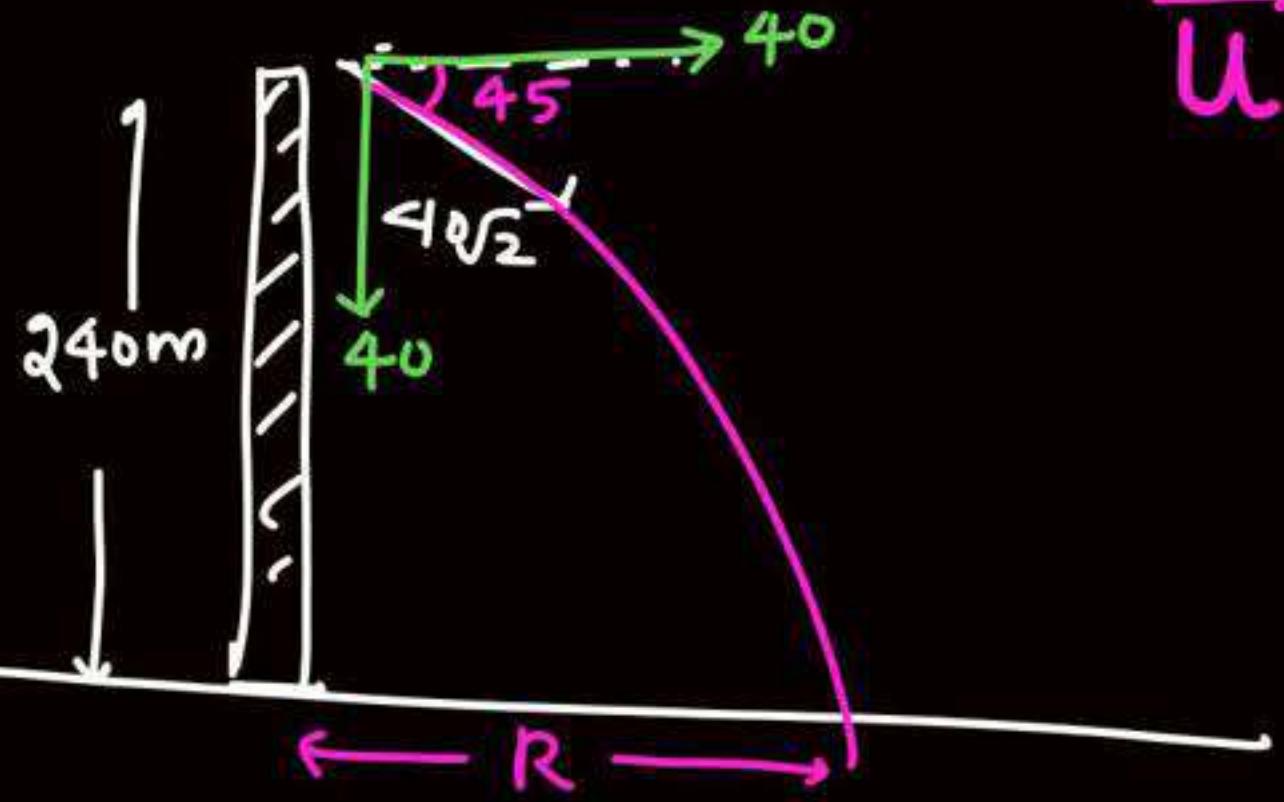
When particle will strike the ground & where

(y)

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

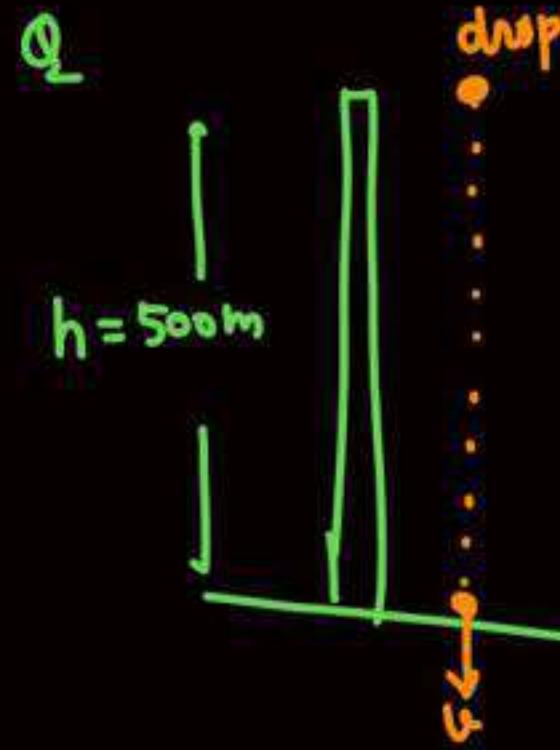
$$240 = 40t + \frac{1}{2} \times 10 \times t^2$$

$$t = 4$$



$$\vec{u}_i = 40\hat{i} - 40\hat{j}$$

$$R = 40 \times 4 = 160$$



$$h = 0 + \frac{1}{2}gt^2$$

$$500 = \frac{1}{2} \times 10 \times t^2$$

$$t^2 = 100$$

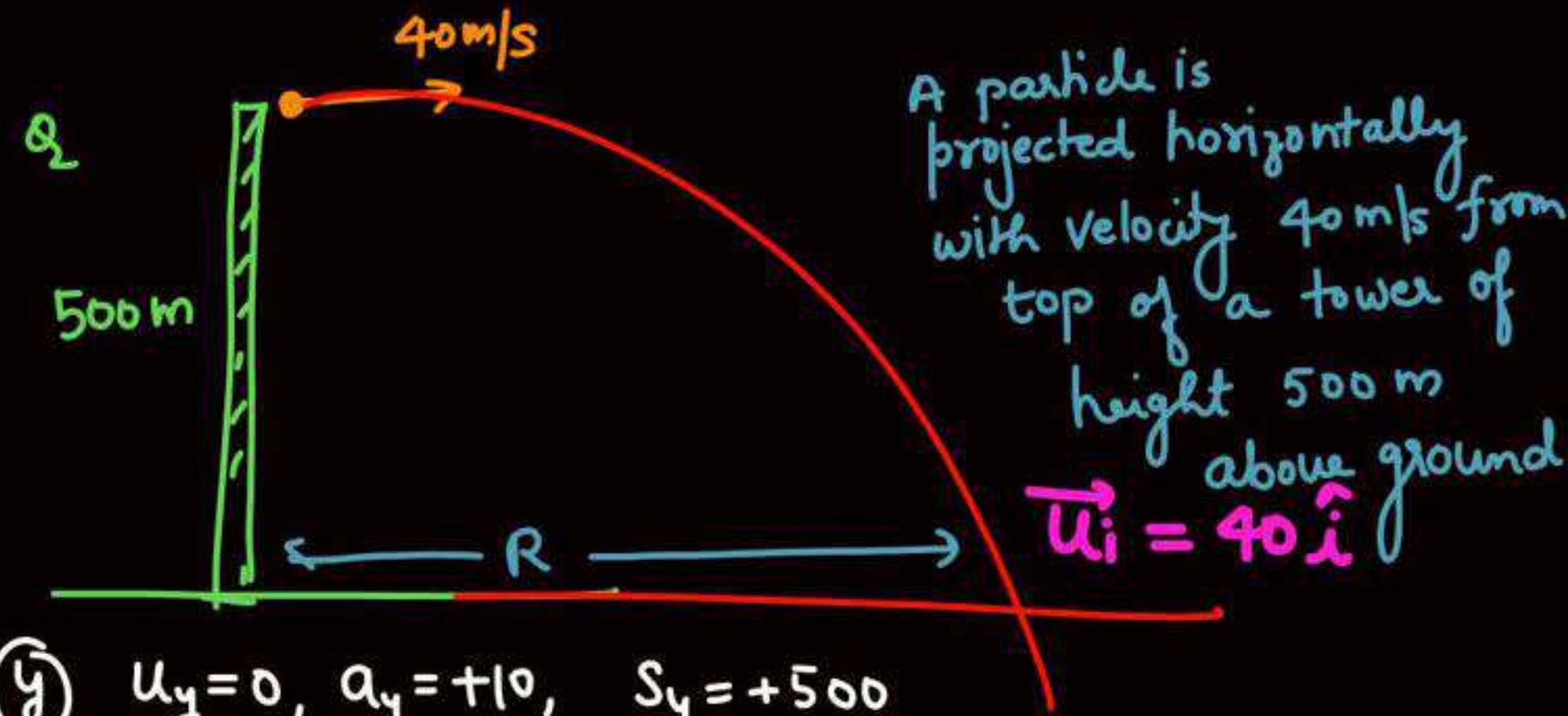
$$\boxed{t = 10 \text{ sec}}$$

$$v^2 = 0^2 + 2gh$$

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

$$= \sqrt{2 \times 10 \times 500}$$

$$= 100$$

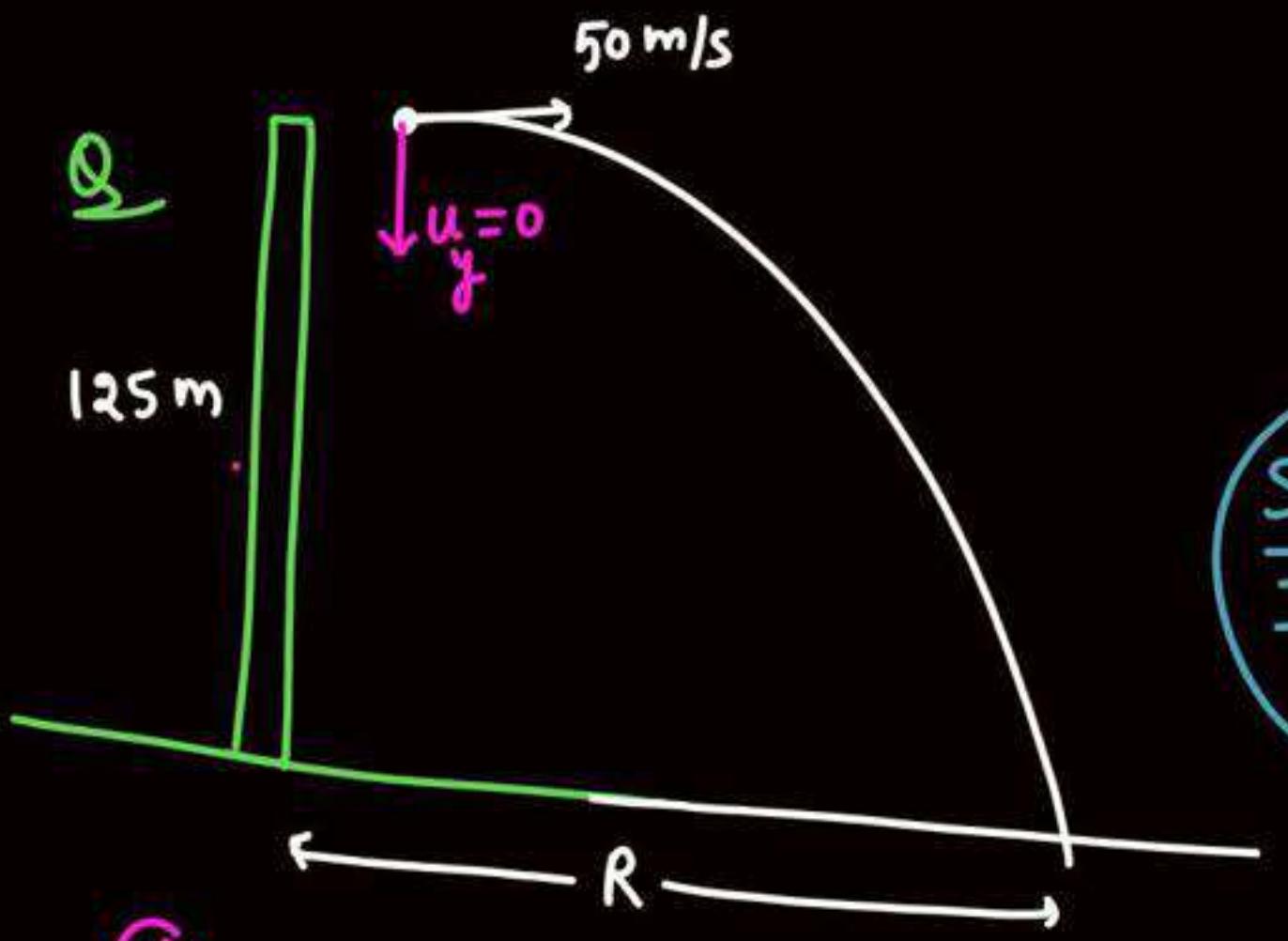


④  $U_y = 0, a_y = +10, S_y = +500$

$$500 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$\boxed{t = 10 \text{ sec}}$$

$$\underline{R = 40 \times 10 = 400 \text{ m}}$$



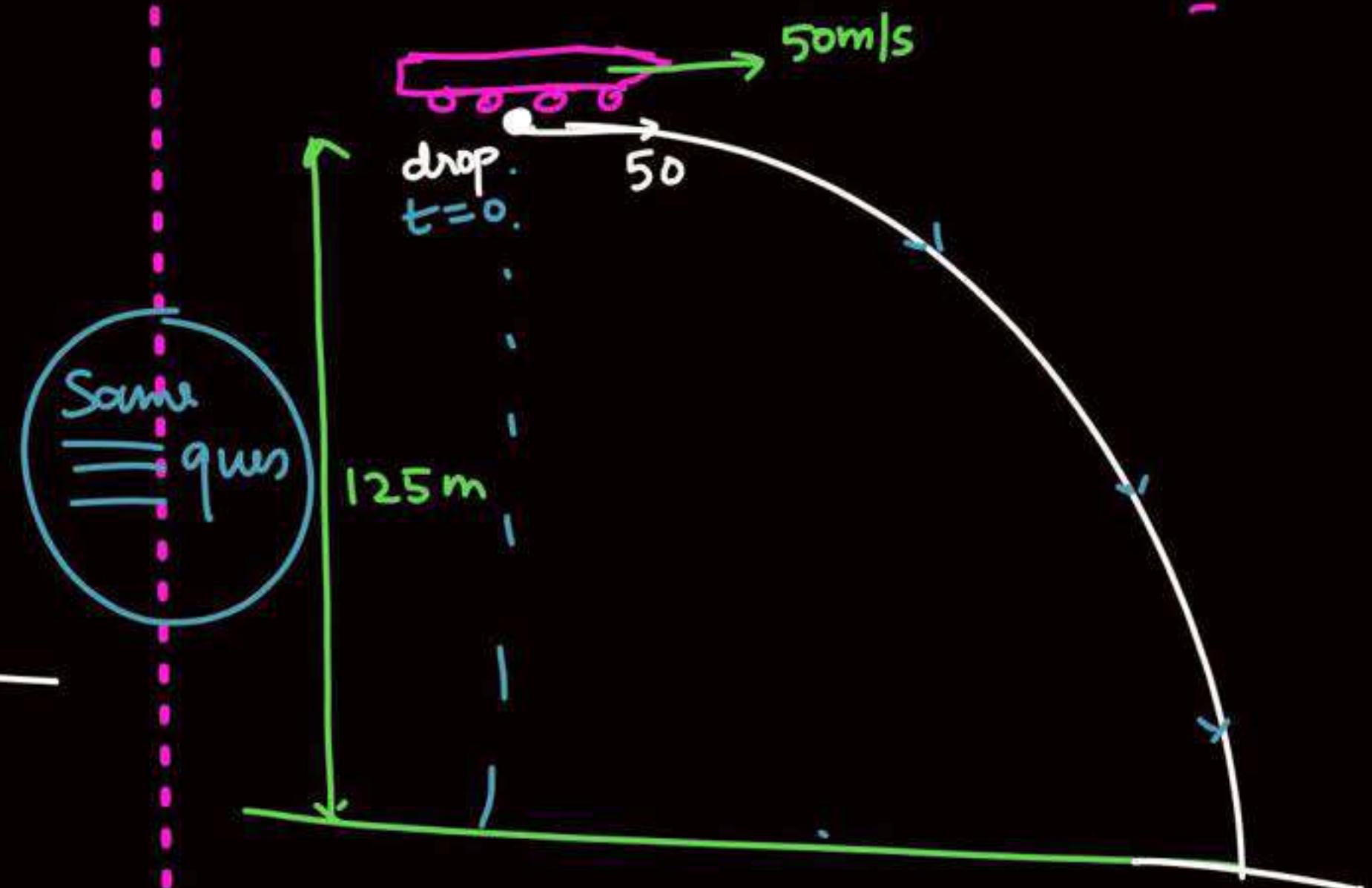
(y)

$$125 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$t = \sqrt{\frac{250}{10}} = 5$$

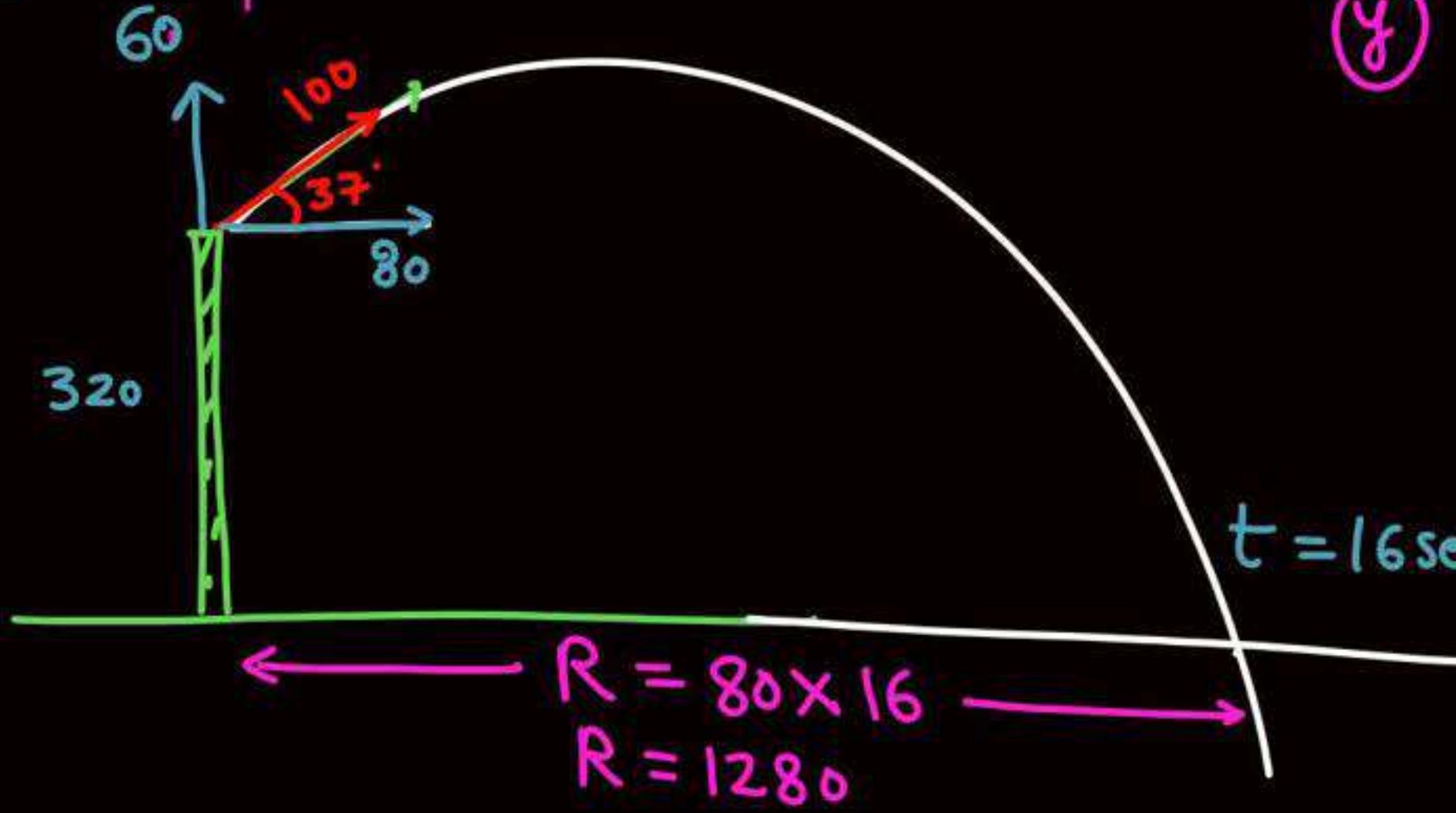
(x)

$$R = 50 \times 5 = 250 \text{ m}$$



$$t = 5 \\ R = 250 \text{ m}$$

Q



$$\begin{aligned} R &= 80 \times 16 \\ R &= 1280 \end{aligned}$$

find  $T$  &  $R$

Q

↑ +ve

$$U_y = +60$$

$$a_y = -10$$

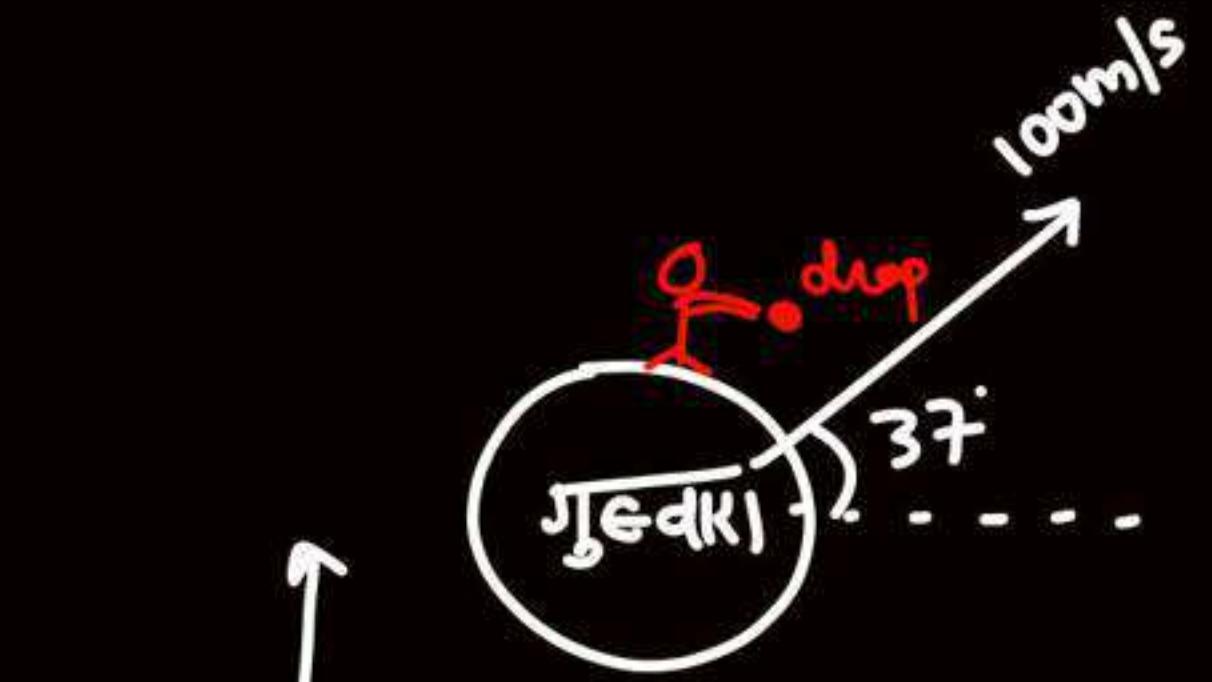
$$S_y = -320$$

Already ✓

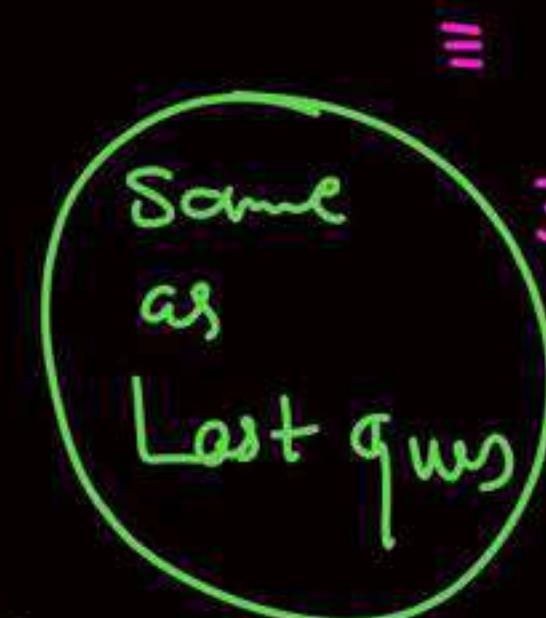
$$-320 = 60t - \frac{1}{2} \times 10 \times t^2$$

$$t = 16 \text{ sec}$$

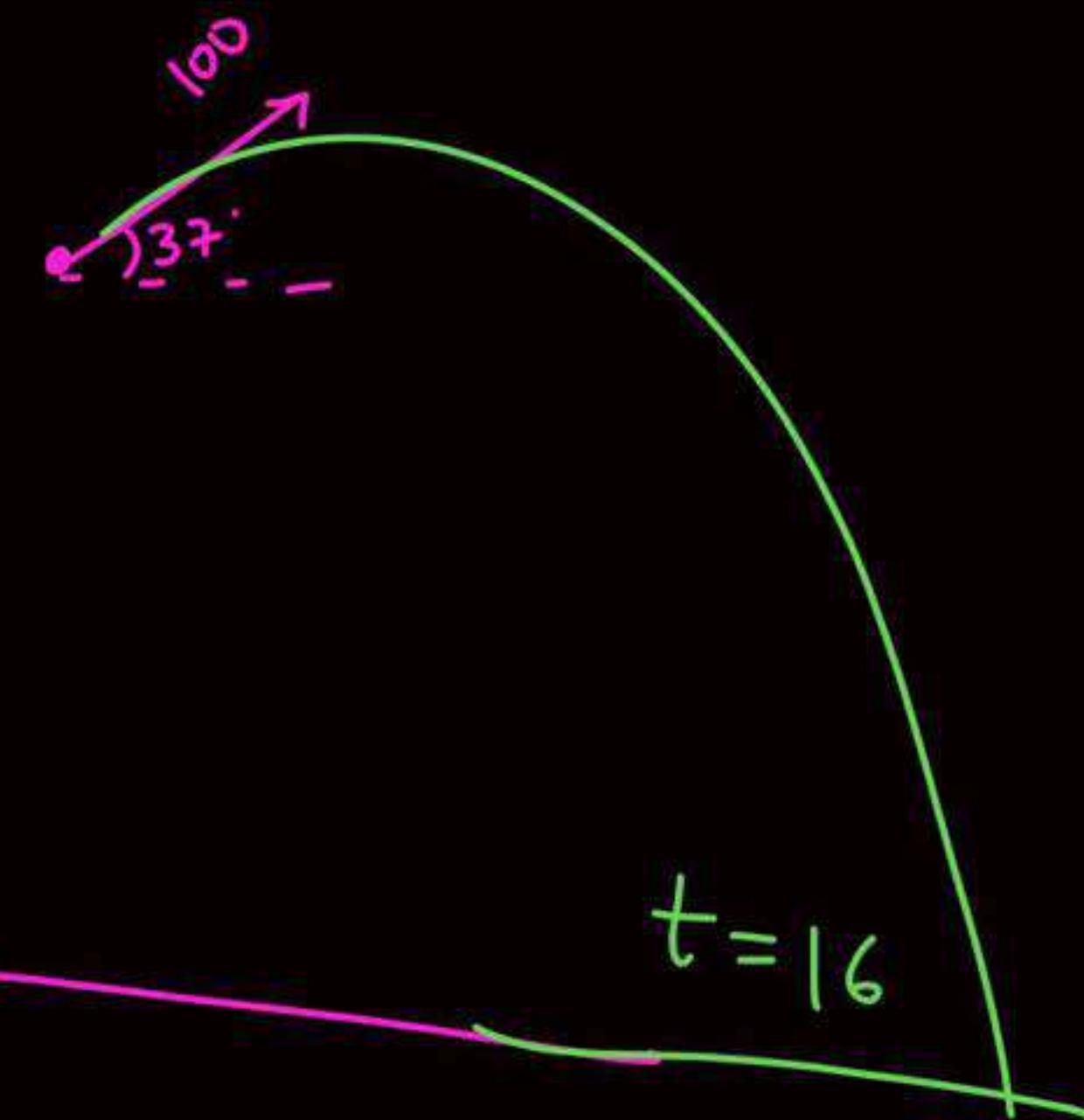
$\theta_1$

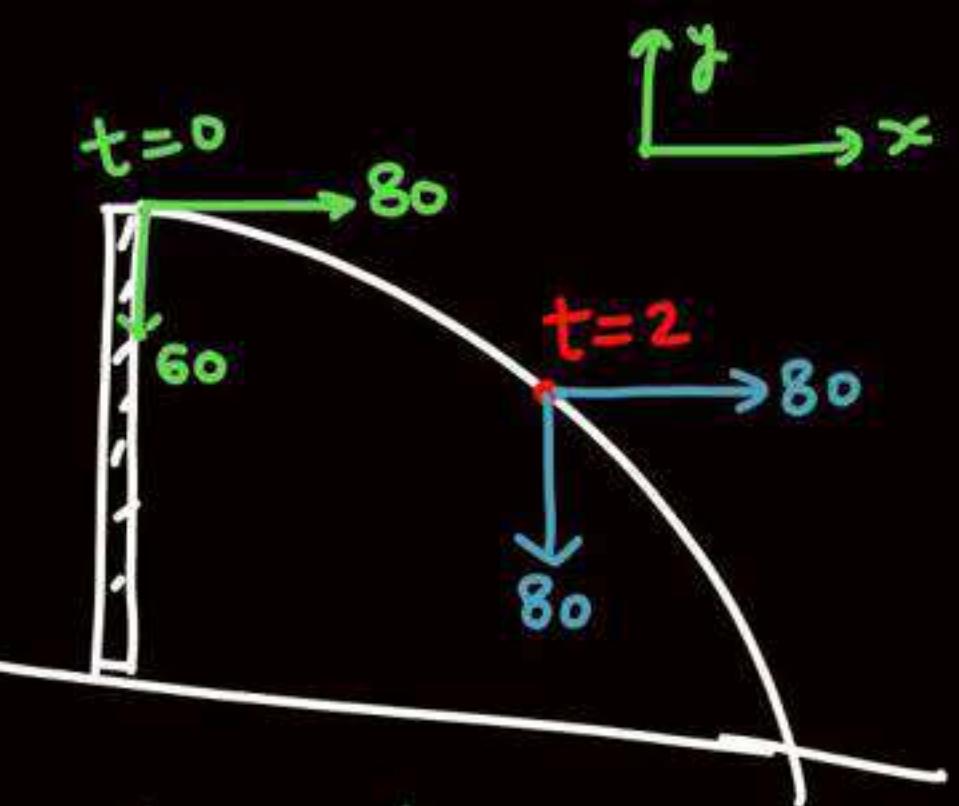


320m



320m





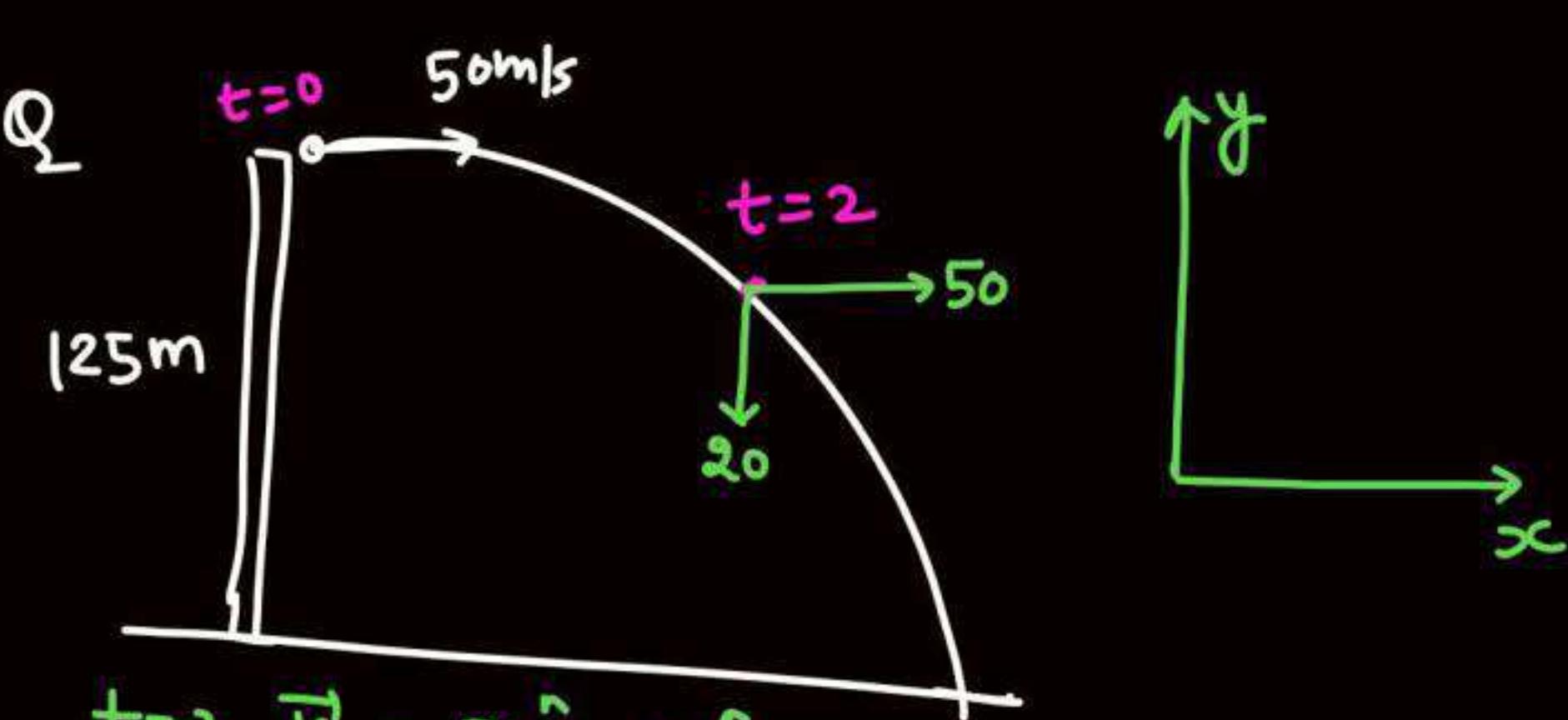
$$t=2, \vec{v} = 80\hat{i} - 80\hat{j}$$

$$t=4, \vec{v} = 80\hat{i} - 100\hat{j}$$

$$v_y = u_y + a_y t$$

$$= +60 + 10 \times 4$$

$$= 100 \text{ m/s}$$

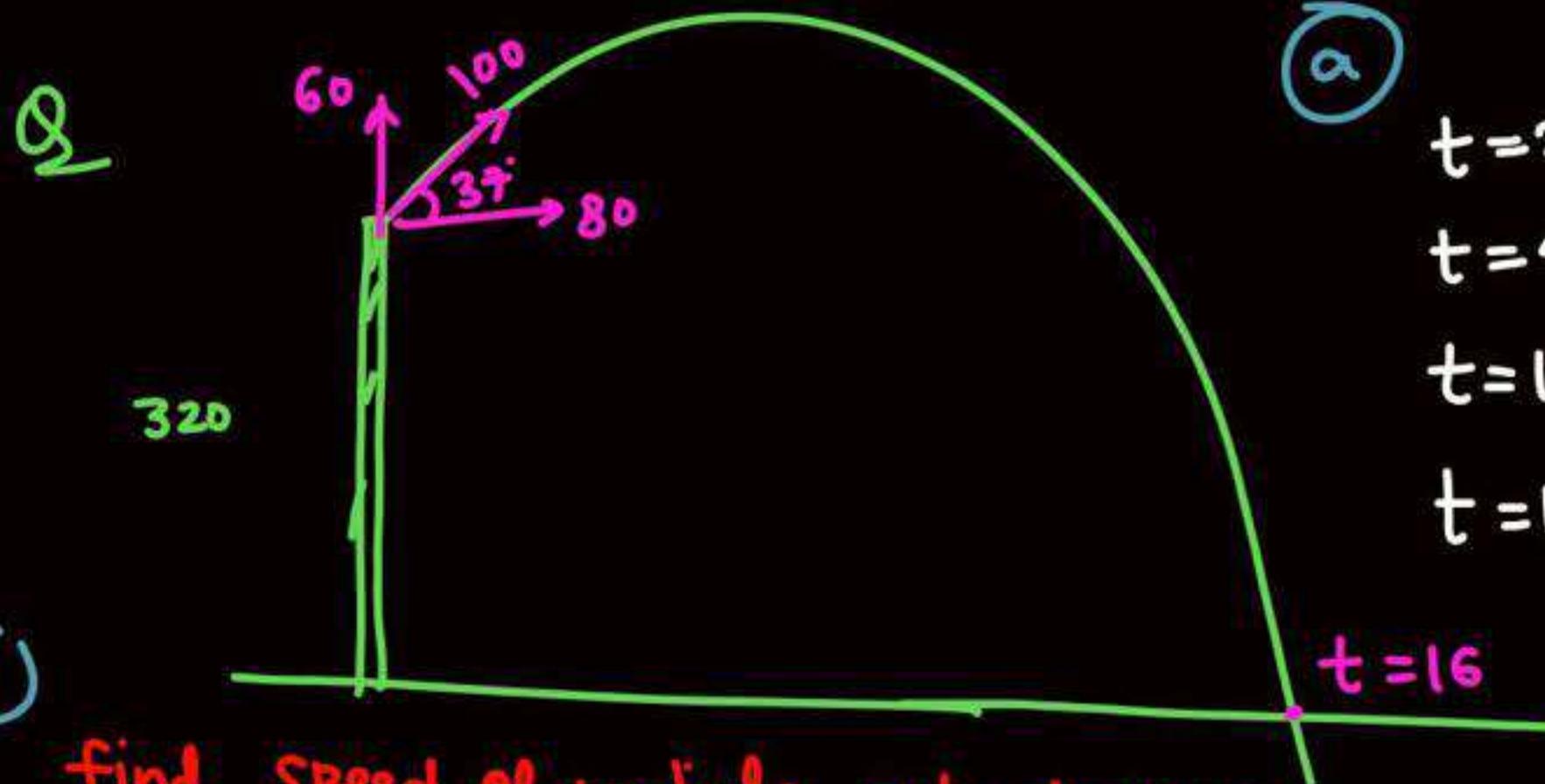


$$t=2, \vec{v} = 50\hat{i} - 20\hat{j}$$

$$\textcircled{y} \quad v = u + at$$

$$v = 0 - 10 \times 2$$

$$v = -20$$



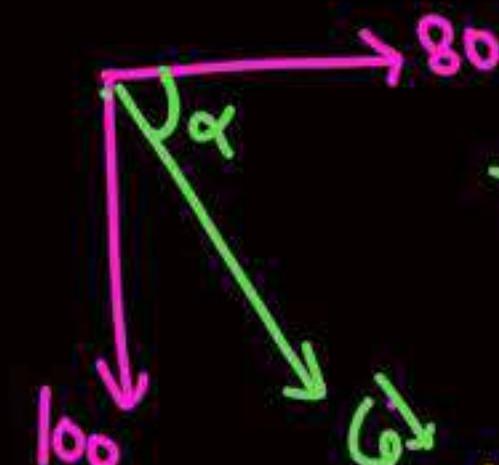
Q  
b) find speed of particle at  $t = 16 \text{ sec}$

$$\vec{V} = 80\hat{i} - 100\hat{j} \quad (\text{just before hit the ground})$$

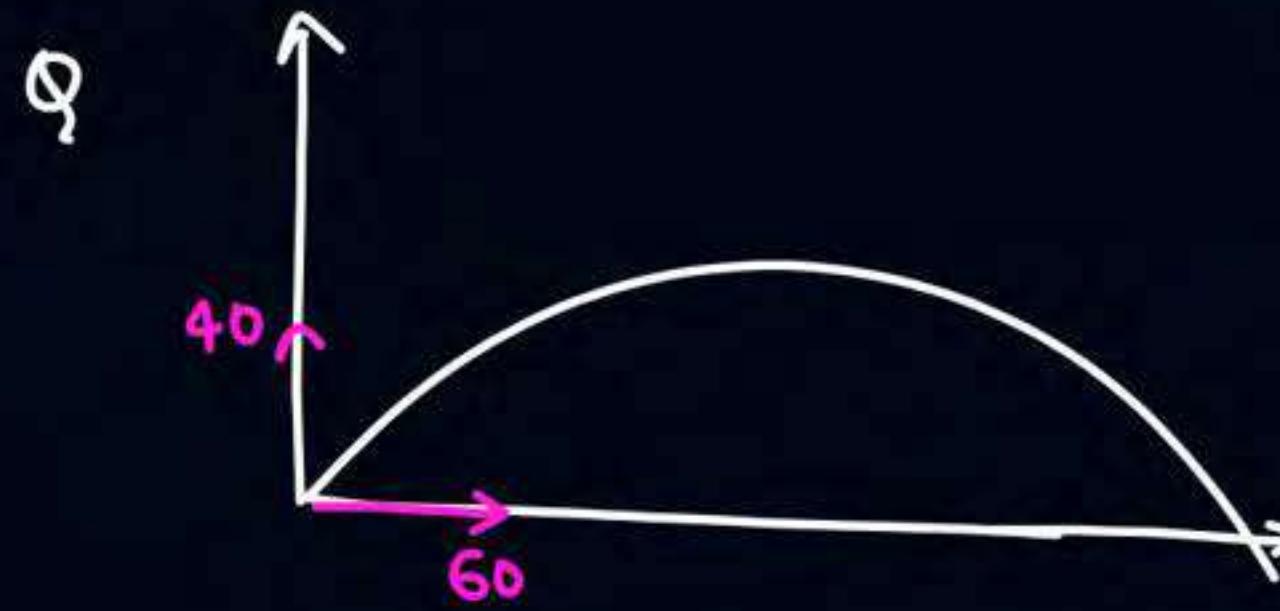
$$|\vec{V}| = \sqrt{(80)^2 + (100)^2}$$

- 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  $t = 16 \text{ sec}$

$$\vec{V} = 80\hat{i} - 100\hat{j}$$



$$\tan \alpha = \frac{100}{80}$$



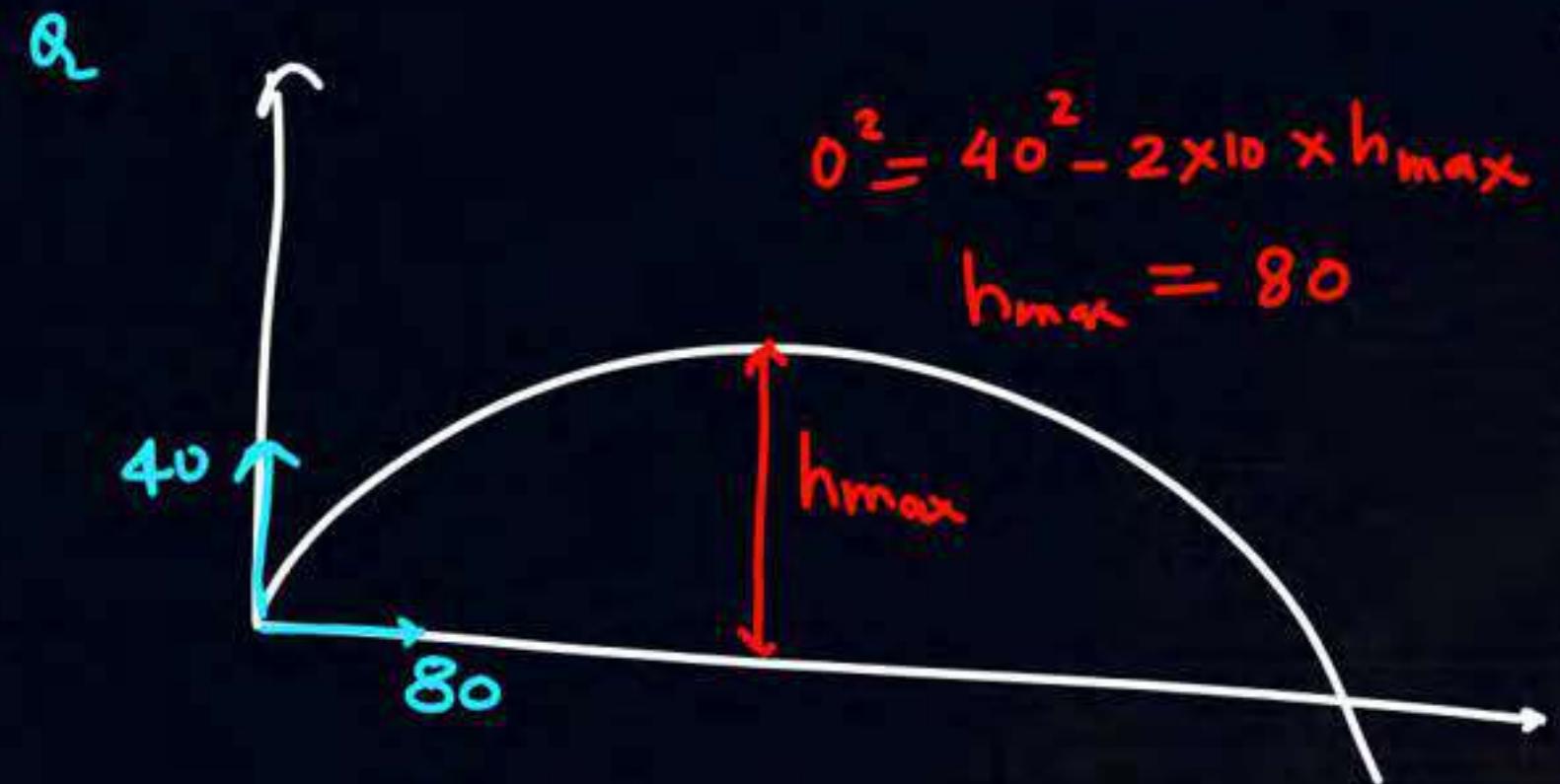
$$0^2 = 40^2 - 2 \times 10 \times h_{\max}$$

$$T = 4 + 4 = 8$$

$$h_{\max} = 80$$

$$R = 60 \times 8 = \underline{480}$$

V0



$$0^2 = 40^2 - 2 \times 10 \times h_{\max}$$

$$h_{\max} = 80$$

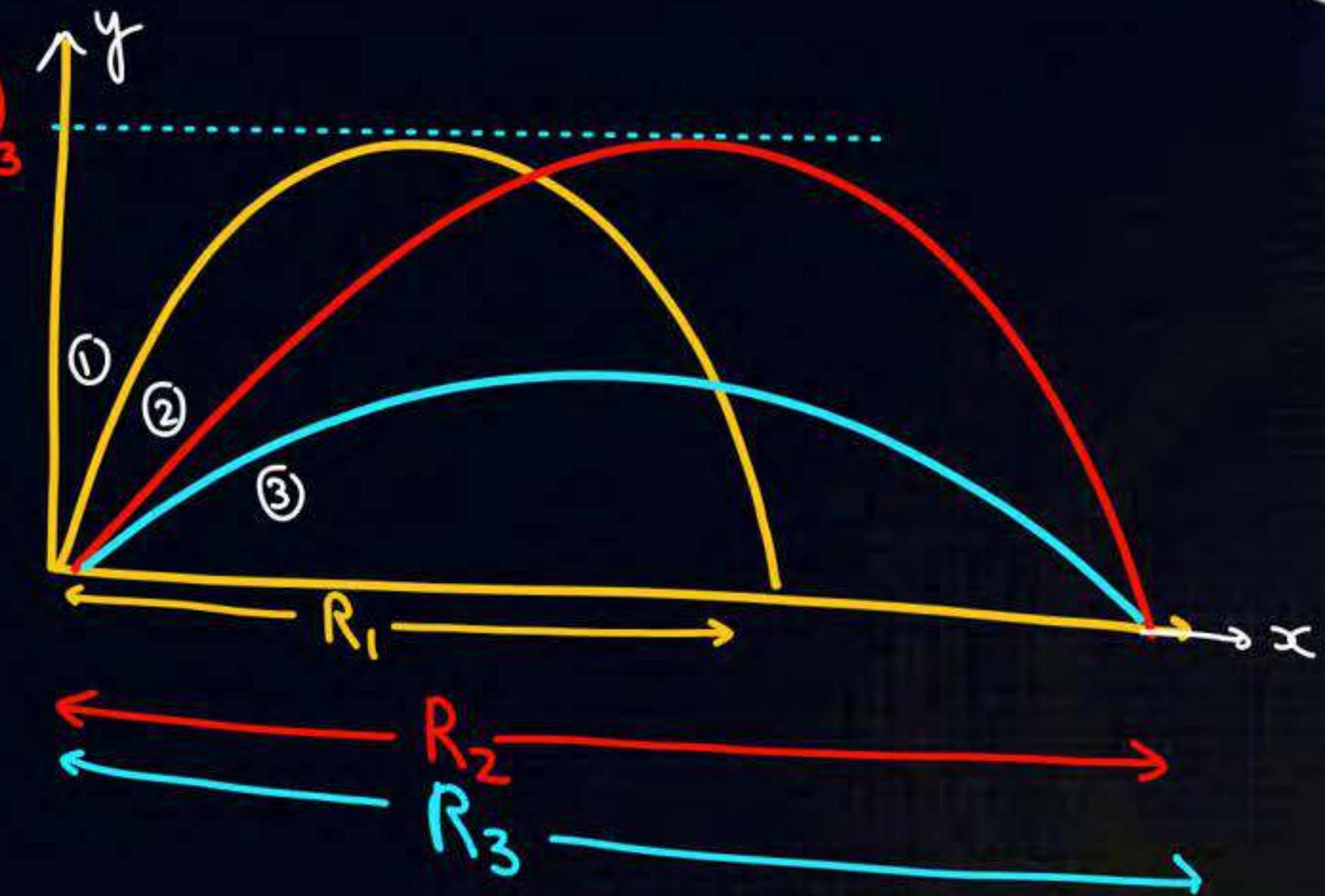
$$T = 4 + 4 = 8$$

$$h_{\max} = 80$$

$$R = 80 \times 8 = \underline{640}$$

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  $\theta$  with horizontal such that its maximum height is half of range. find  $\theta$

$$h_{\max} = \frac{1}{2} R$$

$$\frac{u^2 \sin^2 \theta}{2g} = \frac{1}{2} \frac{u^2 \sin 2\theta}{g}$$

$$\sin^2 \theta = \sin 2\theta$$

$$\sin^2 \theta = 2 \sin \theta \cos \theta$$

$$\tan \theta = 2$$

$$\boxed{\theta = \tan^{-1} 2}$$

Q. Two particle are projected with same speed  $u$  at angle  $30^\circ$  &  $60^\circ$  respectively. find ① Ratio of their max height  
 ② " " Range  
 ③ " " time of flight

$$\textcircled{1} \frac{(h_{\max})_1}{(h_{\max})_2} = \frac{\frac{u^2 \sin^2 30}{2g}}{\frac{u^2 \sin^2 60}{2g}} = \frac{\left(\frac{1}{2}\right)^2}{\left(\frac{\sqrt{3}}{2}\right)^2} = \frac{1}{3}$$

$$\textcircled{2} \frac{R_1}{R_2} = \frac{\frac{u^2 \sin(2 \times 30)}{g}}{\frac{u^2 \sin(2 \times 60)}{g}} = \frac{\sin 60}{\sin 120} = \frac{\sqrt{3}/2}{\sqrt{3}/2} = 1$$

**M-Z**

$$\theta = 30^\circ$$

$$90 - \theta = 60^\circ \rightarrow R_1 = R_2$$

$$\textcircled{3} T = \frac{2u \sin \theta}{g}$$

$$\frac{T_1}{T_2} = \frac{\sin 30}{\sin 60} = \frac{1/2}{\sqrt{3}/2} = \frac{1}{\sqrt{3}}$$

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  $t=0$   
 $\theta = ?$

$$R = 400 = \frac{u^2 \sin 2\theta}{g}$$

$$5 = \frac{2usin\theta}{g}$$

$$u = \frac{25}{\sin\theta}$$

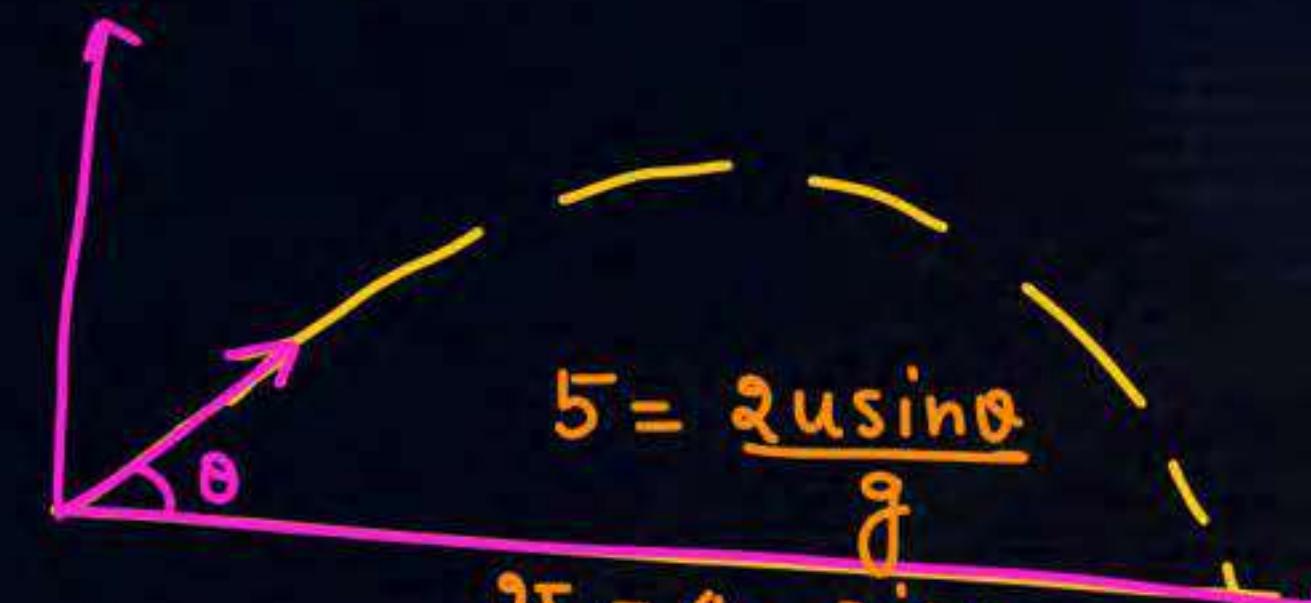
$$400 = \left(\frac{25}{\sin\theta}\right)^2 \cdot \frac{\sin 2\theta}{10}$$

$$400 = \frac{625}{\sin^2\theta} \cdot \frac{2 \sin\theta \cos\theta}{10}$$

$$400 = 125 \frac{\cos\theta}{\sin\theta} = 125 \cot\theta$$

$$\cot\theta = \frac{400}{125}$$

$$\tan\theta = 125/400 = \frac{5}{16}$$



$$5 = \frac{2usin\theta}{g}$$

$$25 = \frac{4}{100} u^2 \sin^2\theta$$

$$u^2 \sin^2\theta = 625$$

$$H_{\max} = \frac{u^2 \sin^2\theta}{2g} = \frac{625}{20}$$

Q An arrow is projected such that its range is 400m and time of flight is 5 sec.  
find

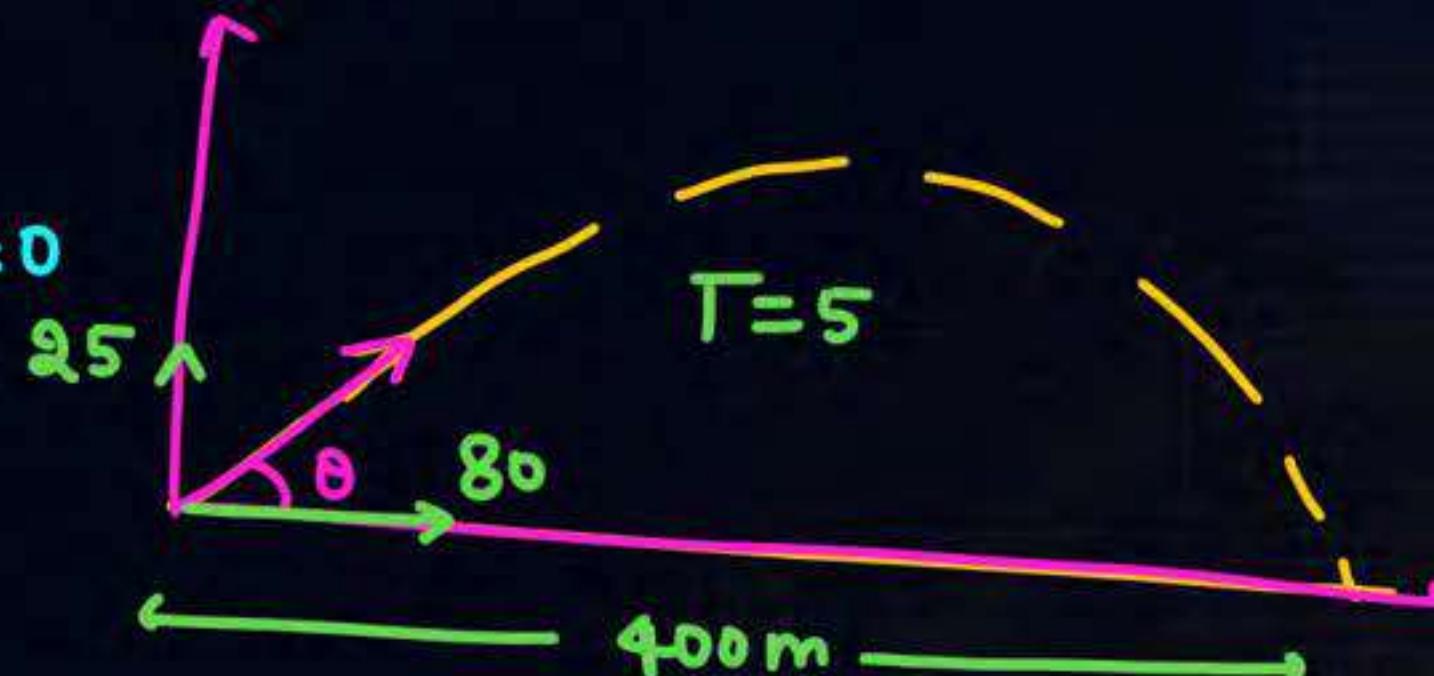
- ①  $h_{\max}$
- ② inclination of arrow at  $t=0$

$$\tan \theta = \frac{25}{80} = \frac{5}{16}$$

$$\vec{u} = 2.5\hat{i} + 80\hat{j}$$

$$0^2 = (25)^2 - 2 \times g \times h_{\max}$$

$$h_{\max} = \frac{(25)^2}{2g} = \frac{625}{20}$$



**Q.** A particle is projected at angle  $\theta$  such that its range is 1200 m and time of flight is 20 sec  
find ① angle at which particle is projected.

$$\tan \theta = \frac{100}{60} = \frac{5}{3}$$



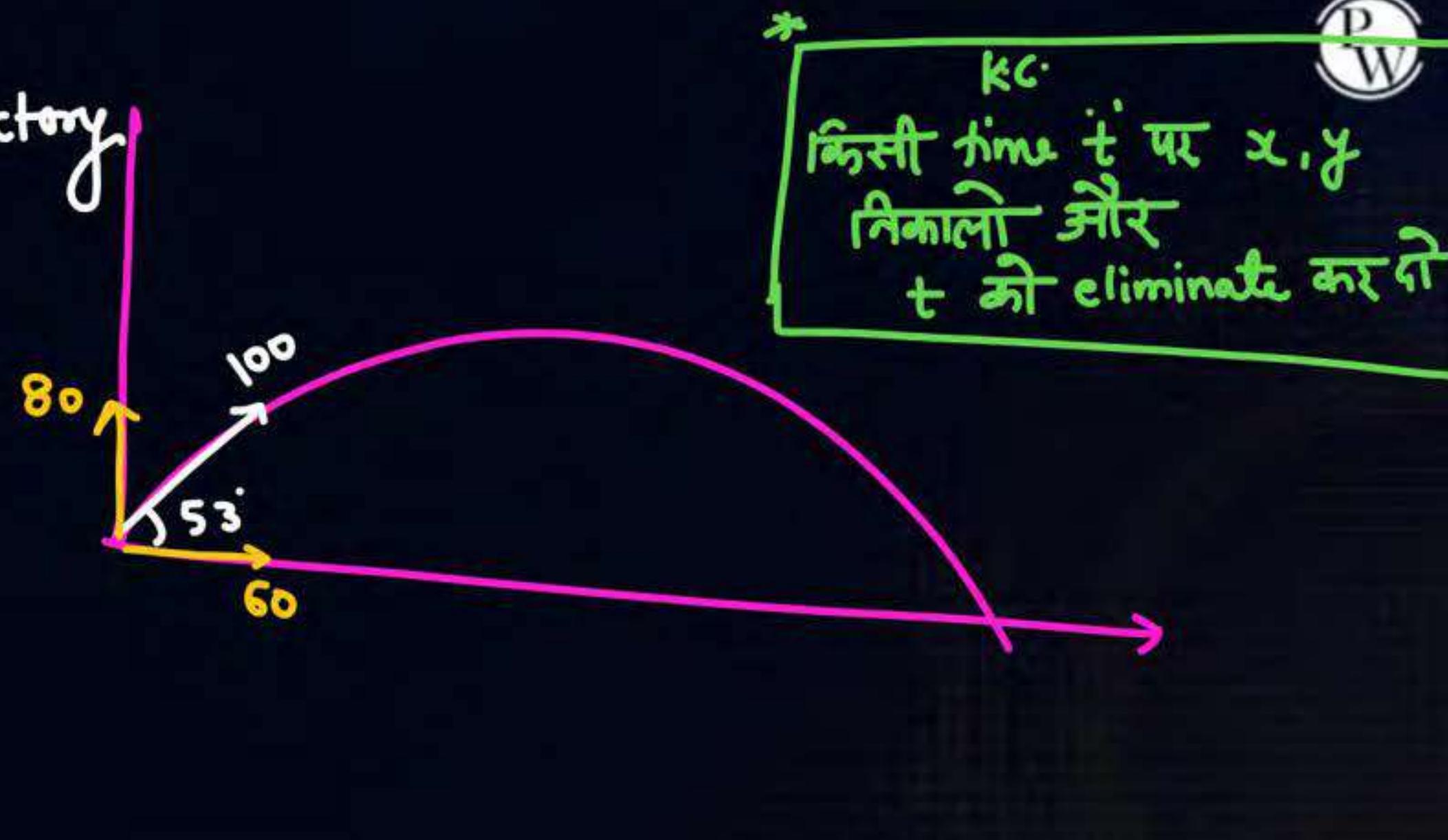
Q. Find equation of trajectory

$$x = 60t \quad t = \frac{x}{60}$$

$$y = 80t - \frac{1}{2} g t^2$$

$$y = 80 \frac{x}{60} - \frac{1}{2} g \left(\frac{x}{60}\right)^2$$

$$y = \frac{4}{3}x - \frac{5}{3600}x^2$$



KC  
किसी time  $t$  पर  $x, y$   
मिकालों और  
 $t$  को eliminate करते

Q

find eq<sup>n</sup> of trajectory

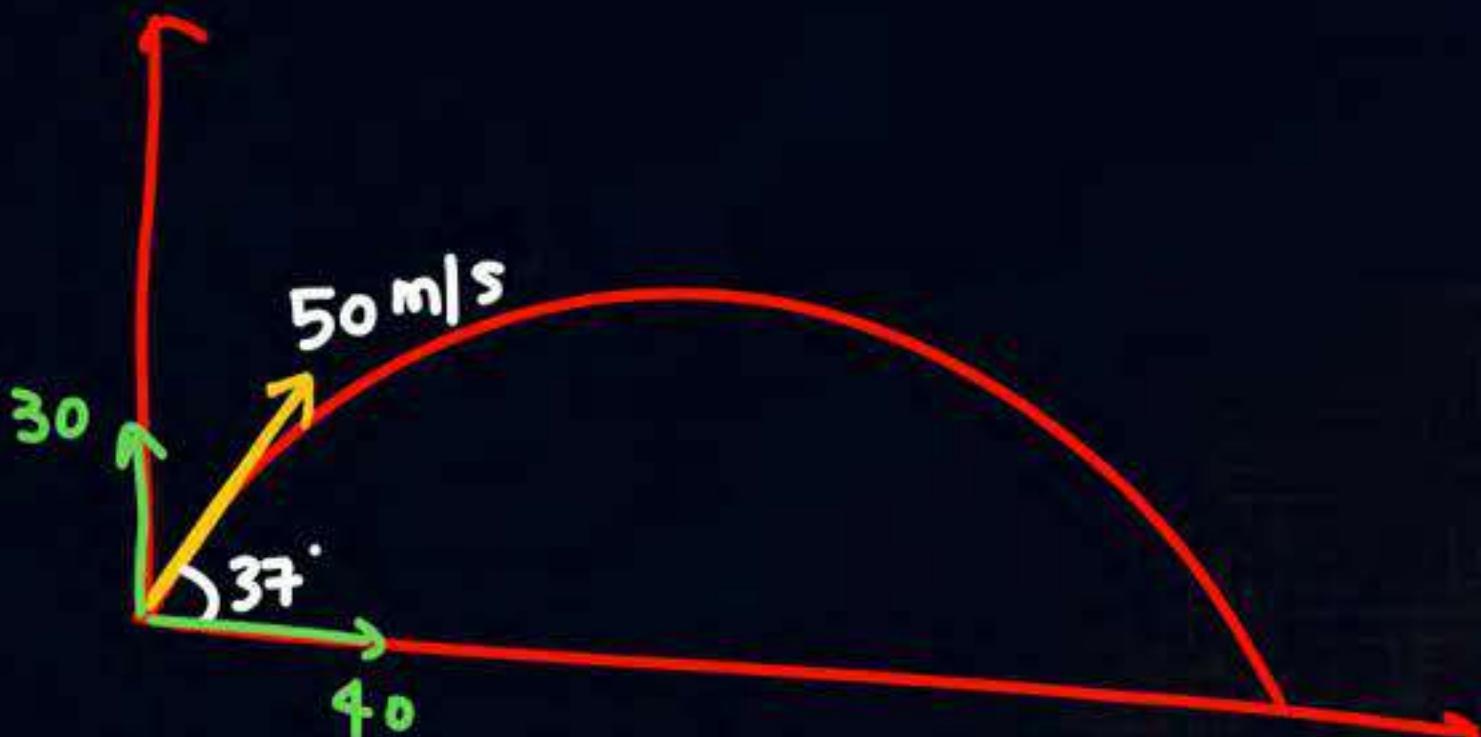
$$x = 40t$$

$$t = x/40$$

$$y = 30t - \frac{1}{2}g t^2$$

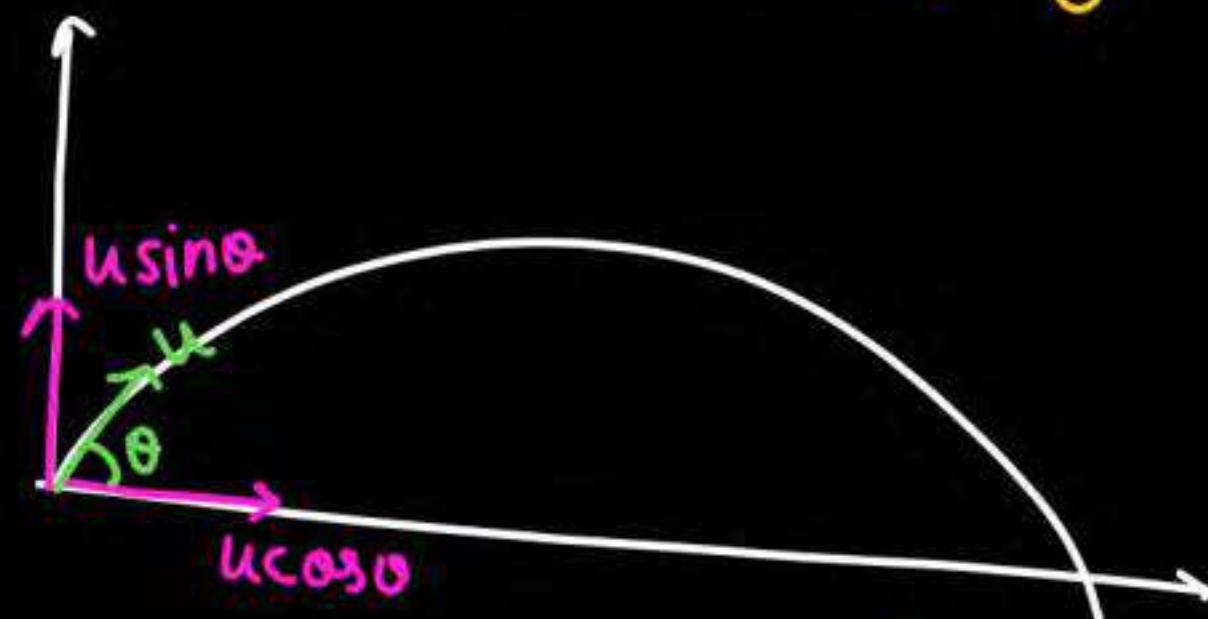
$$y = 30 \cdot \frac{x}{40} - \frac{1}{2}g \frac{x^2}{(40)^2}$$

$$y = \frac{3}{4}x - \frac{5}{1600}x^2$$



# 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  $u, Q, T, R, \theta$

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta} \quad (\text{Compare})$$

$$\sqrt{3} = \tan \theta$$

$$\boxed{\theta = 60^\circ}$$

$$\frac{1}{20} = \frac{g}{2 u^2 \cos^2 \theta}$$

$$\frac{1}{20} = \frac{10}{2 u^2 \cos^2 60^\circ}$$

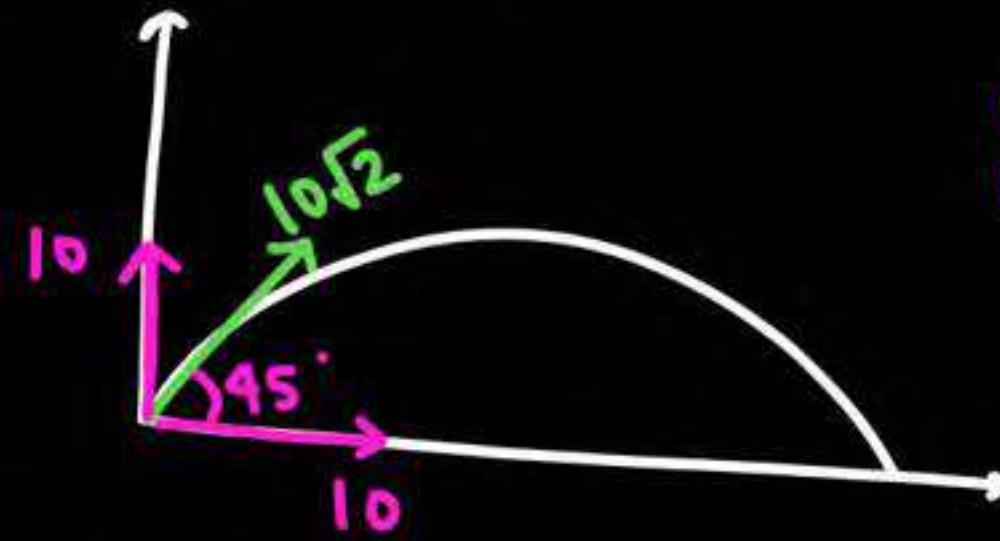
$$2u^2 \frac{1}{4} = 20 \times 10$$

$$\begin{aligned} u^2 &= 400 \\ \boxed{u &= 20} \end{aligned}$$



Q If eqn of trajectory is given by

$$y = x - \frac{x^2}{20}$$



① find  $u, \theta, T, R, \dots$

$$T = l + l = 2$$

$$R = 10 \times 2 = 20$$

$$y = x - \frac{x^2}{20}$$

$$y = x \tan \theta - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \theta}$$

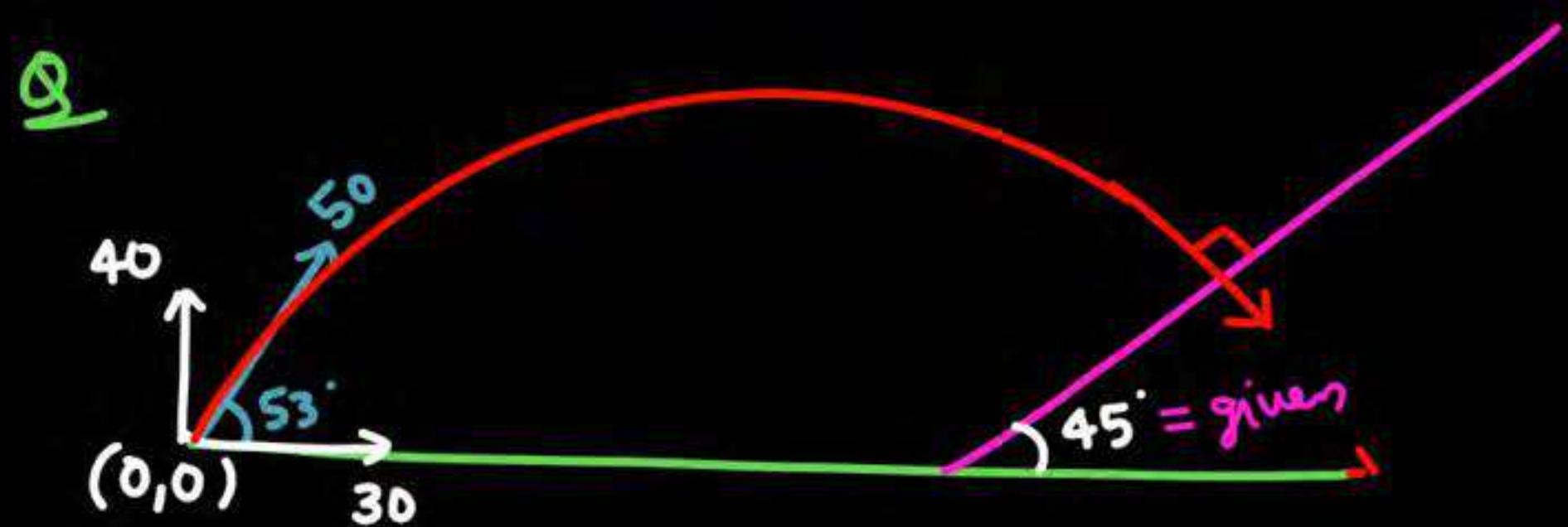
$$\tan \theta = 1$$

$$\theta = 45^\circ$$

$$\frac{1}{20} = \frac{g}{2 u^2 \cos^2 45^\circ}$$

$$2u^2 \frac{1}{2} = 200$$

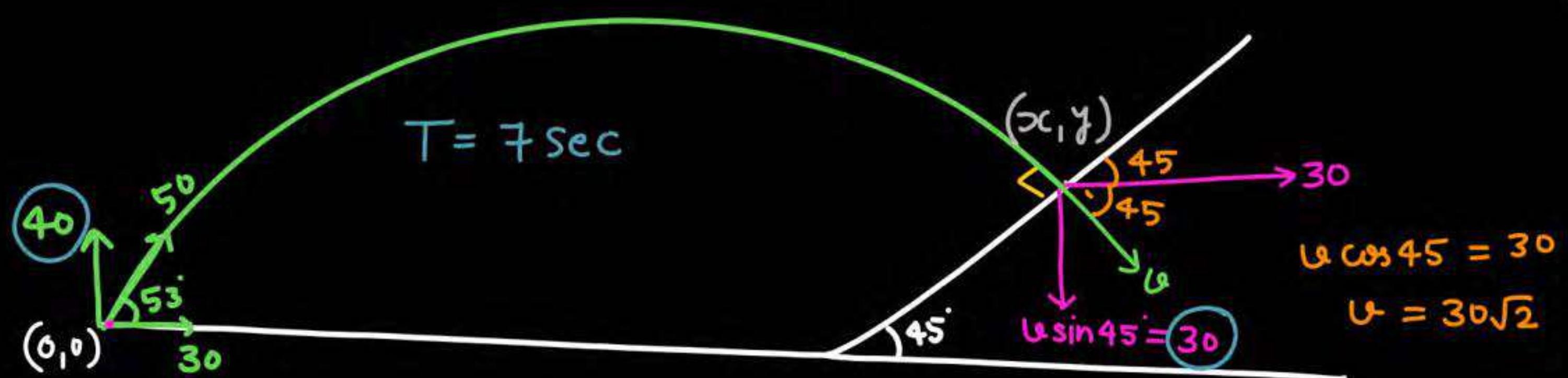
$$u = 10\sqrt{2}$$



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

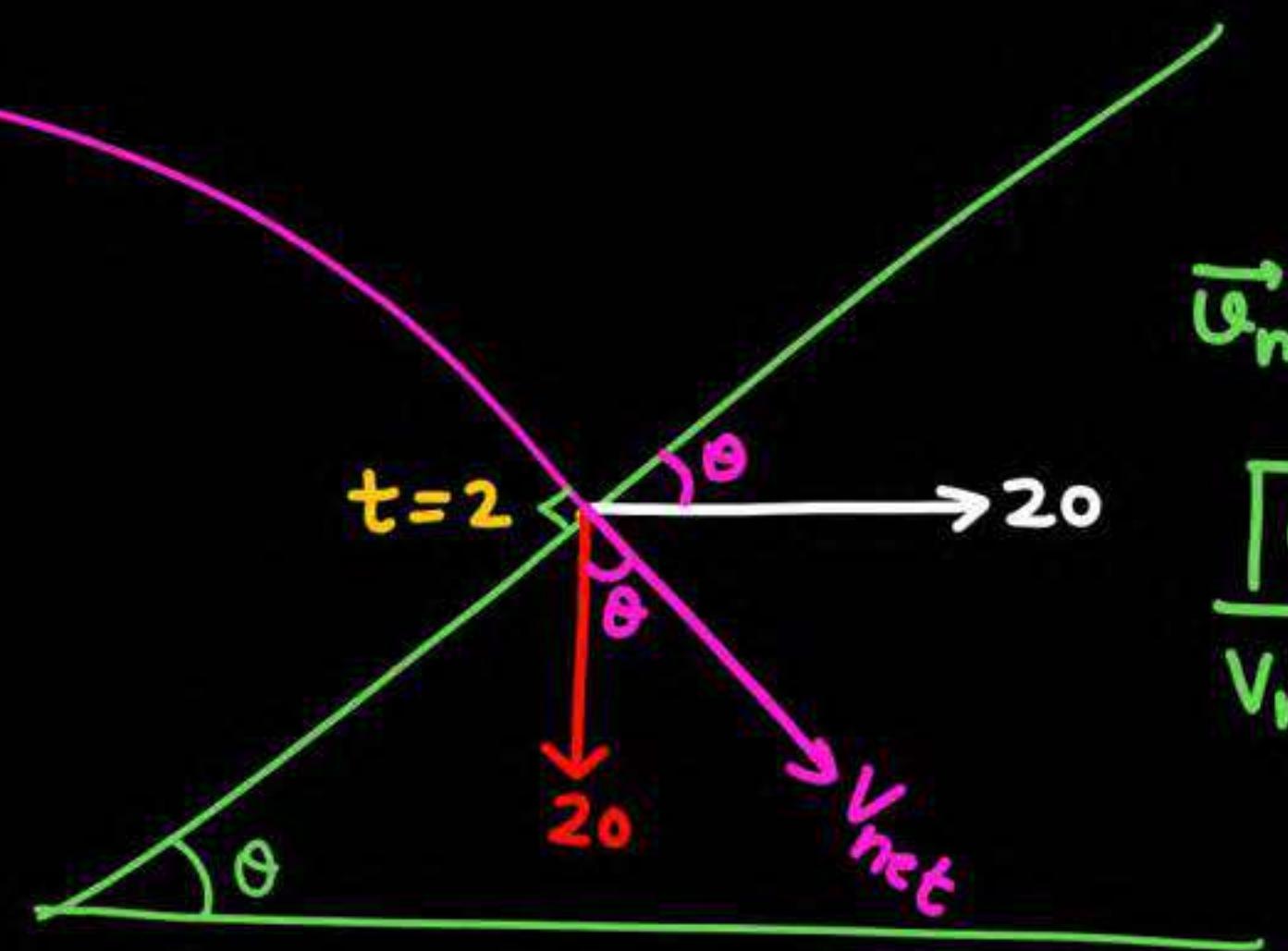
$20 \text{ m/s}$

particle strike the  
plane perpendicularly  
find  $\alpha$

$$\textcircled{y} \quad v = u + at$$

$$v = -10 \times 2$$

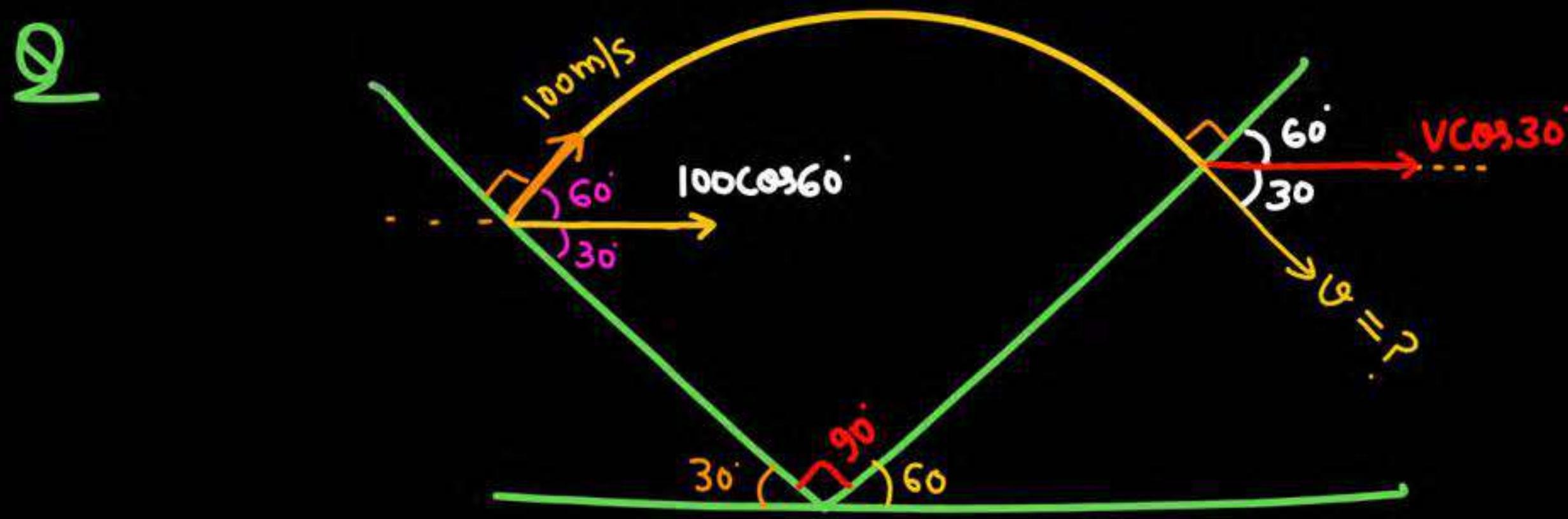
$$v = \theta 20 = u_f$$



$$\vec{v}_{net} = 20\hat{i} - 20\hat{j}$$

$$\boxed{\alpha = 45^\circ}$$

$$V_{net} = 20\sqrt{2}$$



$$100 \cos 60 = V \cos 30$$

$$100 \times \frac{1}{2} = V \frac{\sqrt{3}}{2}$$

$$V = \frac{100}{\sqrt{3}}$$

$$\vec{r} = 4t^2 \hat{i} + 2t^3 \hat{j} + 4t^4 \hat{k}$$

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  $\theta$ , & 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  $t=2 \text{ sec}$

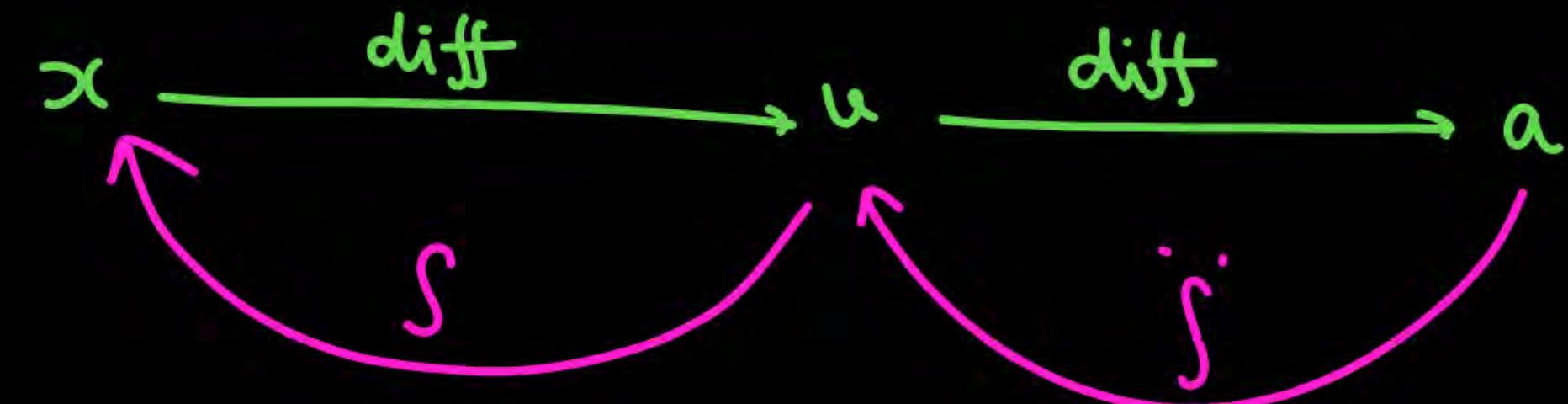
$$x = t^3 + 2t^2 + 6t$$

$$v = 3t^2 + 4t + 6$$

$$a = 6t + 4$$

$$t=2, v = 12+8+6$$

$$a = 16$$

P  
W

at  $t=0$

Q A particle start motion<sup>^</sup> 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

$$a = 24t^2$$

$$v = \int 24t^2 dt = 24 \frac{t^3}{3} + C$$

$$v = 8t^3 + C$$

$$\text{put } t=0, v=10$$

$$10 = 0 + C \Rightarrow C = 10$$

$$v = 8t^3 + 10$$

$$v = 8t^3 + 10$$

$$x = \int (8t^3 + 10) dt =$$

$$x = 8 \frac{t^4}{4} + 10t + C'$$

$$t=0, x=20 \Rightarrow C' = 20$$

$$x = 2t^4 + 10t + 20$$

$$t=2, v = 8 \times 8 + 10 = 74$$

$$x = 2 \times 16 + 10 \times 2 + 20 = 72$$

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)

$$\begin{aligned} v &= \frac{dx}{dt} \\ a &= \frac{dv}{dt} \\ a &= v \frac{dv}{dx} \end{aligned}$$

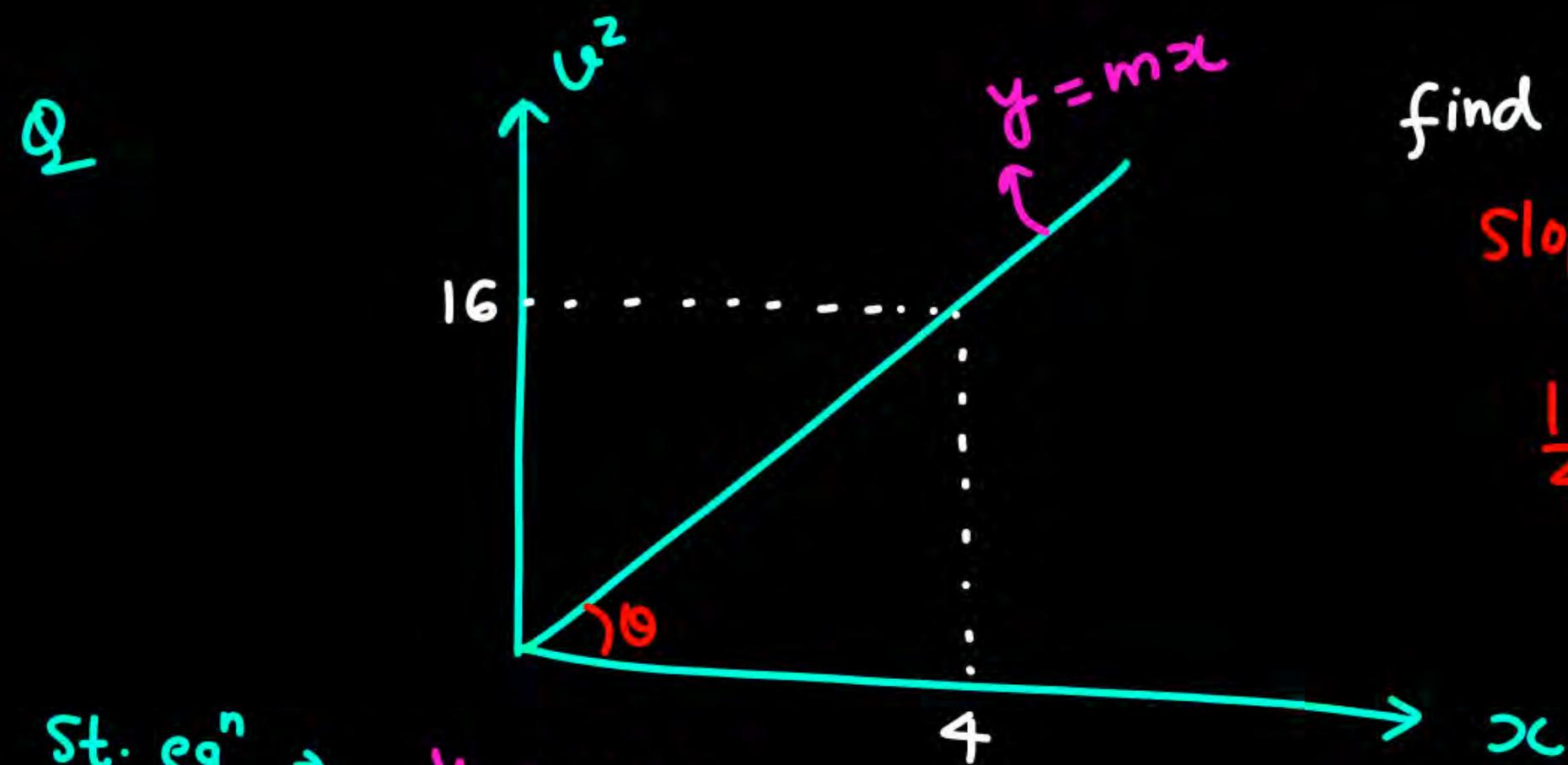
Q If  $v = x^2 + 3x$   
find acc at  $x = 2$

$$a = v \frac{dv}{dx} \quad \frac{dv}{dx} = 2x + 3$$

$$a = (x^2 + 3x)(2x + 3)$$

$$\text{put } x = 2, a = (4+6)(4+3)$$

$$\boxed{a = 70}$$



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. eq<sup>n</sup>  $\Rightarrow y = mx$

$$v^2 = 4x$$

$$2v \frac{dv}{dx} = 4$$

$$\underline{\underline{a = 2}}$$

Q

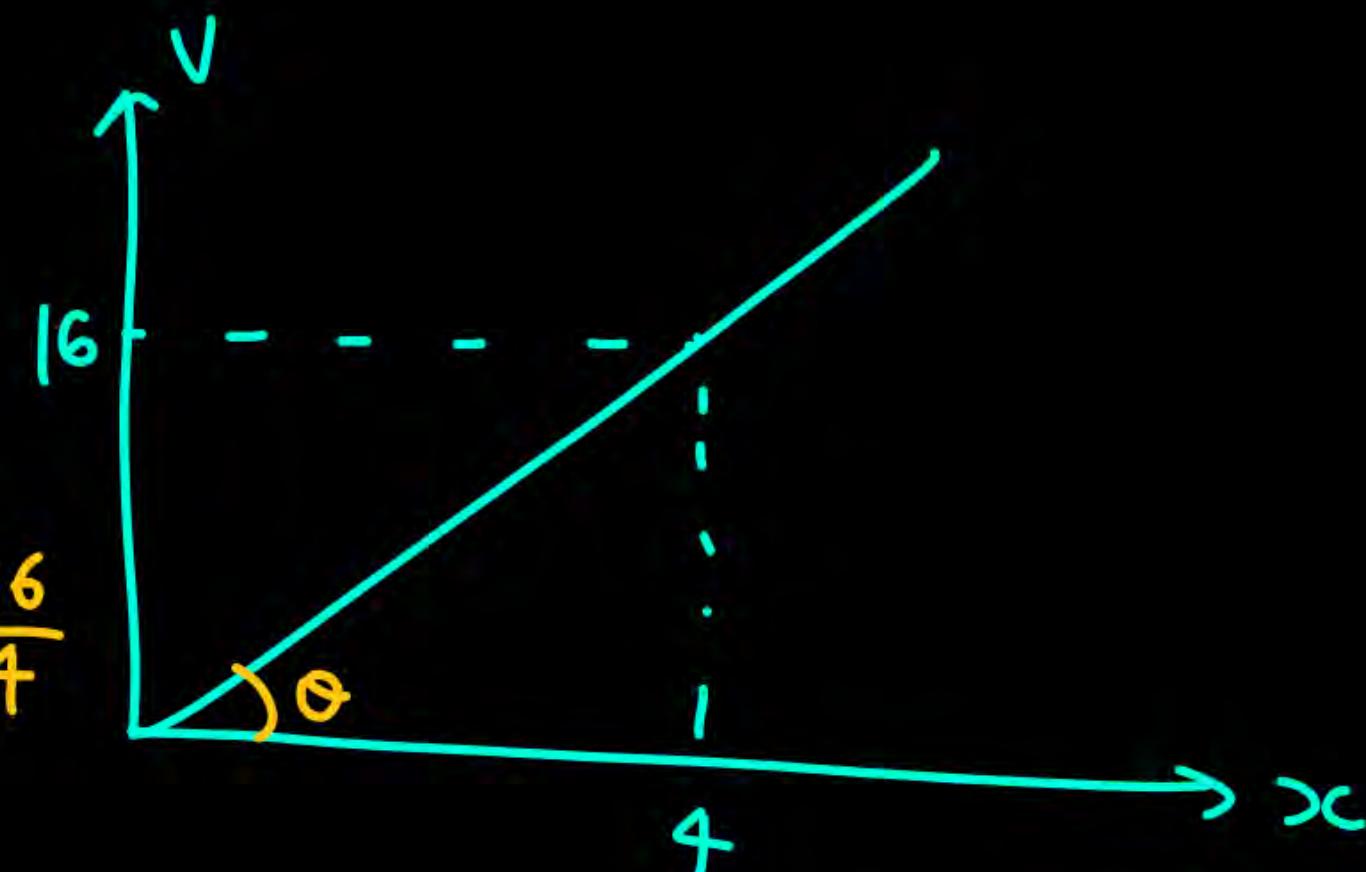
find acc

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 =  $\frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\text{time interval}}$

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

$\vec{v} = \frac{d\vec{r}}{dt}$

$$\vec{v} = \frac{d\vec{r}}{dt} = 9t^2 \hat{i} + 4 \hat{j} + 2t \hat{k}$$

---

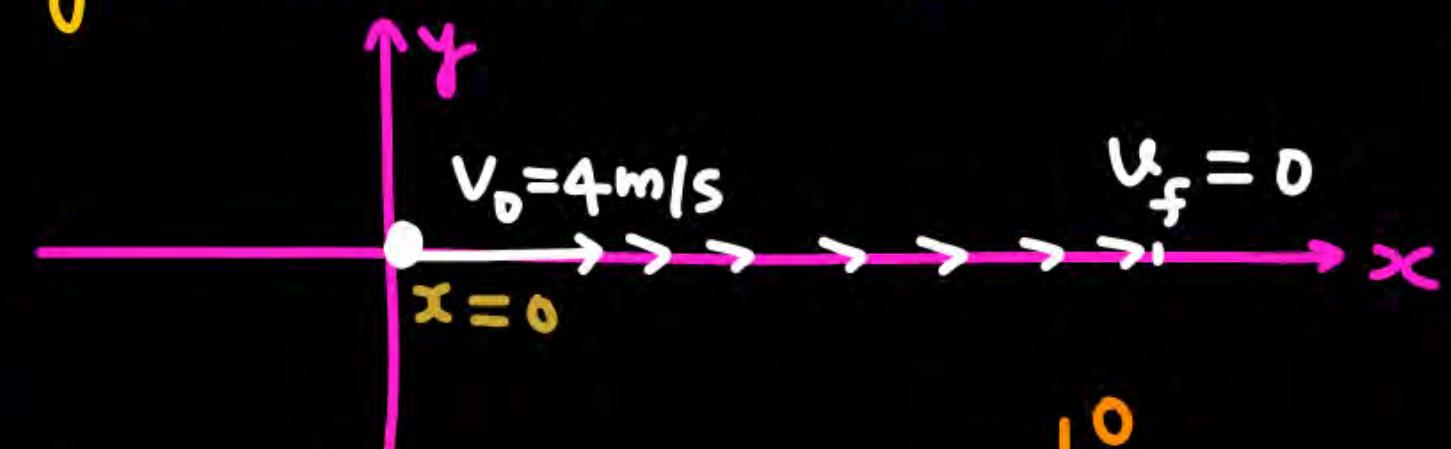
$t = 2$	$\vec{v}_f = 36 \hat{i} + 4 \hat{j} + 4 \hat{k}$
$t = 1$	$\vec{v}_i = 9 \hat{i} + 4 \hat{j} + 2 \hat{k}$

~~$27 + 2 = 29$~~

magnitude  $\sqrt{(27)^2 + 2^2}$

Avg acc =  $\frac{27 \hat{i} + 2 \hat{k}}{2-1} = 27 \hat{i} + 2 \hat{k}$

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



$$a = -3x^2$$

$$\frac{du}{dx} = -3x^2$$

$$\int_4^0 u du = \int_0^{x_f} -3x^2 dx$$

$$\frac{u^2}{2} \Big|_4^0 = -\cancel{3} \frac{x^3}{3} \Big|_0^{x_f}$$

$$\frac{0^2}{2} - \frac{4^2}{2} = -[x_f^3 - 0]$$

$$-8 = -x_f^3$$

$$\boxed{x_f = 2}$$

find acc when velocity become zero.

$$u = 0, x = \frac{2}{\sqrt{a}}$$

$$a = -3x^2$$

$$a = -12$$

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

$$|\vec{v}| = \sqrt{(a \omega \cos \omega t)^2 + (a \omega \sin \omega t)^2}$$

$$= a \omega \sqrt{\cos^2 \omega t + \sin^2 \omega t}$$

$$\text{Speed} = a \omega$$

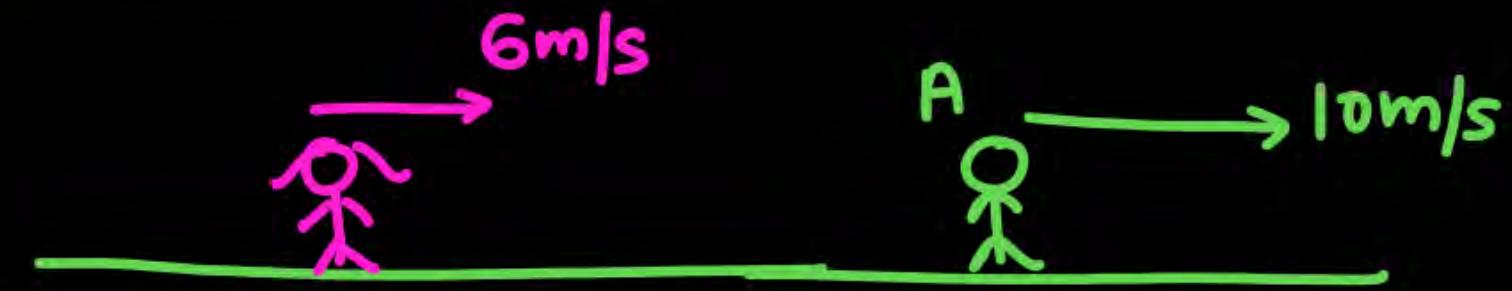
M/w

Ques Discuss ✓

P  
V

Q<sub>2</sub> A particle is projected with  $100 \text{ m/s}$  at angle  $53^\circ$  with horizontal.  
At what time it is moving at an angle  $45^\circ$  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' =  $4 \text{ m/s} \hat{i}$

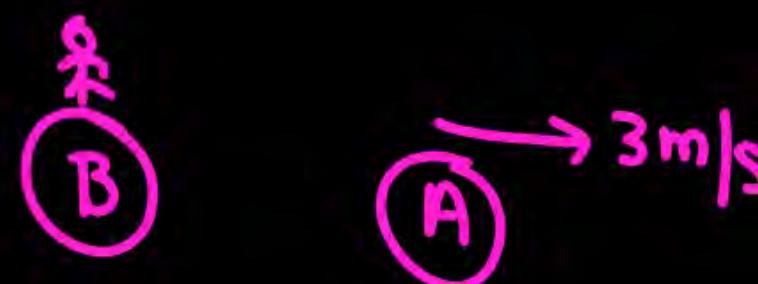
Velocity of A wrt B =  $\vec{v}_{A/B}$  = B की रवाना पर बैठकर A की राह

P  
W

$$\boxed{\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B}$$



$$\begin{aligned}\vec{v}_{A/B} &= \vec{v}_A - \vec{v}_B \\ &= 13\hat{i} - 10\hat{i} = 3\hat{i}\end{aligned}$$



$$\begin{aligned}\vec{v}_{B/A} &= \vec{v}_B - \vec{v}_A = (-10\hat{i}) - (6\hat{i}) \\ &= -16\hat{i}\end{aligned}$$



$$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B$$



$$\vec{v}_{B/A} = 8\hat{i} - 6\hat{i} = 2\hat{i}$$

$$\begin{aligned}\vec{v}_{A/B} &= \vec{v}_A - \vec{v}_B = 6\hat{i} - 8\hat{i} \\ &= -2\hat{i}\end{aligned}$$

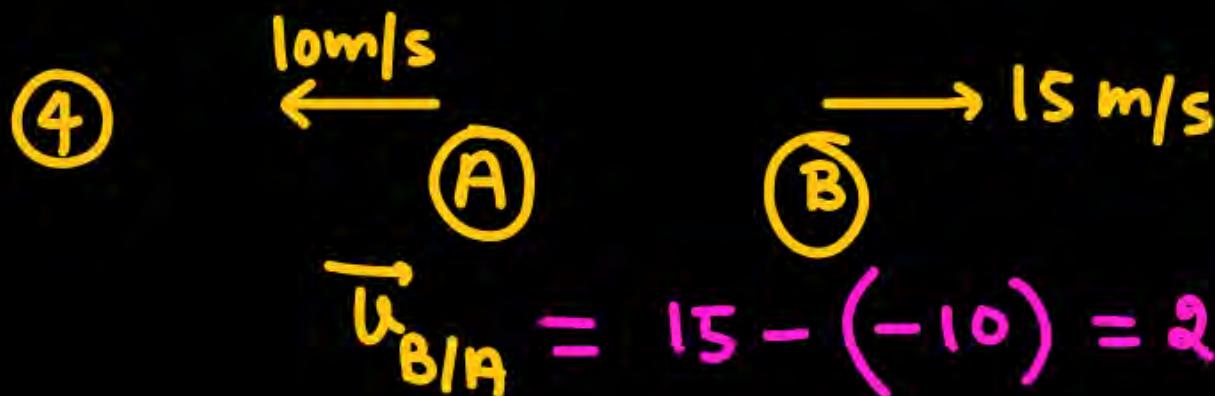


$$\vec{v}_{A/B} = 10 - 4 = 6\hat{i}$$

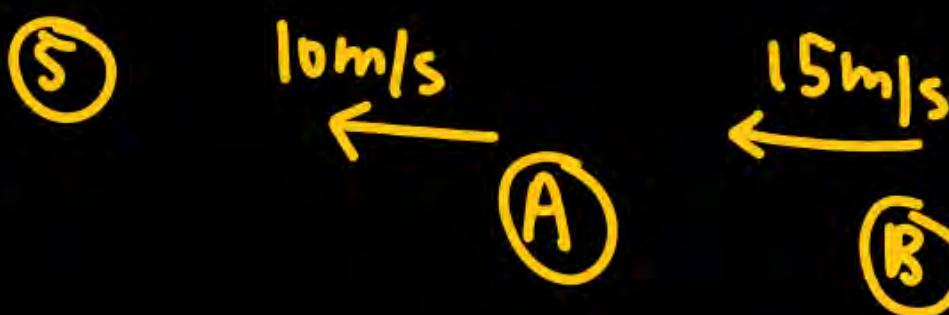
$$\vec{v}_{B/A} = 4 - 10 = -6\hat{i}$$



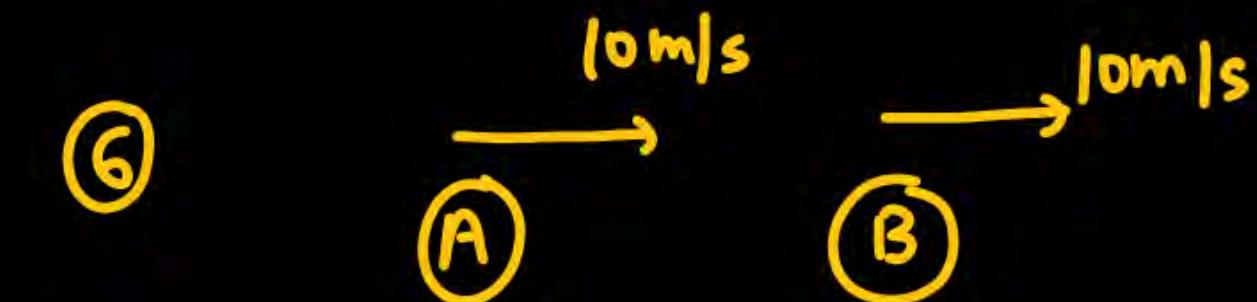
$$\vec{v}_{B/A} = (-10\hat{i}) - (6\hat{i}) = -16\hat{i}$$



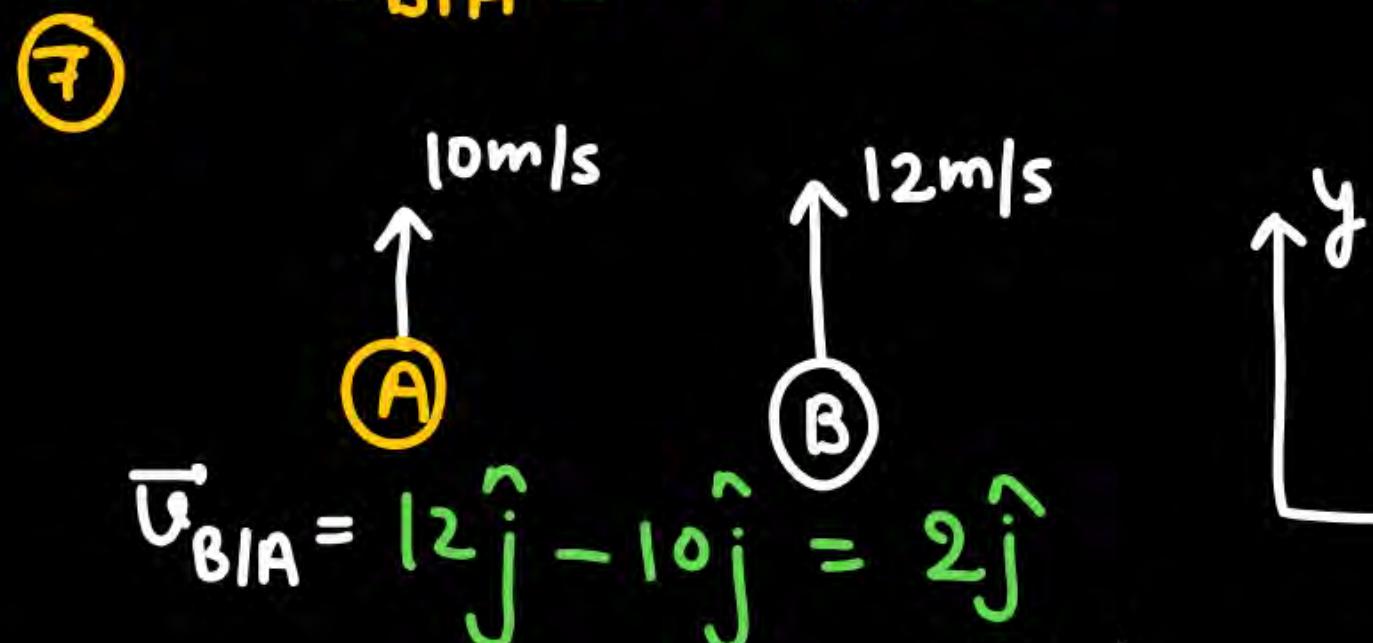
$$\vec{v}_{B/A} = 15 - (-10) = 25$$



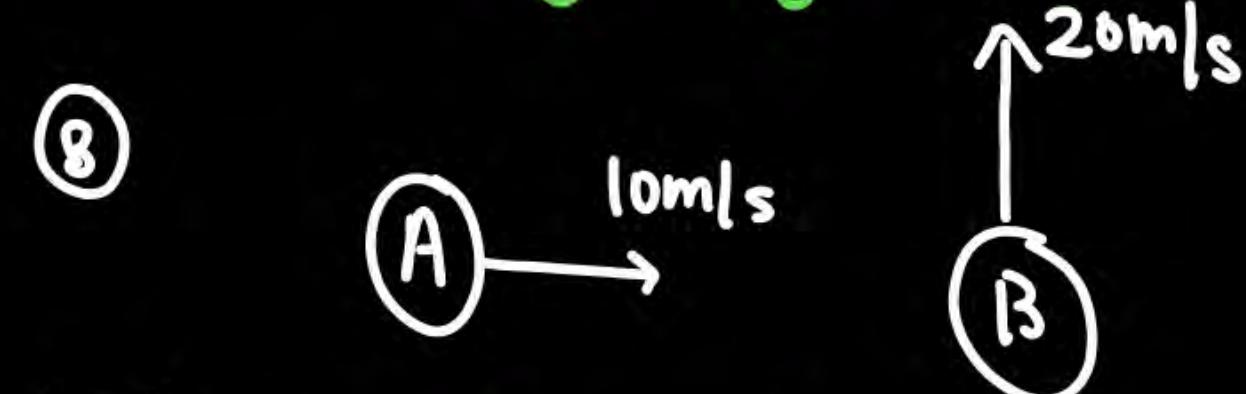
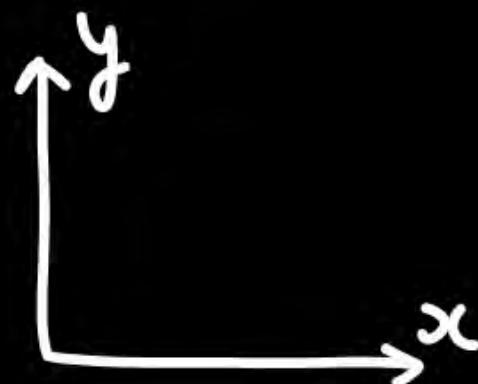
$$\begin{aligned}\vec{v}_{B/A} &= (-15) - (-10) \\ &= -5\hat{i}\end{aligned}$$



$$\vec{v}_{B/A} = 10 - 10 = 0$$



$$\vec{v}_{B/A} = 12\hat{j} - 10\hat{j} = 2\hat{j}$$

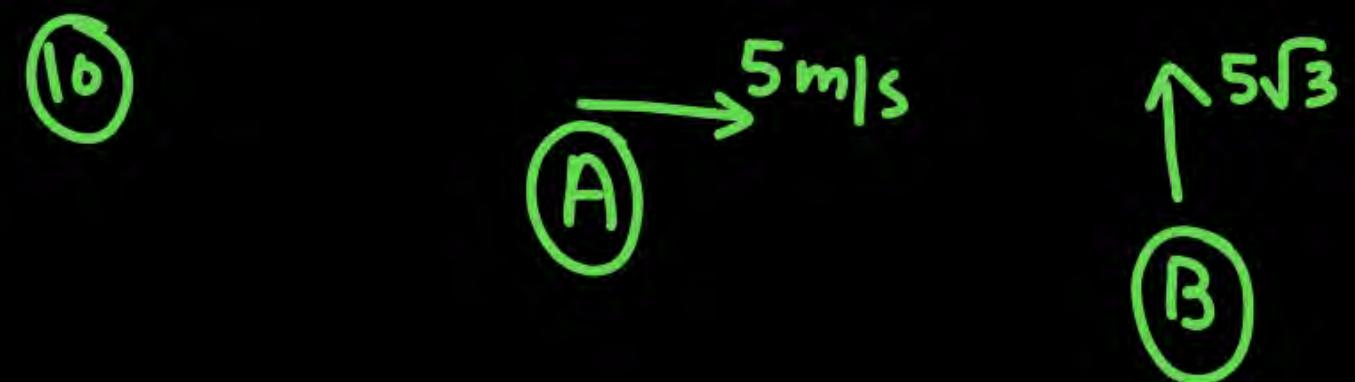


$$\vec{v}_{B/A} = 20\hat{j} - 10\hat{i}$$

P  
W



$$\vec{v}_{B/A} = -10\sqrt{3}\hat{j} - 10\hat{i} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

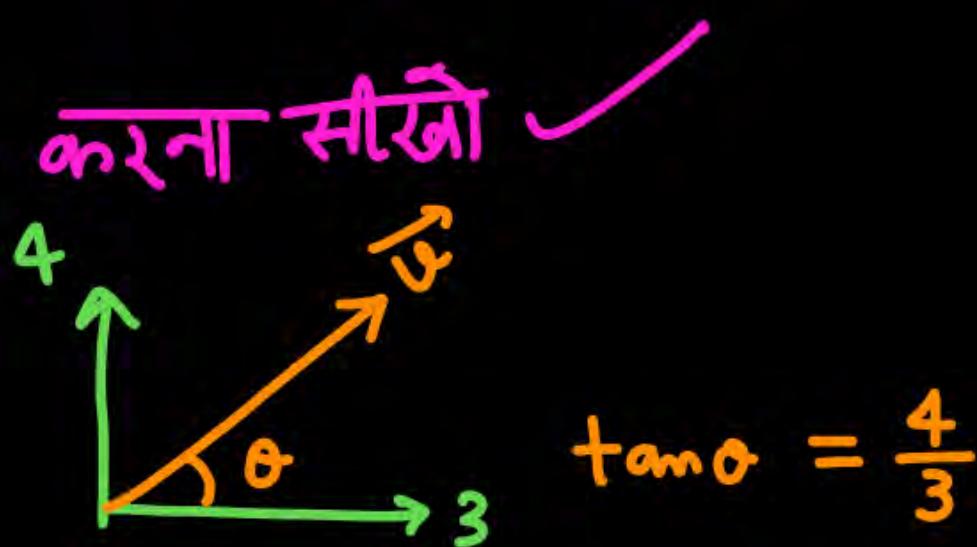


$$\vec{v}_{B/A} = 5\sqrt{3}\hat{j} - 5\hat{i} = -5\hat{i} + 5\sqrt{3}\hat{j}$$

P  
W

Vector की Draw करना सीखो ✓

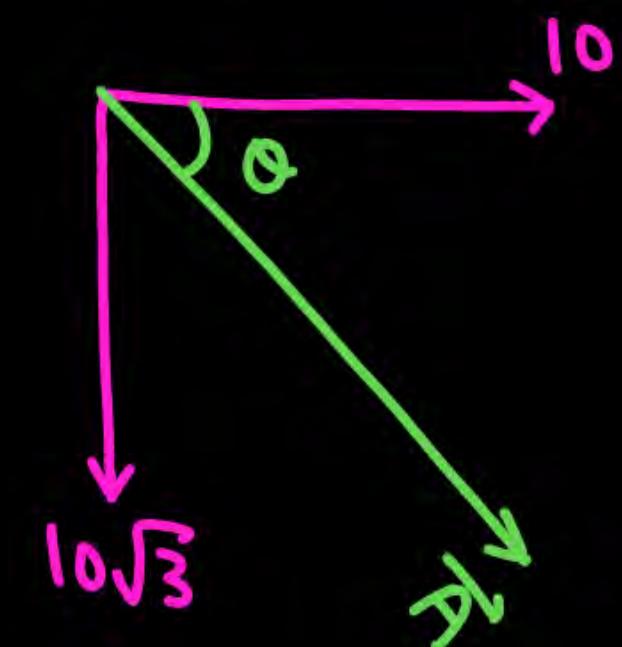
$$① \vec{v} = 3\hat{i} + 4\hat{j}$$



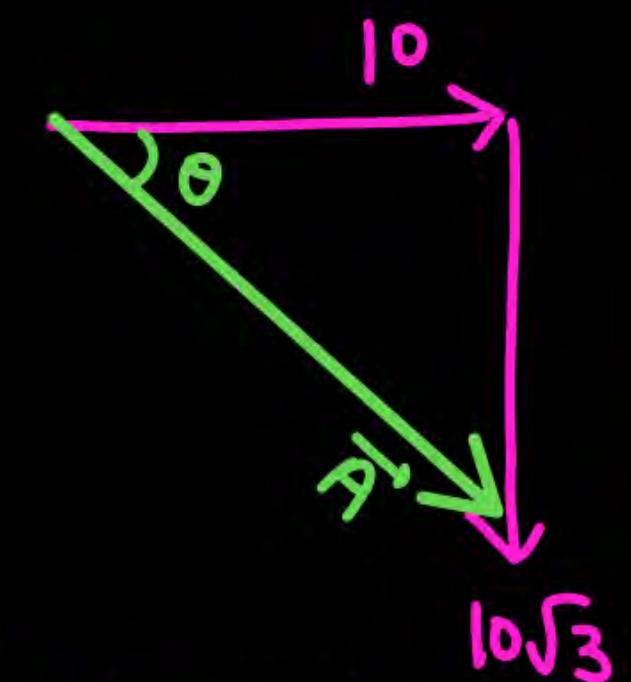
$$\tan \theta = \frac{4}{3}$$

$$② \vec{A} = 10\hat{i} - 10\sqrt{3}\hat{j}$$

$$\tan \theta = \frac{10\sqrt{3}}{10}$$

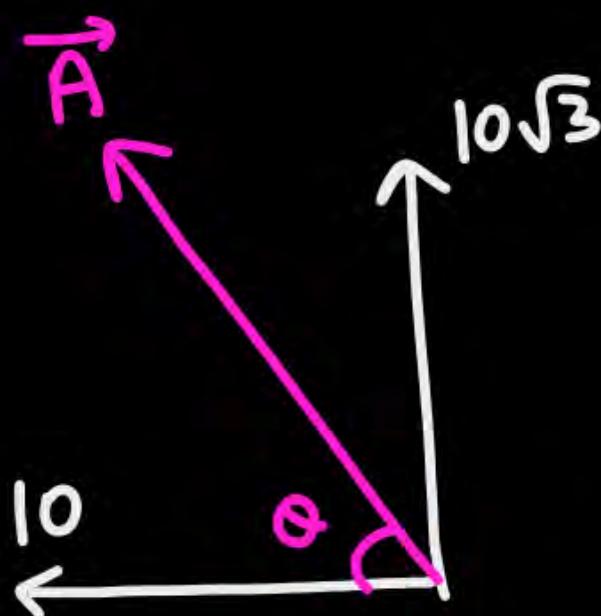


$$\vec{A} = 10\hat{i} - 10\sqrt{3}\hat{j}$$



$$\tan \theta = \frac{10\sqrt{3}}{10}$$

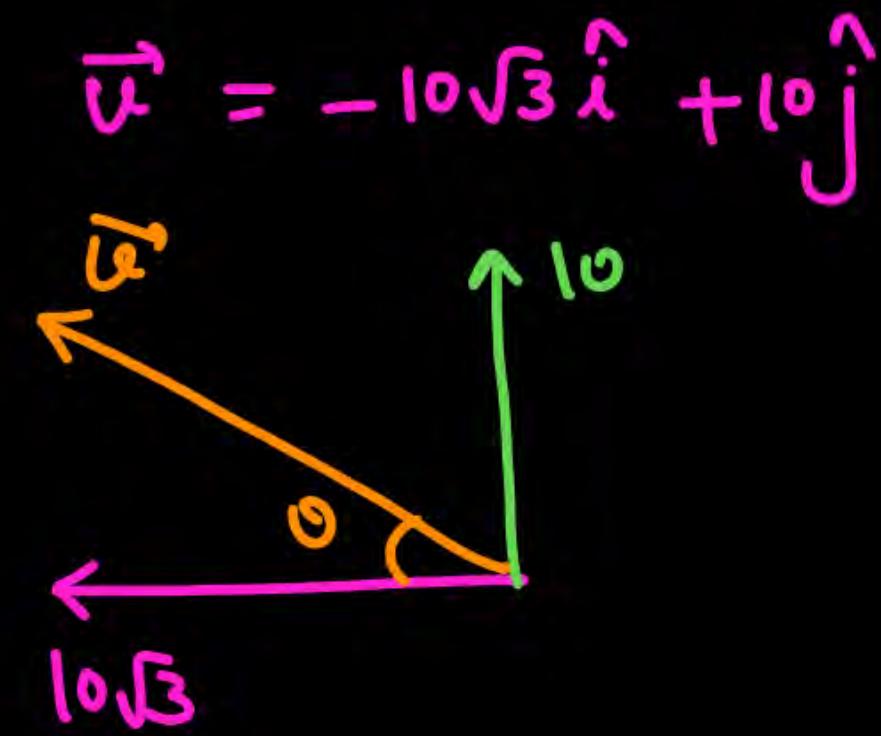
③  $\vec{A} = -10\hat{i} + 10\sqrt{3}\hat{j}$



$$\tan \theta = \frac{10\sqrt{3}}{10}$$

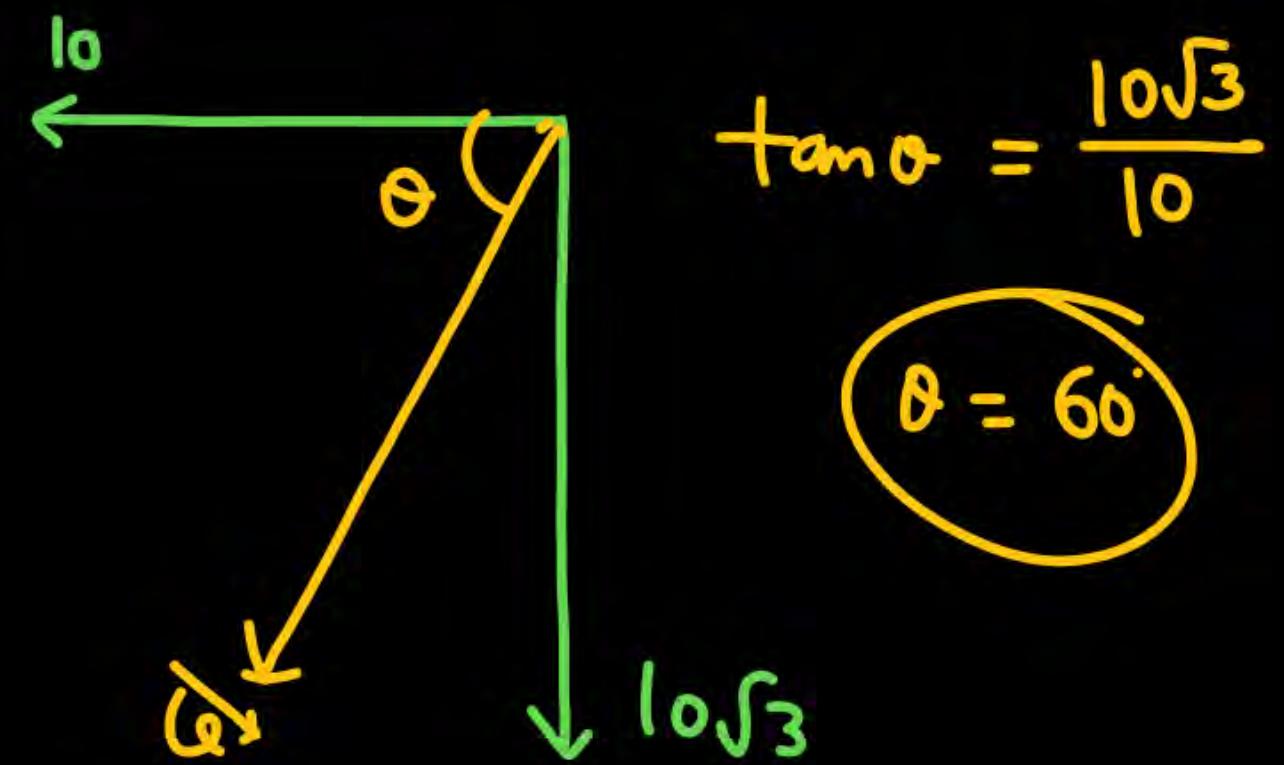
$\theta = 60^\circ$

④  $\vec{v} = 10\hat{j} - 10\sqrt{3}\hat{i}$

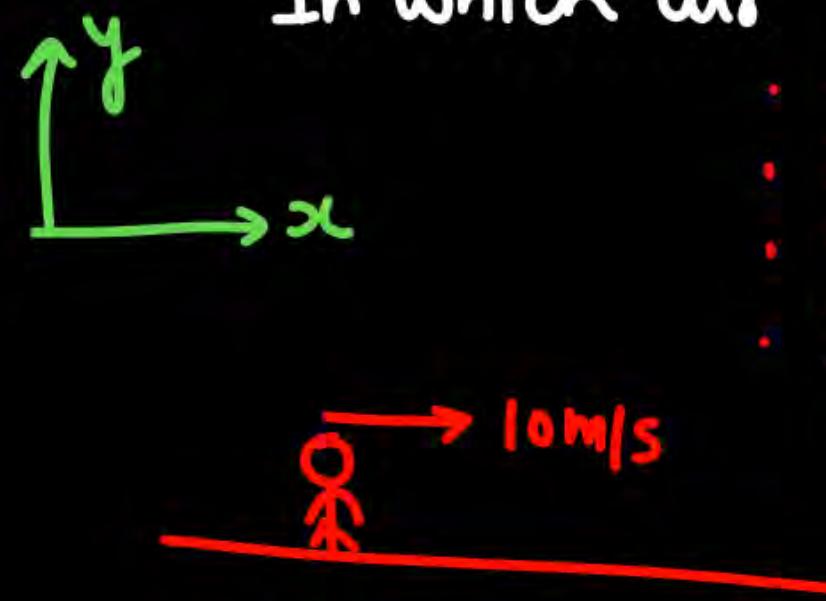


5

$$\vec{v} = -10\hat{i} - 10\sqrt{3}\hat{j}$$



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 dir<sup>n</sup> man should hold umbrella to protect himself.



$$\vec{v}_{\text{man}} = 10\hat{i}$$

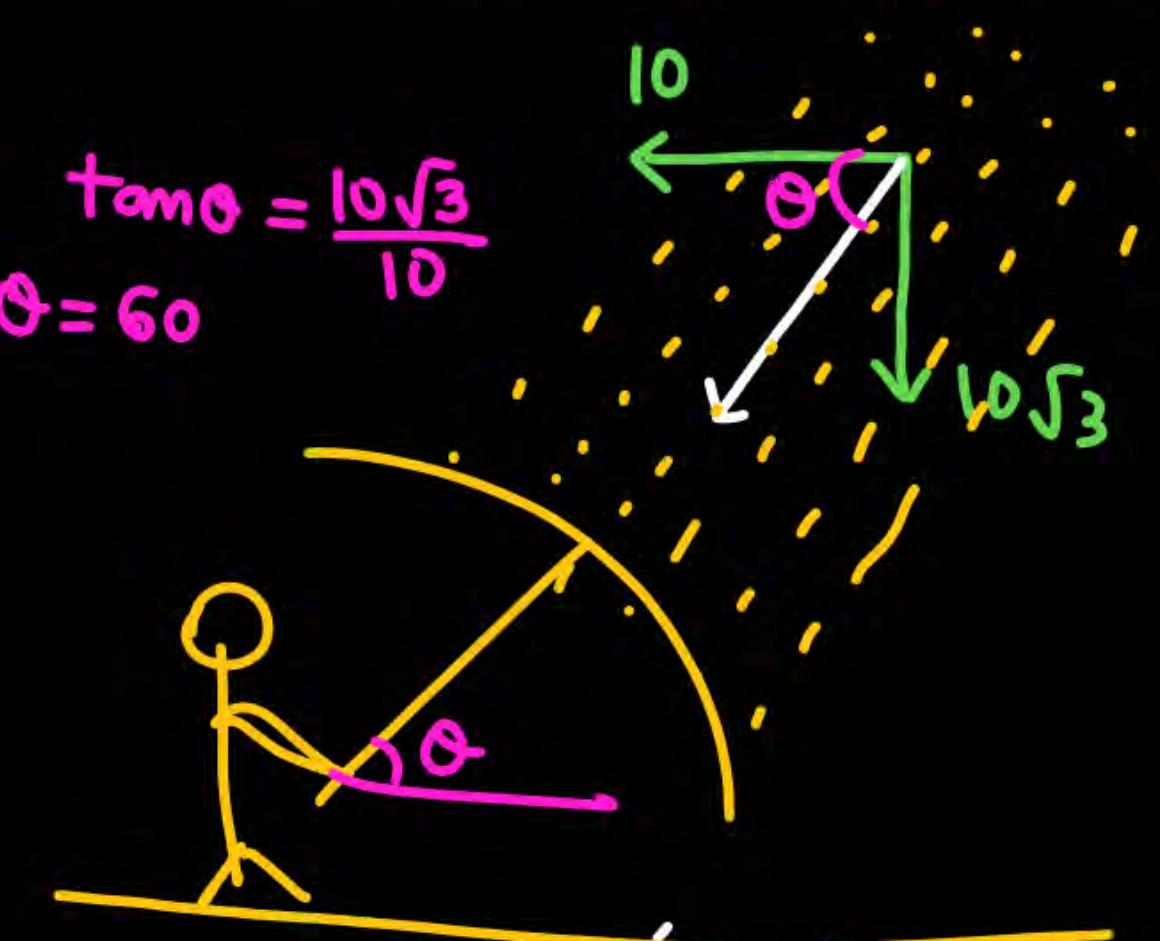
$$\vec{v}_{\text{rain}} = -10\sqrt{3}\hat{j}$$

$$\vec{v}_{\text{rain/man}} = \vec{v}_r - \vec{v}_m$$

$$\vec{v}_{r/m} = -10\sqrt{3}\hat{j} - 10\hat{i} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

$$\tan \theta = \frac{10\sqrt{3}}{10}$$

$$\theta = 60$$



Draw  $\vec{v}_r$

Q A man is moving in east dir<sup>n</sup> with speed 10m/s in a car.

A bird is flying with speed  $10\sqrt{3}$  in south dir<sup>n</sup>.

① find velocity of bird observed by man.

$$\vec{v}_{\text{man}} = 10\hat{i}$$

$$\vec{v}_{\text{bird}} = -10\sqrt{3}\hat{j}$$

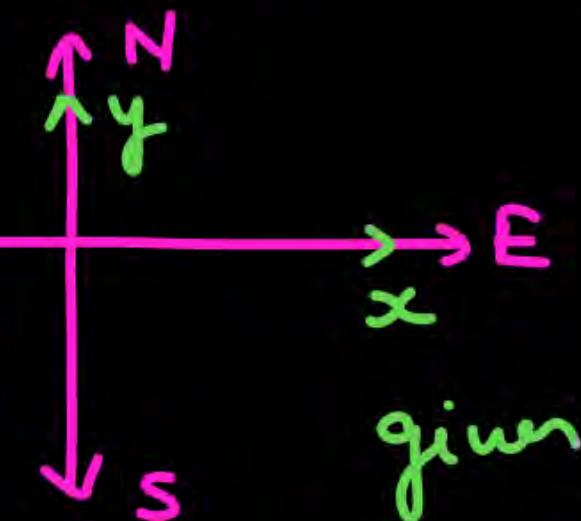
$$\vec{v}_{\text{b/m}} = \vec{v}_b - \vec{v}_{\text{m}}$$

$$= -10\sqrt{3}\hat{j} - 10\hat{i}$$

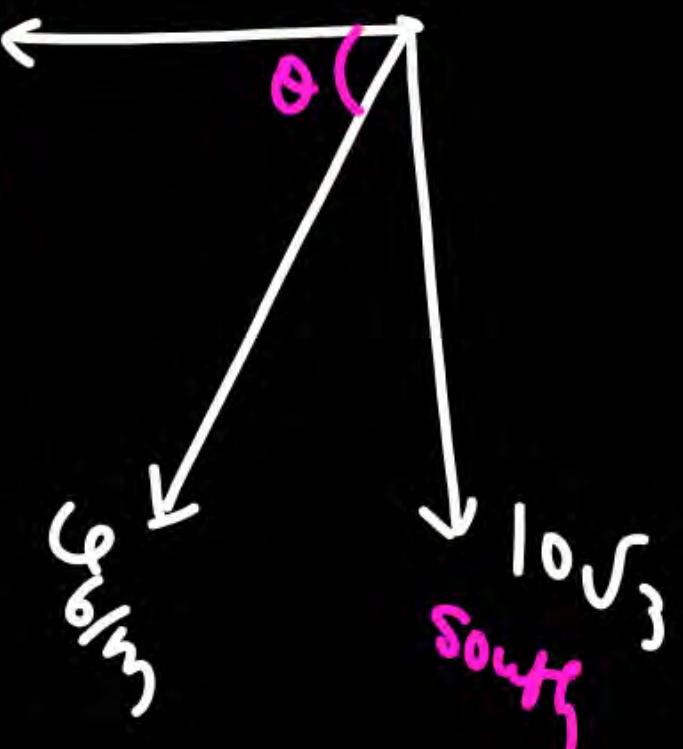
$$\vec{v}_{\text{b/m}} = -10\hat{i} - 10\sqrt{3}\hat{j}$$

$$|\vec{v}_{\text{b/m}}| = \sqrt{10^2 + (10\sqrt{3})^2}$$

$$= 20 \quad (60^\circ \text{ south of west})$$

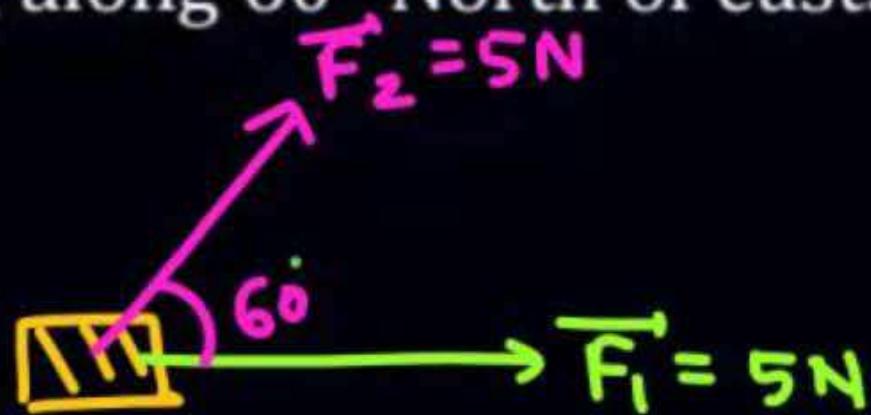


given



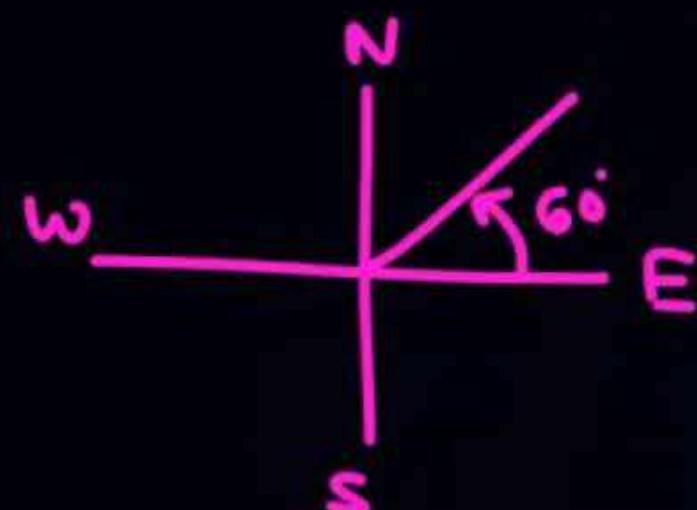
## Question

A block is applied two forces of magnitude 5 N each. One force is acting towards east and the other acting along  $60^\circ$  North of east. The resultant of the two forces (in N) is of magnitude :



Ans

$$5\sqrt{3}$$



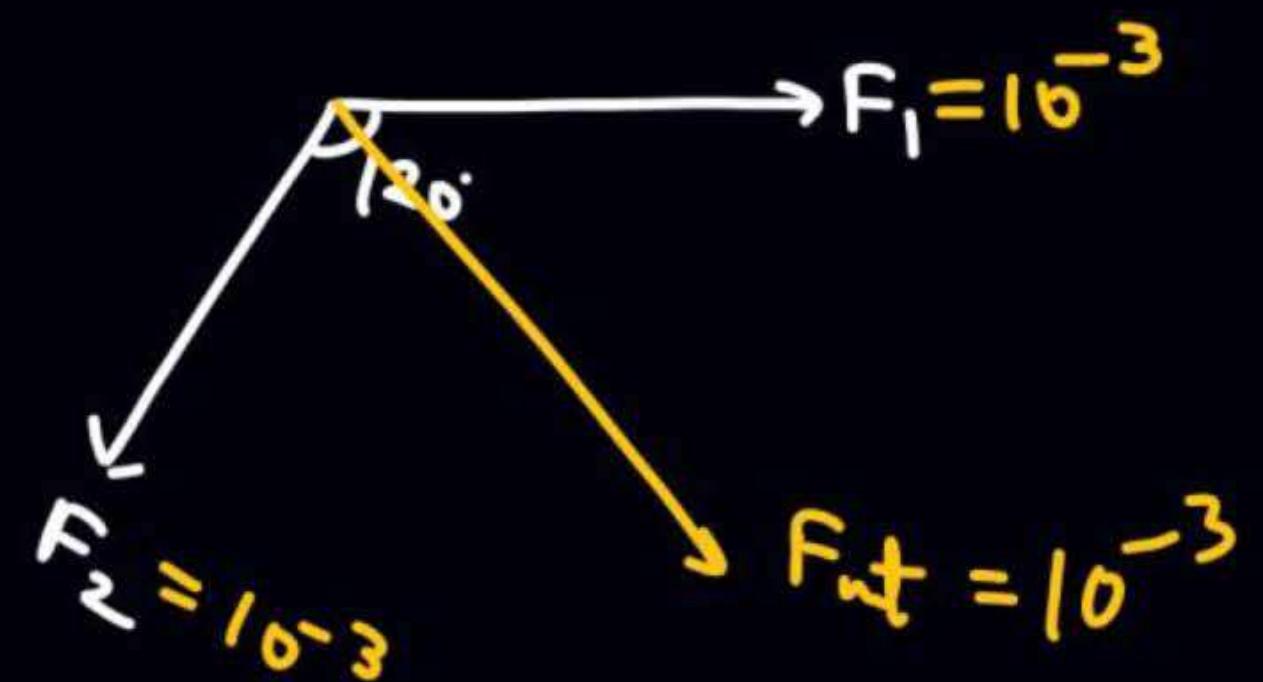
Ans :  $\sqrt{75}$

## 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 :-

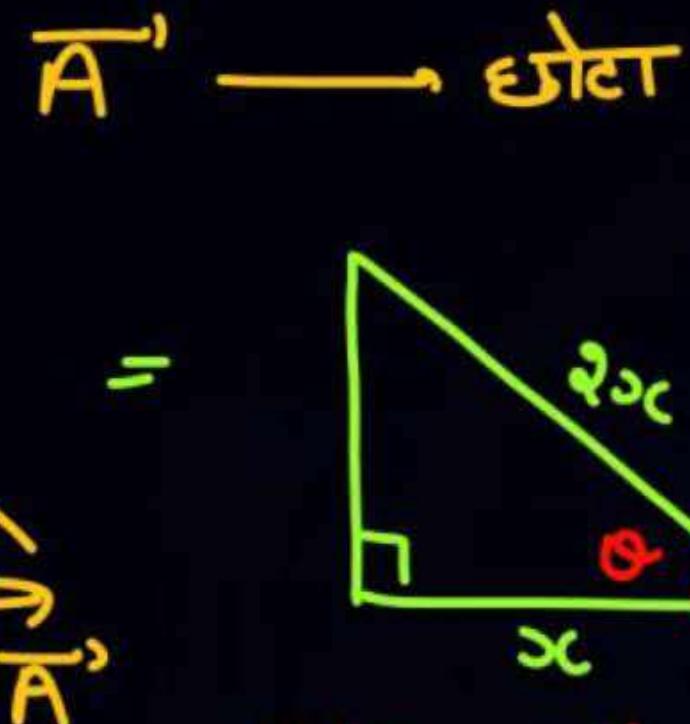
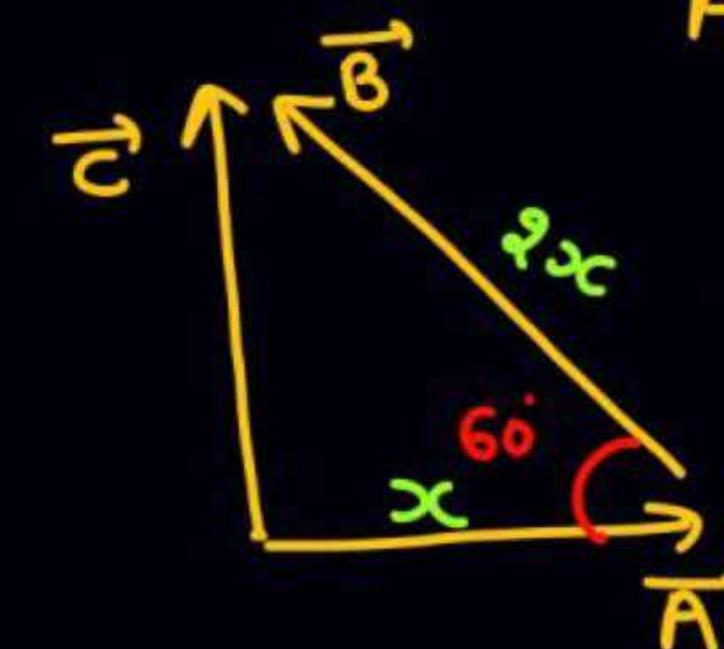
A  $150^\circ$

B  $90^\circ$

C  $60^\circ$

D  $120^\circ$

$$\vec{A} + \vec{B} = \vec{C}$$



$$\cos \theta = \frac{x}{\sqrt{5}x} = \frac{1}{\sqrt{5}}$$

$$\theta = 60^\circ$$

Ans : (D)

Question

P  
W

If the resultant of two forces of magnitudes P and Q acting at a point at an angle of  $60^\circ$  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  $-3$

$$\sqrt{7}Q = \sqrt{P^2 + Q^2 + 2PQ \cos 60^\circ}$$

$$7Q^2 = P^2 + Q^2 + PQ$$

$$P^2 - 6Q^2 + PQ = 0$$

$$\frac{P^2}{Q^2} - 6 + \frac{P}{Q} = 0$$

$$x^2 - 6 + x = 0$$

$$x^2 + x - 6 = 0$$

$$(x+3)(x-2) = 0$$

$x = -3$

$x = 2$

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  $60^\circ$ , 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  $\theta$  (in degree) that the resultant of  $2\vec{P}$  and  $\vec{Q}$  will make with  $\vec{Q}$  is,

$$\vec{P} + \vec{Q} = \vec{R}$$

$$R = P = x$$

$$R = \sqrt{P^2 + Q^2 + 2PQ \cos \theta}$$

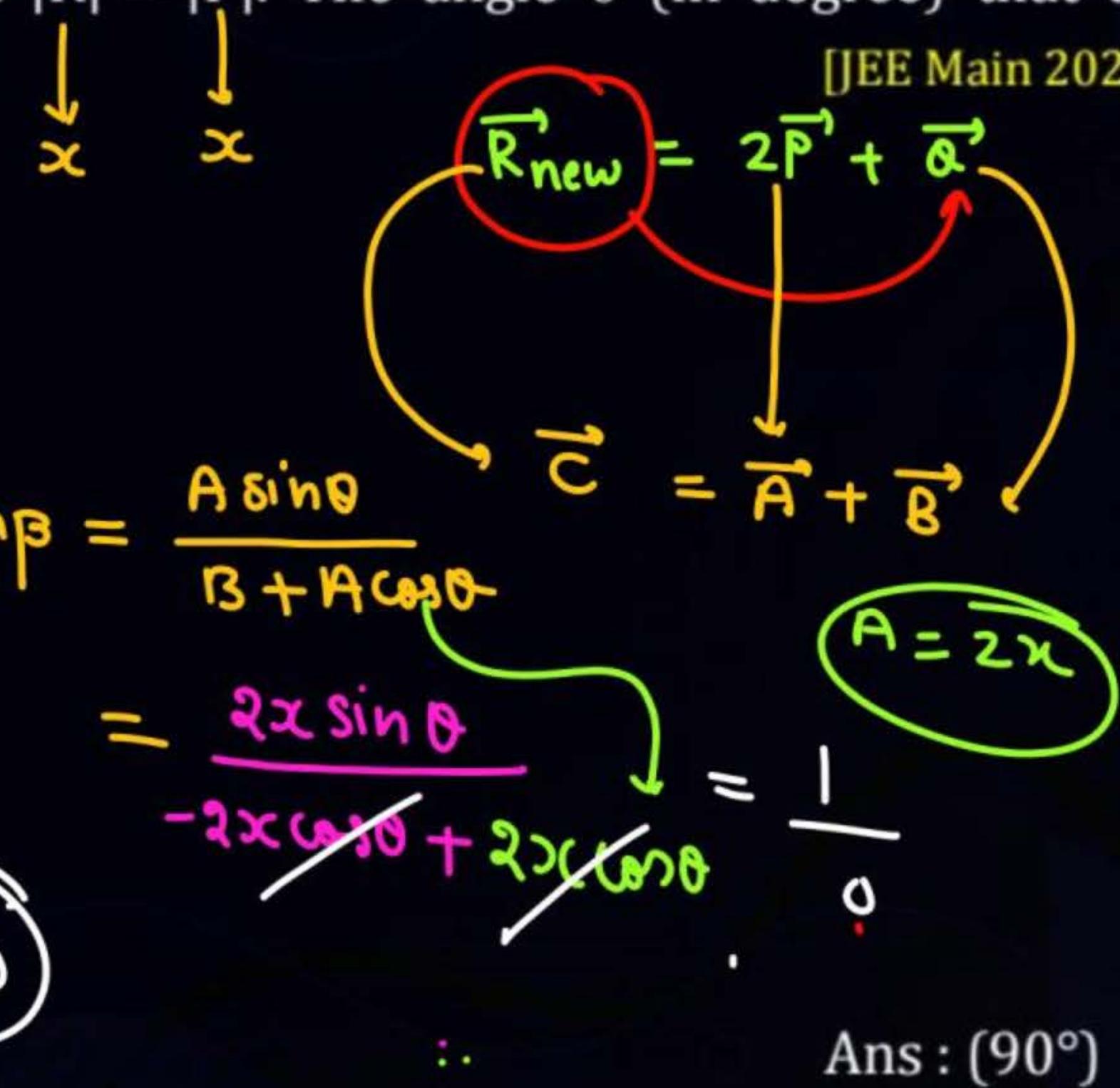
$$x = \sqrt{x^2 + Q^2 + 2xQ \cos \theta}$$

$$x^2 = x^2 + Q^2 + 2xQ \cos \theta$$

$$\theta + 2x \cos \theta = 0$$

$$\theta = -2x \cos \theta$$

$$\beta = 90^\circ$$



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)

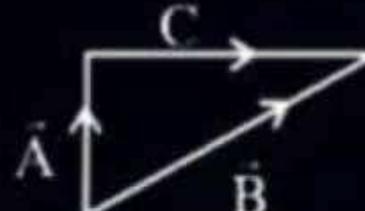
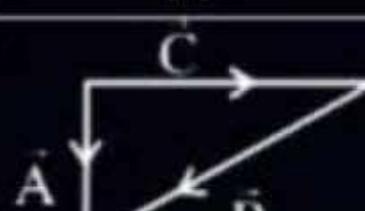
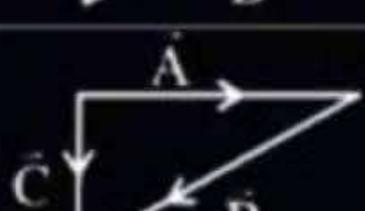
D

(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  $10 \text{ m/s}$  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 dir<sup>n</sup> she should hold his umbrella to protect himself  
from rain



$$v_r = \frac{5}{\sqrt{3}}$$

$$\vec{v}_{r/girl} = \vec{v}_r - \vec{v}_{girl} = -\frac{5}{\sqrt{3}}\hat{j} - 5\hat{i}$$



$$\tan \theta = \frac{5/\sqrt{3}}{5}$$

$$\theta = 30^\circ$$

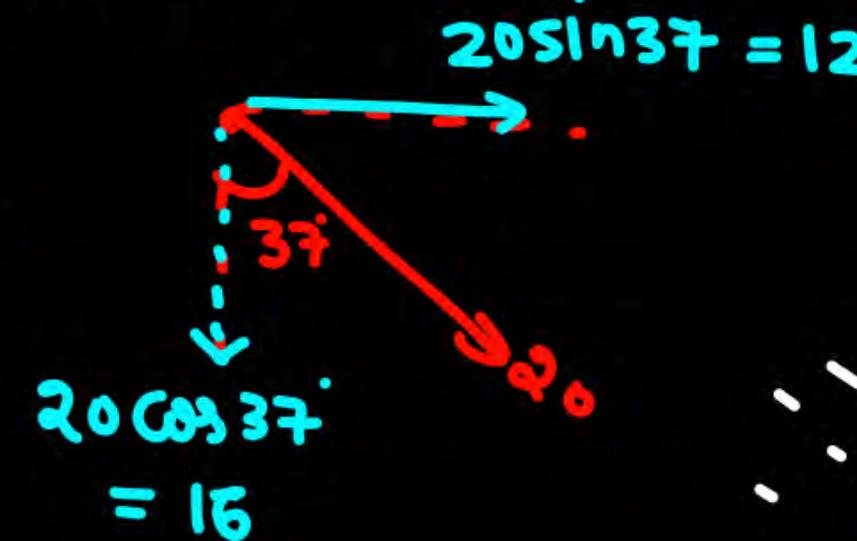
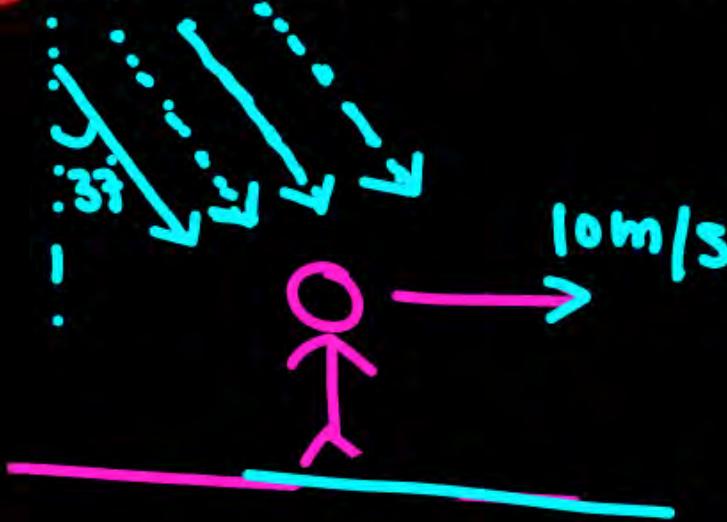


## Rain Man Problem



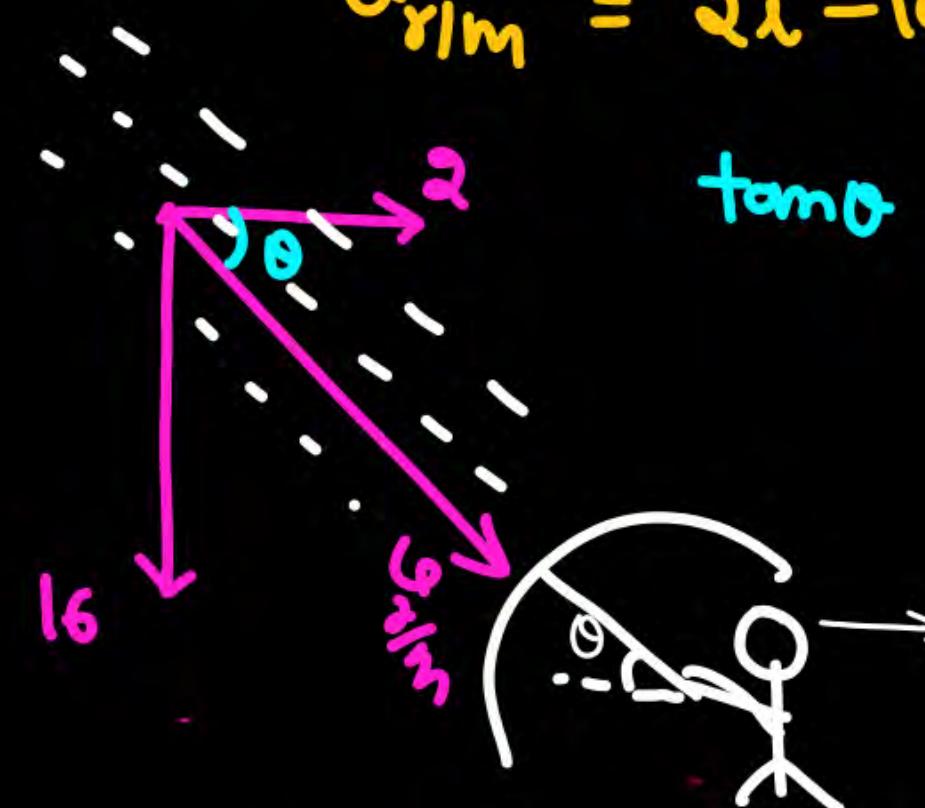
Q A man is moving horizontal with velocity 10 m/s along east. Rain is falling with speed 20 m/s at angle  $37^\circ$  with vertical as shown in diagram.

(a) In which dir<sup>n</sup> man should hold Umbrella - - - - -

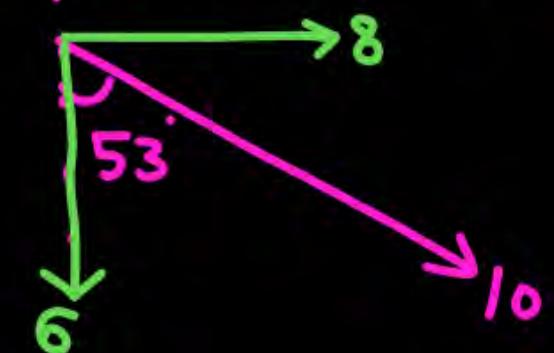
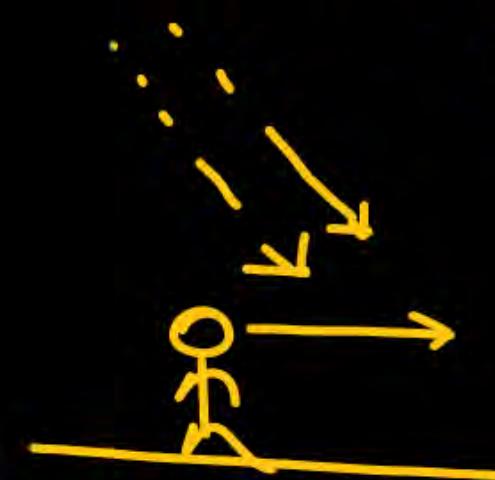


$$\begin{aligned}\vec{v}_m &= 10\hat{i} \\ \vec{v}_r &= 12\hat{i} - 16\hat{j} \\ \vec{v}_{r/m} &= 2\hat{i} - 16\hat{j}\end{aligned}$$

$$\tan \theta = \frac{16}{2} \Rightarrow (\theta = \tan^{-1} 8)$$



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 dir<sup>n</sup> man should hold umbrella to protect him self.



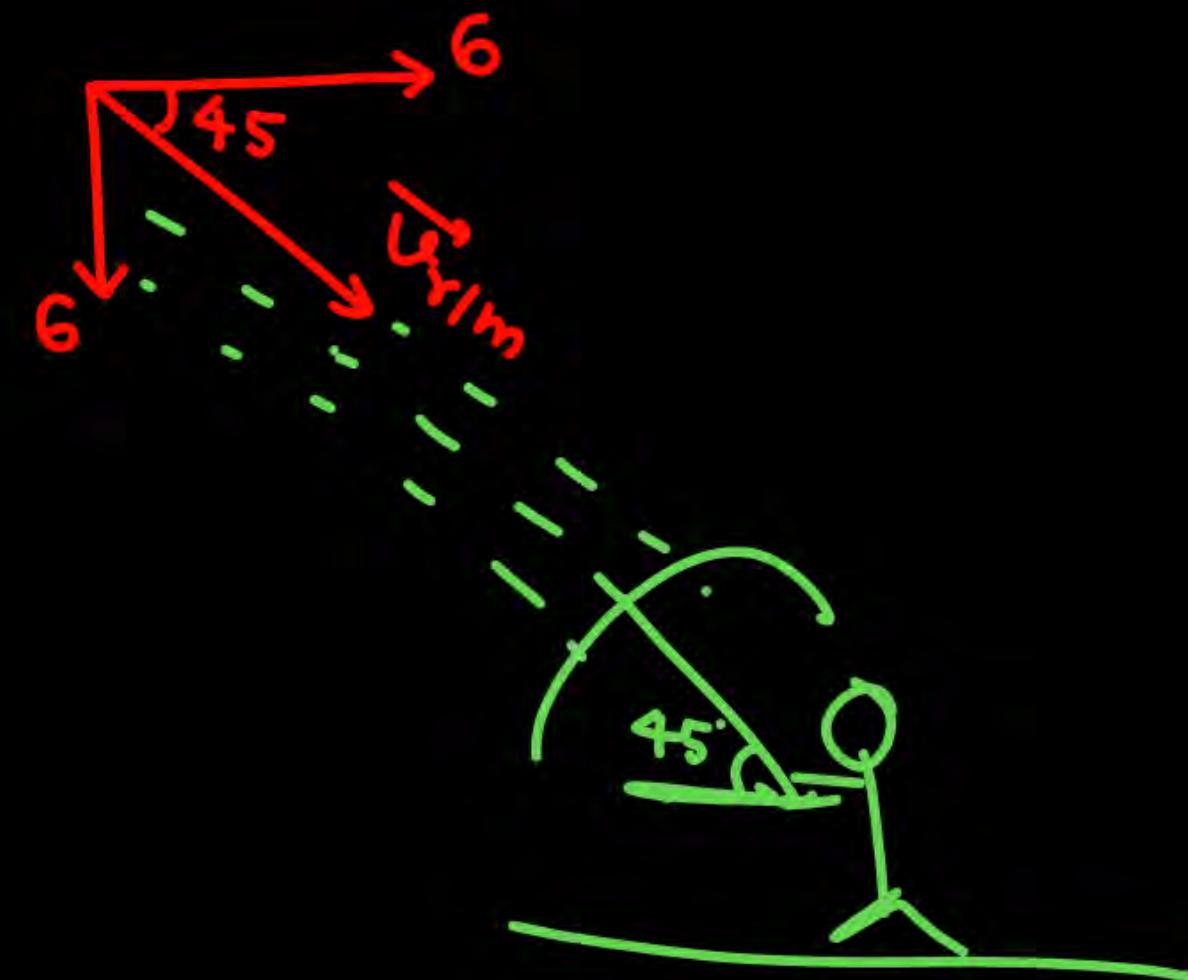
$$\vec{v}_r = 8\hat{i} - 6\hat{j}$$

$$\vec{v}_m = 2\hat{i}$$

$$\vec{v}_{r/m} = 6\hat{i} - 6\hat{j}$$

(b) what should be velocity of man so that  
 rain appear falling vertically to him

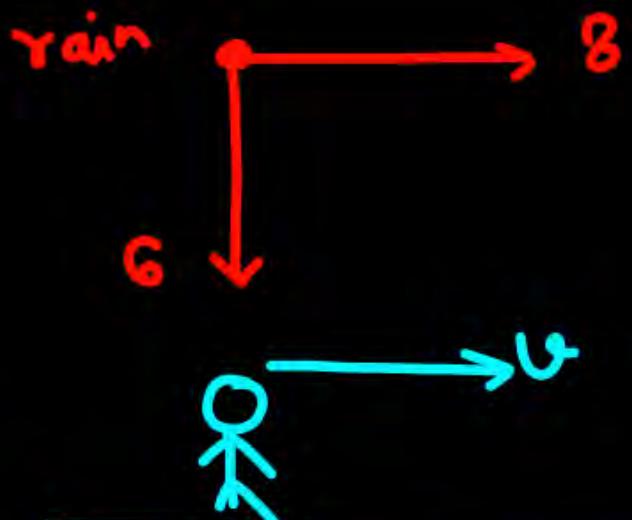
Ans 8



$$U_y \sin 53^\circ = 8$$

$$U_y \cos 53^\circ = 6$$

$$U_y = 10$$



U = 8 Ans

m-2

$\vec{v}_{im} = (8\hat{i} - 6\hat{j}) - U\hat{i}$

$= (8-U)\hat{i} - 6\hat{j}$

$8-U = 0$

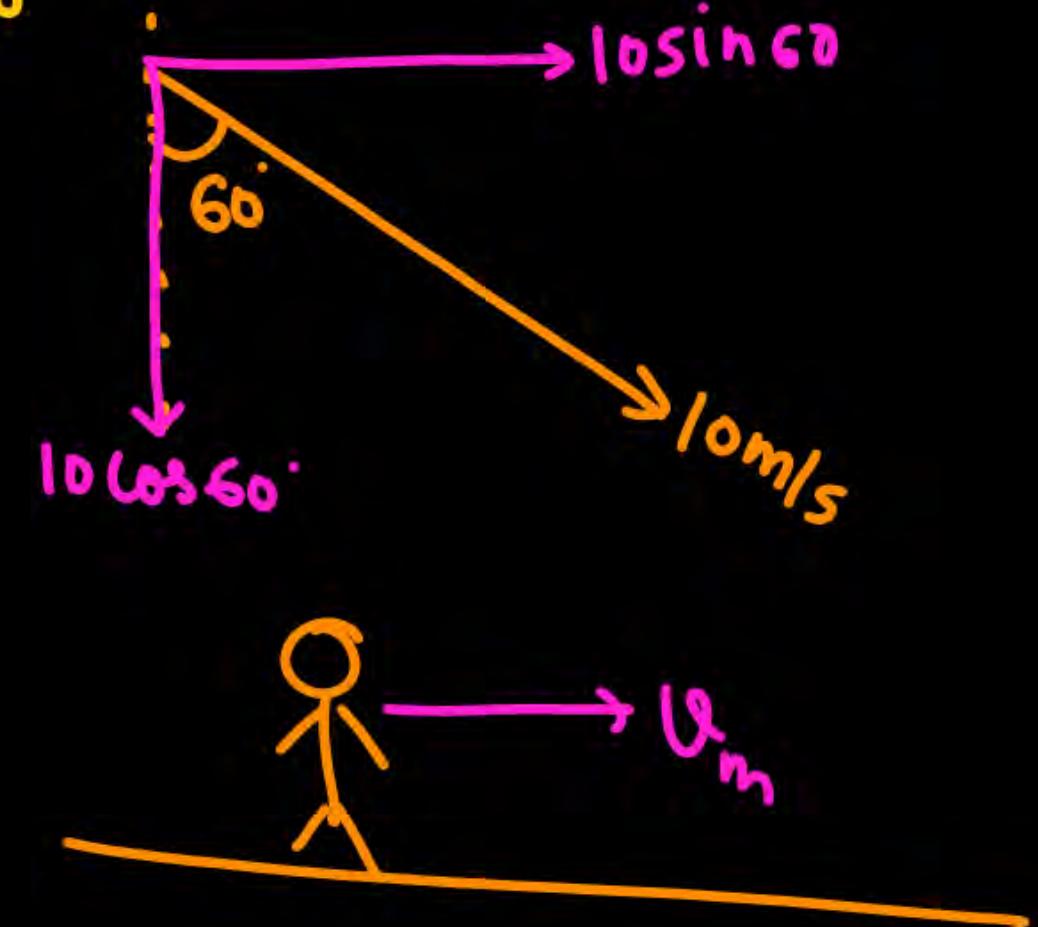
U = 8

only  $\hat{i}, \hat{j}$  are  $\vec{v}_{im}$

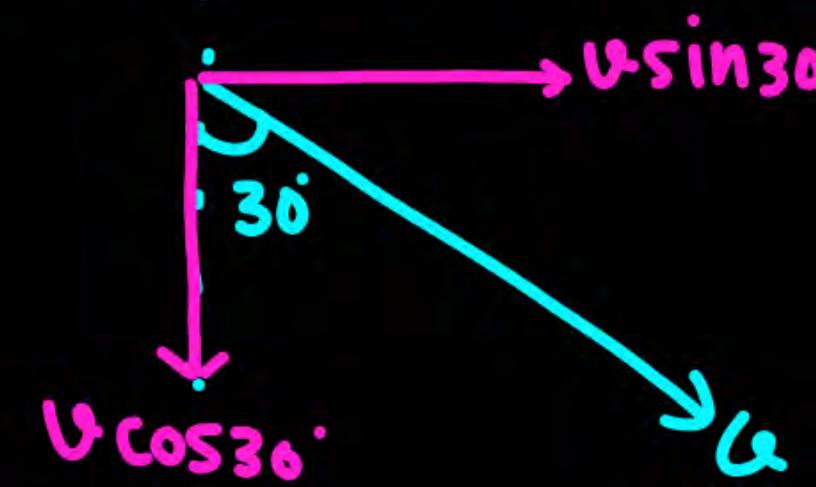
**Q** rain is falling with speed  $10\text{ m/s}$  at angle  $60^\circ$  with vertical what should be velocity of man so that rain falls vertically on his head.

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  $30^\circ$  with the vertical. As he starts moving with speed of  $5 \text{ m/s}$  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  $30^\circ$  with the vertical. As he starts moving with a speed of  $0.5 \text{ m/s}$  he finds that the rain is falling vertically. Then the speed of rain w.r.t. the moving man is:

- A  $0.5 \text{ m/s}$
- B  $1 \text{ m/s}$
- C  $0.5\sqrt{3} \text{ m/s}$
- D  $\sqrt{3} \text{ m/s}$

Ans. (C)

notes

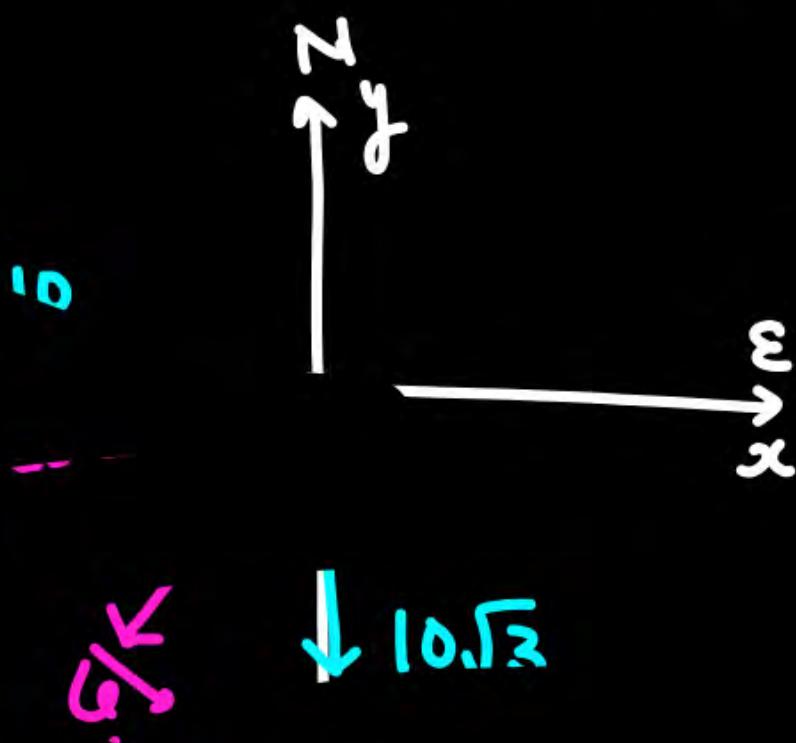
Q

A man holding flag is running with speed 10 m/s along east  
 Wind is flowing with speed  $10\sqrt{3}$  along south.  
 In which dir flag will flutter



- N.Y

$$\overrightarrow{V}_{man} = 10\hat{i}$$



$$V_{wind}/main =$$

$$\vec{v}_{\text{man}} = 10 \hat{i}$$

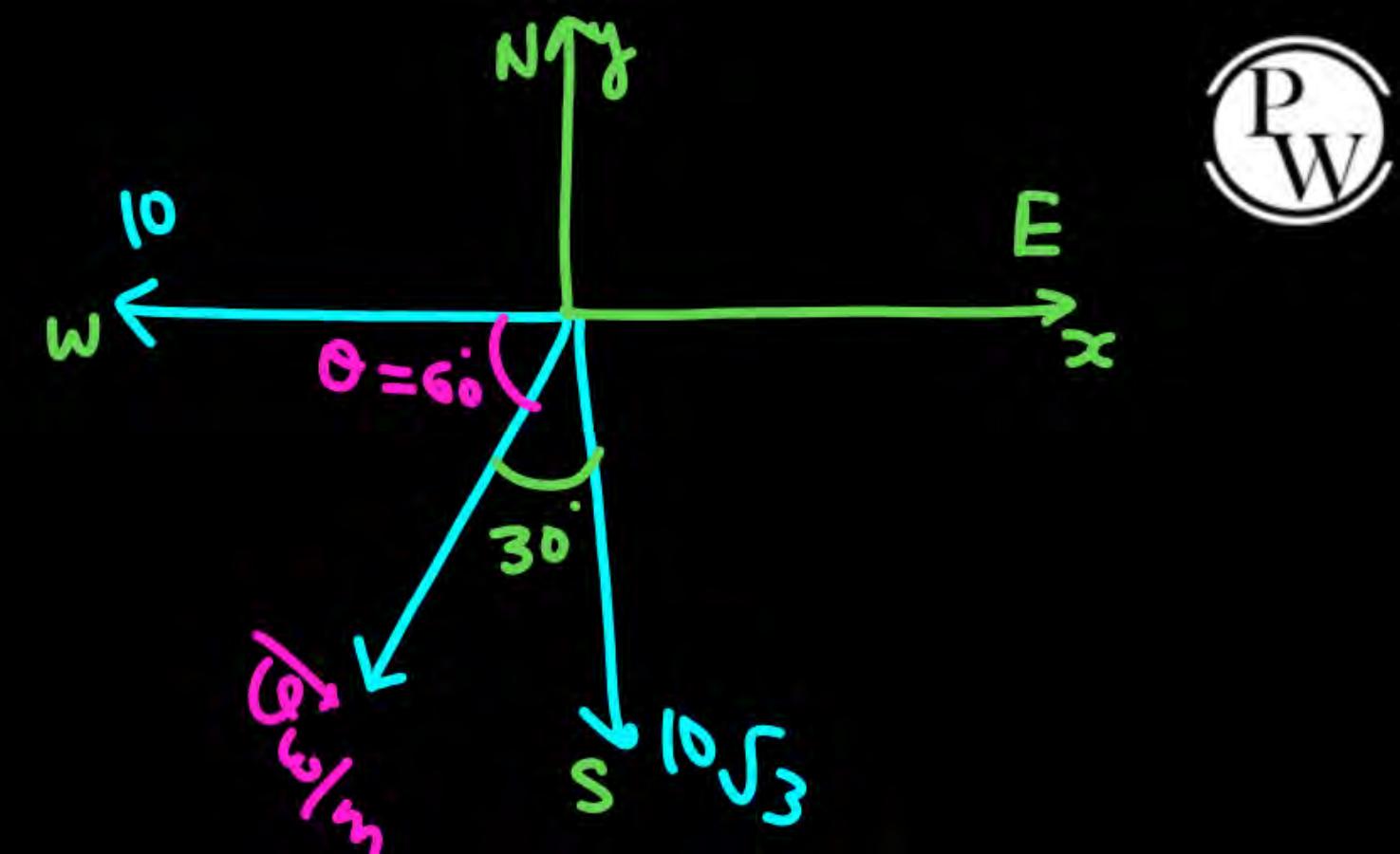
$$\vec{v}_{\text{wind}} = -10\sqrt{3} \hat{j}$$

$$\vec{v}_{\text{wind/man}} = -10\sqrt{3} \hat{j} - 10 \hat{i}$$

Ans  $\Rightarrow$  60° south of west

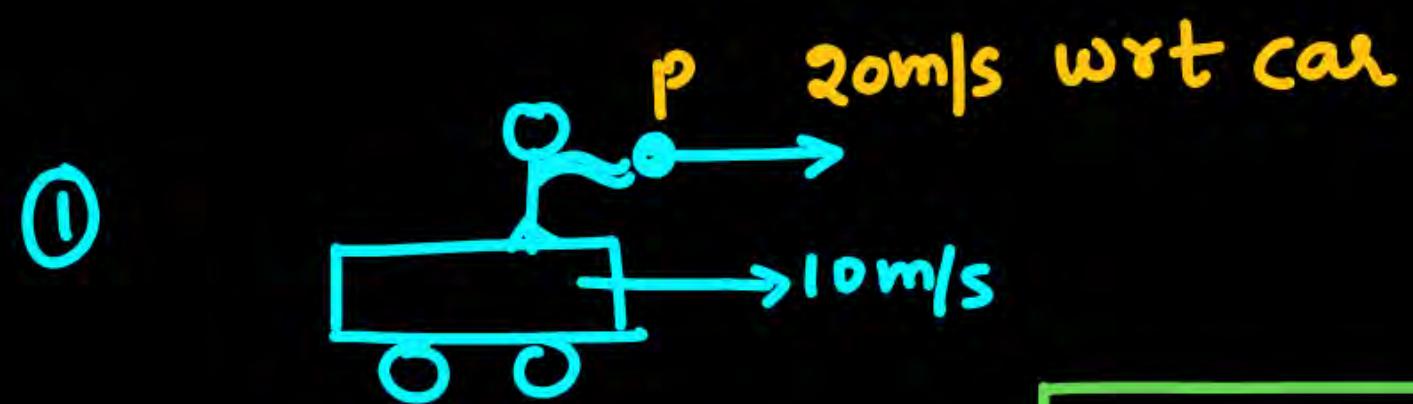
30° west of south

~~South West~~



P  
W

P  
W

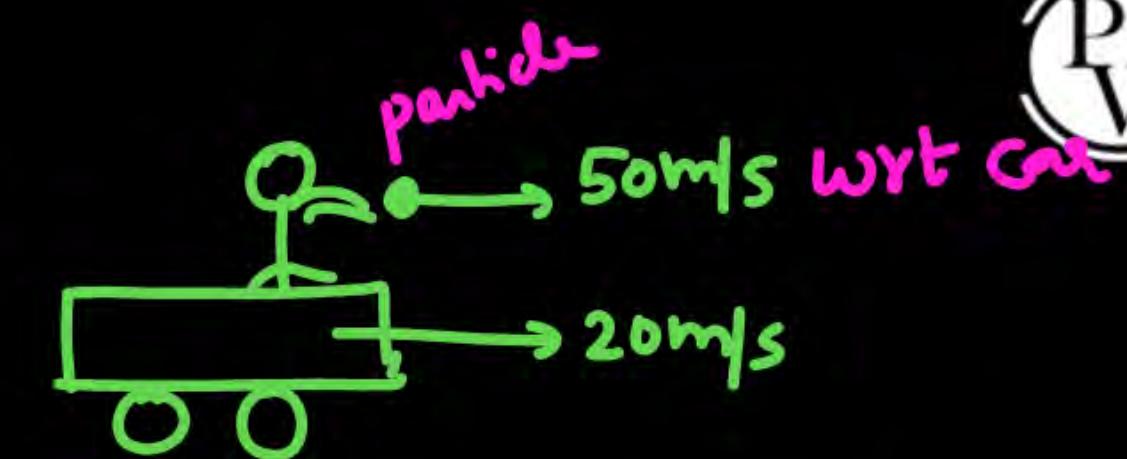


$$\vec{v}_{P/c} = \vec{v}_P - \vec{v}_c$$

$$20\hat{i} = \vec{v}_P - 10\hat{i}$$

$$\vec{v}_P = 30\hat{i} \Rightarrow (\text{wrt ground})$$

$$\boxed{\vec{v}_P = \vec{v}_{P/c} + \vec{v}_c}$$

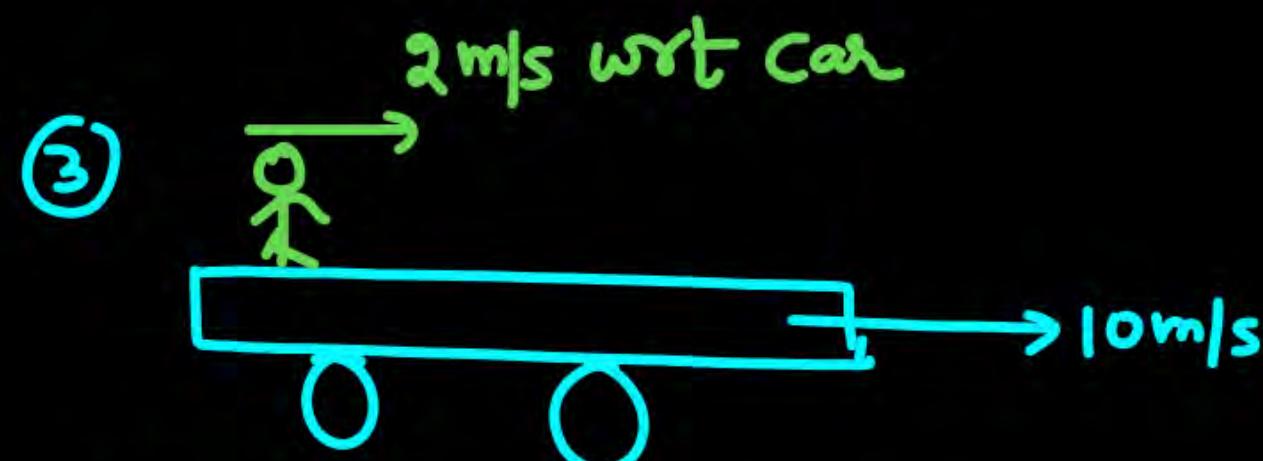


$$\vec{v}_P = (20 + 50) = 70\hat{i}$$

$$\vec{v}_{P/c} = \vec{v}_P - \vec{v}_c$$

$$50\hat{i} = \vec{v}_P - 20\hat{i}$$

$$\boxed{\vec{v}_P = 70\hat{i}}$$



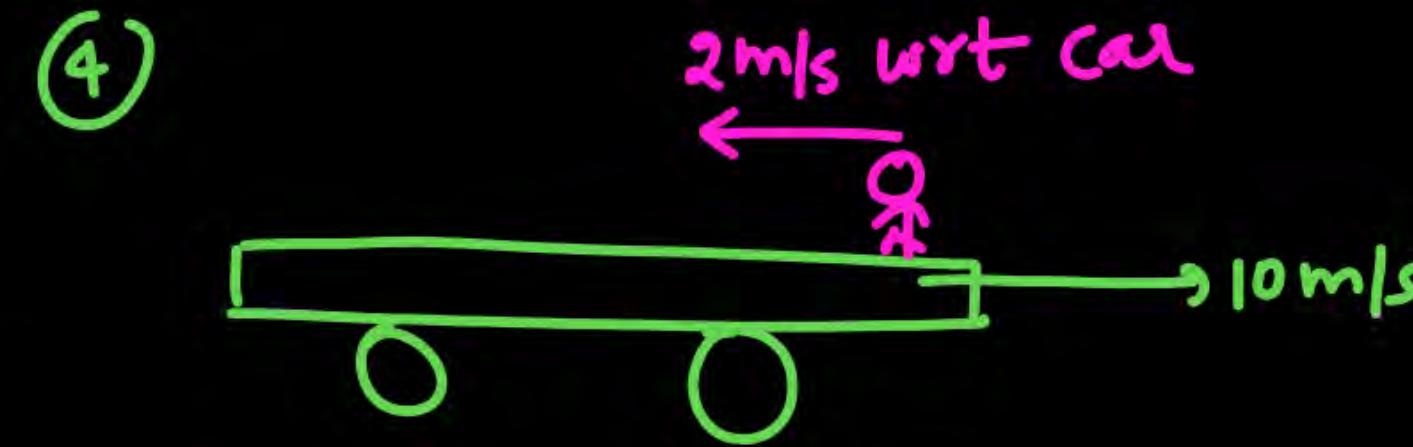
$$\vec{v}_{m/ground} = ? = 10 + 2 = 12 \hat{i}$$

$$\vec{v}_{m/c} = 2 \hat{i}$$

$$\vec{v}_m - \vec{v}_c = 2 \hat{i}$$

$$\vec{v}_m - 10 \hat{i} = 2 \hat{i}$$

$$\vec{v}_m = 12 \hat{i}$$



$$\vec{v}_{m/ground} = 8 \hat{i}$$

$$\vec{v}_{m/c} = -2 \hat{i}$$

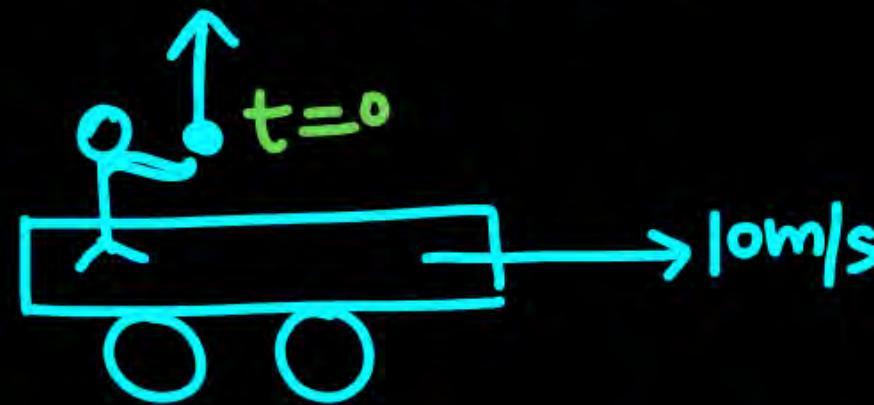
$$\vec{v}_m - \vec{v}_c = -2 \hat{i}$$

$$\vec{v}_m - 10 \hat{i} = -2 \hat{i}$$

$$\vec{v}_m = 8 \hat{i}$$

20m/s wrt car

⑤



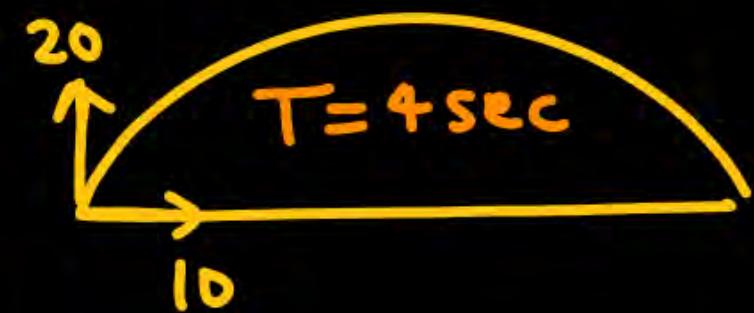
find velocity of particle  
in ground frame at  $t = 0^+$

$$\vec{v}_{p/c} = 20\hat{j}$$

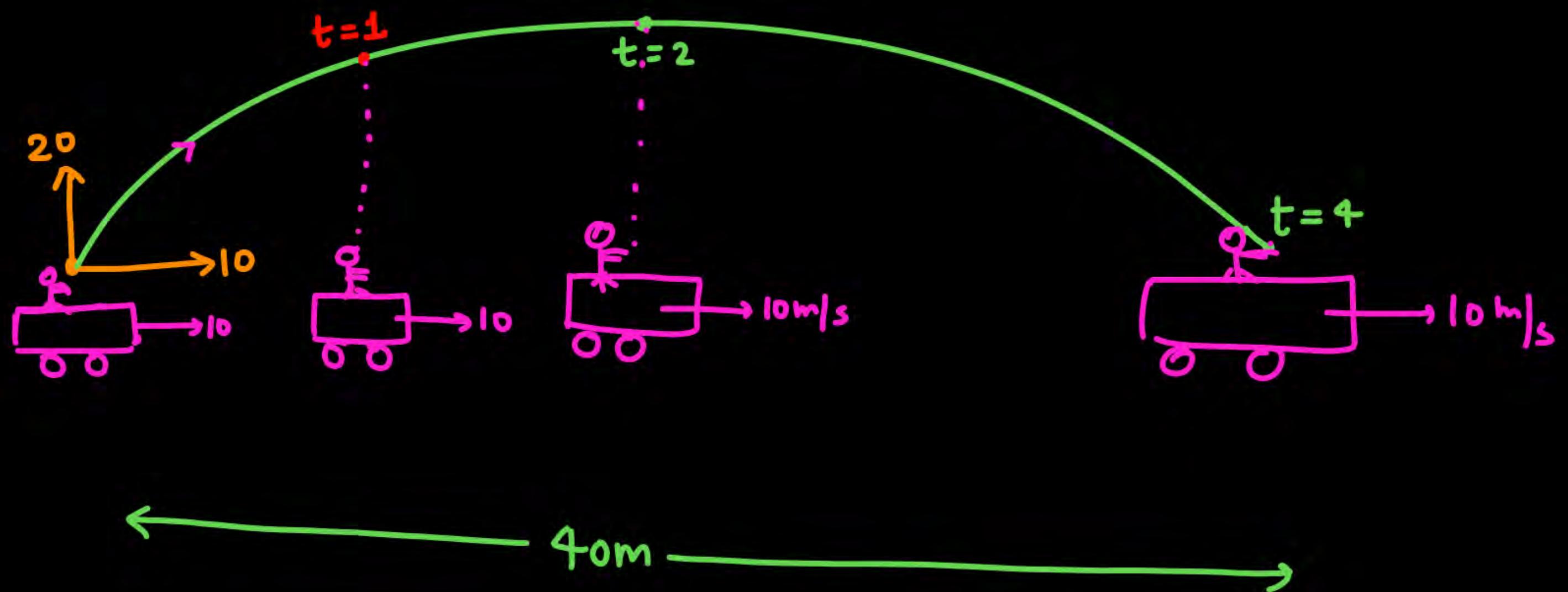
$$\vec{v}_p - \vec{v}_c = 20\hat{j}$$

$$\vec{v}_p - 10\hat{i} = 20\hat{j}$$

$$\vec{v}_p = 10\hat{i} + 20\hat{j}$$

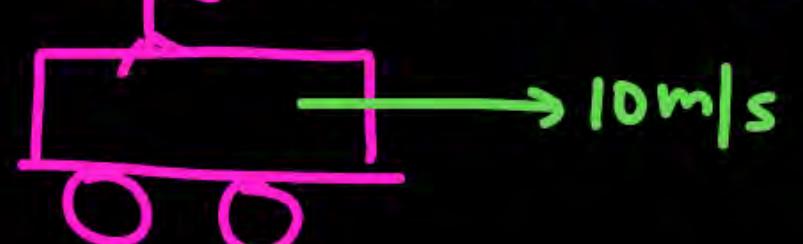


P  
W



$10\sin 37^\circ$

$37^\circ$



$10\text{m/s wrt car}$

Q

$t = 0^+$

$$\vec{v}_p = ?$$

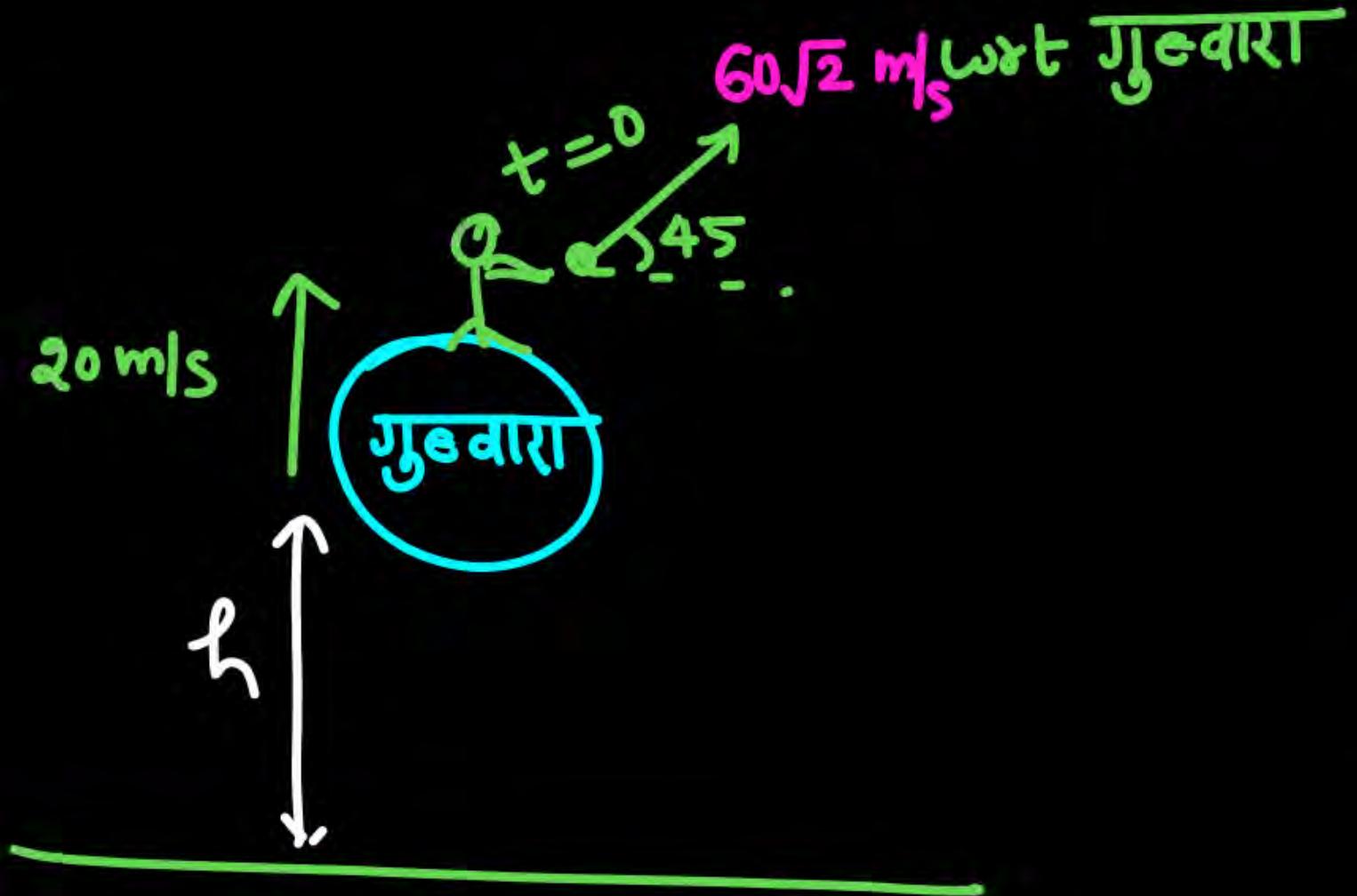
$$\vec{v}_{P/C} = 8\hat{i} + 6\hat{j} = \vec{v}_p - \vec{v}_c$$

$$\vec{v}_c = 10\hat{i}$$

$$8\hat{i} + 6\hat{j} = \vec{v}_p - 10\hat{i}$$

$$\boxed{\vec{v}_p = 18\hat{i} + 6\hat{j}}$$

Q



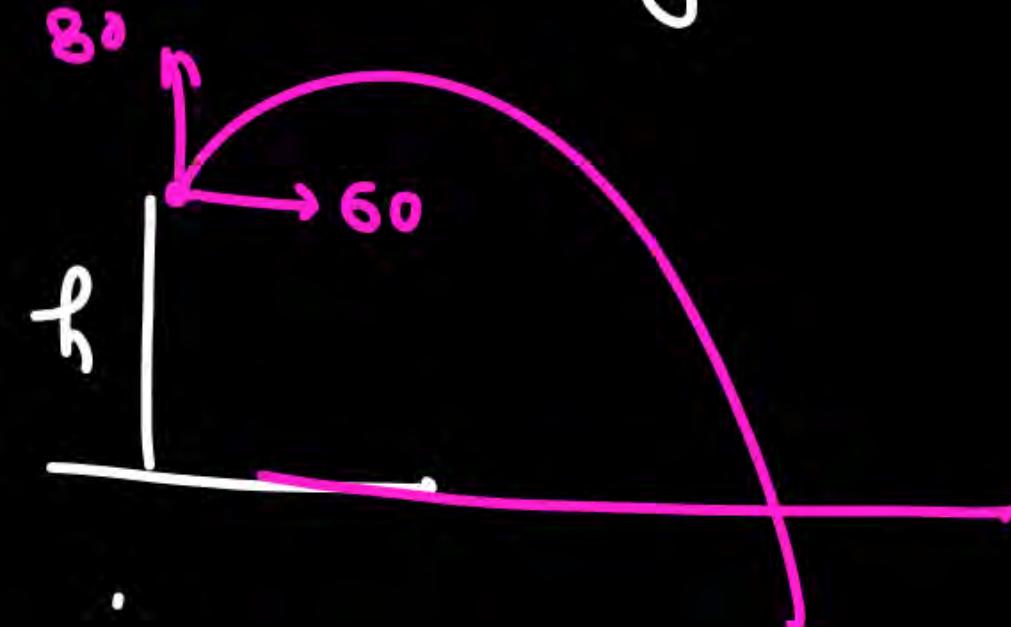
$$t=0^+ \quad \vec{v}_P = ? \quad (\text{wrt ground})$$

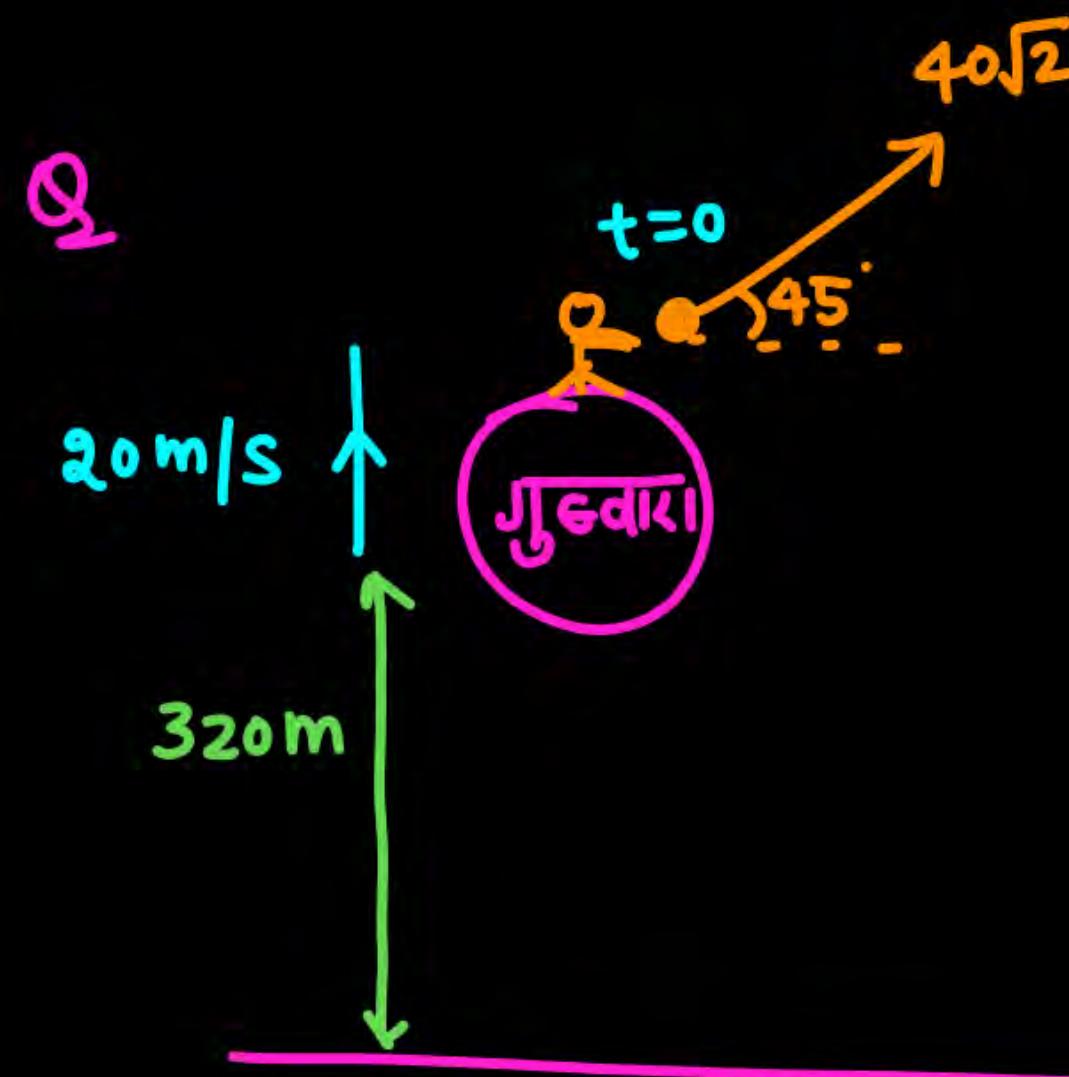
$$\vec{v}_{P/\text{जुडवारा}} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P - \vec{v}_{\text{जुडवारा}} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P - 20\hat{j} = 60\hat{i} + 60\hat{j}$$

$$\vec{v}_P = 60\hat{i} + 80\hat{j}$$





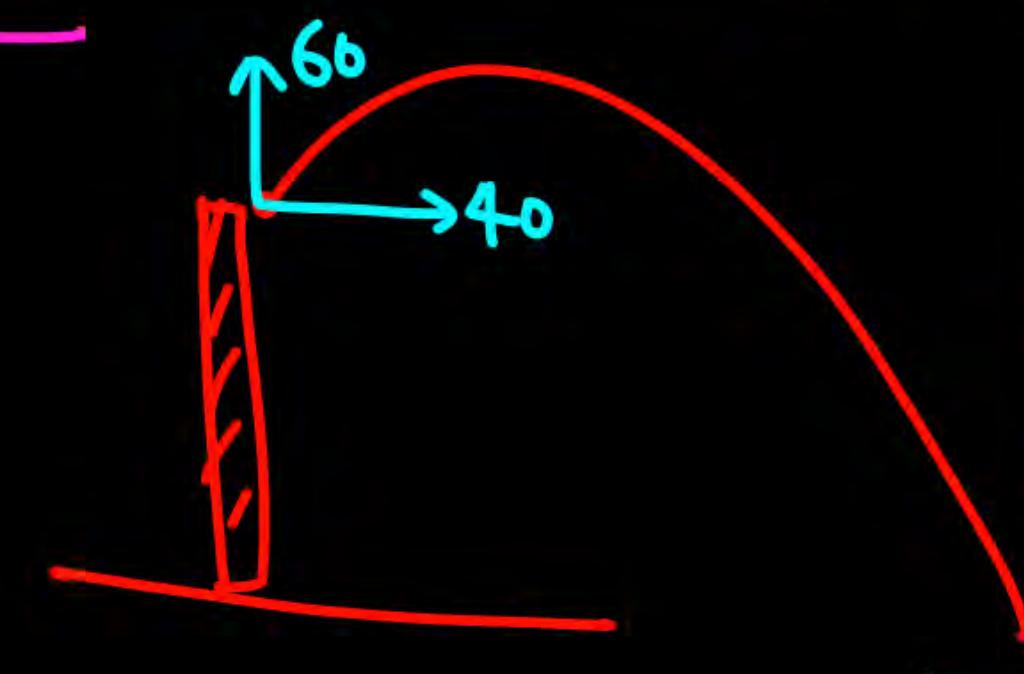
$t = 0^+$ ,  $\vec{v}_{\text{particle}} = ?$

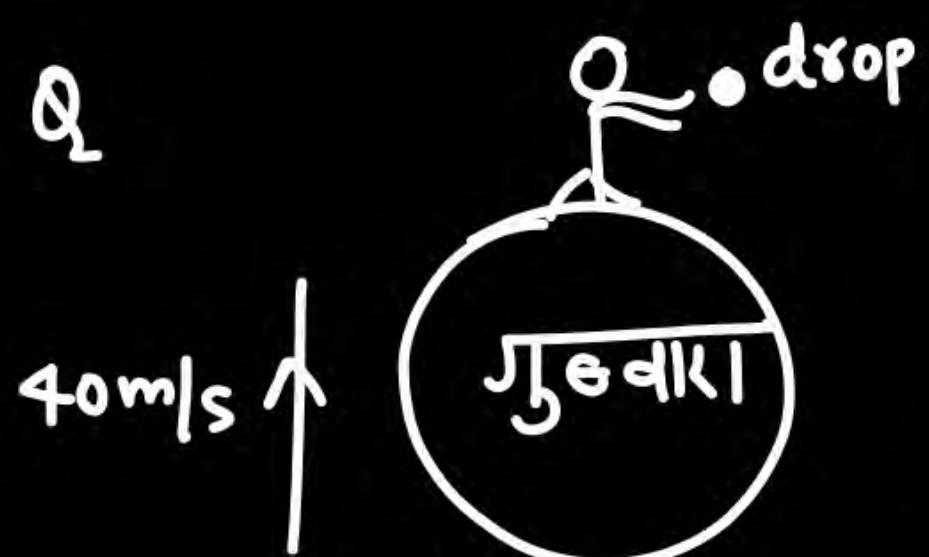
$$\vec{v}_{P/\text{ज्योति भवानी}} = 40\hat{i} + 40\hat{j}$$

$$\vec{v}_P - \vec{v}_{\text{ज्योति भवानी}} = 40\hat{i} + 40\hat{j}$$

$$\vec{v}_P - 20\hat{j} = 40\hat{i} + 40\hat{j}$$

$$\underline{\underline{\vec{v}_P = 40\hat{i} + 60\hat{j}}}.$$





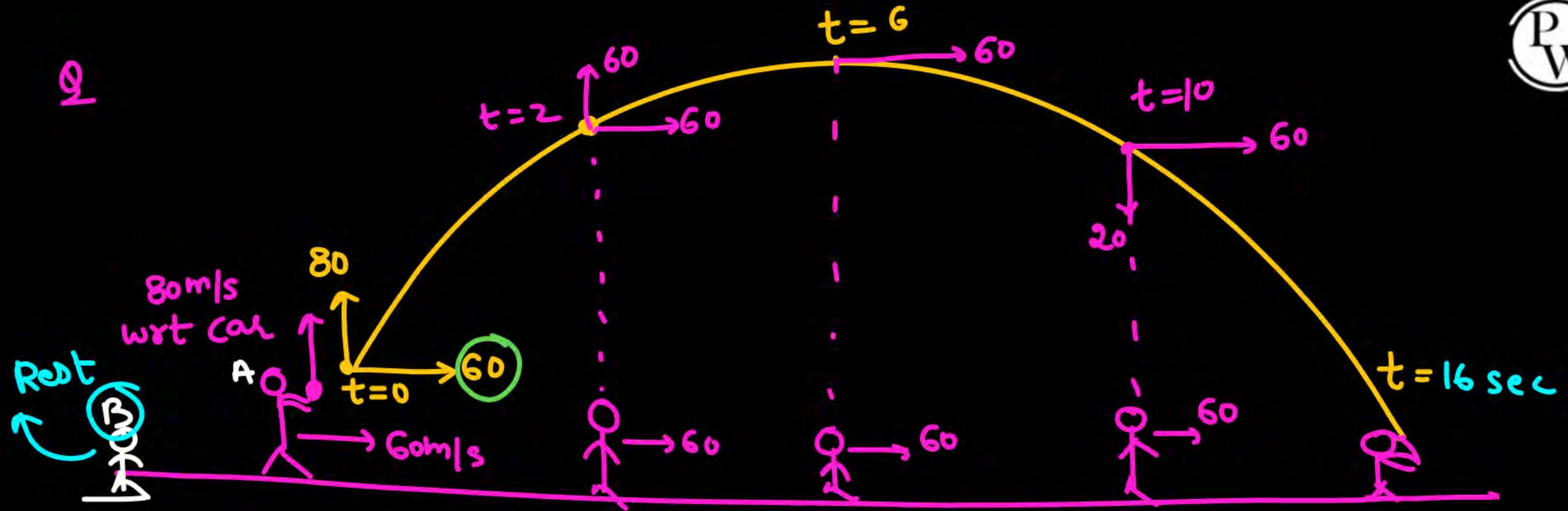
$$\vec{U}_{P/Judo} = 0 \quad (\text{drop})$$

$$\vec{U}_P - \vec{U}_{Judo} = 0$$

$$\boxed{\vec{U}_P = 40\hat{j}}$$

9

P  
W



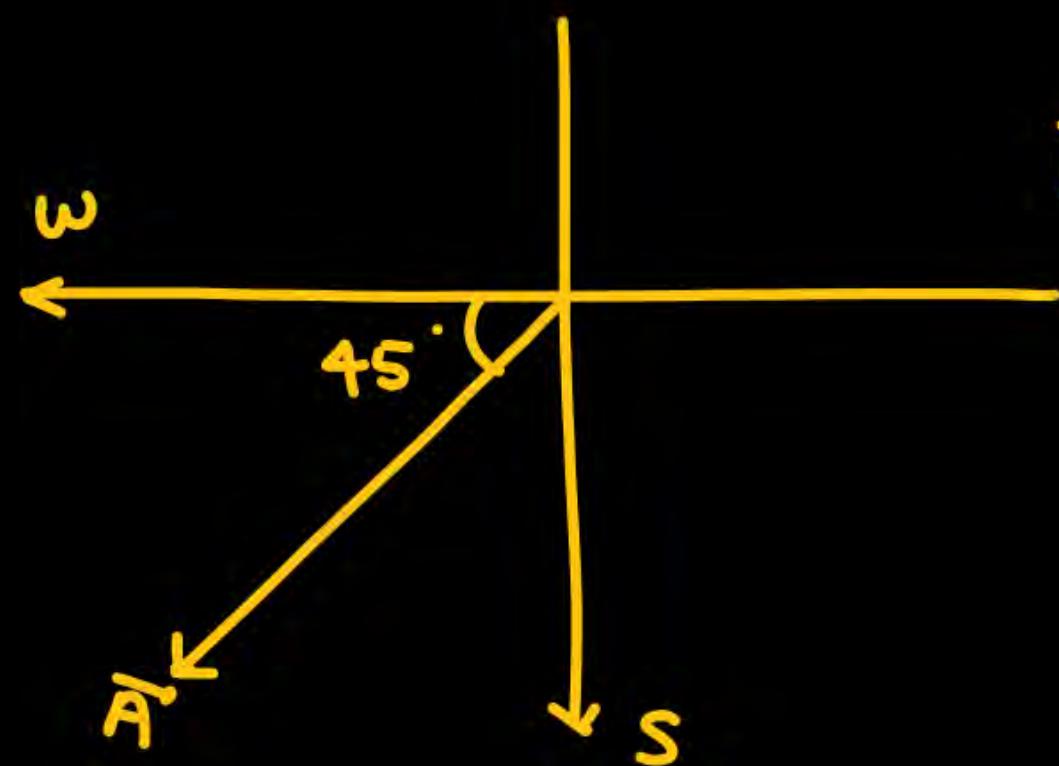
$$\vec{v}_{P/C} = +80 \hat{j}$$

$$\vec{v}_p - \vec{v}_c = 80\hat{j}$$

$$\vec{v}_p = 60\hat{i} + 80\hat{j}$$

A → st. line

B → parabola



$\vec{A}$  की dir<sup>n</sup>  $\Rightarrow$  45° west of south  
45° south of west

**South-west**

By danfallit 45° ✓

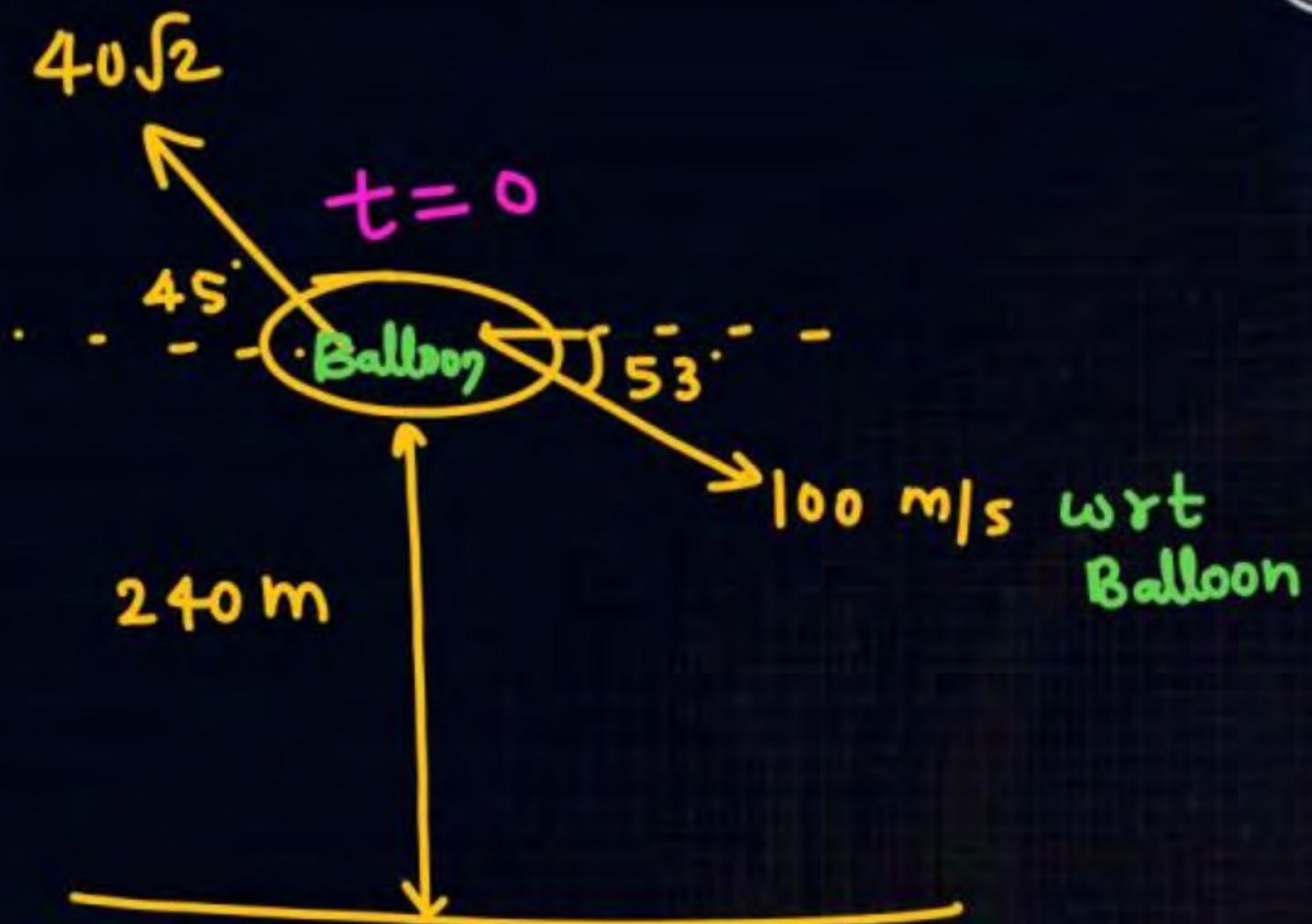
Q

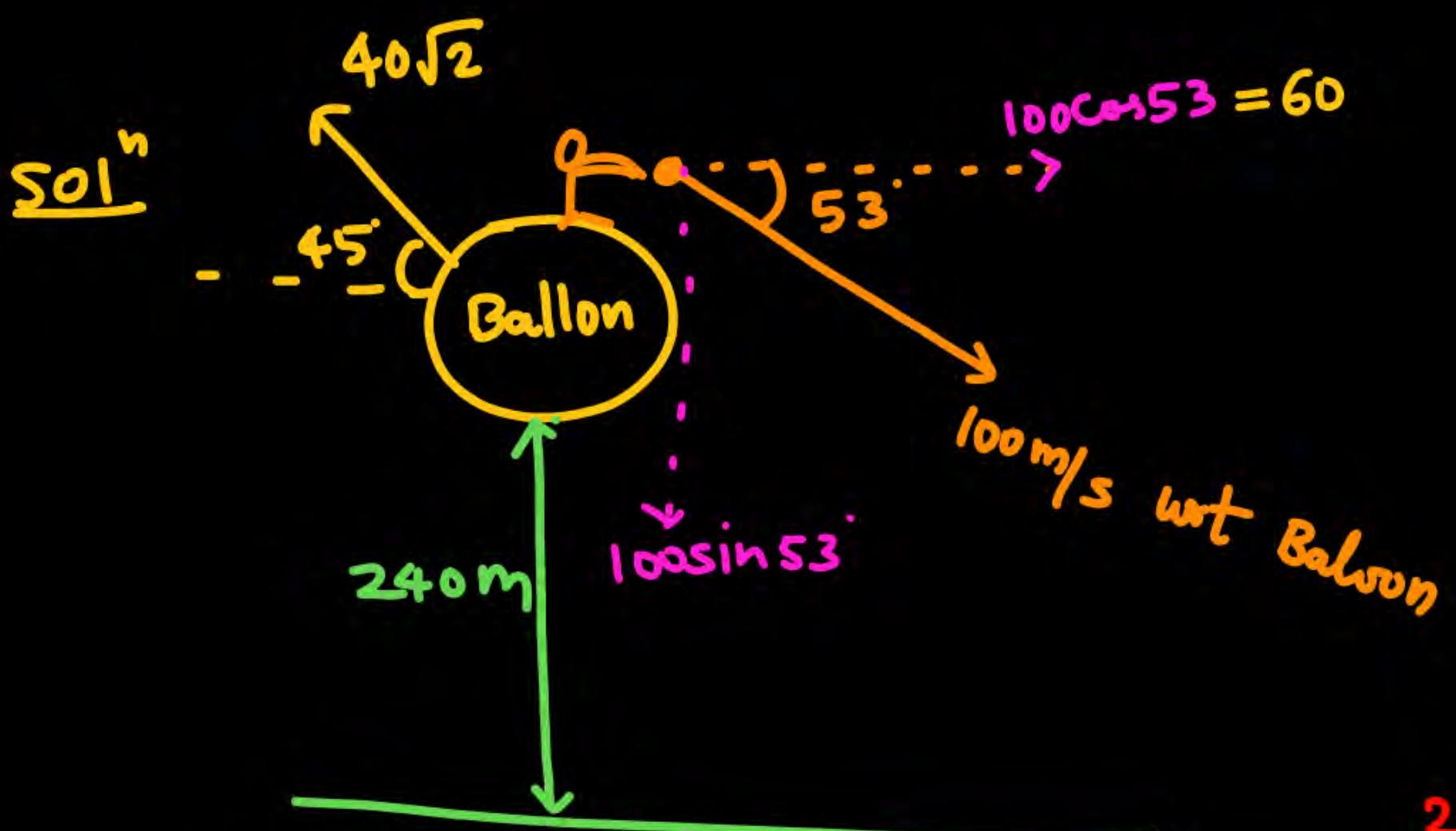
P  
W

Balloon is moving with speed  $40\sqrt{2}$  making angle  $45^\circ$  with horizontal as shown in diagram.

A particle projected downward with speed  $100 \text{ m/s}$  wrt balloon at angle of  $53^\circ$  with horizontal. as shown in diagram.

When particle will hit the ground & where





$$\vec{v}_{\text{जलवाय}} = -40\hat{i} + 40\hat{j}$$

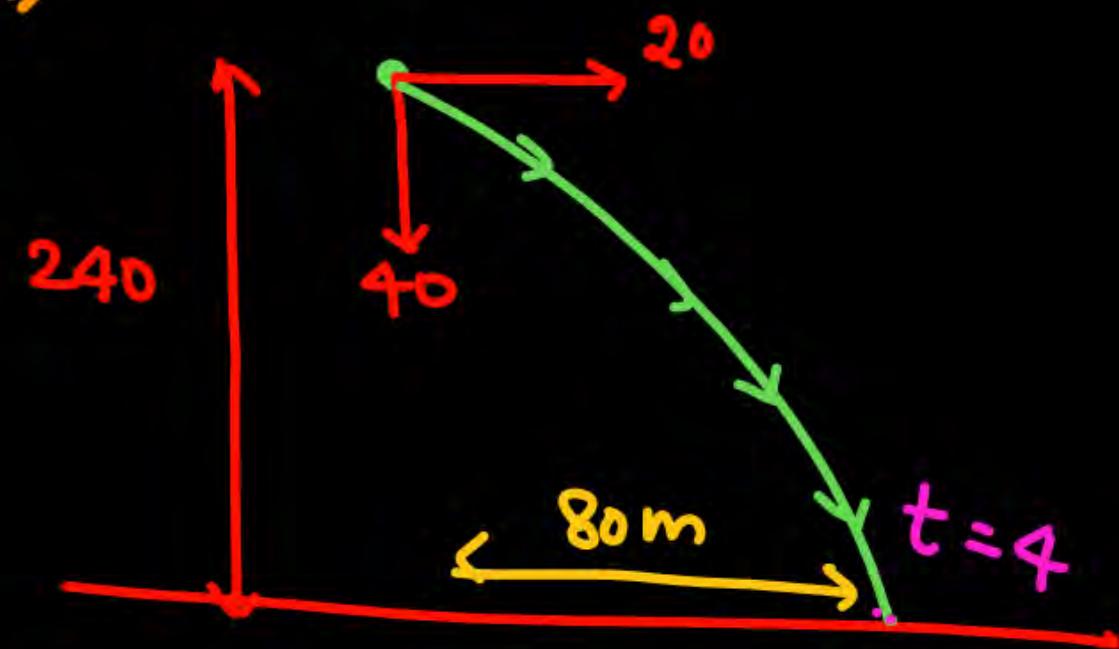
$$\vec{v}_b / \sqrt{601 \text{ m/s}} = 60\hat{i} - 80\hat{j}$$

P W

$$\vec{v}_{\text{ball/jलवाय}} = \vec{v}_b - \vec{v}_{\text{जलवाय}}$$

$$60\hat{i} - 80\hat{j} = \vec{v}_b - (-40\hat{i} + 40\hat{j})$$

$$\vec{v}_{\text{ball}} = 20\hat{i} - 40\hat{j}$$

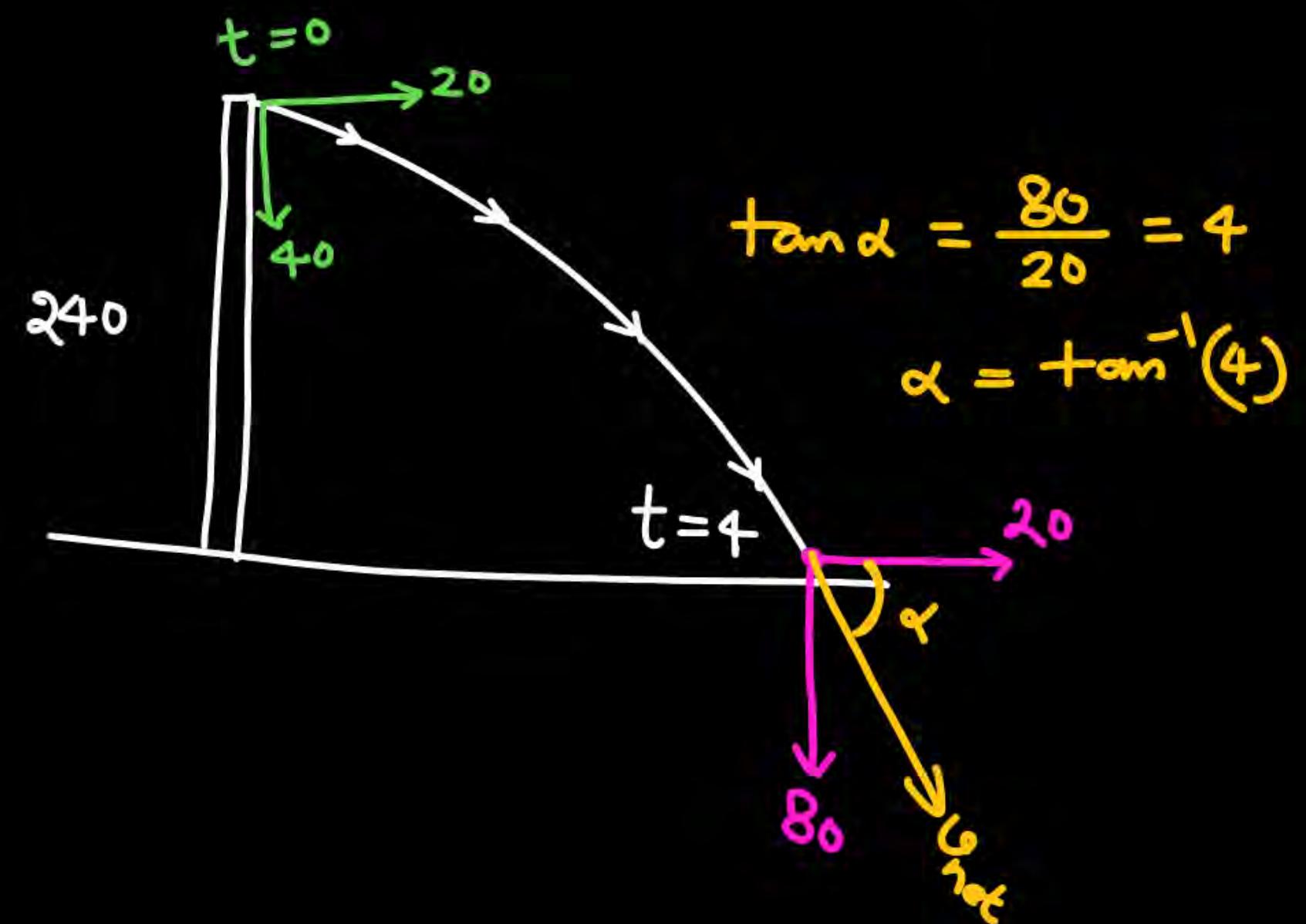


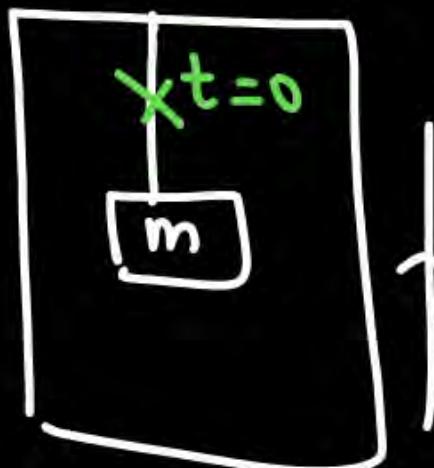
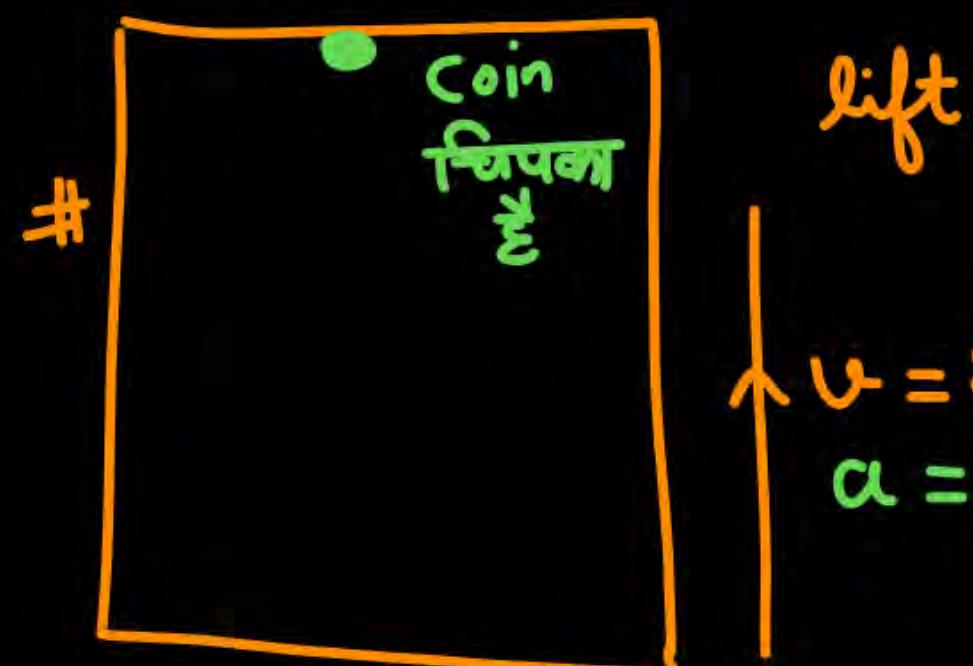
$$240 = 40t + \frac{1}{2} \times 16 \times t^2$$

$t = 4 \text{ sec}$

(b) find angle made by velocity with horizontal just before it hit the ground.

P  
W





$$v = 20 \text{ m/s}$$

$$a = 2 \text{ m/s}^2$$

(Same  
Situation)

lift

at  $t=0$ , coin drop

$t=0^+$



$$v = 20$$

$$a = 2$$

↑ +ve

$$\begin{aligned} t &= 0^+ \\ &= 0.0000000 \\ &\quad 0000001 \end{aligned}$$

at  $t=0^+$

$\vec{v}$

$$\vec{v}_{\text{coin/ground}} = +20 \hat{j}$$

$$\vec{a}_{\text{coin/ground}} = \vec{a}_c = -10 \hat{j}$$

$$\vec{v}_{\text{coin/lift}} = \vec{v}_c - \vec{v}_l = +20 - 20 = 0$$

$$\vec{a}_{\text{coin/lift}} = \vec{a}_c - \vec{a}_{\text{lift}} = -10 - (+2) = -12$$

find

↑ +ve

Q.



$$\vec{v}_{\text{coin}} = +15 \hat{j}$$

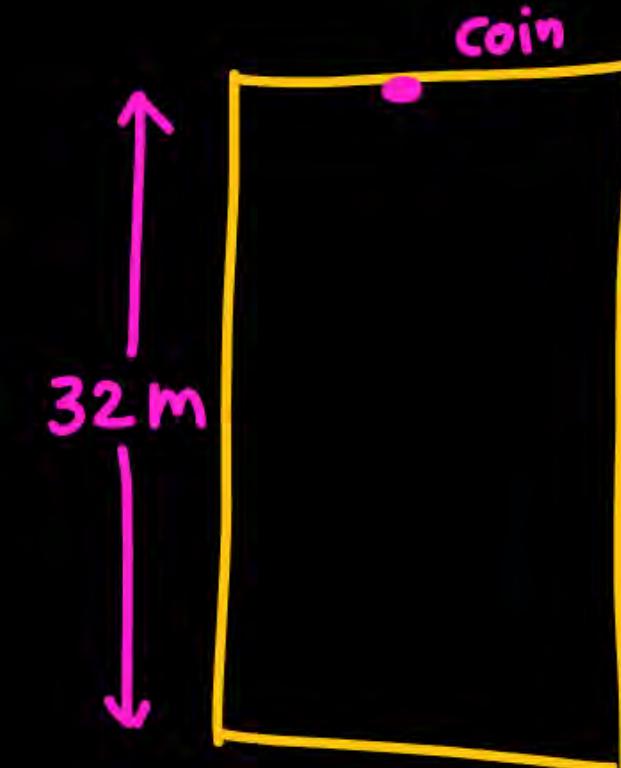
$$\vec{a}_{\text{coin}} = -10 \hat{j} = \begin{matrix} \text{wrt} \\ \text{grav} \end{matrix}$$

$$\vec{v}_{\text{coin/left}} = 15 - 15 = 0$$

$$\begin{aligned}\vec{a}_{\text{coin/left}} &= -10 \hat{j} - (+6) \\ &= -16 \hat{j}.\end{aligned}$$

at  $t = 0^+$   
just  
after  
coin  
drop

Q At  $t=0$ , coin drop  
find when coin will hit the  
floor.



$$v = +15 \text{ m/s}$$

$$a = +6 \text{ m/s}^2$$

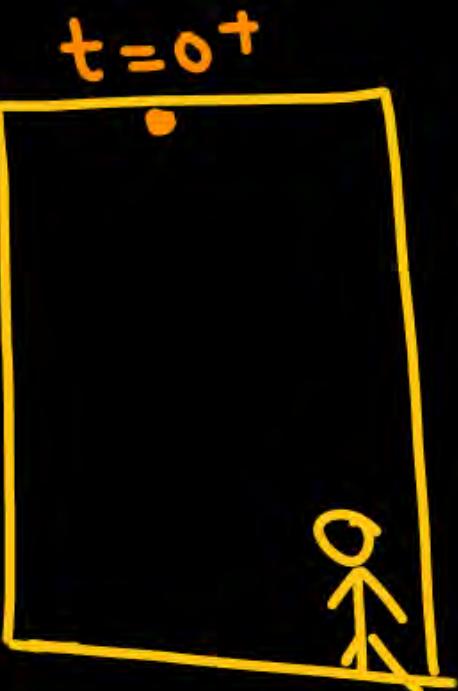
इससे कैक्स  
नहीं पड़ा

P  
W

formula

$$t = \sqrt{\frac{2 \times 32}{16}}$$

wrt lift



$$\vec{u}_{\text{coin|lift}} = 0$$

$$\vec{a}_{\text{coin|lift}} = -10 - (+6) = -16$$

$$\vec{s}_{\text{coin|lift}} = -32$$

(In lift frame)  
or wrt lift

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

$$-32 = 0 - \frac{1}{2} \times 16 \times t^2$$

$$t = 2 \text{ sec}$$

Q At  $t=0$ , coin drop  
find when coin will hit the  
floor.

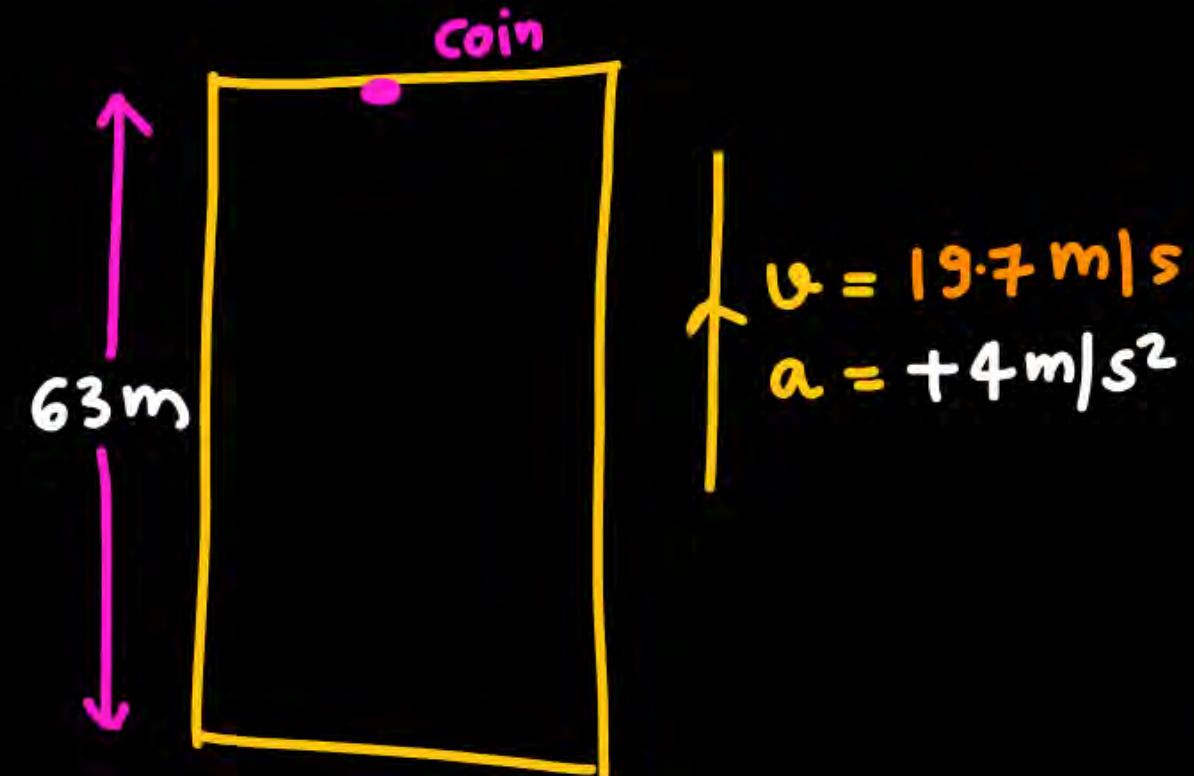
wrt lift.

$$\vec{u}_{\text{coin/lift}} = 0$$

$$\vec{a}_{c/l} = \vec{a}_c - \vec{a}_l$$

$$\vec{a}_{c/l} = (-10) - (+4) = -14$$

$$\vec{s}_{c/l} = -63$$

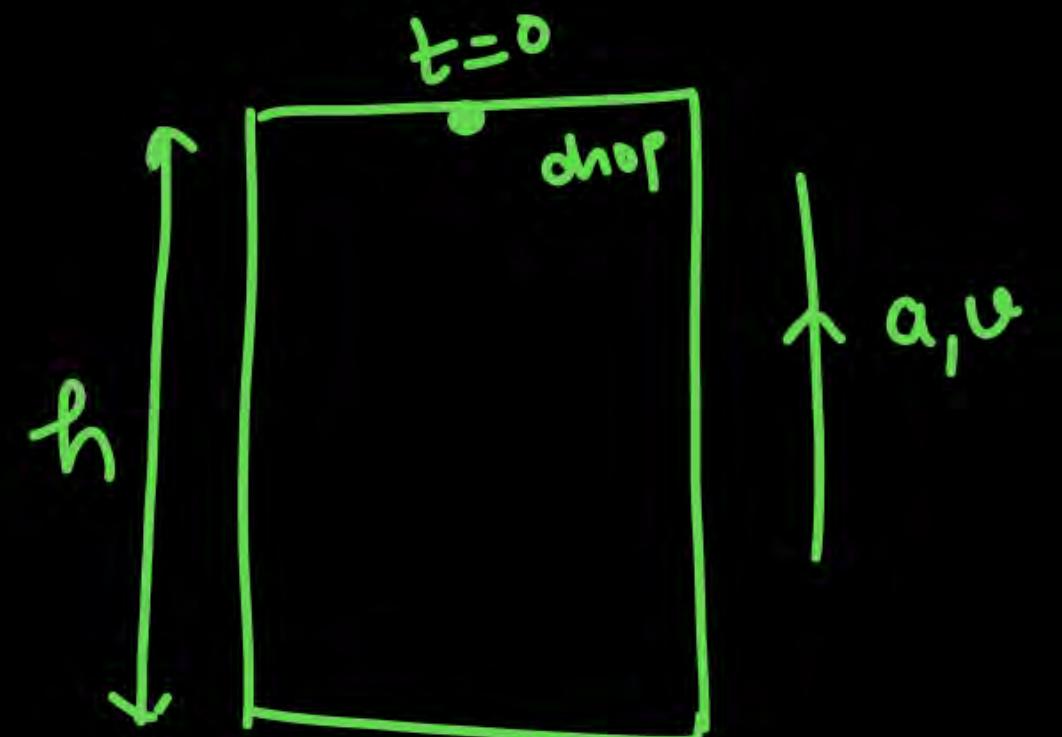


formula

$$t = \sqrt{\frac{2 \times 63}{14}}$$

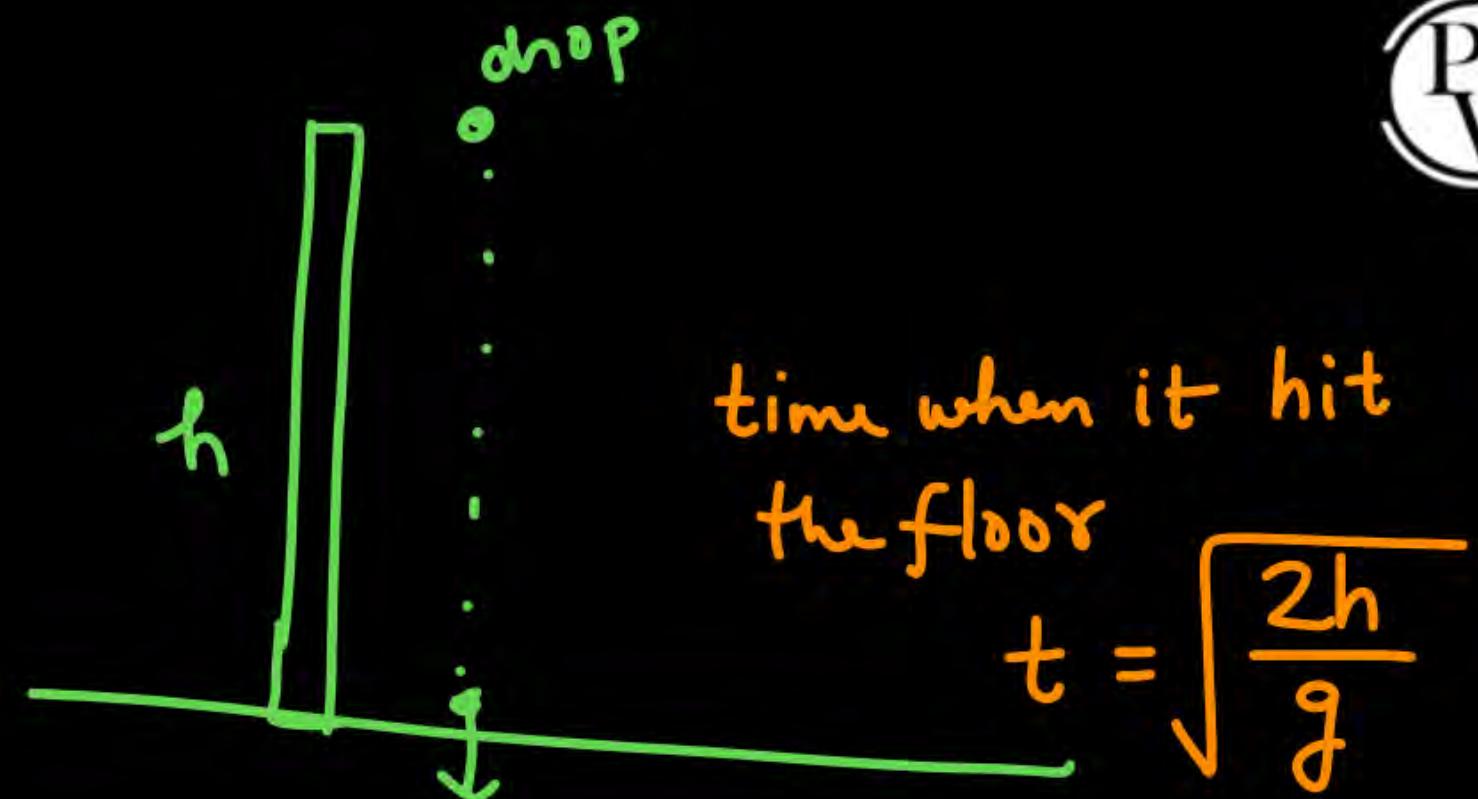
$$-63 = 0 + \frac{1}{2} \times (-14) t^2$$

$$t = 3 \text{ sec}$$



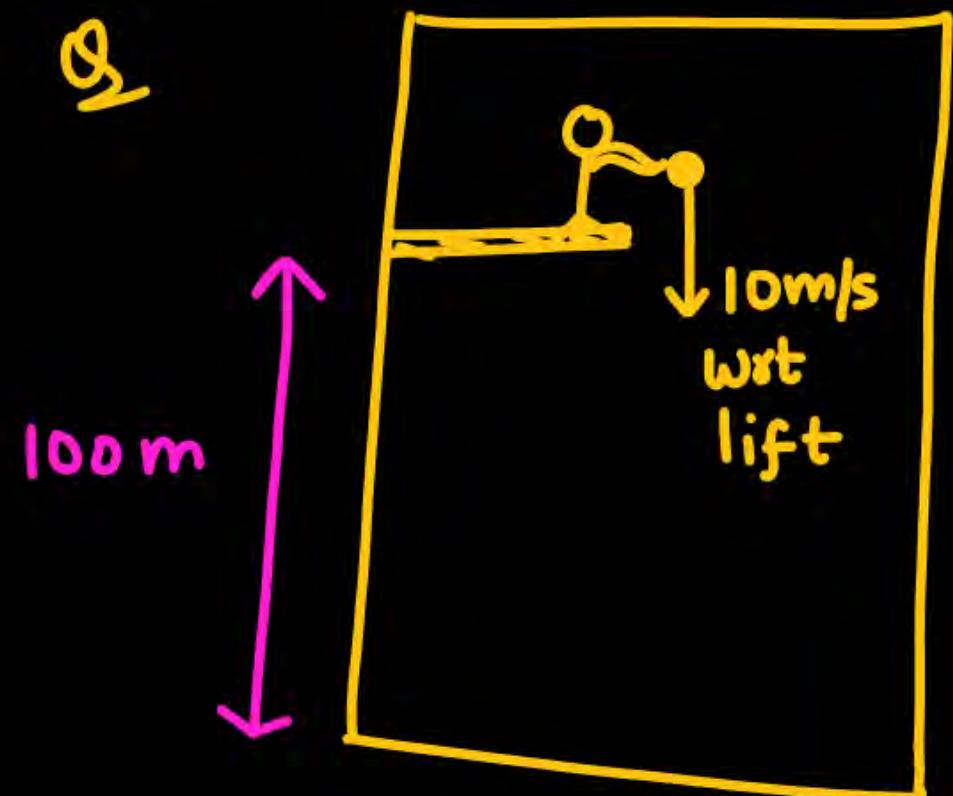
$$\text{wrt lift} \Rightarrow h = 0 + \frac{1}{2} a_{\text{lift}} t^2$$

$$t = \sqrt{\frac{2h}{a_{\text{coin lift}}}}$$



$$h = 0 + \frac{1}{2} g t^2$$

Q.



$$a = 2 \text{ नीचे} \\ g = 40 \text{ m/s नीचे}$$

when coin will strike the floor.

P  
W

① lift के संदर खाकर ✓  
wrt lift.

3.8  
3.9

$$u_{\text{coin/lift}} = -10$$

$$a_{\text{coin/lift}} = -10 - (-2) = -8$$

$$s_{\text{coin/lift}} = -100$$

$$-100 = -10t + \frac{1}{2}(-8)t^2$$

$$100 = 10t + 4t^2$$

$$2t^2 + 5t - 50 = 0$$

$$t = \frac{-5 + \sqrt{25 - 4 \times 2 \times (-50)}}{4} = \frac{-5 + \sqrt{425}}{4}$$

∴

$$\begin{aligned}\vec{a}_{\text{coin/lift}} &= \vec{a}_{\text{coin}} - \vec{a}_{\text{lift}} \\ &= (g \text{ नीचे}) - (2 \text{ नीचे}) \\ &= (-10) - (-2) \\ &= -10 + 2 = -8\end{aligned}$$

$$\theta_2 \quad t = \sqrt{\frac{2 \times 120}{15}} = 4$$

① When coin will strike on ground

$$\vec{u}_{c/l} = 0$$

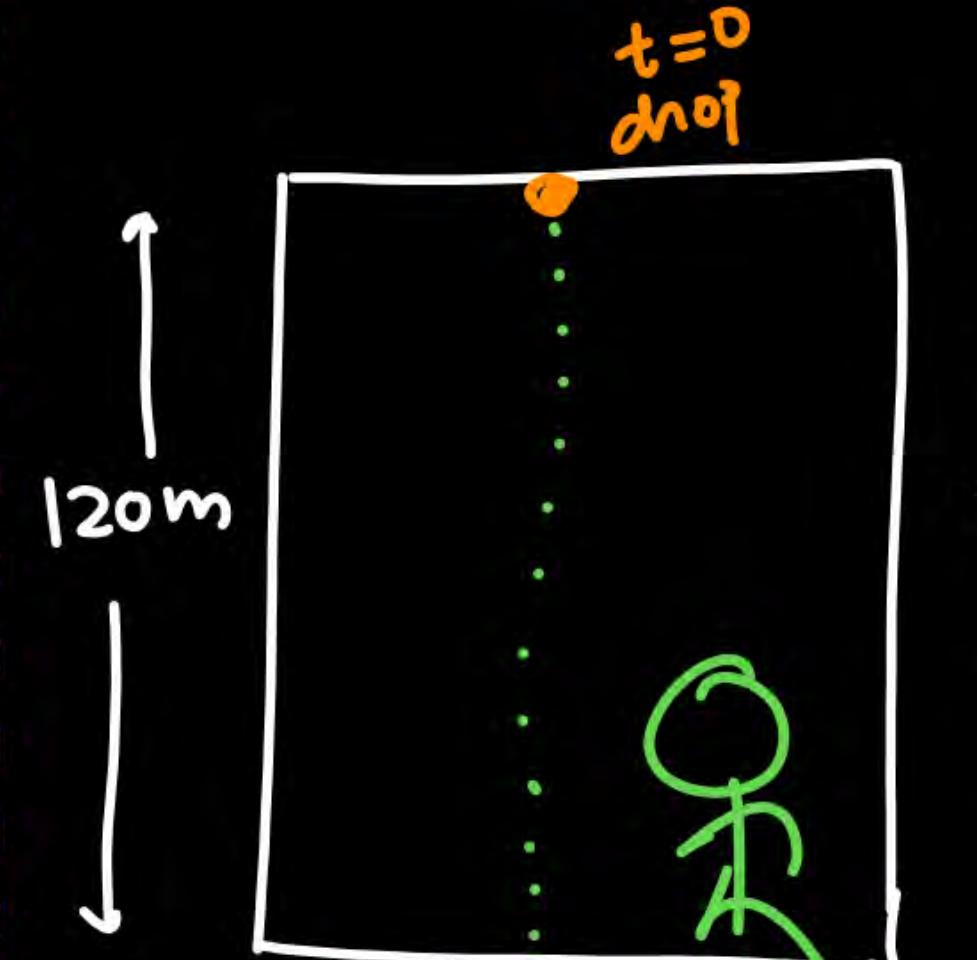
$$\vec{a}_{c/l} = -10 - 5 = -15$$

$$\vec{s}_{c/l} = -120$$

$$S = Ut + \frac{1}{2}at^2, \text{ (in lift frame)}$$

$$-120 = 0 - \frac{1}{2} \times 15 \times t^2$$

$$\boxed{t = 4 \text{ sec}}$$



② find displacement of lift wrt ground before coin strikes the floor

$$\underline{\text{lift}} \quad t = 4, S = ?, u = 10, a = 5$$

$$\vec{s}_{\text{lift}} = S = 10 \times 4 + \frac{1}{2} \times 5 \times 4^2 = +80$$

\* \* \*  
③ find displacement of coin in ground frame before hit the ground  
वात coin की कररट है जमीन के respect में

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

$$S = 10 \times 4 + \frac{1}{2} (-10) 4^2$$

$$S = 40 - 80$$

$$\boxed{S = -40} = \vec{S}_{\text{coin}}^{\text{ground}}$$

$$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B$$

$$\vec{v}_{\text{coin/lift}} = \vec{v}_{\text{coin}} - \vec{v}_{\text{lift}}$$

$$\vec{s}_{\text{coin/lift}} = \vec{s}_{\text{coin}} - \vec{s}_{\text{lift}}$$

$$= (-40) - (+80)$$

$$\vec{s}_{\text{coin/lift}} = -120 = \sqrt{40^2 + 80^2} = \sqrt{120}$$

coin ↑ 10m/s

displacement of coin in  $t = 4 \text{ sec}$   
in ground fram

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

$$S = 10 \times 4 + \frac{1}{2}(-10) \times 4^2$$

$$= 40 - 80 = -40$$



==



## Arjun JEE 2024

### Motion in a Plane (PYQ)

1. An object is thrown vertically upwards. At its maximum height, which of the following quantity becomes zero?  
[JEE Main 2022]  
(A) Momentum      (B) Potential energy  
(C) Acceleration    (D) Force
2. A ball is projected vertically upward with an initial velocity of  $50 \text{ ms}^{-1}$  at  $t = 0\text{s}$ . At  $t = 2\text{s}$ , another ball is projected vertically upward with same velocity. At  $t = \text{_____ s}$ , second ball will meet the first ball ( $g = 10 \text{ ms}^{-2}$ )  
[JEE Main 2022]
3. A body is projected from the ground at an angle of  $45^\circ$  with the horizontal. Its velocity after  $2\text{s}$  is  $20 \text{ ms}^{-1}$ . The maximum height reached by the body during its motion is  $\text{_____ m}$ . (use  $g = 10 \text{ ms}^{-2}$ )  
[JEE Main 2022]
4. A fighter jet is flying horizontally at a certain altitude with a speed of  $200 \text{ ms}^{-1}$ . When it passes directly overhead an anti-aircraft gun, bullet is fired from the gun, at an angle  $\theta$  with the horizontal, to hit the jet, if the bullet speed is  $400 \text{ m/s}$ , the value of  $\theta$  will be.....°  
[JEE Main 2022]
5. A projectile is launched at an angle ' $\alpha$ ' with the horizontal with a velocity  $20 \text{ ms}^{-1}$ . After  $10 \text{ s}$ , its inclination with horizontal is ' $\beta$ '. The value of  $\tan\beta$  will be: ( $g = 10 \text{ ms}^{-2}$ )  
[JEE Main 2022]  
(A)  $\tan\alpha + 5 \sec\alpha$     (B)  $\tan\alpha - 5 \sec\alpha$   
(C)  $2 \tan\alpha - 5 \sec\alpha$     (D)  $2 \tan\alpha + 5 \sec\alpha$
6. A girl standing on road holds her umbrella at  $45^\circ$  with the vertical to keep the rain away. If she starts running without umbrella with a speed of, the rain drops hit her head vertically. The speed of rain drops with respect to the moving girl is :  
[JEE Main 2022]
- (A)  $30 \text{ kmh}^{-1}$       (B)  $\frac{25}{\sqrt{2}} \text{ kmh}^{-1}$   
(C)  $\frac{30}{\sqrt{2}} \text{ kmh}^{-1}$     (D)  $25 \text{ kmh}^{-1}$
7. Motion of particle in x-y plane is described by a set of following equations  $x = 4\sin\left(\frac{\pi}{2} - \omega t\right)\text{m}$  and  $y = 4 \sin(\omega t)\text{m}$ . The path of particle will be  
[JEE Main 2022]  
(A) Circular      (B) Helical  
(C) parabolic      (D) elliptical
8. A person can throw a ball upto a maximum range of  $100 \text{ m}$ . How high above the ground he can throw the same ball?  
[JEE Main 2022]  
(A)  $25 \text{ m}$       (B)  $50 \text{ m}$   
(C)  $100 \text{ m}$       (D)  $200 \text{ m}$
9. A particle is moving in a straight line such that its velocity is increasing at  $5 \text{ ms}^{-1}$  per meter. The acceleration of the particle is  $\text{_____ ms}^{-2}$  at a point where its velocity is  $20 \text{ ms}^{-1}$ .  
[JEE Main 2022]
10. Two projectiles are thrown with same initial velocity making an angle of  $45^\circ$  and  $30^\circ$  with the horizontal respectively. The ratio of their range respectively will be  
[JEE Main 2022]  
(A)  $1 : \sqrt{2}$       (B)  $\sqrt{2} : 1$   
(C)  $2 : \sqrt{3}$       (D)  $\sqrt{3} : 2$
11. A ball is thrown vertically upwards with a velocity of  $19.6 \text{ ms}^{-1}$  from the top of a tower. The ball strikes the ground after  $6 \text{ s}$ . The height from the ground up to which the ball can rise will be  $\left(\frac{k}{5}\right)\text{m}$ . The value of  $k$  is  $\text{_____}$  (use  $g = 9.8 \text{ m/s}^{-2}$ )  
[JEE Main 2022]



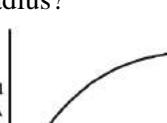
12. A ball is projected from the ground with a speed  $15\text{ms}^{-1}$  at an angle  $\theta$  with horizontal so that its range and maximum height are equal, then ' $\tan \theta$ ' will be equal to [JEE Main 2022]  
(A)  $1/4$       (B)  $2 : 1$   
(C)  $2$       (D)  $4$
13. Two projectiles thrown at  $30^\circ$  and  $45^\circ$  with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is [JEE Main 2022]  
(A)  $1 : \sqrt{2}$       (B)  $2 : 1$   
(C)  $\sqrt{2} : 1$       (D)  $1 : 2$
14. If the initial velocity in horizontal direction of a projectile is unit vector  $\hat{i}$  and the equation of trajectory is  $y = 5x(1 - x)$ . The y component vector of the initial velocity is \_\_\_\_\_  $\hat{j}$ . [JEE Main 2022]  
(Take  $g = 10\text{m/s}^2$ )
15. A body of mass 10 kg is projected at an angle of  $45^\circ$  with the horizontal. The trajectory of the body is observed to pass through a point  $(20, 10)$ . If  $T$  is the time of flight, then the momentum vector, at time  $t = \frac{T}{\sqrt{2}}$ , is \_\_\_\_\_ (Take  $g = 10 \text{ m/s}^2$ ) [JEE Main 2022]  
(A)  $100\hat{i} + (100\sqrt{2} - 200)\hat{j}$   
(B)  $100\sqrt{2}\hat{i} + (100 - 200\sqrt{2})\hat{j}$   
(C)  $100\hat{i} + (100 - 200\sqrt{2})\hat{j}$   
(D)  $100\sqrt{2}\hat{i} + (100\sqrt{2} - 200)\hat{j}$
16. A ball is projected with kinetic energy  $E$ , at an angle of  $60^\circ$  to the horizontal. The kinetic energy of this ball at the highest point of its flight will become : [JEE Main 2022]  
(A) Zero      (B)  $E/2$   
(C)  $E/4$       (D)  $E$
17. An object is projected in the air with initial velocity  $u$  at an angle  $\theta$ . The projectile motion is such that the horizontal range  $R$ , is maximum. Another object is projected in the air with a horizontal range half of the range of first object. The initial velocity of the angle of projection, at which the second object is projected, will be \_\_\_\_\_ degree. (Mark the smallest angle possible) [JEE Main 2022]
18. A person is swimming with a speed of  $10 \text{ m/s}$  at an angle of  $120^\circ$  with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is ' $x$ '  $\text{m/s}$ . The value of ' $x$ ' to the nearest integer is \_\_\_\_\_. [JEE Main 2021]
19. A force  $\vec{F} = (40\hat{i} + 10\hat{j})\text{N}$  acts on a body of mass 5 kg. If the body starts from rest, its position vector  $\vec{r}$  at time  $t = 10 \text{ s}$ , will be : [JEE Main 2021]  
(A)  $(100\hat{i} + 400\hat{j})\text{m}$       (B)  $(100\hat{i} + 100\hat{j})\text{m}$   
(C)  $(400\hat{i} + 100\hat{j})\text{m}$       (D)  $(400\hat{i} + 400\hat{j})\text{m}$
20. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of  $30^\circ$  with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle  $\theta$  with the line AB should be \_\_\_\_\_  $^\circ$ , so that the swimmer reaches point B. [JEE Main 2021]
21. A bomb is dropped by fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a : [JEE Main 2021]  
(A) hyperbola  
(B) parabola in the direction of motion of plane  
(C) straight line vertically down the plane  
(D) parabola in a direction opposite to the motion of plane
22. If the velocity of a body related to displacement  $x$  is given by  $v = \sqrt{5000 + 24x} \text{ m/s}$ , then the acceleration of the body is .....  $\text{m/s}^2$ . [JEE Main 2021]

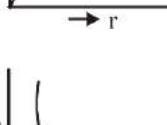
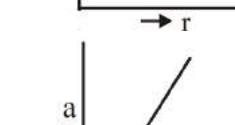
23. A player kicks a football with an initial speed of  $25 \text{ ms}^{-1}$  at an angle of  $45^\circ$  from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion? (Take  $g = 10 \text{ ms}^{-2}$ ) [JEE Main 2021]
- (A)  $h_{\max} = 10 \text{ m}$      $T = 2.5 \text{ s}$   
 (B)  $h_{\max} = 15.625 \text{ m}$      $T = 3.54 \text{ s}$   
 (C)  $h_{\max} = 15.625 \text{ m}$      $T = 1.77 \text{ s}$   
 (D)  $h_{\max} = 3.54 \text{ m}$      $T = 0.125 \text{ s}$
24. A helicopter is flying horizontally with a speed 'v' at an altitude 'h' has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped? [JEE Main 2021]
- (A)  $\sqrt{\frac{2ghv^2 + 1}{h^2}}$     (B)  $\sqrt{2ghv^2 + h^2}$   
 (C)  $\sqrt{\frac{2v^2h}{g} + h^2}$     (D)  $\sqrt{\frac{2gh}{v^2} + h^2}$
25. A particle is moving with constant acceleration 'a'. Following graph shows  $v^2$  versus x(displacement) plot. The acceleration of the particle is \_\_\_\_  $\text{m/s}^2$ . [JEE Main 2021]
- 
- | x (m) | $v^2$ ( $\text{m/s}^2$ ) |
|-------|--------------------------|
| 0     | 0                        |
| 10    | 40                       |
| 20    | 60                       |
| 30    | 80                       |
26. Starting from the origin at time  $t = 0$ , with initial velocity  $5\hat{j} \text{ ms}^{-1}$ , a particle moves in the x-y plane with a constant acceleration of  $(10\hat{i} + 4\hat{j}) \text{ ms}^{-2}$ . At time  $t$ , its coordinates are  $(20 \text{ m}, y_0 \text{ m})$ . The values of  $t$  and  $y_0$ , are respectively: [JEE Main 2020]
- (A) 4s and 52 m    (B) 2s and 24 m  
 (C) 2s and 18 m    (D) 5s and 25 m
27. A Tennis ball is released from a height  $h$  and after freely falling on a wooden floor it rebounds and reaches height  $\frac{h}{2}$ . The velocity versus height of the ball during its motion may be represented graphically by : [JEE Main 2020]
- 
- (A)
- (B)
- (C)
- (D)
28. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed  $v$ , he sees that rain drops are coming at an angle  $60^\circ$  from the horizontal. On further increasing the speed of the car to  $(1 + \beta)v$ , this angle changes to  $45^\circ$ . The value of  $\beta$  is close to: [JEE Main 2020]
- (A) 0.41    (B) 0.50  
 (C) 0.37    (D) 0.73
29. A particle starts from the origin at  $t = 0$  with an initial velocity of  $3.0\hat{i} \text{ m/s}$  and moves in the x-y plane with a constant acceleration  $(6.0\hat{i} + 4.0\hat{j}) \text{ m/s}^2$ . The x-coordinate of the particle at the instant when its y-coordinate is 32 m is D meters. The value of D is: [Main 9 Jan. 2020 (II)]
- (A) 32    (B) 50  
 (C) 60    (D) 40
30. A particle moves such that its position vector  $\vec{r}(t) = \cos \omega t \hat{i} + \sin \omega t \hat{j}$  where  $\omega$  is a constant and  $t$  is time. Then which of the following statements is true for the velocity  $\vec{v}(t)$  and acceleration  $\vec{a}(t)$  of the particle: [Main 8 Jan. 2020 (II)]
- (a)  $\vec{v}$  is perpendicular to  $\vec{r}$  and  $\vec{a}$  is directed away from the origin  
 (b)  $\vec{v}$  and  $\vec{a}$  both are perpendicular to  $\vec{r}$   
 (c)  $\vec{v}$  and  $\vec{a}$  both are parallel to  $\vec{r}$   
 (d)  $\vec{v}$  is perpendicular to  $\vec{r}$  and  $\vec{a}$  is directed towards the origin





41. If a body moving in circular path maintains constant speed of  $10 \text{ ms}^{-1}$ , then which of the following correctly describes relation between acceleration and radius?  
**[Main Online April 10, 2015]**

(A)  (B) 

(C)  (D) 

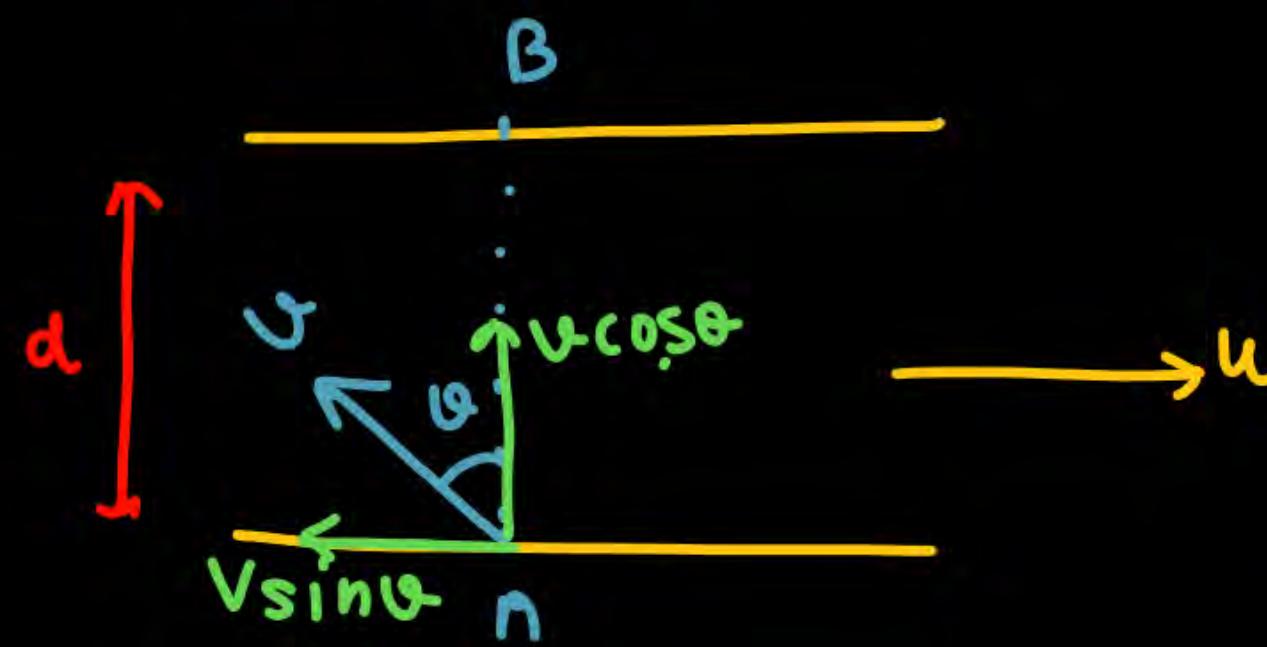
42. A boat which has a speed of  $5 \text{ km/hr}$  in still water crosses a river of width  $1 \text{ km}$  along the shortest possible pass in  $15 \text{ minutes}$ . The velocity of the river water in  $\text{km/hr}$  is  
**[1998 – 1 Mark]**

(A) 1 (B) 3  
 (C) 4 (D)  $\sqrt{41}$

43. A river is flowing from west to east at a speed of  $5$  meters per minute. A man on the south bank of the river, capable of swimming at  $10$  metres per minute in still water, wants to swim across the river in the shortest time. He should swim in a direction  
**[1983 – 1 Mark]**

(A) due north (B)  $30^\circ$  east of north  
 (C)  $30^\circ$  west of north (D)  $60^\circ$  east of north

min distance

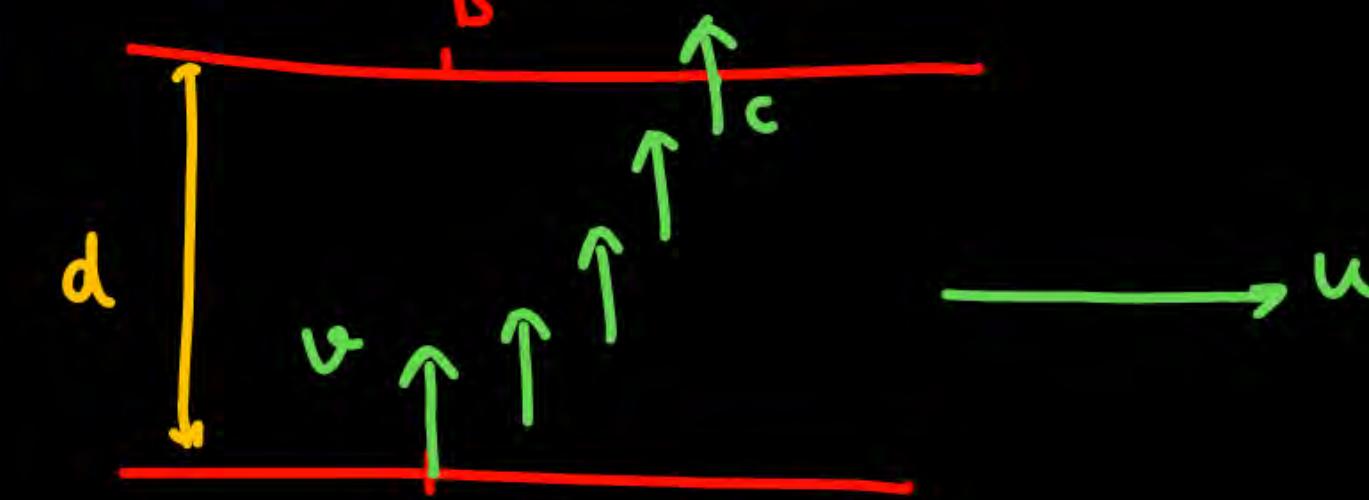


$$v \sin \theta = u$$

$$t = \frac{d}{v \cos \theta}$$

min time

$$\text{Dift} = CB = ut$$



$$t = \frac{d}{v}$$

Q River is flowing with speed 5 m/s

$$\overrightarrow{v}_{\text{river}} = 10 \text{ m/s} \quad d = 100 \text{ m}$$

- ① In which dir? man should swim so that he crosses the river in min distance travel.

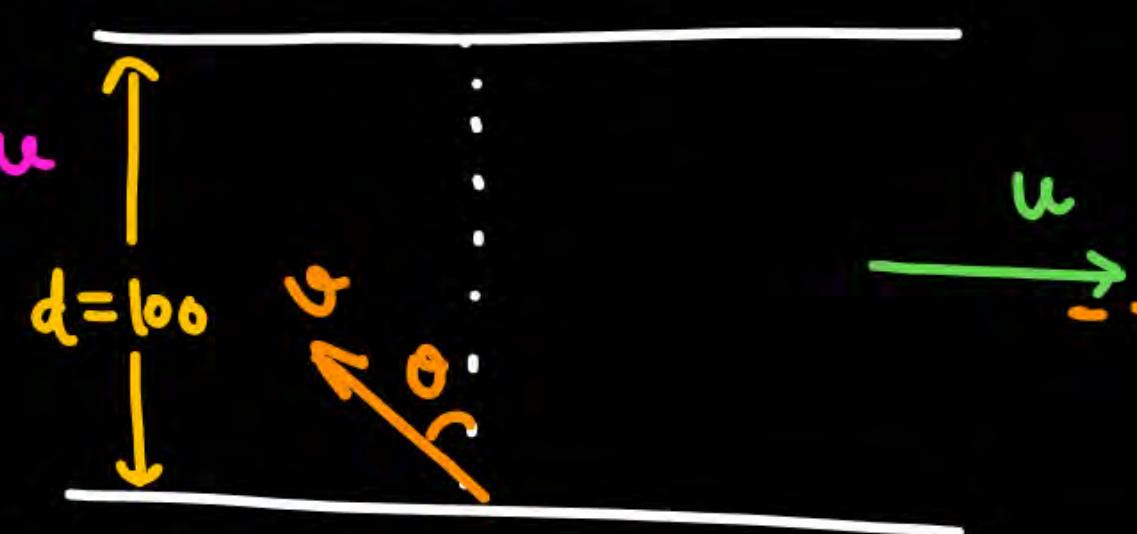
also find time taken to cross the river.

$$u \sin \theta = u$$

$$10 \sin \theta = 5$$

$$\sin \theta = \frac{1}{2}$$

$$\boxed{\theta = 30^\circ}$$



$$t = \frac{d}{v \cos \theta} = \frac{100}{10 \cos 30^\circ} = \frac{20}{\sqrt{3}}$$

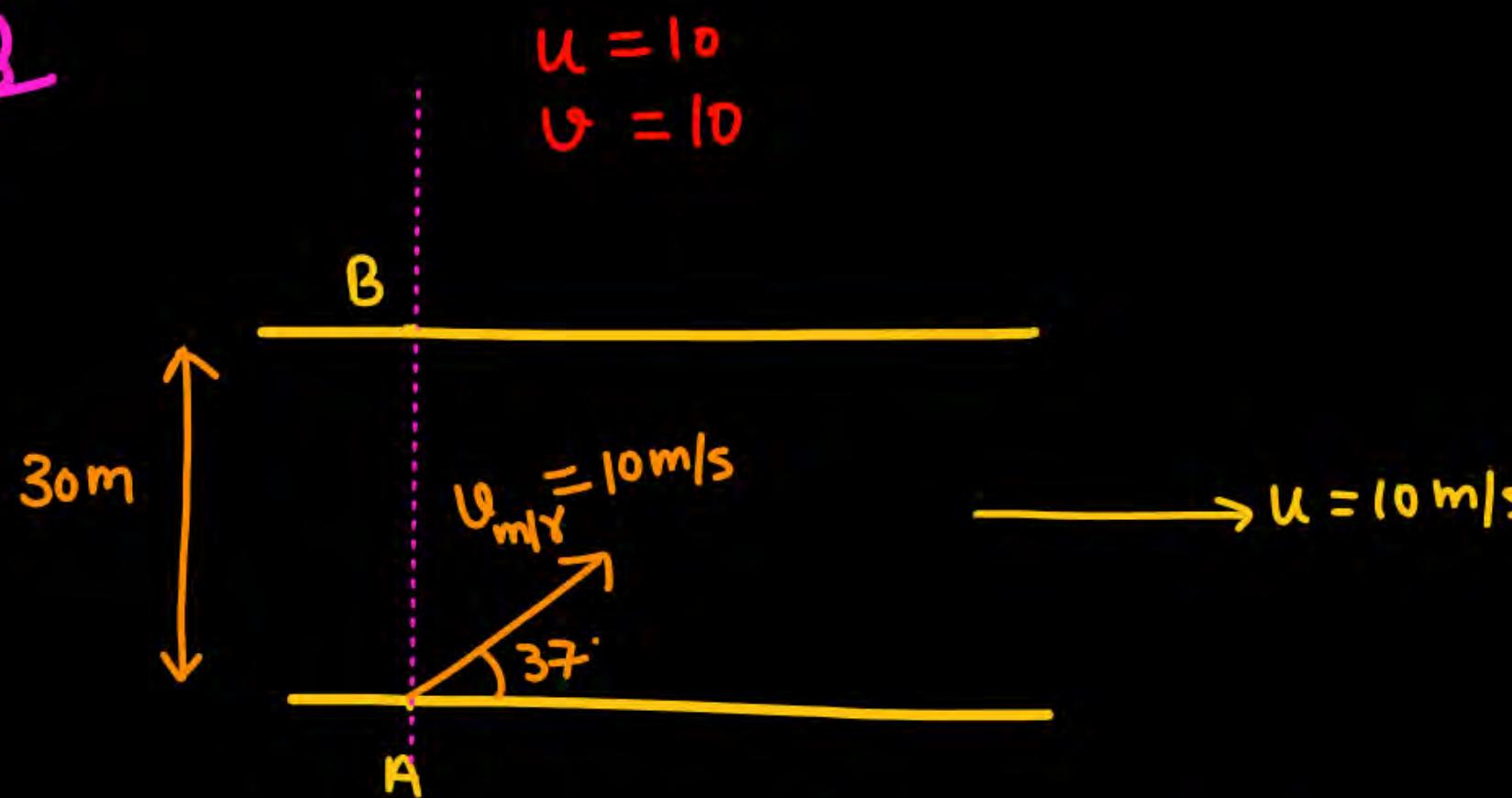
(b) If he want to cross the river in min possible time find min time to cross the river & drift



$$t = \frac{100}{10} = 10 \text{ sec}$$

$$\begin{aligned} BC &= \text{drift} = 5 \times 10 \\ &= \underline{\underline{50 \text{ m}}} \end{aligned}$$

Q



(a) find time taken to cross the river

$$\underline{\text{Soln}} \quad t = \frac{d}{v \sin 37} = \frac{30}{6} = 5 \text{ sec}$$

Sol<sup>n</sup> b find drift

$$BC = 18 \times 5 = 90$$



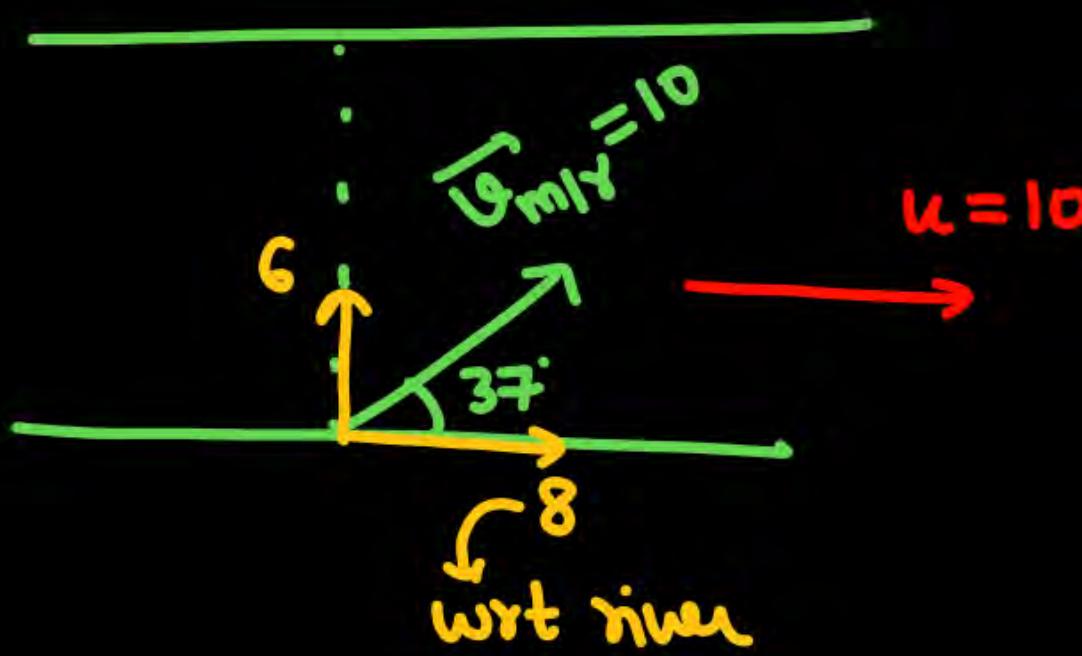
$v_{m/y} = v_m - v_y \quad (\text{x Axis})$

$$8\hat{i} = v_m - 10\hat{i}$$

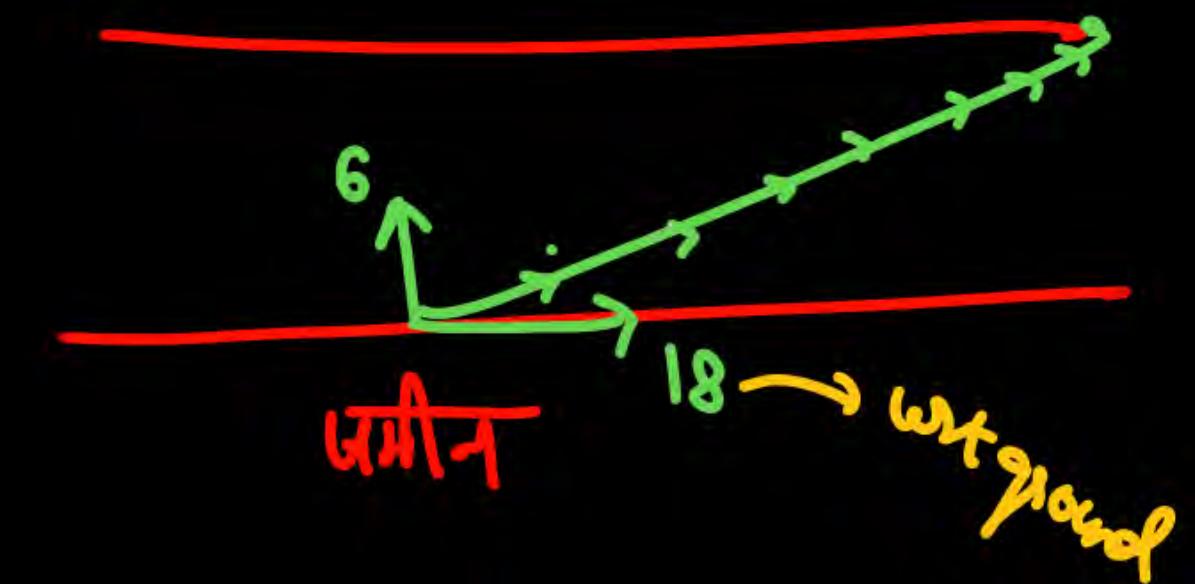
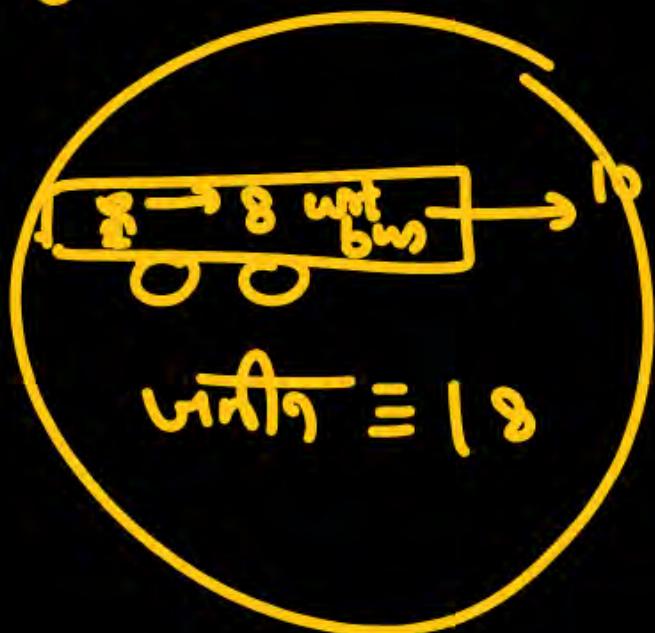
$\boxed{v_m = 18\hat{i}}$

(wrt river)

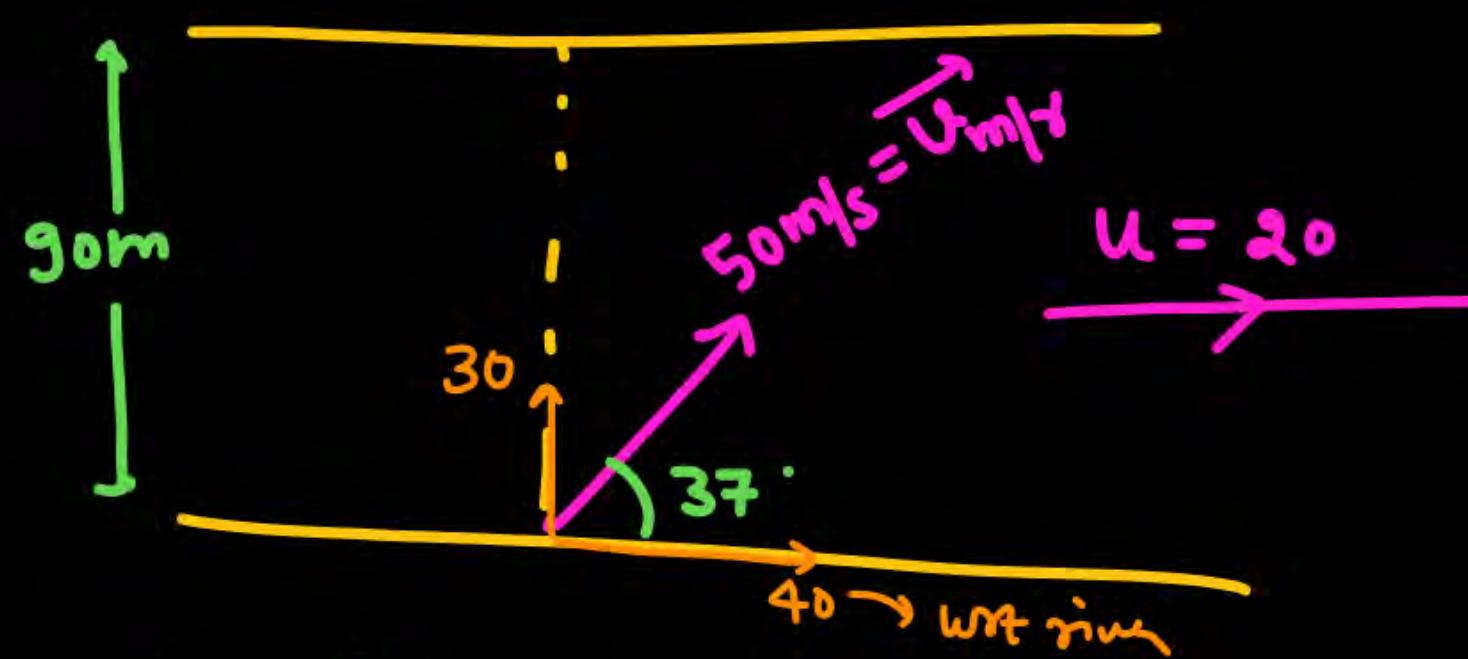
Ansatz



$$\begin{aligned}\vec{v}_{m/r} &= 10 \cos 37^\circ \hat{i} + 10 \sin 37^\circ \hat{j} \\ \vec{v}_{m/r} &= 8\hat{i} + 6\hat{j} \\ \vec{v}_m - \vec{v}_r &= 8\hat{i} + 6\hat{j} \\ \vec{v}_m - 10\hat{i} &= 8\hat{i} + 6\hat{j} \\ \vec{v}_m &= 18\hat{i} + 6\hat{j}\end{aligned}$$

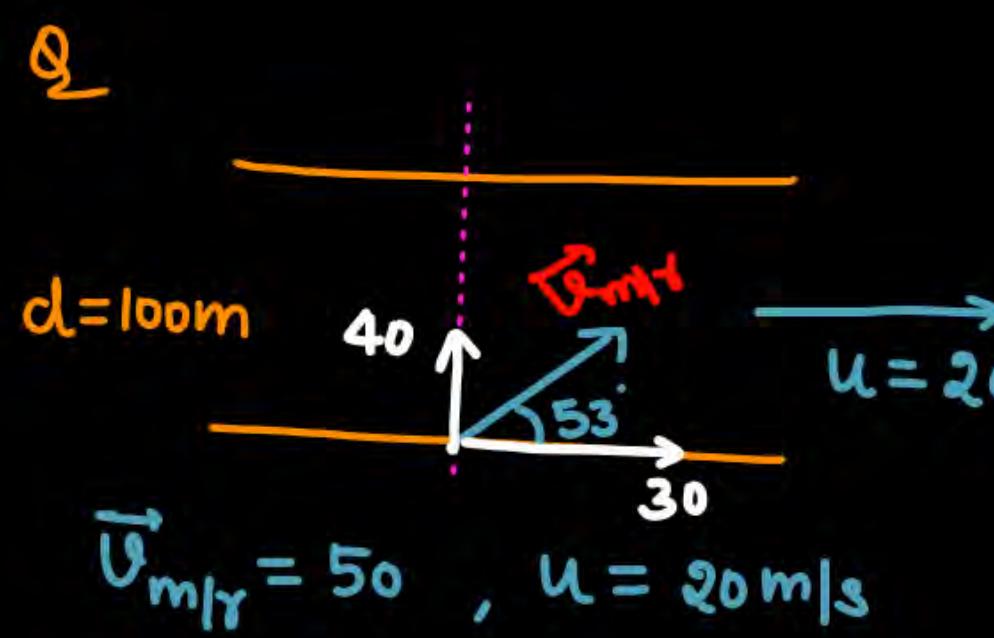


Q



$$\text{Drift} = 60 \times 3 = 180$$

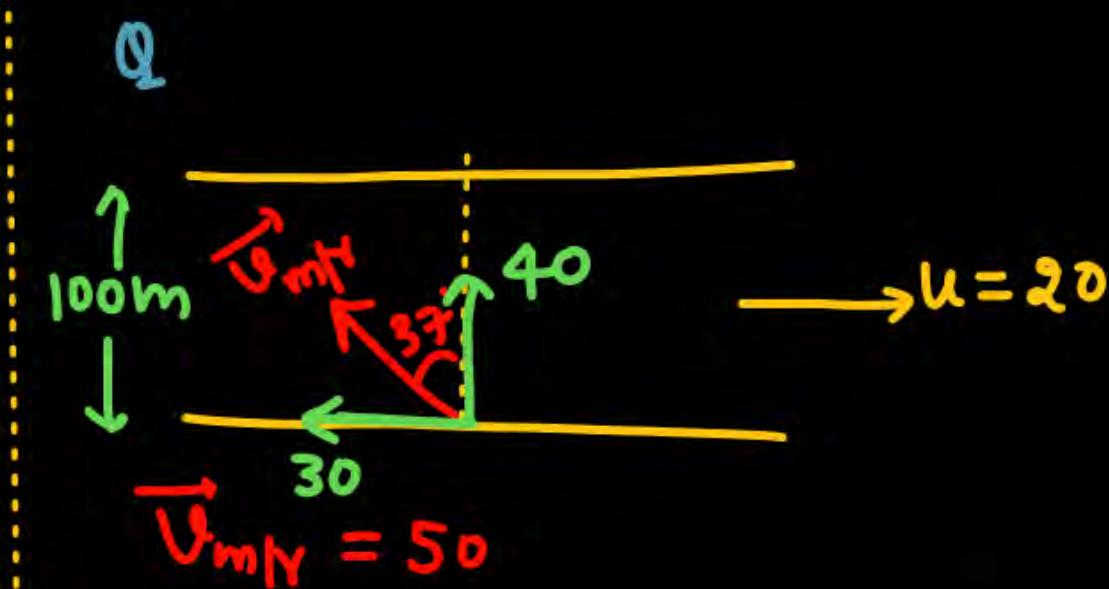
$$t = \frac{90}{50 \sin 37} = \frac{90}{30} = 3$$



① time to cross river

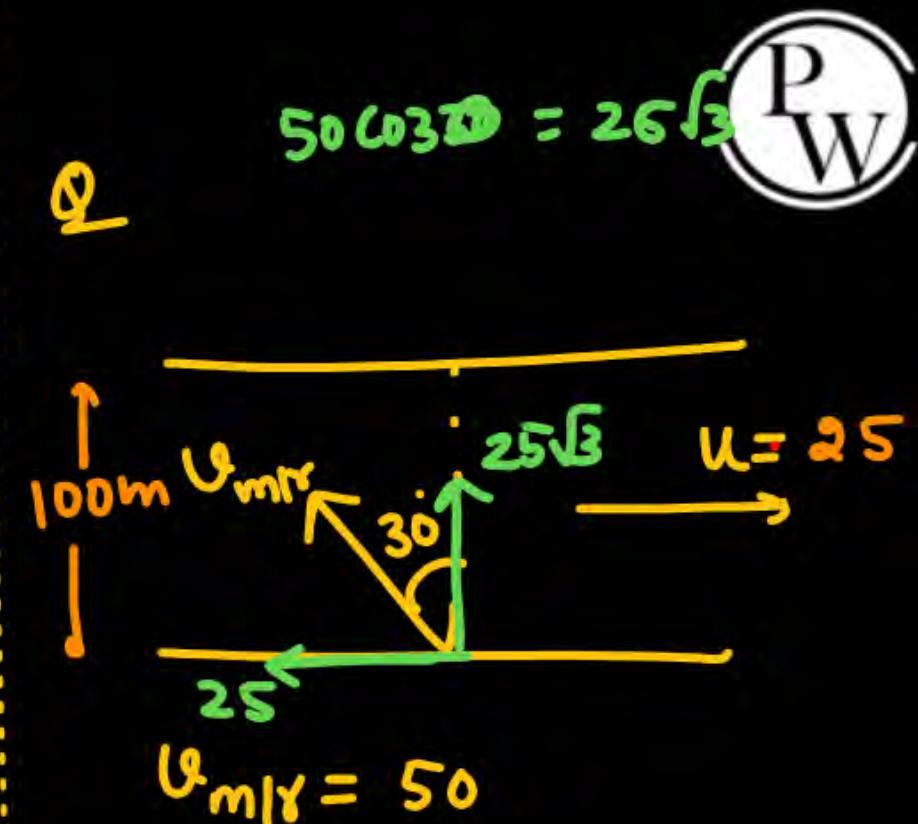
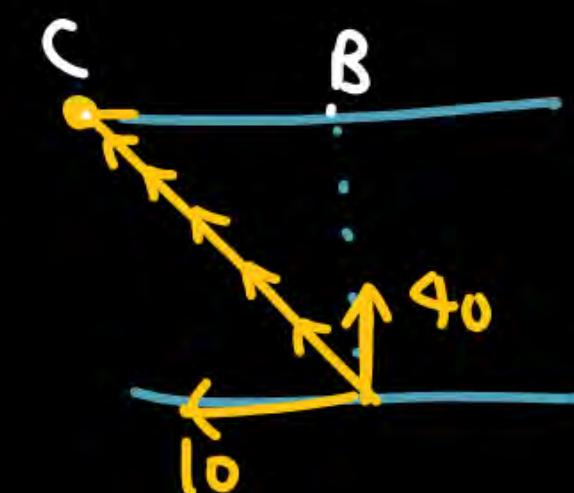
$$t = \frac{100}{40} = 2.5$$

$$\begin{aligned} \textcircled{2} \quad \text{Drift} &= (30 + 20) \times 2.5 \\ &= 125 \end{aligned}$$



$$\textcircled{1} \quad \text{time to cross} = \frac{100}{40} = 2.5$$

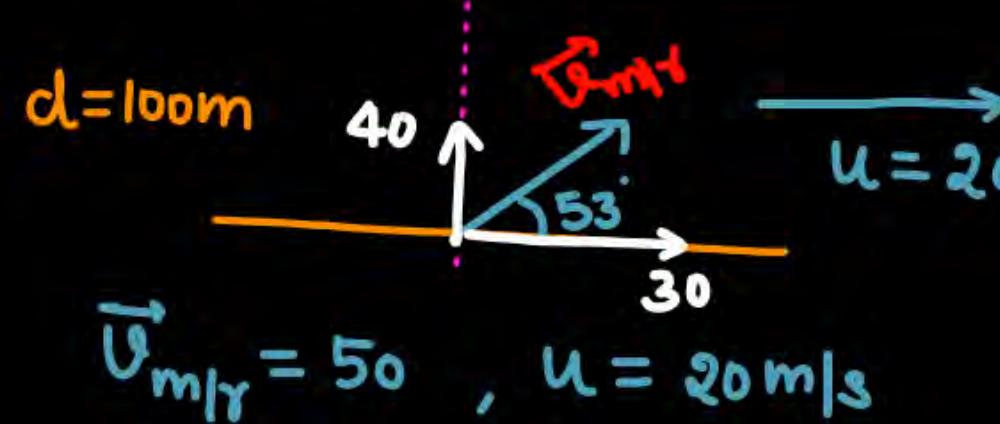
$$\textcircled{2} \quad \text{Drift} = 10 \times 2.5 = \underline{\underline{25}}$$



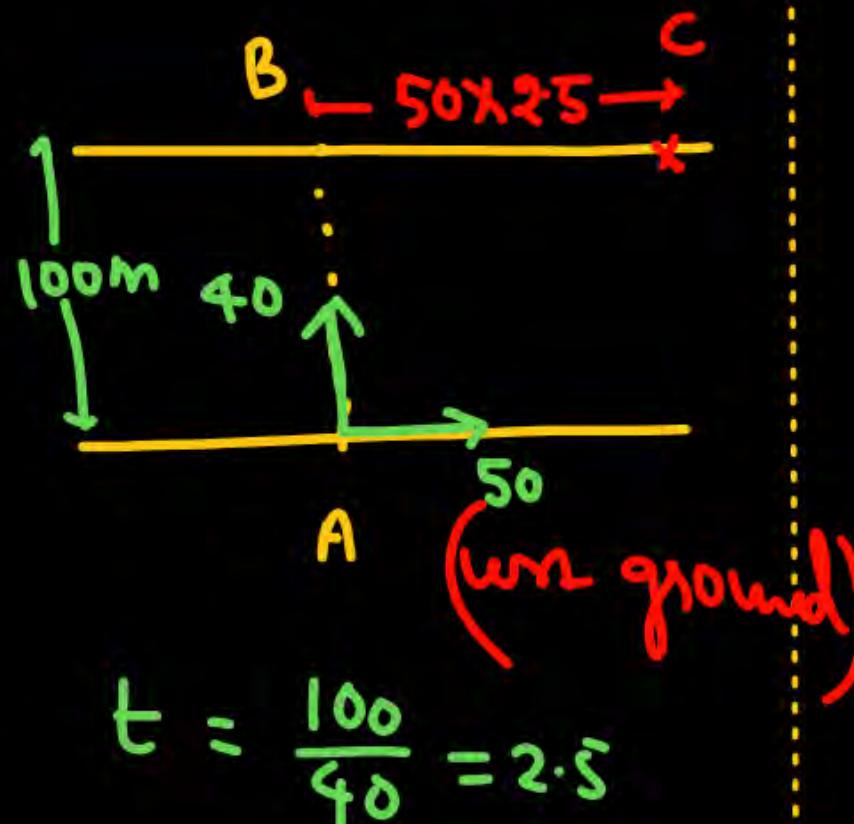
$$\text{time to cross} = \frac{100}{25\sqrt{3}}$$

$$\text{Drift} = 0$$

Q

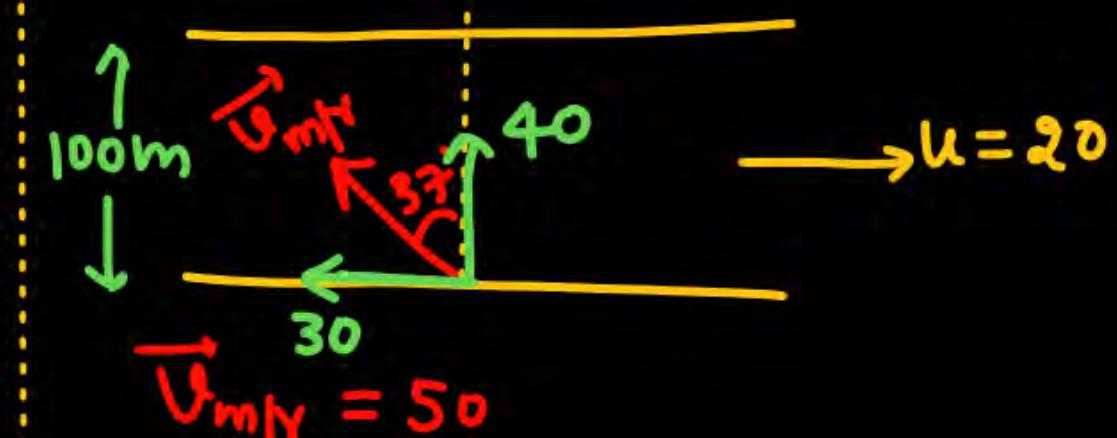


$$\begin{aligned}\vec{v}_{m/Y} &= 30\hat{i} + 40\hat{j} \\ \vec{v}_m - 20\hat{i} &= 30\hat{i} + 40\hat{j} \\ \vec{v}_m &= 50\hat{i} + 40\hat{j}\end{aligned}$$



$$t = \frac{100}{40} = 2.5$$

Q



HCV

Q2

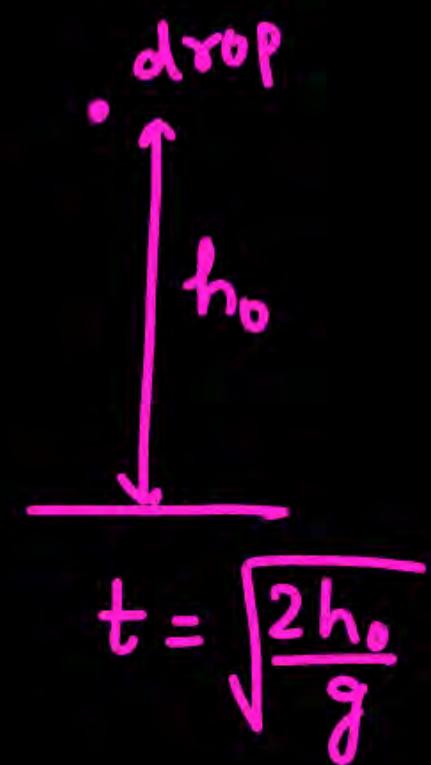
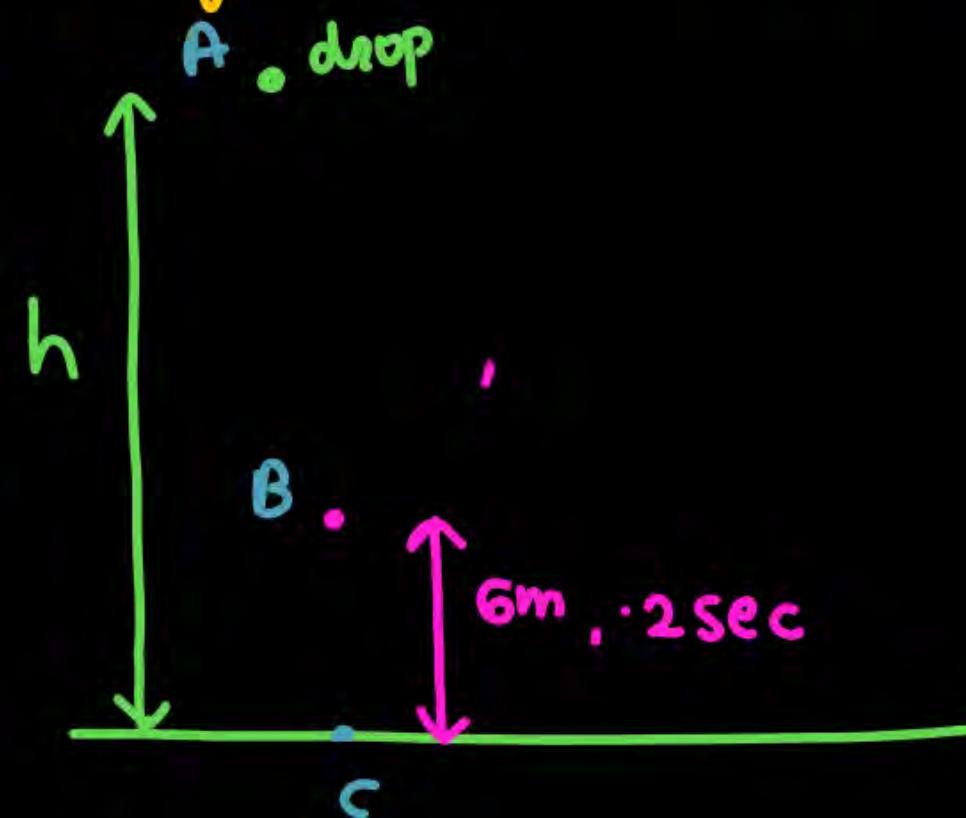
A ball dropped from a height, if it takes  $\cdot 2$  sec to cross the last 6m before hitting the ground. find height from which it was dropped.

P  
W

$$t_{A \rightarrow C} = t = \sqrt{\frac{2h}{g}}$$

$$t_{A \rightarrow B} = t - \cdot 2 = \sqrt{\frac{2(h-6)}{g}}$$

hit & trial



R.m

Q

A ball is projected vertically upward with velocity 50 m/s  
find distance travelled by ball in last sec of upward journey.

P  
W

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

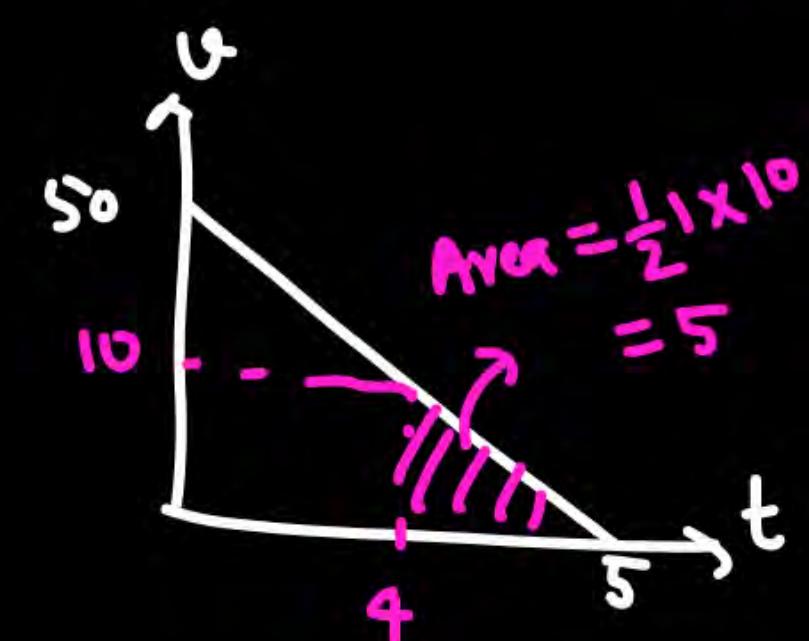
$$0^2 = 10^2 - 2 \times 10 \times h_0$$

$$h_0 = 5 \text{ m}$$

$$v_f = 0 \quad t = 5$$

$$h_0 \uparrow \quad t = 4 \quad \uparrow 10 \text{ m/s}$$

$$\frac{50 \text{ m/s}}{t=0}$$



R.m

Q

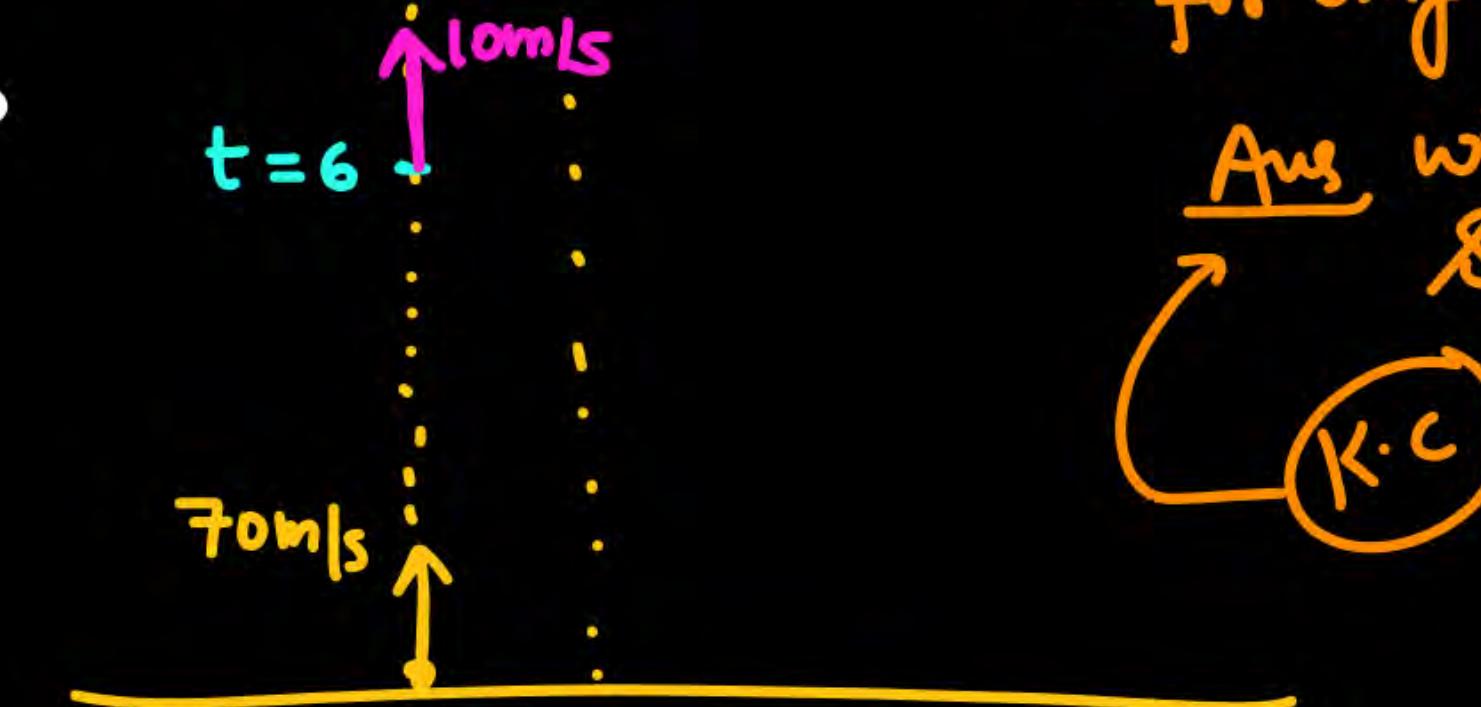
A ball is projected vertically upward with velocity 70 m/s. find distance travelled by ball in last sec of upward journey.

$$t=7 \quad u_f=0 \quad t=7 \text{ sec}$$

$$t=6 \longrightarrow t=7$$

$$0^2 = 10^2 - 2 \times 10 \times h_0$$

$$h_0 = 5 \text{ m}$$



P  
W

70 m/s

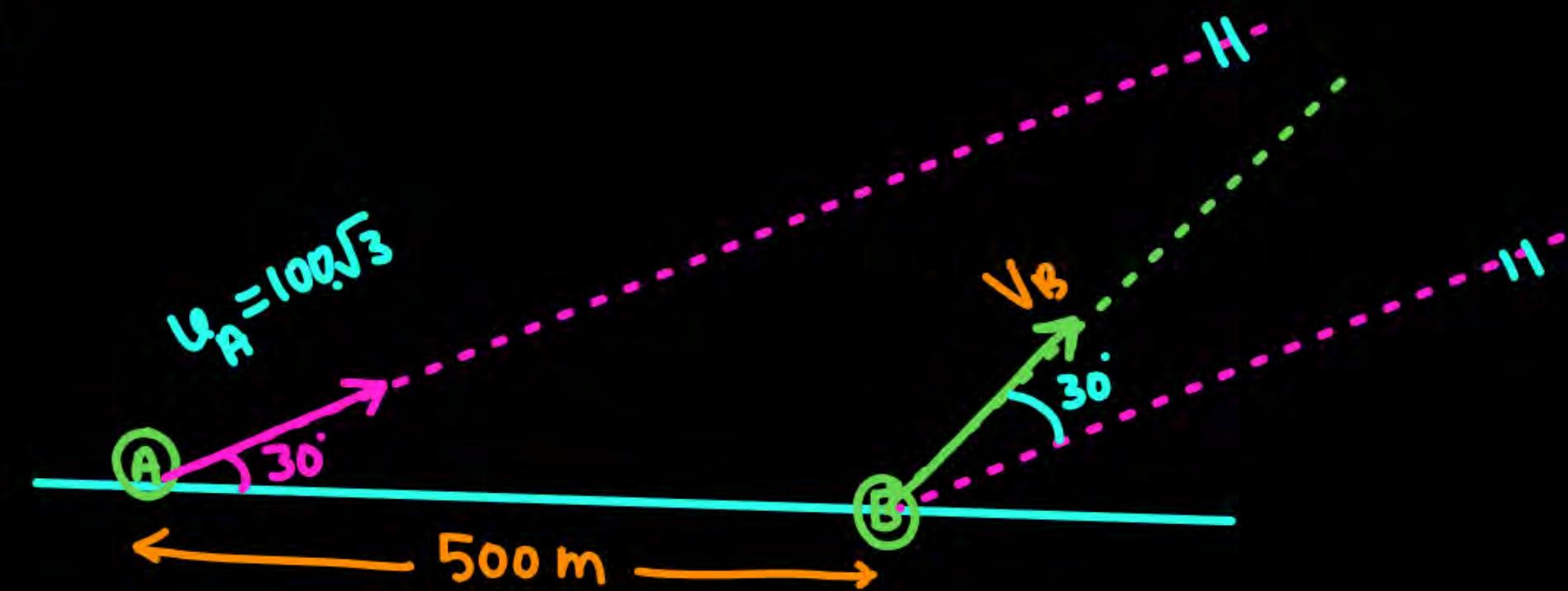
upward journey.

for any velocity

Ans will be same.

K.C

Q



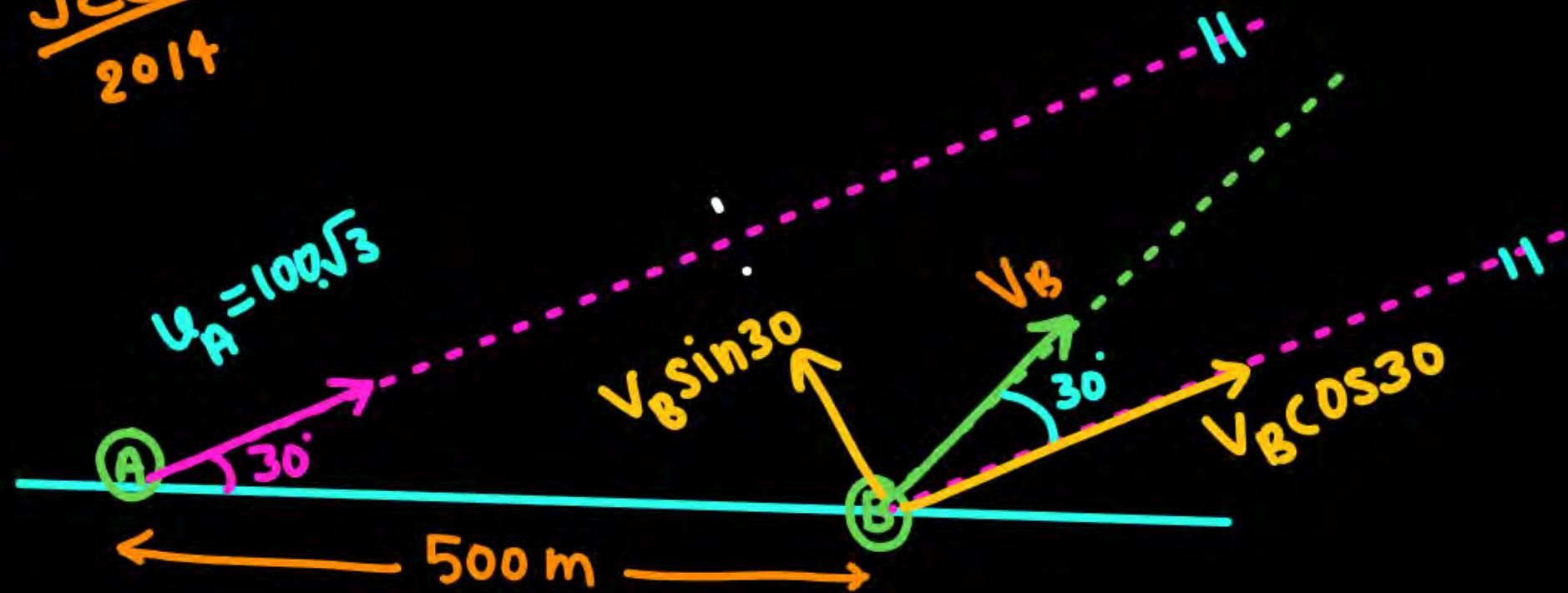
① find  $v_B$   
if observer in A  
observe that B is moving  
with const velocity.  
perpendicular to the  
line of motion of A

P  
W

tough

JEE ADV.  
2014

P  
W



① find  $v_B$

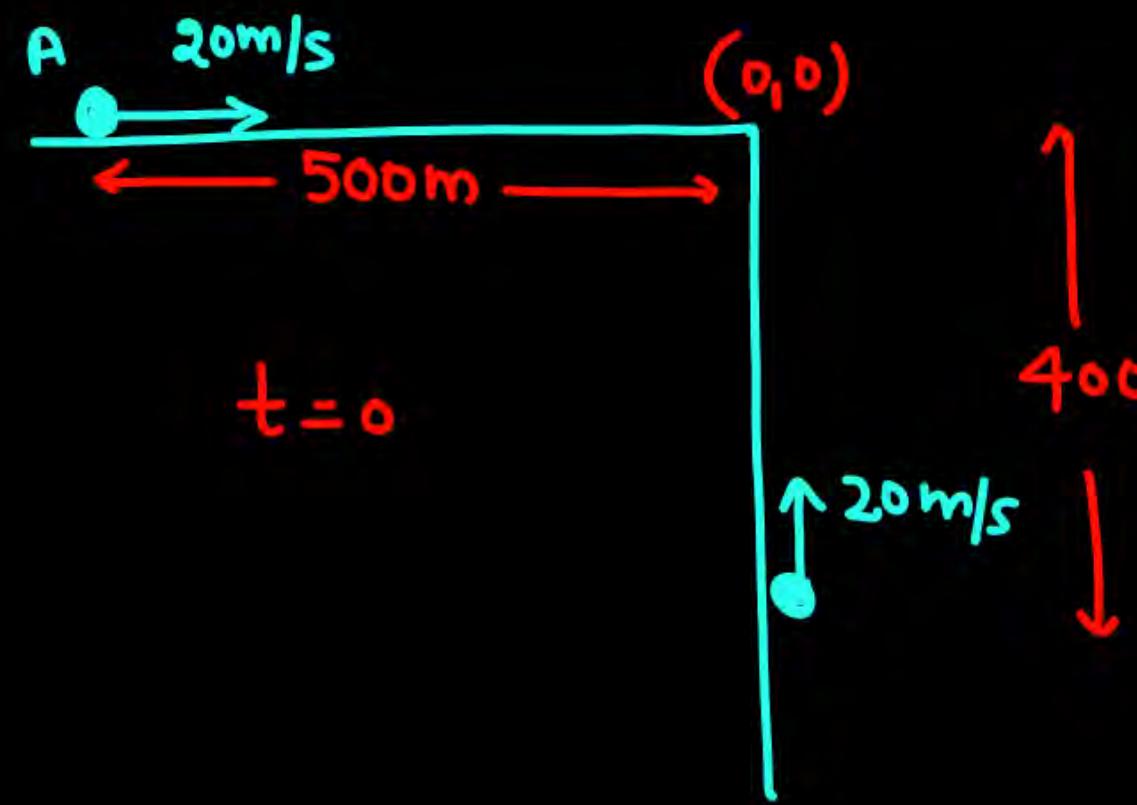
if observer in A

Observe that B is moving  
with const velocity  
perpendicular to the  
line of motion of A

$$v_A = v_B \cos 30$$

$$100\sqrt{3} = v_B \frac{\sqrt{3}}{2}$$

## Min distance between two moving particle:



find min gap between them

Soln

$$\vec{v}_A = 20\hat{i}$$

$$\vec{v}_B = 20\hat{j}$$

$$\vec{v}_{B/A} = 20\hat{j} - 20\hat{i}$$

$$\vec{v}_{B/A} = -20\hat{i} + 20\hat{j}$$

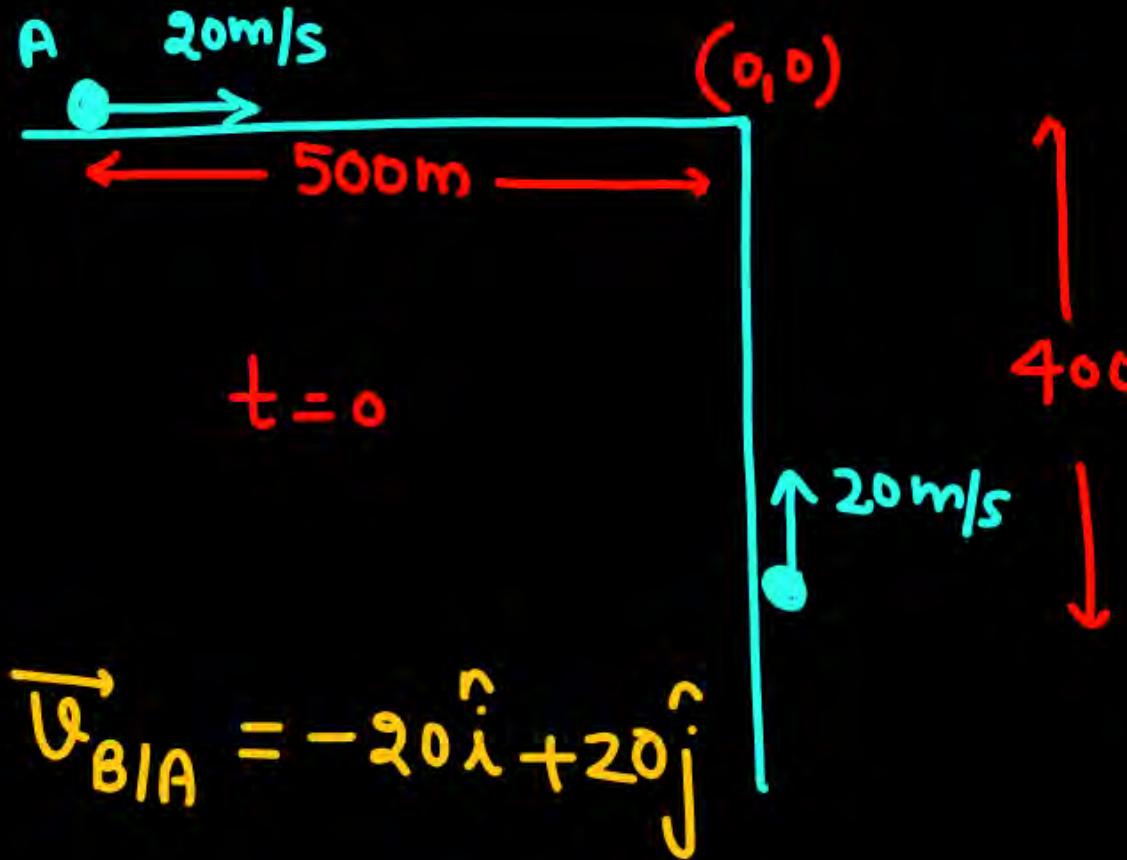
①  $v_A \ v_B = \checkmark$

②  $v_{B/A} = ?$

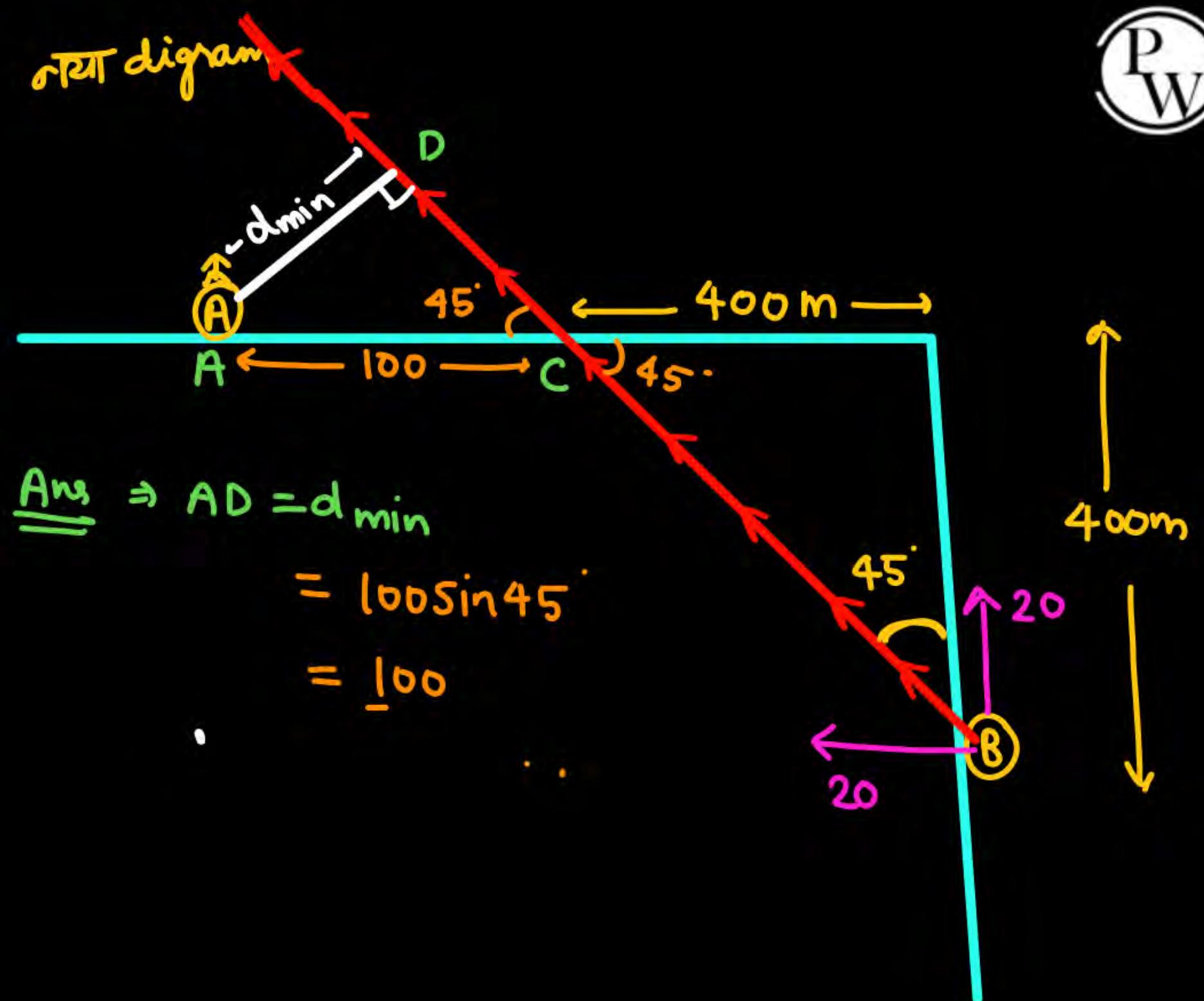
③ नया फिर्मे  
वनामों

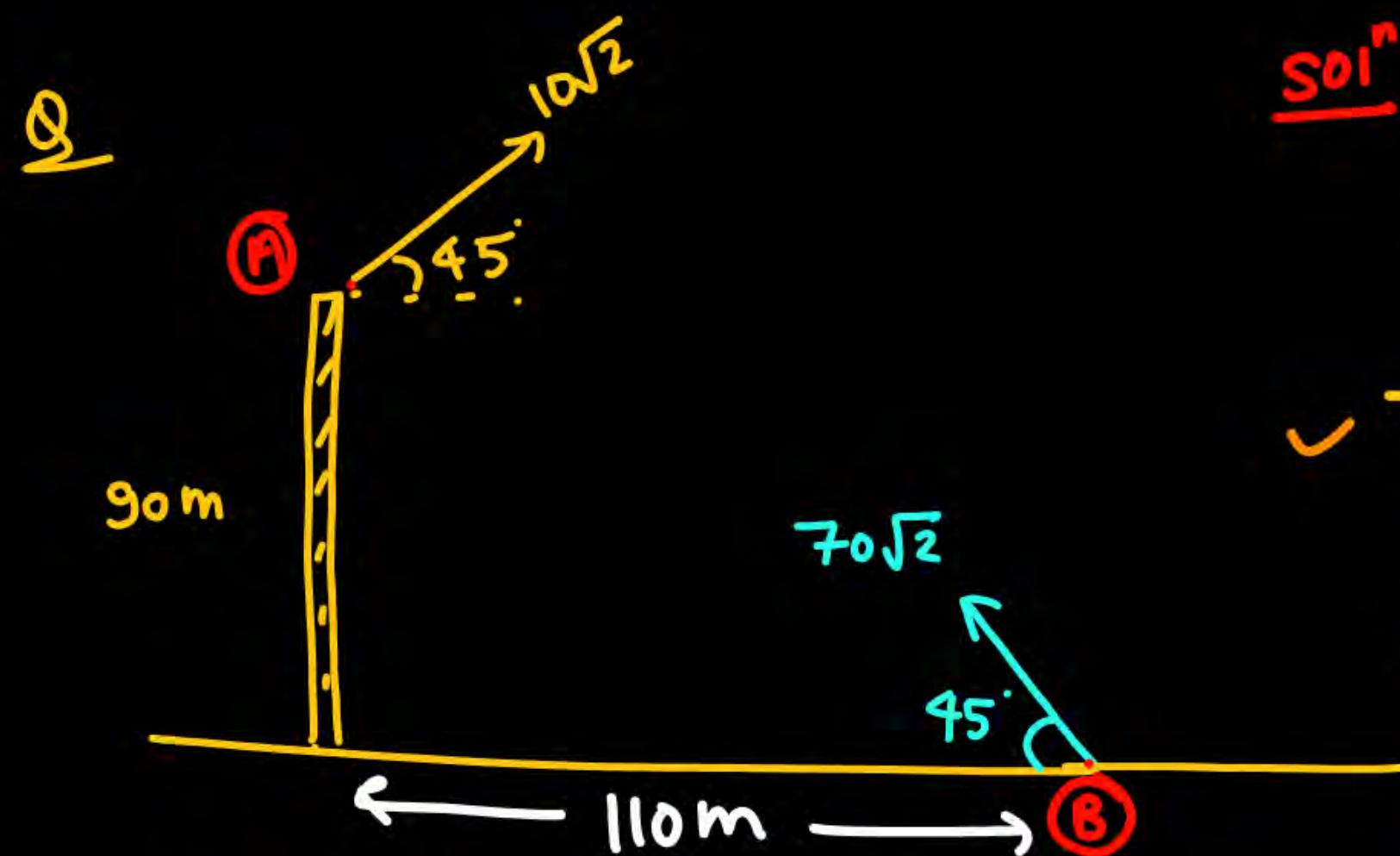
④ रास्ता लागती  
→  $\perp$  draw करो।

(maths)



$$\vec{v}_{B/A} = -20\hat{i} + 20\hat{j}$$





min Distance  
between them

SOL,

$$\vec{v}_A = 10\hat{i} + 10\hat{j}$$

$$\vec{v}_B = -70\hat{i} + 70\hat{j}$$

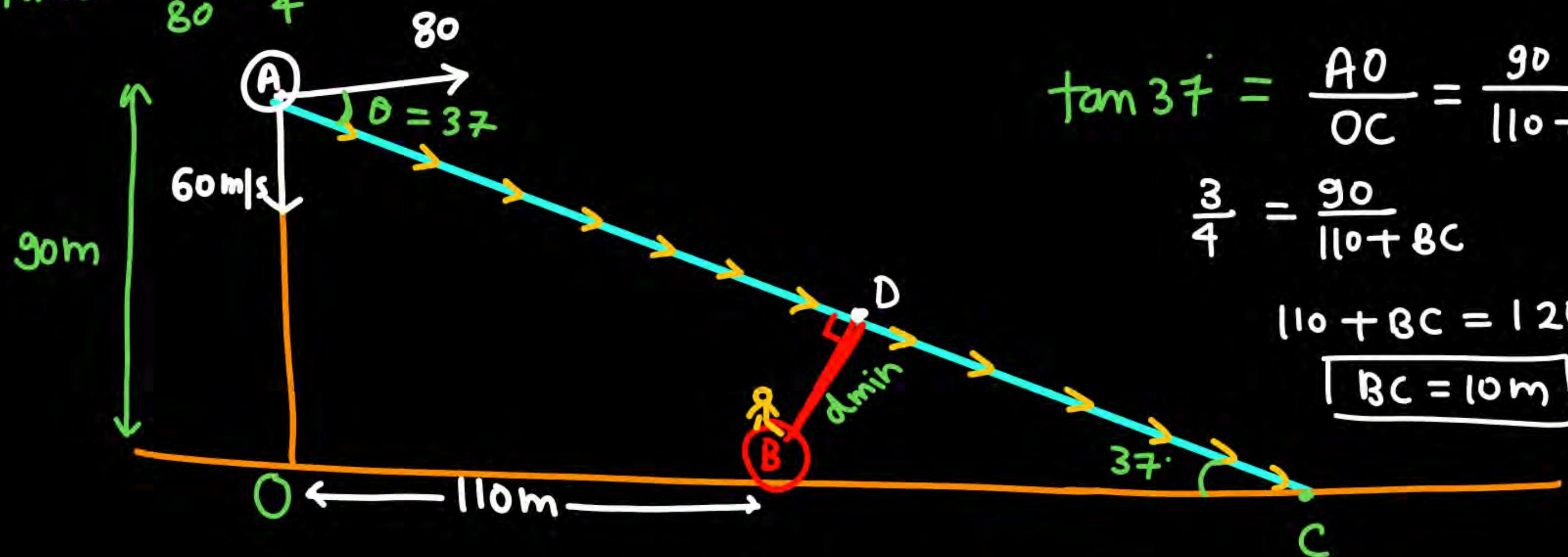
$$\checkmark \vec{v}_{A/B} = 80\hat{i} - 60\hat{j}$$

प्रयोग

$$\vec{\alpha}_{A/B} = 0$$

P  
W

$$\tan \theta = \frac{60}{80} = \frac{3}{4}$$



$$\tan 37^\circ = \frac{AO}{OC} = \frac{90}{110 + BC}$$

$$\frac{3}{4} = \frac{90}{110 + BC}$$

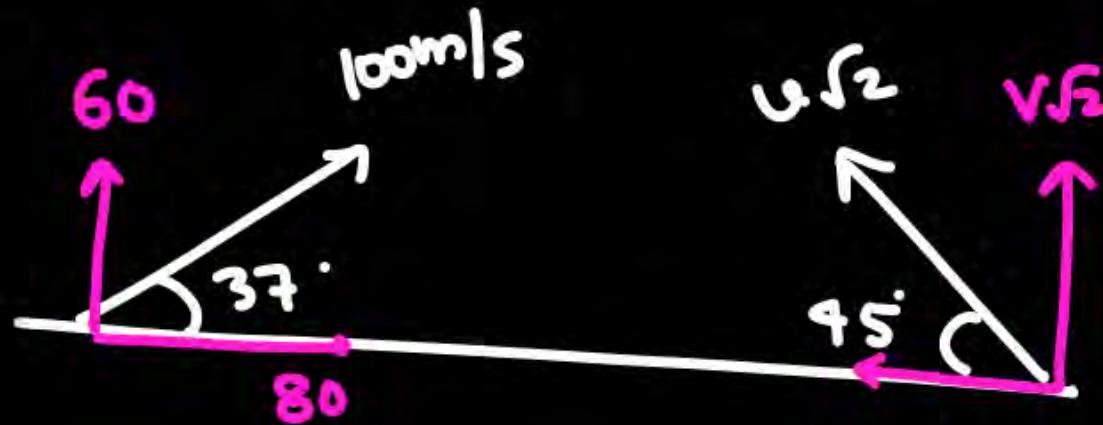
$$110 + BC = 120$$

$$BC = 10 \text{ m}$$

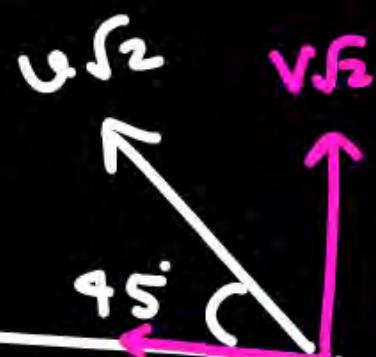
Ans  $BD = d_{\min} = 10 \sin 37^\circ = 6$

$$\sin 37^\circ = \frac{BD}{BC} = \frac{BD}{10}$$

Q



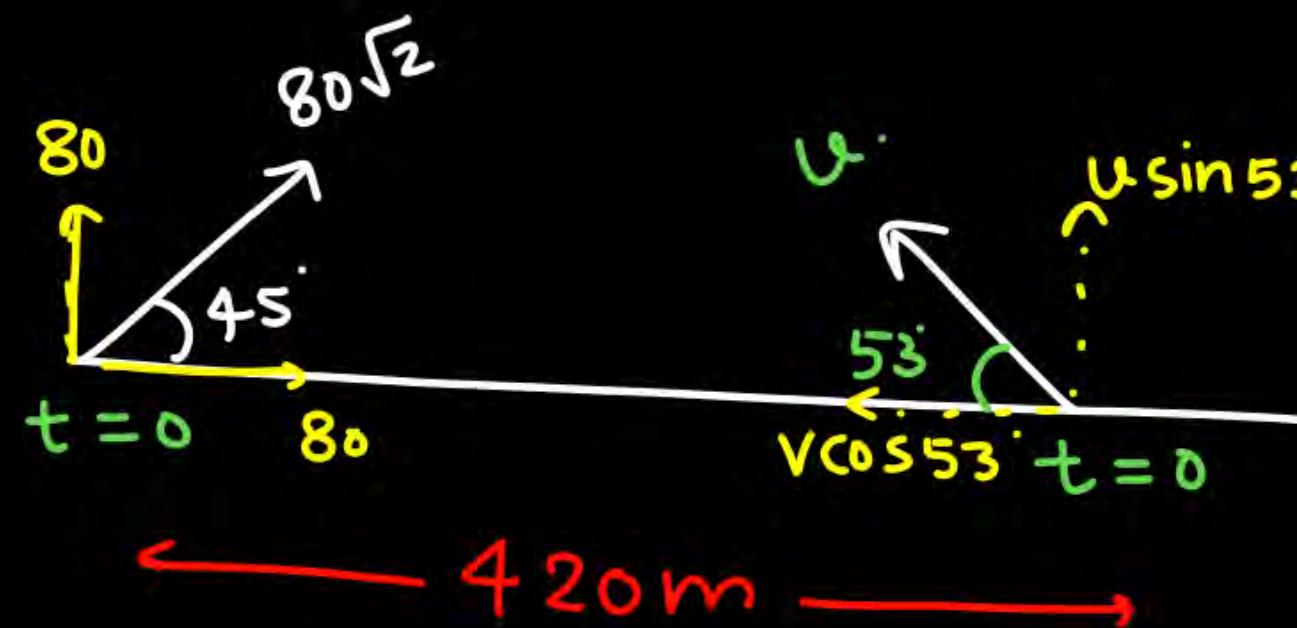
Both collide in air  
find  $v = ?$



$$60 = v\sqrt{2} \sin 45$$

$$\boxed{v = 60 \text{ Ans}}$$

Q



$$80\sqrt{2} \sin 45^\circ = v \sin 53^\circ$$

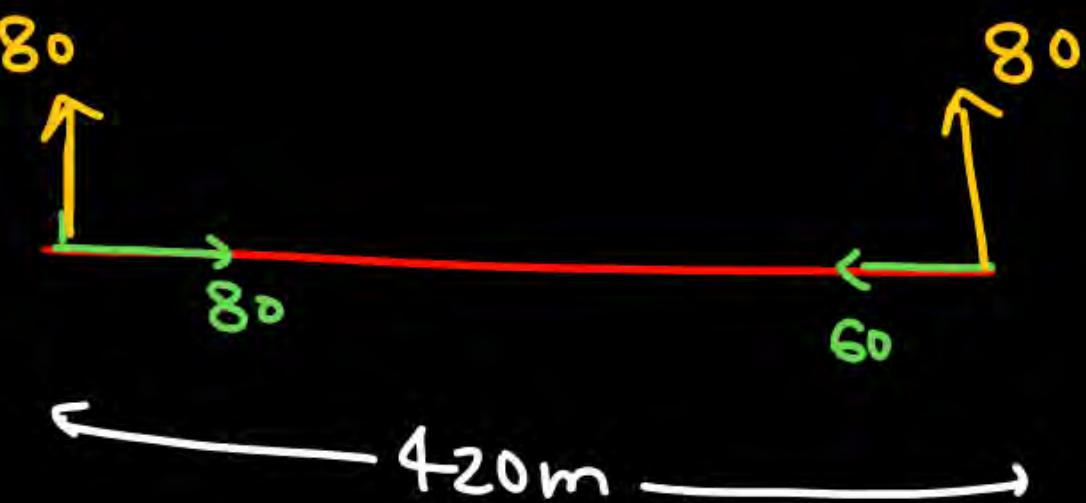
$$80 = v \times \frac{4}{5}$$

$$\boxed{v = 100}$$

① find  $v$  if both collide in air

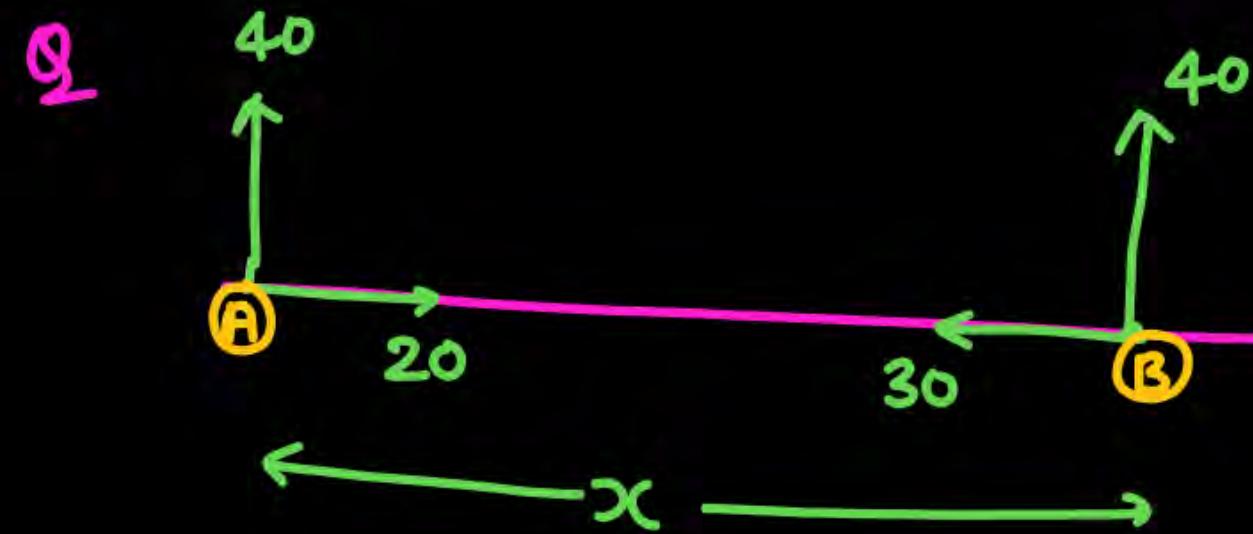
$$v = 100$$

② find when they will collide.



$$\textcircled{x} = v_{rel} = 140$$

$$t = \frac{420}{140} = 3\text{ sec}$$



find Value of  $x$  for which both particle collide.

$$x_{\max} = u_{\text{rel}} \cdot T = 50 \times 8 = 400$$

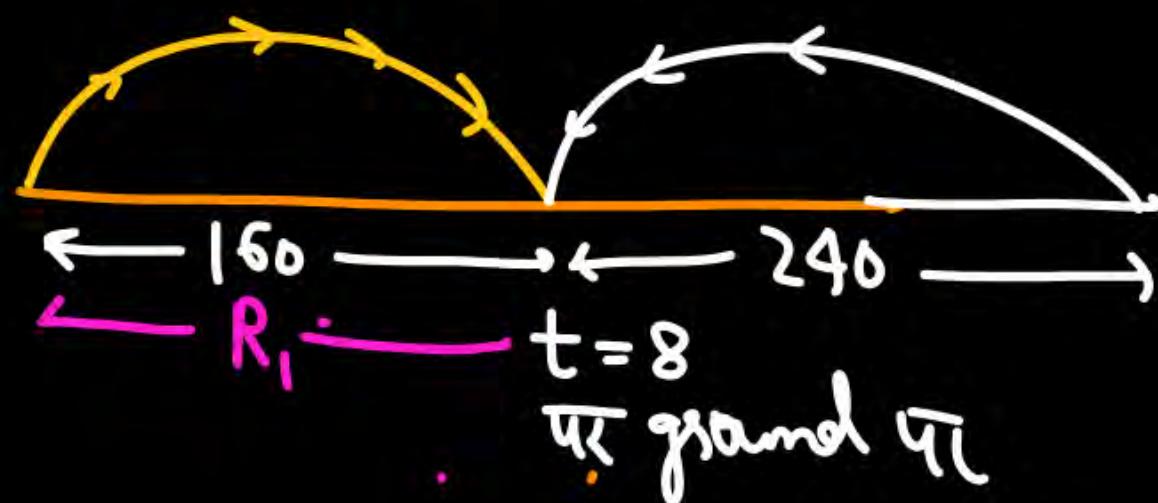
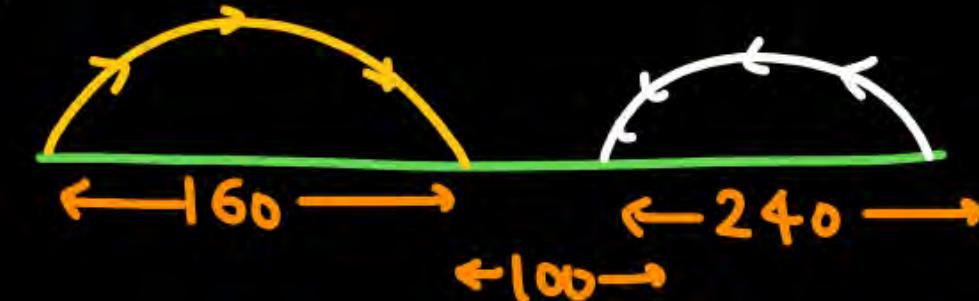
$$x \leq 400$$

case ①  $x > 400$   
 $x = 500$

① ज्यादा से ज्यादा कितनी दूर दूरमें रह सकता है  $\Rightarrow T = 8 \text{ sec}$

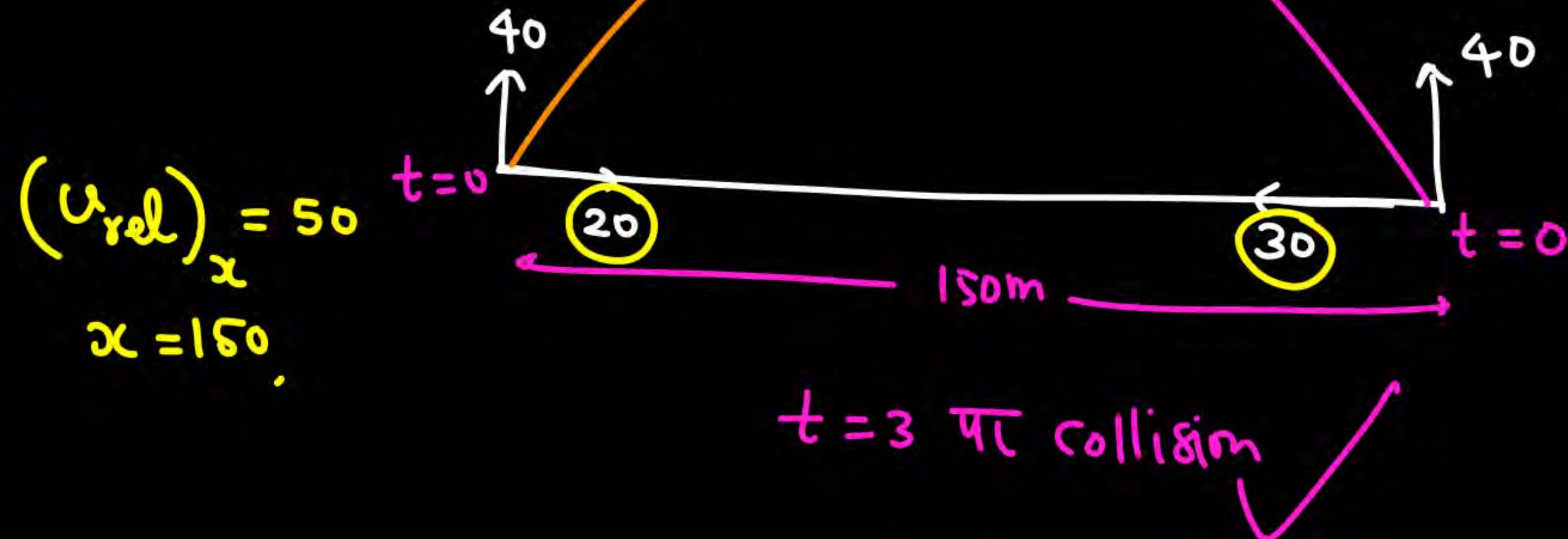
$$160 + 240 = 400$$

case ②  $x = 400$

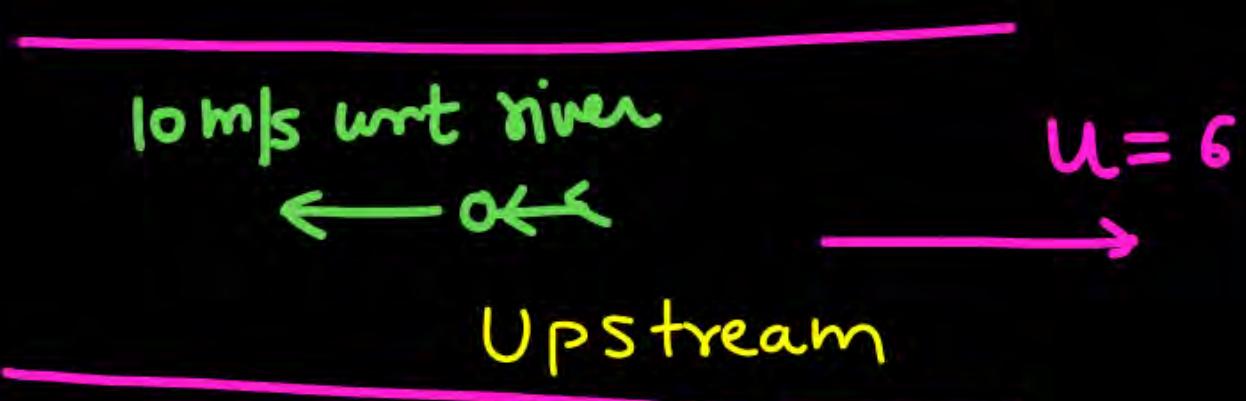
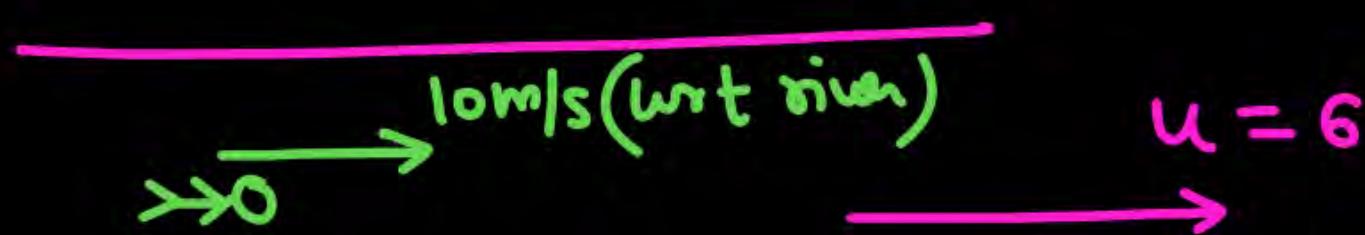


Case  $x < 400$

$x = 150$  let



Q River is flowing with speed 6 m/s, and  
 $\vec{v}_{\text{man/river}}$  is 10 m/s.



$\vec{v}_{\text{man/ground}} = 16$  (Downstream)

$\vec{u}_m = 16\hat{i}$

$$\vec{v}_{m|r} = 10\hat{i}$$

$$\vec{v}_m - \vec{v}_r = 10\hat{i}$$

$$\vec{v}_m - 6\hat{i} = 10\hat{i}$$

$$\vec{v}_{m|\text{ground}} = -4\hat{i}$$

$$\vec{v}_{m|r} = -10\hat{i}$$

$$\vec{v}_m - 6\hat{i} = -10\hat{i}$$

$\vec{v}_m = -4\hat{i}$

note

Q

River is flowing with speed 6m/s, and  
 $\vec{v}_{\text{man/river}}$  is 10m/s.

P  
W

man start swimming from  
A to B and return back  
to A. find time taken.

Sol<sup>n</sup>

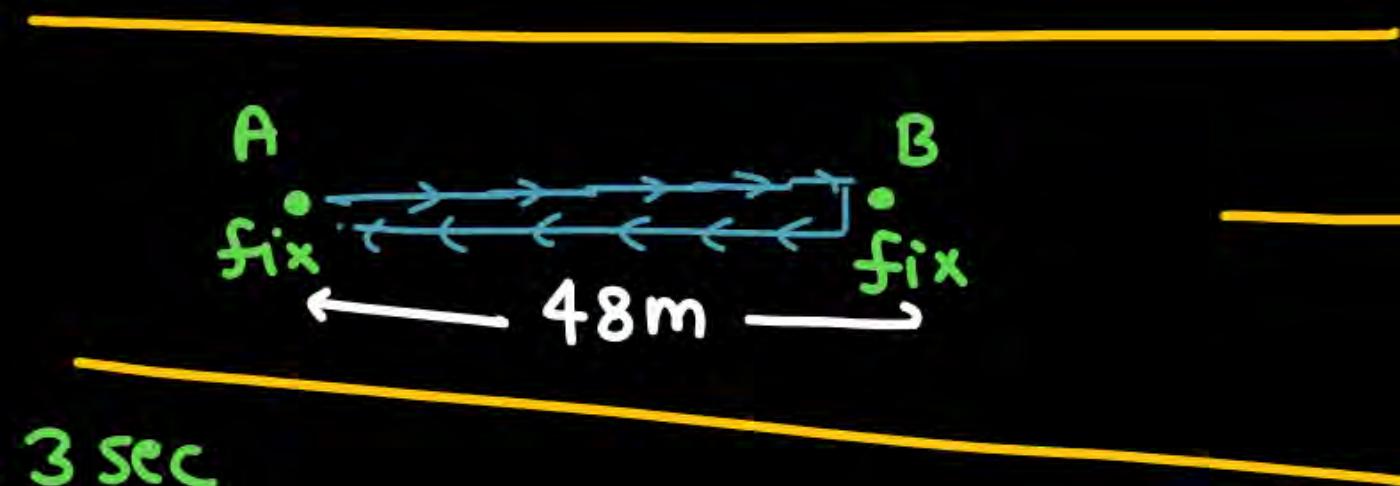
(A  $\rightarrow$  B)

$$t_{A \rightarrow B} = \frac{48}{10+6} = 3 \text{ sec}$$

B  $\rightarrow$  A

$$t_{B \rightarrow A} = \frac{48}{10-6} = 12 \text{ sec}$$

$$\text{total time} = 3 + 12 = 15 \text{ sec}$$



$$u = 6$$

$$\text{Avg Speed} = \frac{48+48}{15}$$

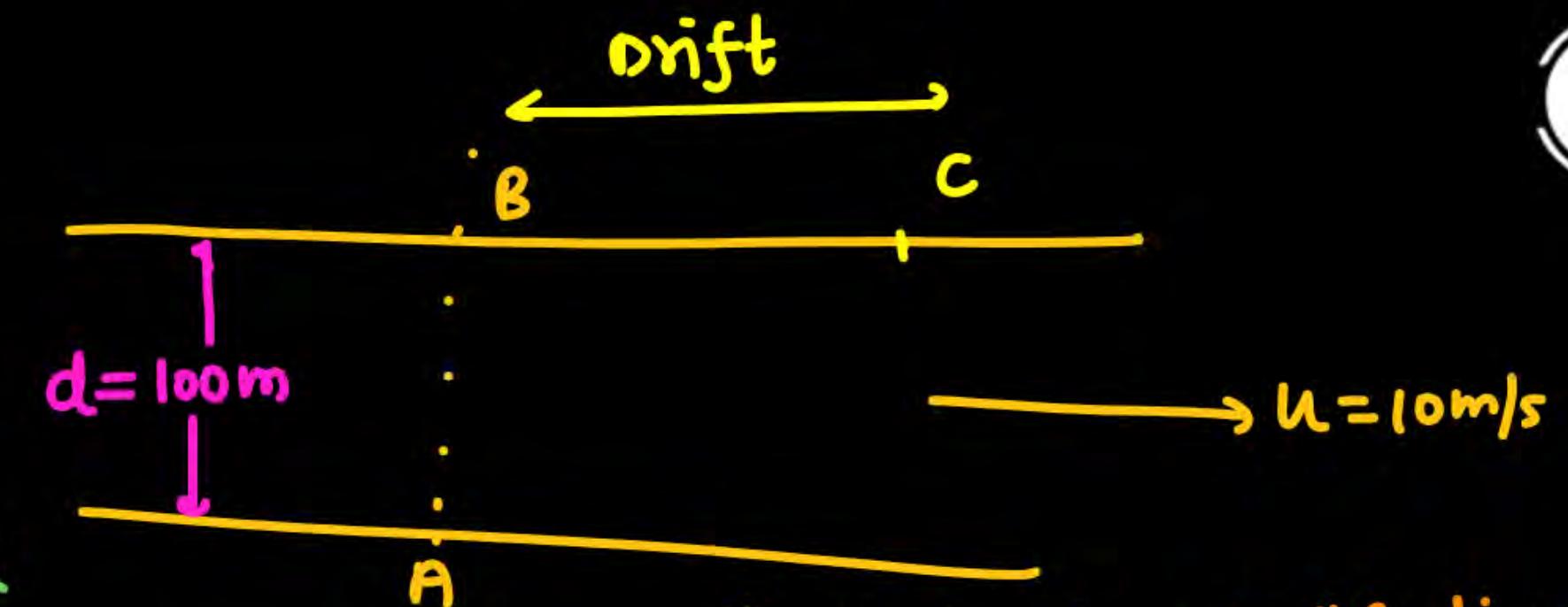
$$\text{Avg. Velocity} = 0$$

Q

width of river = 100m

$\vec{v}_r$  wrt ground = 10m/s

$v_{m/r} = v = 20\text{ m/s}$



- ① In which dir<sup>n</sup> man should swim to cross the river in min. distance path

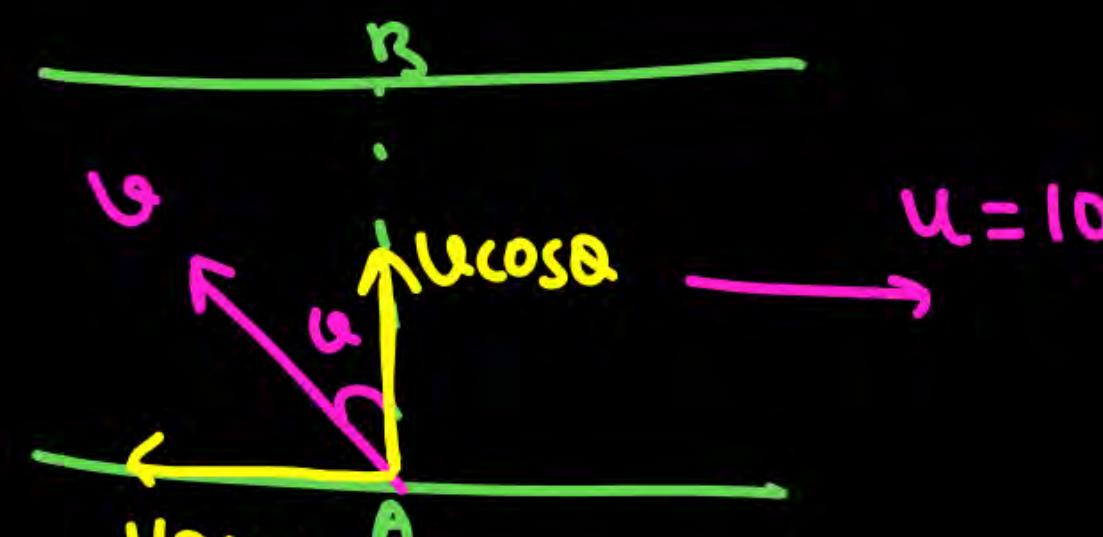
$$v \sin \theta = u$$

$$20 \sin \theta = 10$$

$$\boxed{\theta = 30^\circ}$$

$30^\circ \Rightarrow$  with AB

$120^\circ \Rightarrow$  with river Velocity



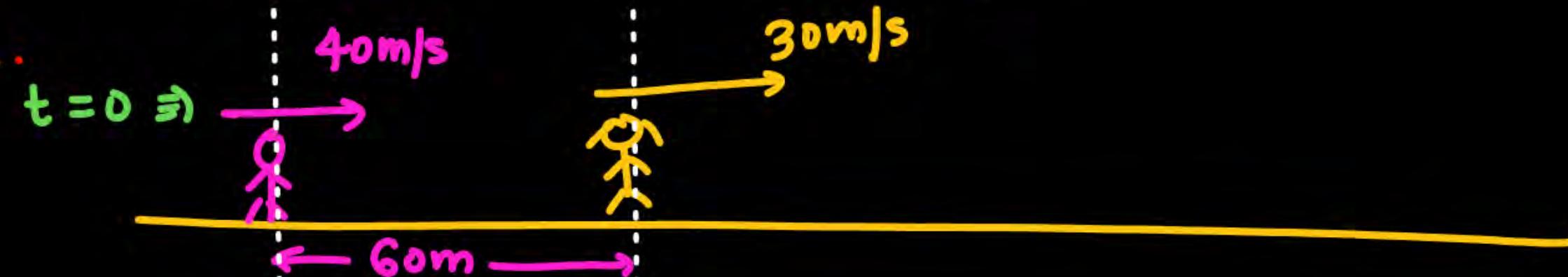
- ② find min possible time to cross the river & Drift in this case

$$t = \frac{100}{20} = 5\text{ sec}$$

$$\begin{aligned} \text{Drift} &= CB = 10 \times 5 \\ &= 50 \end{aligned}$$

find when and where they will meet.

Q.



(m-1) let they meet at time  $t$



$$60 + 30t = 40t$$

$$60 = 10t$$

$$\boxed{t = 6 \text{ sec}}$$

$$s = vt \quad \text{ground}$$

m-2 (Relative)

wrt B.

$$\vec{v}_{A/B} = 40 - 30 = 10\hat{i}$$



when they meet let time 't'

$$\vec{s}_{A/B} = +60$$

$$\vec{v}_{A/B} = 10$$

$$\vec{s}_{A/B} = \vec{v}_{A/B} \times t$$

$$60 = 10 \times t$$

$$t = 6 \text{ sec}$$

$$\vec{d} = \vec{v} \cdot t, \quad (a=0)$$

$$\left. \begin{array}{l} v = u + at \\ s = ut + \frac{1}{2}at^2 \\ v^2 = u^2 + 2as \end{array} \right\} \bar{a} \rightarrow \text{const}$$

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

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

wyś B'

$$\vec{d}_{A/B} = \vec{v}_{A/B} \times t, \quad (a_{A/B} = 0)$$

$$v_{A/B} = u_{A/B} + a_{A/B} t$$

$$s_{A/B} = u_{A/B} t + \frac{1}{2} a_{A/B} t^2$$

$$v_{A/B}^2 = u_{A/B}^2 + 2 a_{A/B} s_{A/B}$$

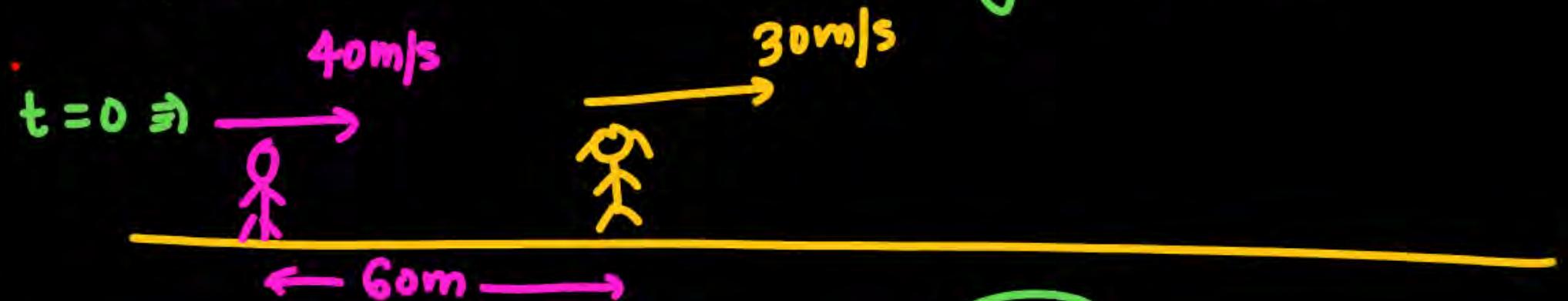
$$v_{rd} = u_{rd} + a_{rd} t$$

$$s_{rd} = u_{rd} t + \frac{1}{2} \cdot a_{rd} t^2$$

$$v_{rel}^2 = u_{rel}^2 + 2 a_{rel} s_{rel}$$

find when and where they will meet.

Q



m-2 (Relative)

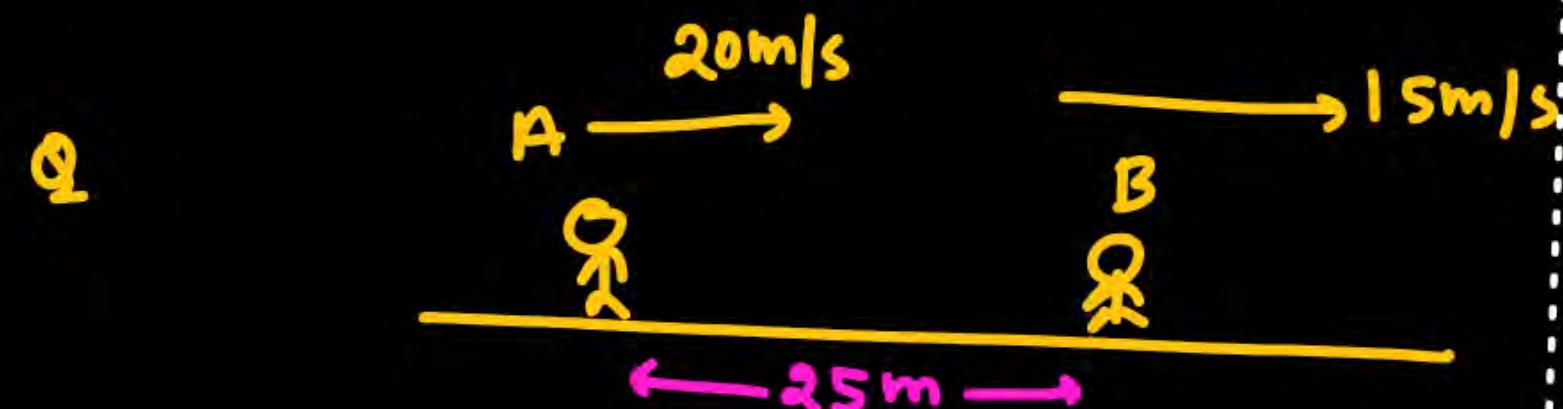
$$U_{rel} = 10$$

$$S_{rel} = 60$$

$$60 = 10 \times t$$

$$\boxed{t = 6}$$

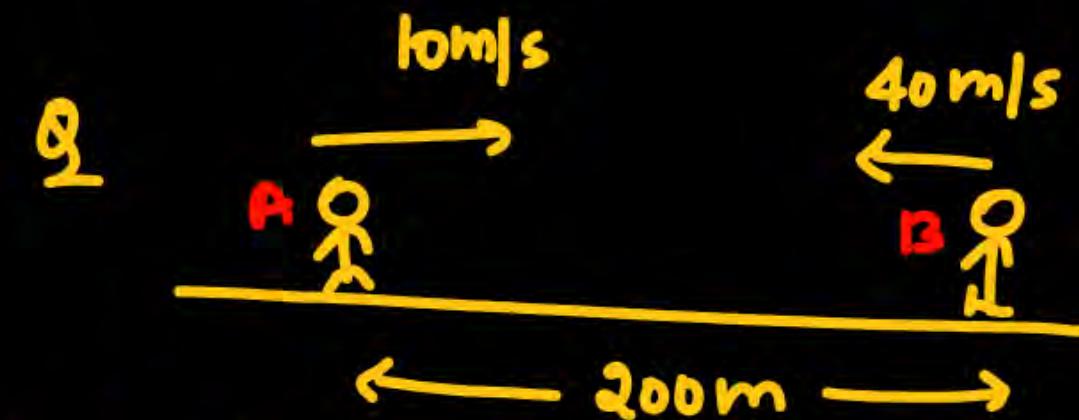
Short  
cut



when they will meet

$$25 = 5 \times t$$

$$t = 5 \text{ sec}$$



when they will meet

$$200 = 50t, \quad t = \underline{\underline{4 \text{ sec}}} \quad \text{Ans}$$

wrt B



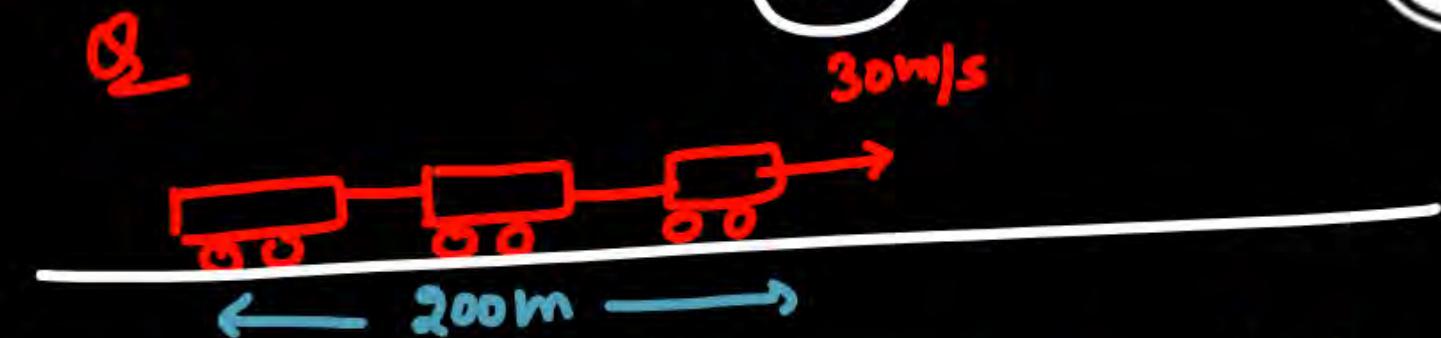
$$v_{A/B} = 10 - (-40) = 50$$

$$s_{A/B} = +200$$

$$200 = 50 \times t$$

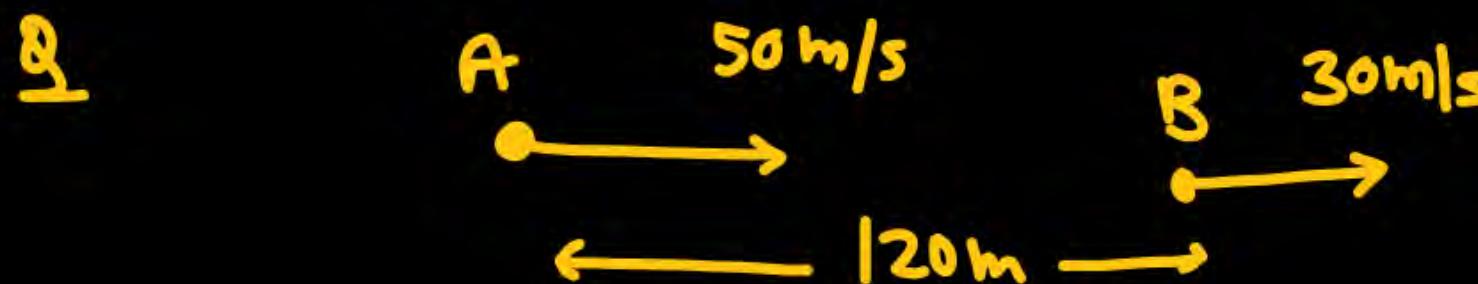


when they will meet  $t = 10 \text{ sec}$



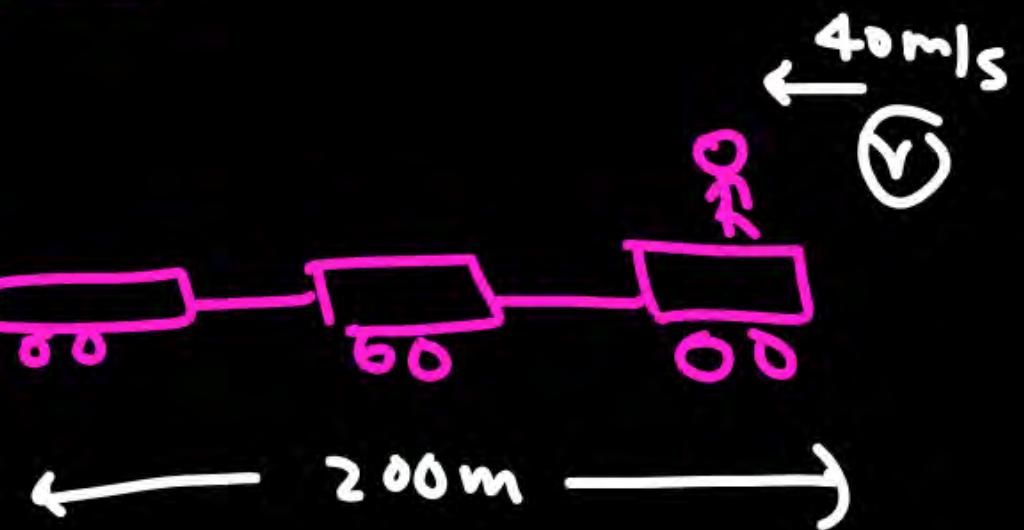
when Bird will cross the train

$$V_{\text{rel}} = 40, S_{\text{rel}} = 200$$

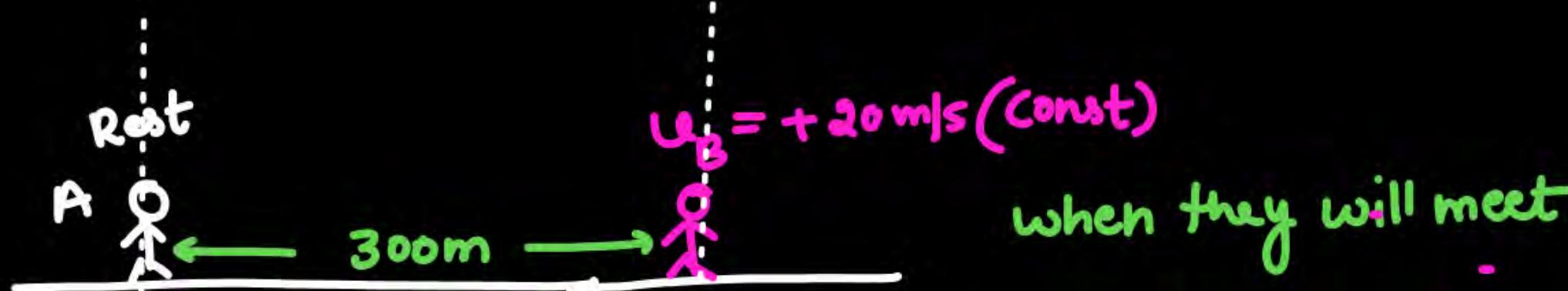


when they will meet

$$t = \frac{120}{20} = 6$$



Q



$$a_A = +10$$

m1 (पुराना)

$$300 \text{ m} \xrightarrow{\quad} 20t \xleftarrow{\quad}$$

$$S = 0 + \frac{1}{2} 10t^2 = 5t^2$$

$$5t^2$$



$$300 + 20t = 5t^2$$

$$5t^2 - 20t - 300 = 0$$

$$t^2 - 4t - 60 = 0$$

$$t^2 - 10t + 6t - 60 = 0$$

$$(t-10)(t+6) = 0$$

$$t = 10 \text{ sec}$$

P  
W

m-2 Relative

(A)

$$u_A = 0$$

$$a_A = +10$$

(B)

$$u_B = 20$$

$$a_B = 0$$

$\longleftrightarrow 300\text{m} \longrightarrow$

wrt B अंगी वाला

$$t=0$$

(A)

$\leftarrow 300\text{m}$

(B)

$$\begin{aligned}\vec{u}_{A/B} &= 0 - 20 \\ &= -20\end{aligned}$$

$$a_{A/B} = 10 - (0) = 10$$

let they meet at time t

$$\vec{s}_{A/B} = +300$$

wrt B

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

$$+300 = -20t + \frac{1}{2} \cdot 10 \cdot t^2$$

$$5t^2 - 20t - 300 = 0$$

$$t^2 - 4t - 60 = 0$$

$$(t-10)(t+6) = 0$$

$$t = 10$$

Q

$$A \xrightarrow{u_A = 10 \text{ m/s}}$$

$$a_A = +20 \text{ m/s}^2$$

75m

$$B \xrightarrow{u_B = 20 \text{ m/s}}$$

$$B$$

$$a_A = +10 \text{ m/s}^2$$

$$\vec{u}_{AIB} = 10 - 20 = -10$$

$$\vec{a}_{AIB} = 20 - 10 = +10$$

$$\vec{s}_{AIB} = +75$$

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

$$75 = -10t + \frac{1}{2} \times 10 \times t^2$$

$$5t^2 - 10t - 75 = 0$$

$$t^2 - 2t - 15 = 0$$

$$(t-5)(t+3) = 0$$

$$\boxed{t=5}$$

when they will meet  
=?

पुराना method

$$75 + 20t + \frac{1}{2} \times 10 \times t^2 = 10t + \frac{1}{2} \times 20 \times t^2$$

$$75 + 20t + 5t^2 = 10t + 10t^2$$

$$5t^2 - 10t - 75 = 0$$

$$t^2 - 2t - 15 = 0$$

$$(t-5)(t+3) = 0$$

$$\boxed{t=5}$$

Q

when they  
will meet

$$m_1 \Rightarrow 30t + \frac{1}{2} \cdot 7 \cdot t^2 + 100 = 20t + \frac{1}{2} \times 15t^2$$

$$4t^2 - 10t - 100 = 0$$

$$2t^2 - 5t - 50 = 0$$

m-2

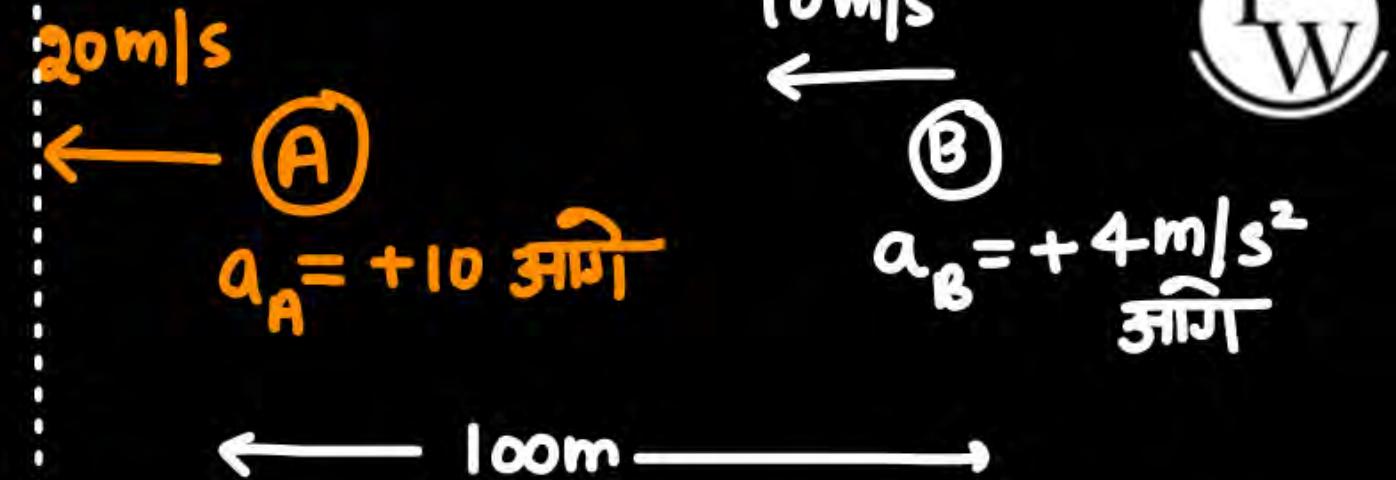
$$u_{A|B} = 20 - 30 = -10$$

$$a_{A|B} = 15 - 7 = 8$$

$$s_{A|B} = +100$$

$$\frac{100}{4t^2 - 10t - 100 = 0} = -10t + \frac{1}{2} \times 8t^2$$

$$4t^2 - 10t - 100 = 0$$



$$m_1 \Rightarrow -10t + \frac{1}{2} \times 4t^2 + 100 = -20t + \frac{1}{2} \times 10t^2$$

$$3t^2 - 10t - 100 = 0$$

$$u_{A|B} = (-20) - (-10) = -10$$

$$a_{A|B} = (+10) - (+4) = +6$$

$$s_{A|B} = +100$$

$$100 = -10t + \frac{1}{2} \times 6 \times t^2$$

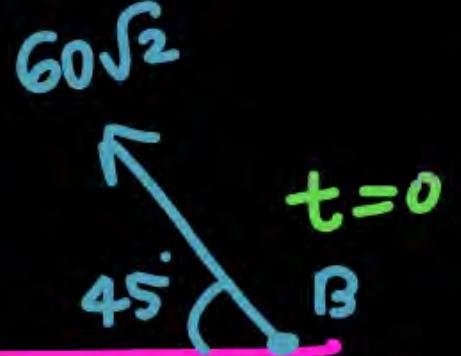
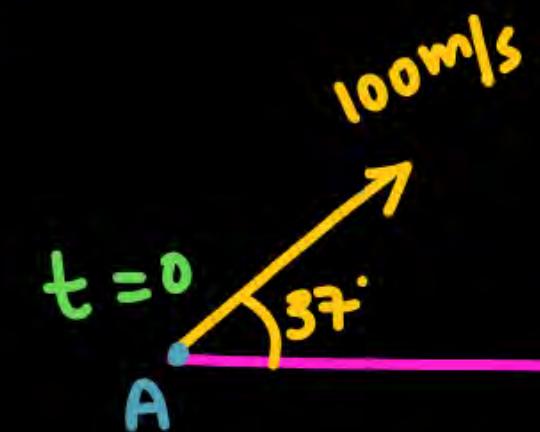
$$3t^2 - 10t - 100 = 0$$



Path of projectile  
पराबोला (wrt ground)

wrt ground

if  $a = 0$   
 $v = \text{const}$



जब तक  
till  
Both  
are  
in Air

path of A wrt B = st. line

$$a_A = g \text{ नीचे} = -10 \hat{j}$$

$$a_B = g \text{ नीचे} = -10 \hat{j}$$

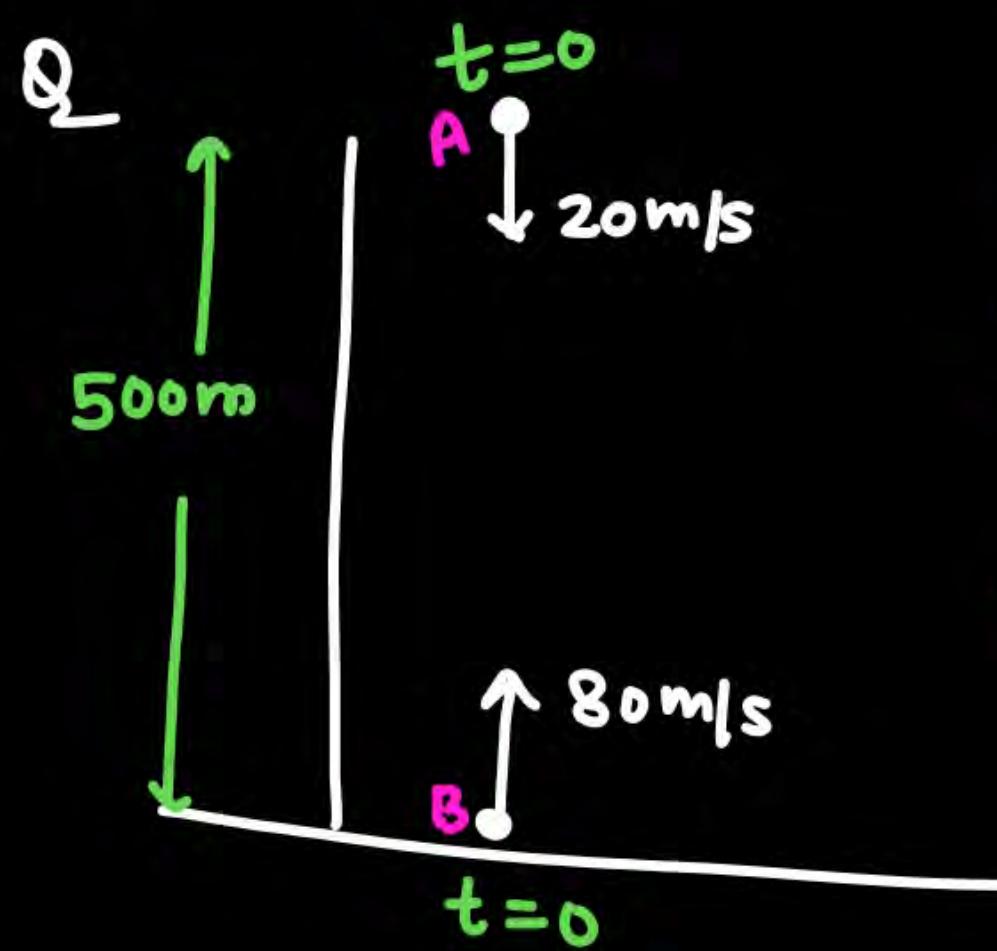
$$\vec{a}_{A/B} = 0$$

$$\vec{v}_{A/B} = \text{const}$$

$$\vec{a}_{B/A} = 0$$

$$\vec{v}_{B/A} = \text{const}$$

B पर जाकर वैरने पर A की  
velocity की दूरी ना const  $\equiv$  (st. line path)



when they will meet

$$u_{A/B} = -20 - 80 = -100$$

$$a_{A/B} = (-10) - (-10) = 0$$

$$s_{A/B} = -500$$

$$-500 = -100t + \frac{1}{2} \times 0 \times t^2$$

$$t = 5 \text{ sec}$$

direct

$$a_{\text{rel}} = 0$$

$$v_{\text{rel}} = 100$$

$$500 = 100 \times t$$

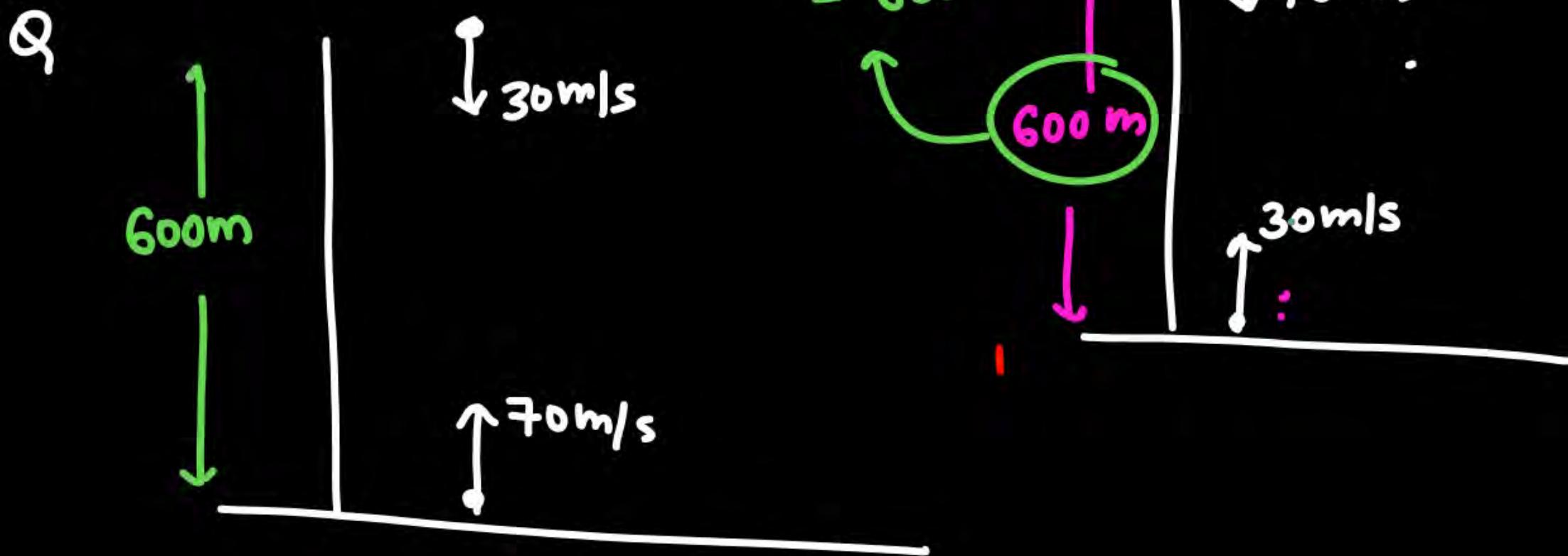
$$t = 5 \text{ sec}$$

$$S = 70 \times 6 + \frac{1}{2} \times 10 \times 6^2$$

$$= 420 + 180$$

$$= 600$$

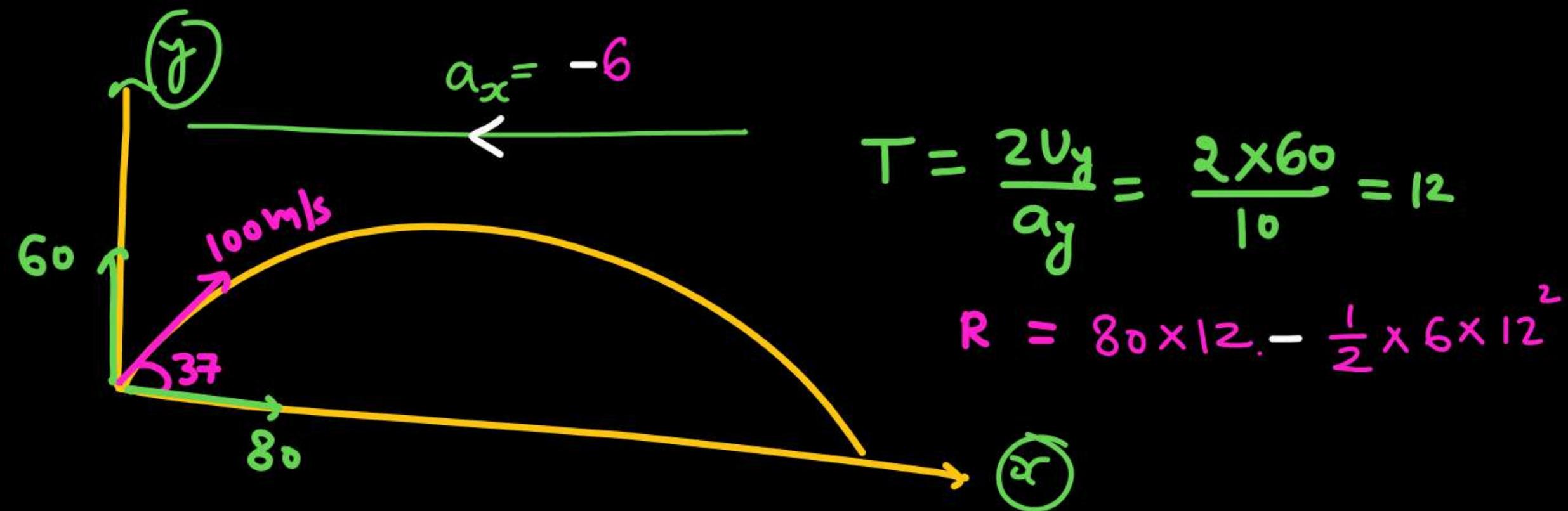
↓ 70 m/s



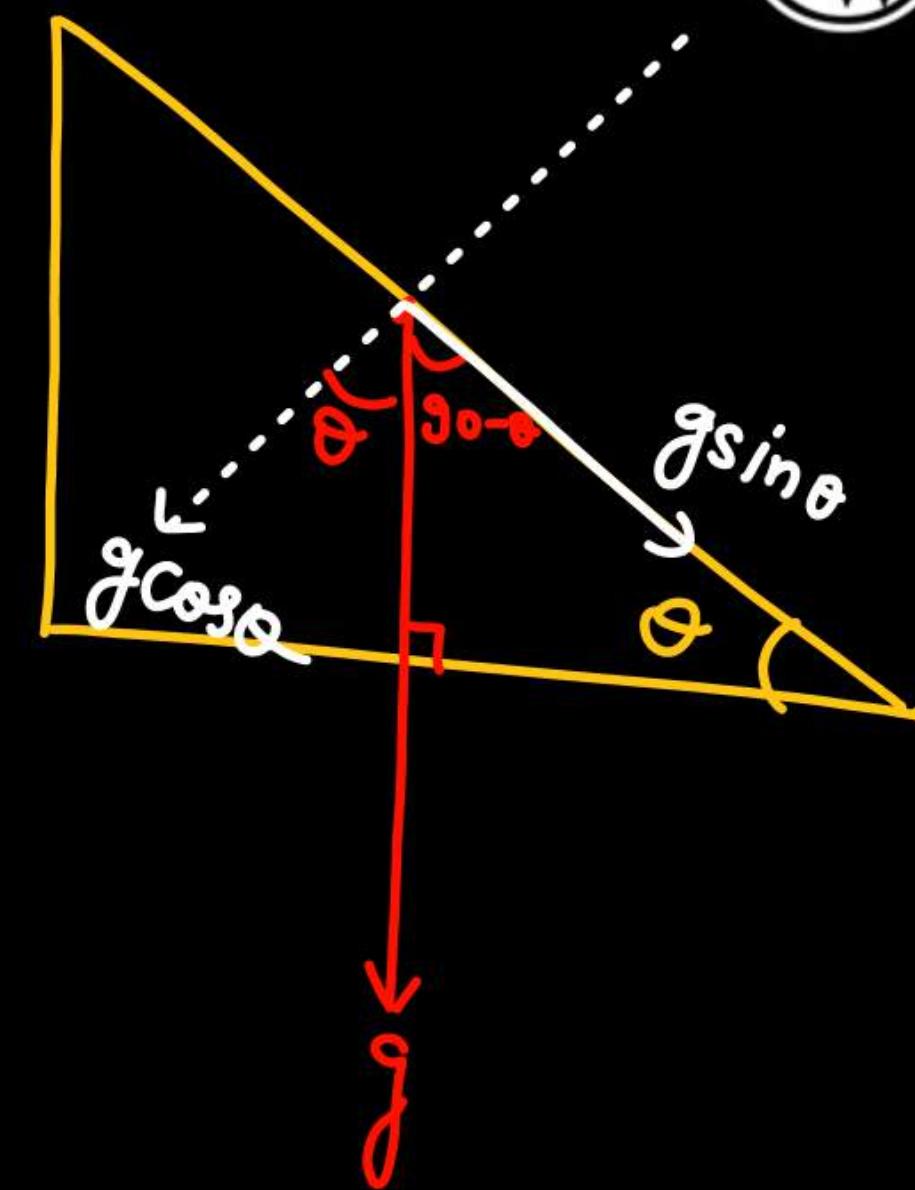
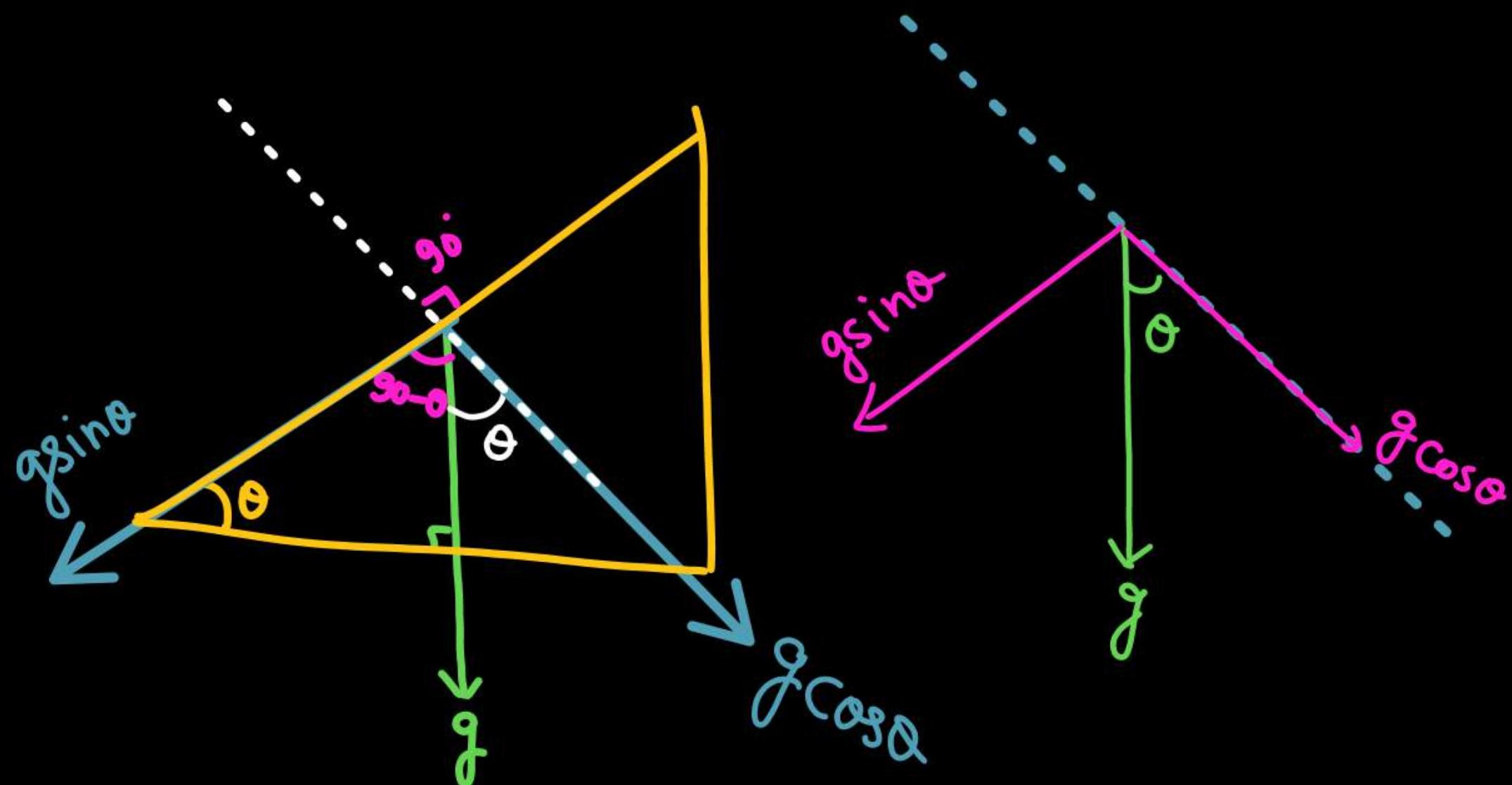
$$t = \frac{600}{100} = 6 \text{ sec}$$

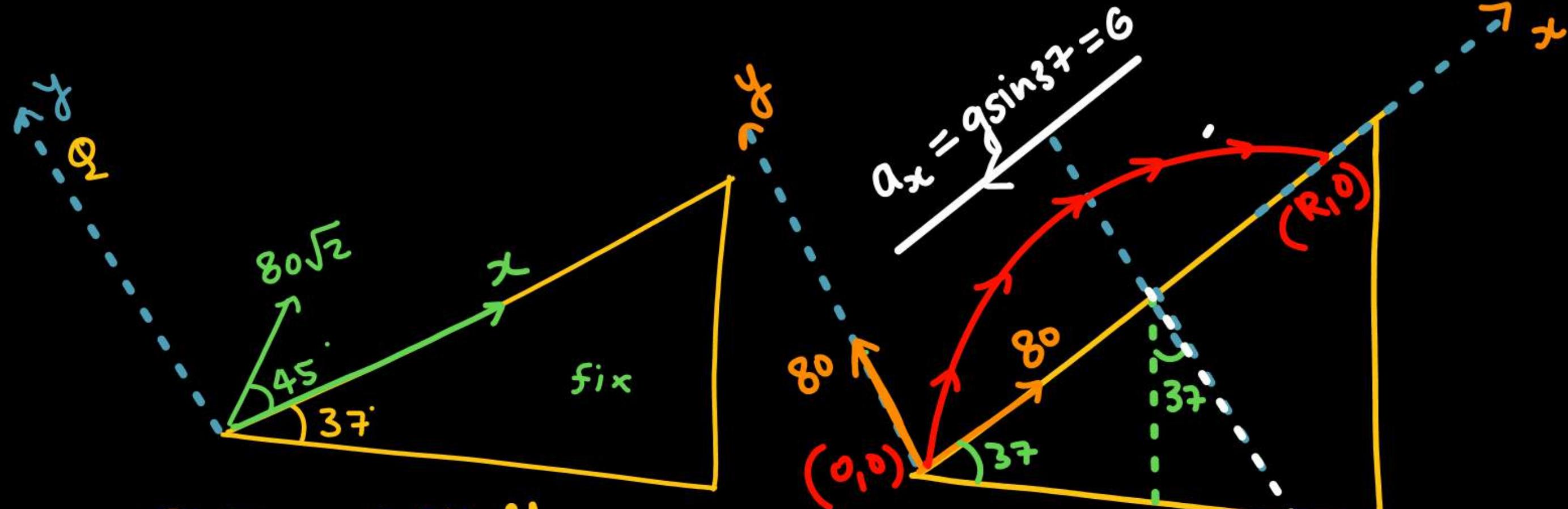
$$600 = 100t$$

$$t=6\text{ sec}$$



P  
W





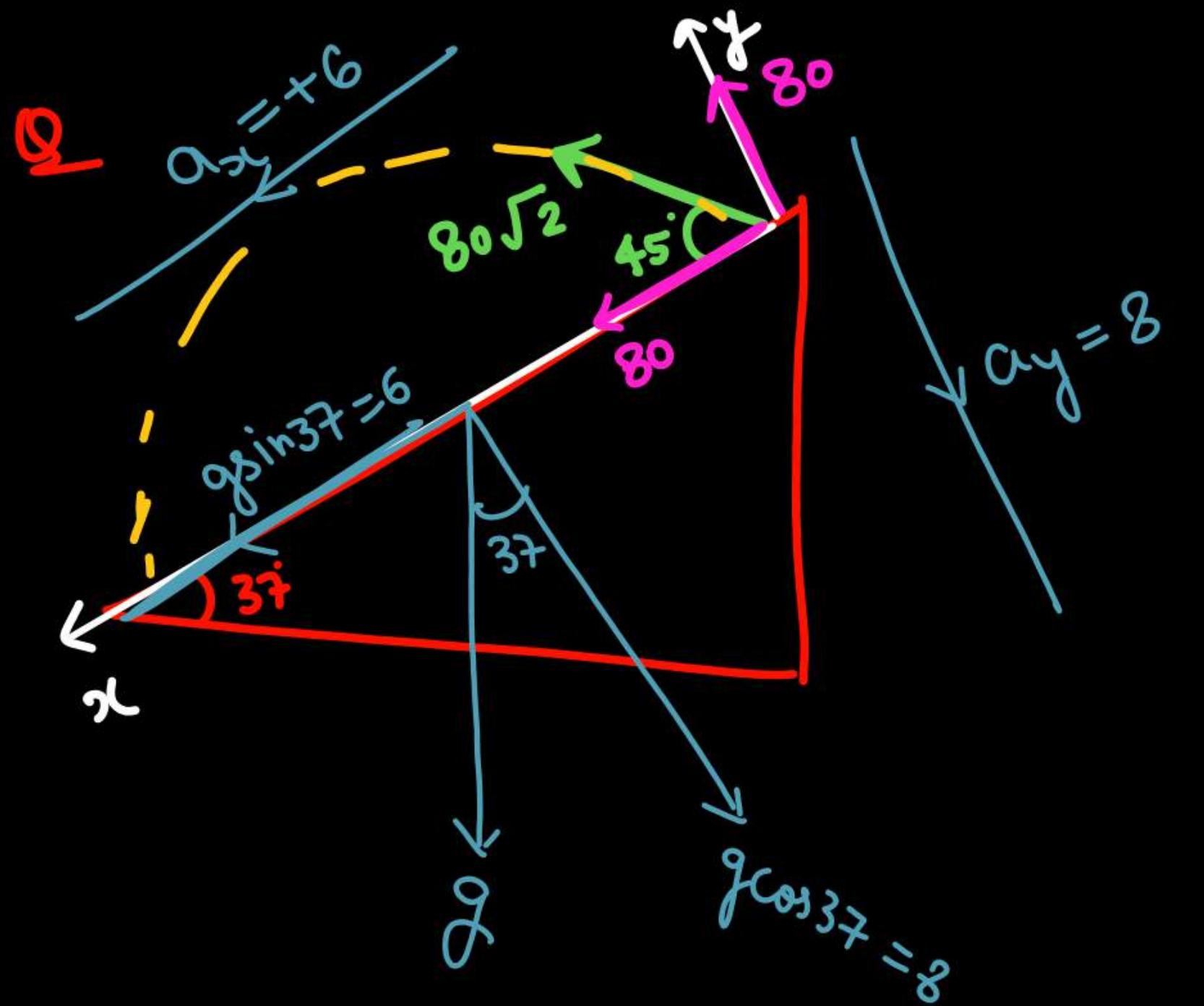
① Time of flight =  $T = 10 + 10 = 20$

$$T = \frac{2v_y}{a_y} = \frac{2 \times 80}{8} = 20 \text{ sec}$$

②  $R = ut + \frac{1}{2}at^2$  ( $x \hat{i}$ )

$$R = 80 \times 20 - \frac{1}{2} \times 6 \times (20)^2$$

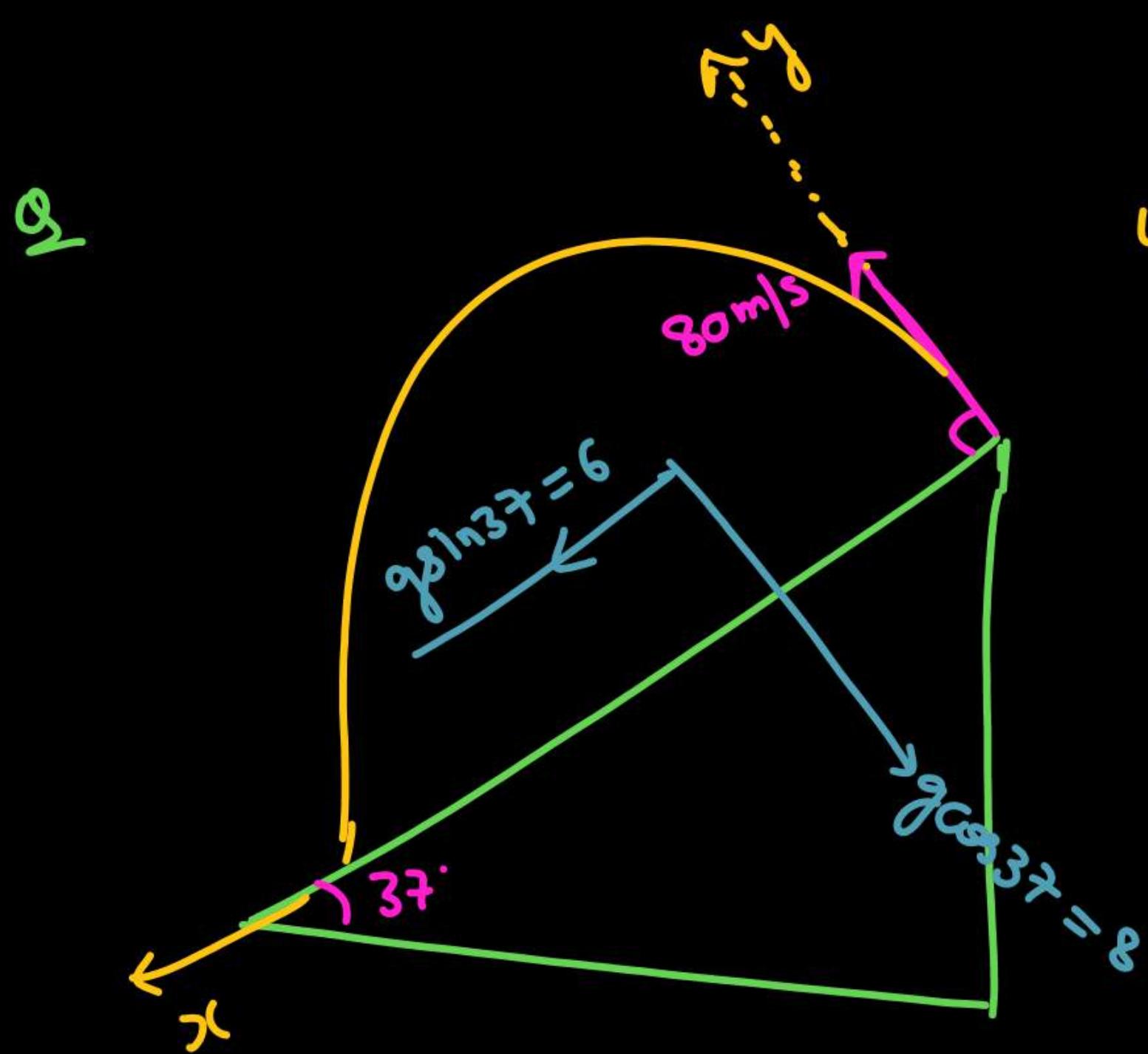
$$\begin{aligned} & g \cos 37 \\ & \parallel \theta = \alpha_x \\ & g = a_x \end{aligned}$$



$$T = 10 + 10 = 20$$

$$T = \frac{2Uy}{ay} = \frac{2 \times 80}{8} = 20$$

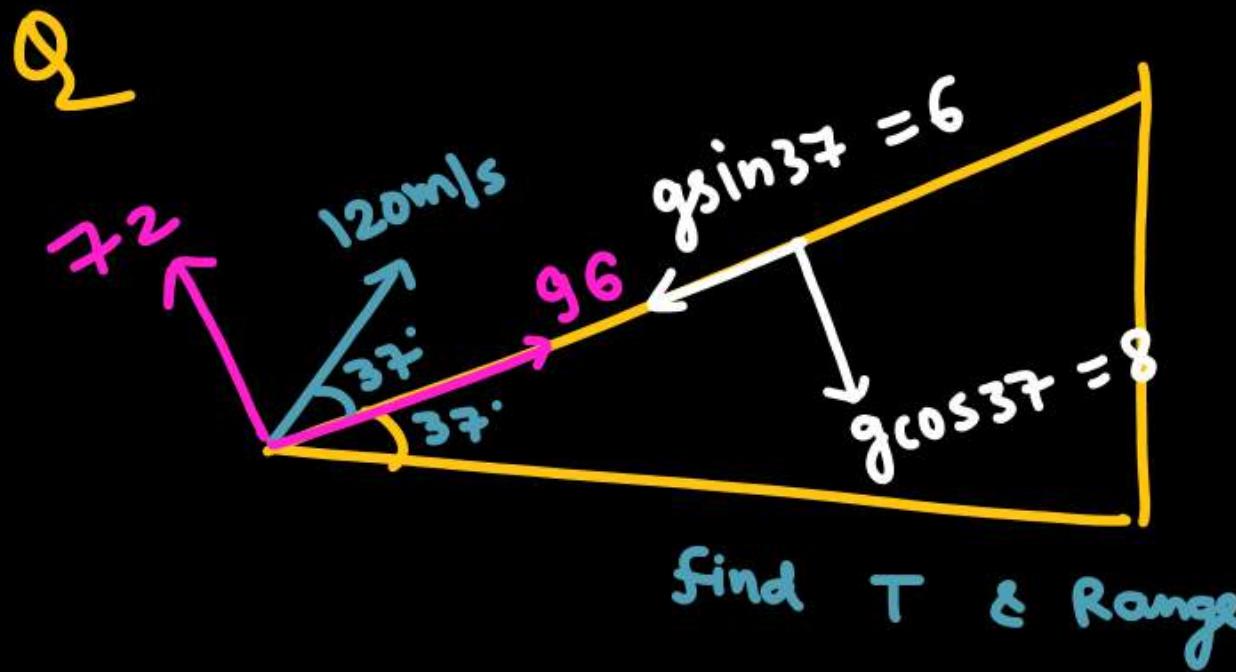
$$\text{Range} = 80 \times 20 + \frac{1}{2} \times 6 \times 20^2$$



$$v_x = 0,$$

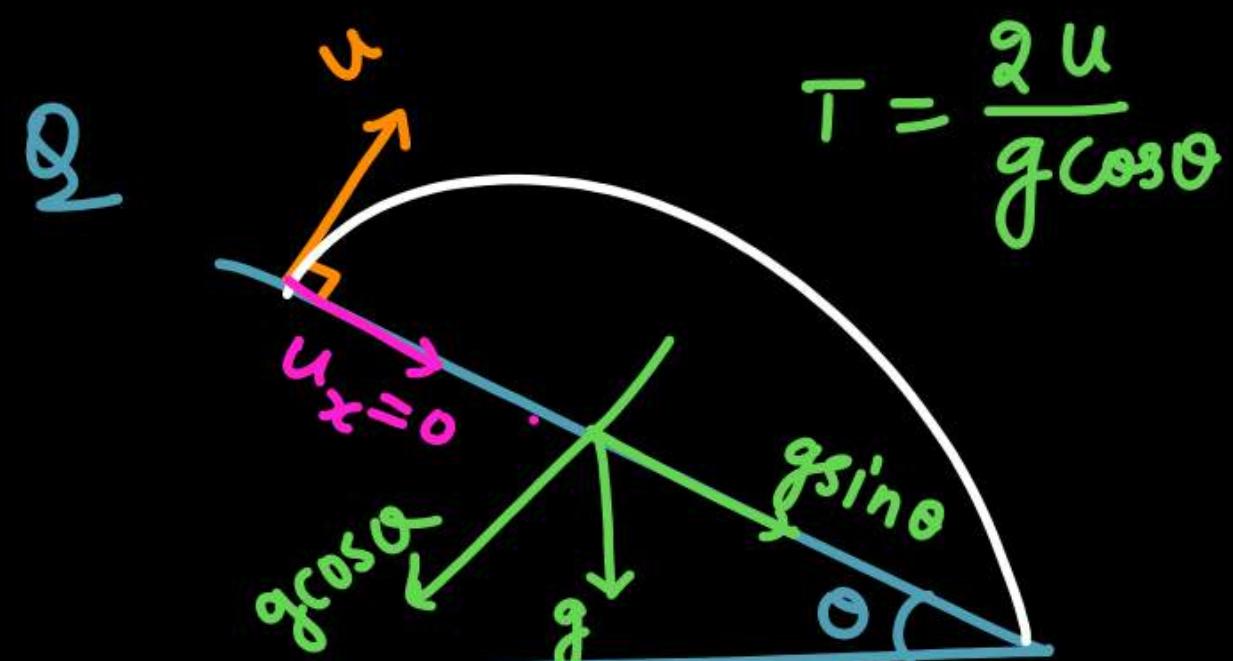
$$T = \frac{2 \times 80}{g} = 20$$

$$R = 0 + \frac{1}{2} \times 6 \times (20)^2$$



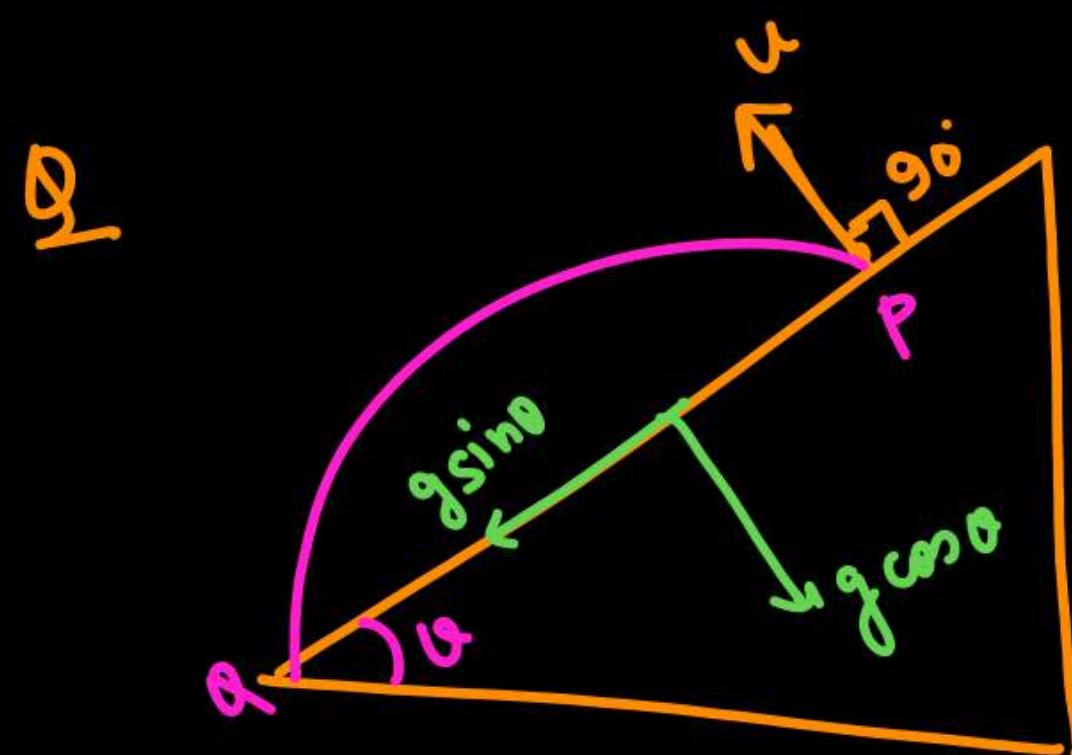
$$T = \frac{2 \times 72}{g} = 18$$

$$R = 96 \times 18 - \frac{1}{2} \times 6 \times 18^2$$



find how far from the point of projection particle will hit the plane

$$R = 0 + \frac{1}{2} \cdot g \sin \theta \cdot T^2$$



$$T = \frac{2v}{g \cos \theta}$$

$$PO = R = v + \frac{1}{2} g \sin \theta T^2$$

time of flight is  $T$  find  $PO$

- (a)  $Tv \sin \theta$
- (b)  $Tv \cos \theta$
- (c)  $Tv \sec \theta$
- (d)  $Tv \tan \theta$

$$PO = \frac{1}{2} g \sin \theta \cdot T^2$$

$$= \frac{1}{2} g \sin \theta \cdot T \cdot T$$

$$= \frac{1}{2} g \sin \theta \cdot T \cdot \frac{2v}{g \cos \theta} = \underline{Tv \tan \theta}$$

Q  $y = x^2 - 4x + 20$

find  $y_{\min} = ?$

$\frac{dy}{dx} = 2x - 4 = 0$

$x = 2$

$\frac{d^2y}{dx^2} = 2 - 0 = 2 > 0$

$\frac{d^2y}{dx^2} > 0 \Rightarrow x=2$  put  $y = 2^2 - 4 \times 2 + 20$   
 $y_{\min}$   $y = 4 - 8 + 20 = 16 = y_{\min}$

$$\text{Slope} = \frac{dy}{dx}$$

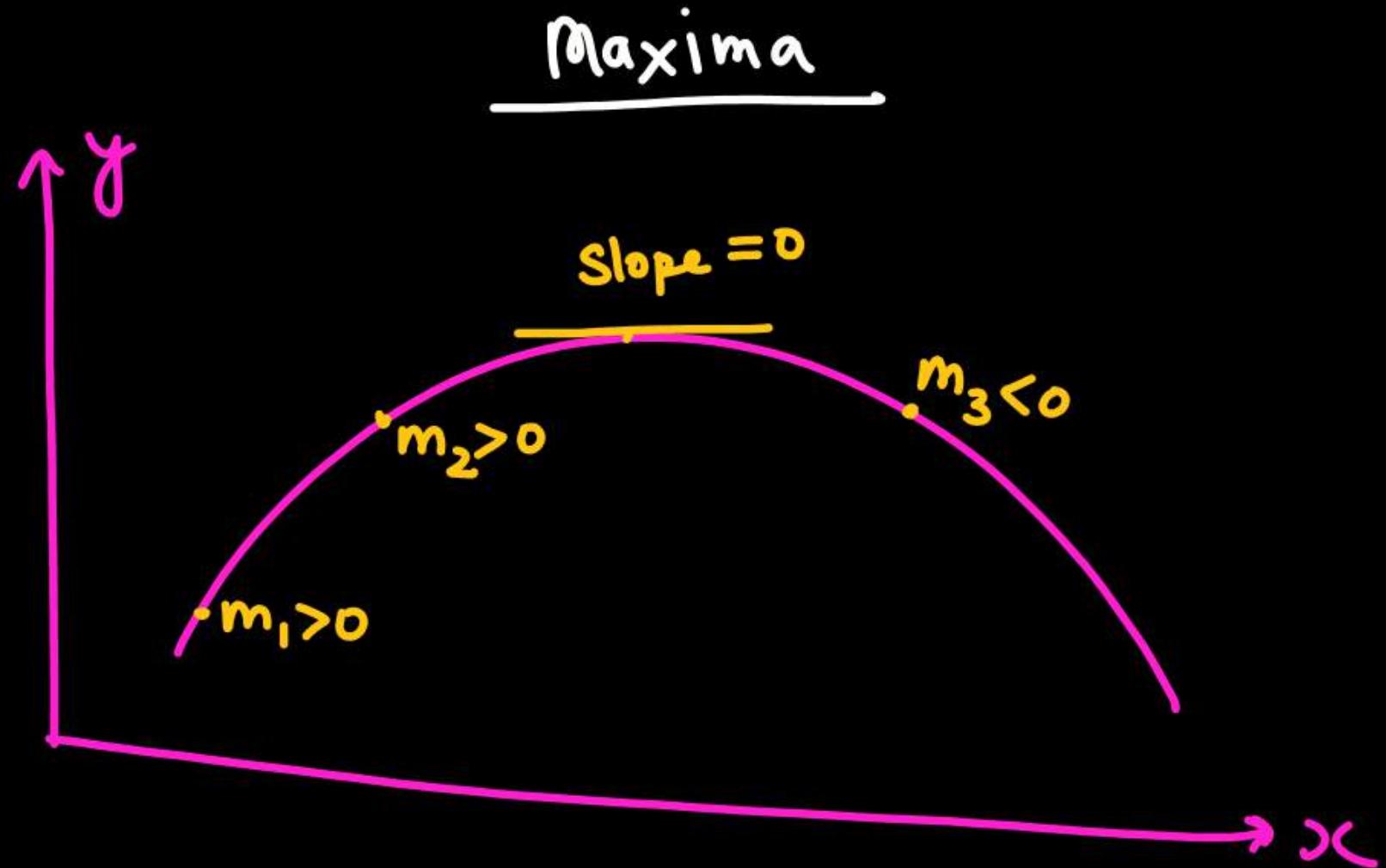
At point of maxima

$$\text{Slope} = 0, \quad \frac{dy}{dx} = 0$$

mathematically

- $\frac{d(\text{Slope})}{dx} < 0$

$$\frac{d}{dx} \left( \frac{dy}{dx} \right) = \frac{d^2 y}{dx^2} < 0$$



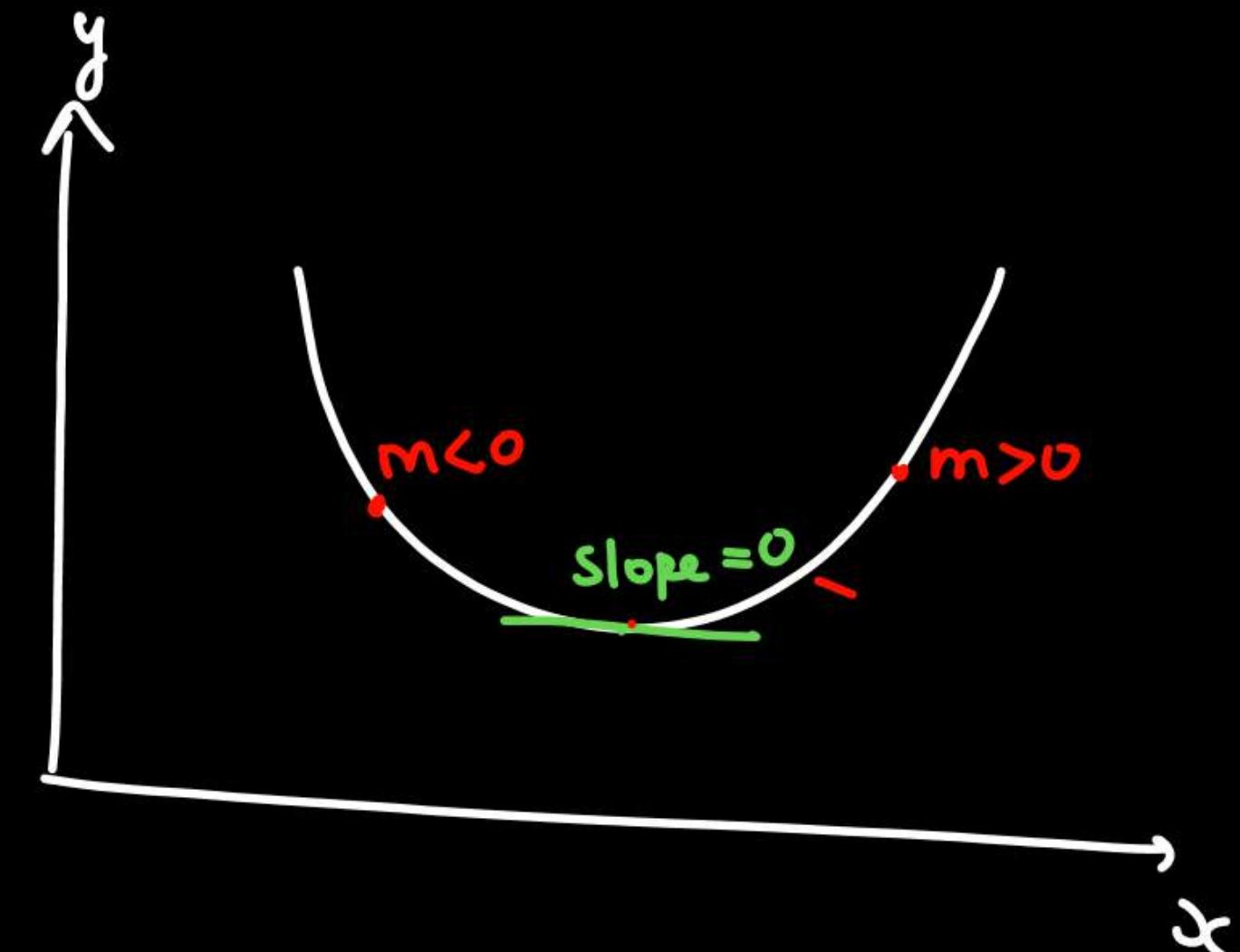
at point of minima

$$\text{Slope} = \frac{dy}{dx} = 0$$

$$\frac{d(\text{Slope})}{dx} > 0$$

$$\frac{d}{dx}\left(\frac{dy}{dx}\right) > 0$$

$$\frac{d^2y}{dx^2} > 0$$



$$Q \quad y = 2x^3 - 21x^2 + 36x - 15$$

find maxima & minima

$$\frac{dy}{dx} = 6x^2 - 42x + 36$$

$$\frac{dy}{dx} = 6(x^2 - 7x + 6) = 0$$

$$(x-6)(x-1) = 0$$

$$x=6, x=1$$

$$\frac{d^2y}{dx^2} = 12x - 42$$

$$x=6, \frac{d^2y}{dx^2} = 12 \times 6 - 42 = 30$$

30  $\rightarrow \frac{d^2y}{dx^2} > 0$

$x=6 \Rightarrow$  point of minima

$$x=1, \frac{d^2y}{dx^2} < 0 \Rightarrow \text{maxima}$$

$$x=1, y=2 \Rightarrow \text{maxima}$$

$$x=6, y = -123 \text{ (check)} \Rightarrow \text{minima}$$

$$Q \quad y = x^3 - x^2 + 6$$

find max & min

$$\frac{dy}{dx} = 3x^2 - 2x + 0 = 0$$

$$x(3x-2) = 0$$

$$x = 0, \quad x = 2/3$$

$$\frac{d^2y}{dx^2} = 6x - 2$$

$x=0, \quad \frac{d^2y}{dx^2} < 0 \equiv \text{maxima}$

$x = \frac{2}{3}, \quad \text{minima}$

$$\underline{Q} \quad y = \frac{x^3}{3} - 4x^2 + 15x + 10$$

$$\text{Q}_1 \quad y = x^2 - 4x$$

find min value of  $y$

$$\frac{dy}{dx} = 2x - 4 = 0, \quad x = 2$$

$$\frac{d^2y}{dx^2} = 2 > 0 \quad \Rightarrow \text{(minima)}$$

$$x=2, \quad y = 2^2 - 4 \times 2 = -4$$

$$\text{Q}_2 \quad y = 10 - 8x - 2x^2$$

find max value of  $y$

$$x = -2 \Rightarrow \text{max}$$

$$y = 10 + 16 - 8 = \checkmark$$

Q A particle is projected upward such that its height

at any time  $t$  given by  $h = -5t^2 + 10t + 40$

find max. height

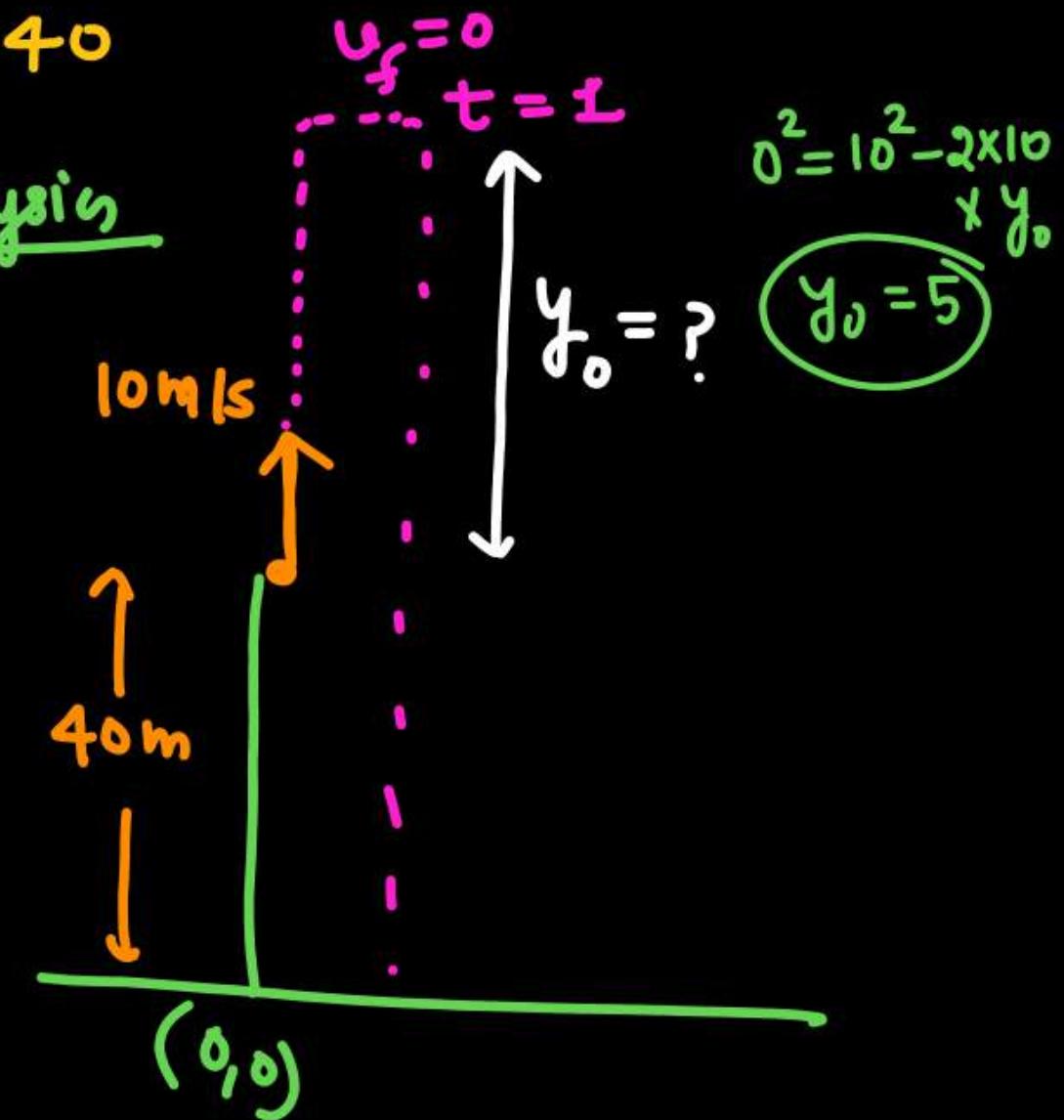
$$\frac{dh}{dt} = 0, \quad -10t + 10 = 0$$

$$t = 1 \text{ sec}$$

$$h = -5 \times 1^2 + 10 \times 1 + 40$$

$$h = 45$$

Physics



$$\text{Q} \quad y = \sqrt{3} \sin \theta + \cos \theta$$

find  $y_{\max}$

$$\frac{dy}{d\theta} = \sqrt{3} \cos \theta - \sin \theta = 0$$

$$\sqrt{3} \cos \theta = \sin \theta$$

$$\boxed{\theta = 60^\circ}$$

$$y = \sqrt{3} \sin 60 + \cos 60$$

$$= \sqrt{3} \cdot \frac{\sqrt{3}}{2} + \frac{1}{2} = 2$$

$$y = a \sin \theta + b \cos \theta$$

$$y_{\max} = \sqrt{a^2 + b^2}$$

$$y_{\max} = \sqrt{3+1} = 2$$

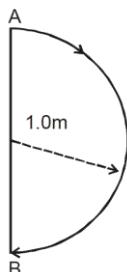
## Motion in a straight line (PYQ)

1. A particle is moving with speed  $v = d\sqrt{x}$  along positive x-axis. Calculate the speed of the particle at time  $t = \tau$  (assume that the particle is at origin at  $t = 0$ ). [Main 12 Apr. 2019 II]

(A)  $\frac{b^2\tau}{4}$       (B)  $\frac{b^2\tau}{2}$   
 (C)  $b^2\tau$       (D)  $\frac{b^2\tau}{\sqrt{2}}$

2. In 1.0 s, a particle goes from point A to point B, moving in a semicircle of radius 1.0 m (see Figure). The magnitude of the average velocity A

[1999 S - 2 Marks]

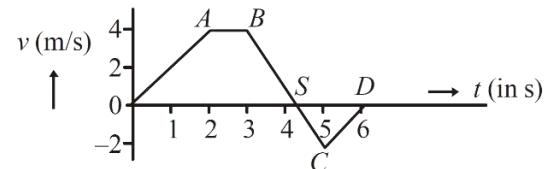


(A) 3.14 m/s      (B) 2.0 m/s  
 (C) 1.0 m/s      (D) Zero

3. A particle is moving eastwards with a velocity of 5 m/s. In 10 s the velocity changes to 5 m/s northwards. The average acceleration in this time is/are [1982 - 3 Marks]

(A) Zero  
 (B)  $1/\sqrt{2} \text{ m/s}^2$  towards north-west  
 (C)  $1/\sqrt{2} \text{ m/s}^2$  towards north-east  
 (D)  $1/2 \text{ m/s}^2$  towards north-west  
 (E)  $1/2 \text{ m/s}^2$  towards north

4. The velocity (v) and time (t) graph of a body in a straight line motion is shown in the figure. The point S is at 4.333 seconds. The total distance covered by the body in 6s is: [Main 05 Sep. 2020 (II)]



(A)  $37/3 \text{ m}$       (B)  $12 \text{ m}$   
 (C)  $11 \text{ m}$       (D)  $49/4 \text{ m}$

5. A bullet of mass 20 g has an initial speed of  $1 \text{ ms}^{-1}$ , just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of  $2.5 \times 10^{-2} \text{ N}$ , the speed of the bullet after emerging from the other side of the wall is close to:

[Main 10 Apr. 2019 (II)]

(A)  $0.1 \text{ ms}^{-1}$       (B)  $0.7 \text{ ms}^{-1}$   
 (C)  $0.3 \text{ ms}^{-1}$       (D)  $0.4 \text{ ms}^{-1}$

6. The position of a particle as a function of time t, is given by  $x(t) = at + bt^2 - ct^3$  where, a, b and c are constants. When the particle attains zero acceleration, then its velocity will be:

[Main 9 Apr. 2019 (II)]

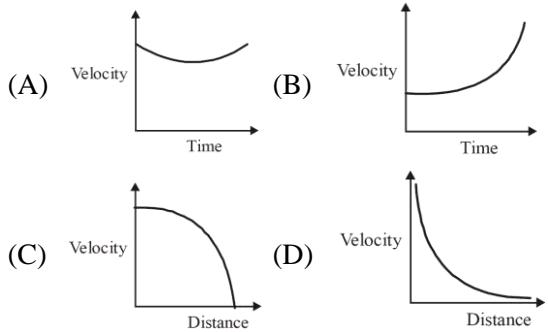
(A)  $a + \frac{b^2}{4c}$       (B)  $a + \frac{b^2}{3c}$   
 (C)  $a + \frac{b^2}{c}$       (D)  $a + \frac{b^2}{2c}$

7. The velocity-time graphs of a car and a scooter are shown in the figure. (i) the difference between the distance travelled by the car and the scooter in 15 s and (ii) the time at which the car will catch up with the scooter are, respectively

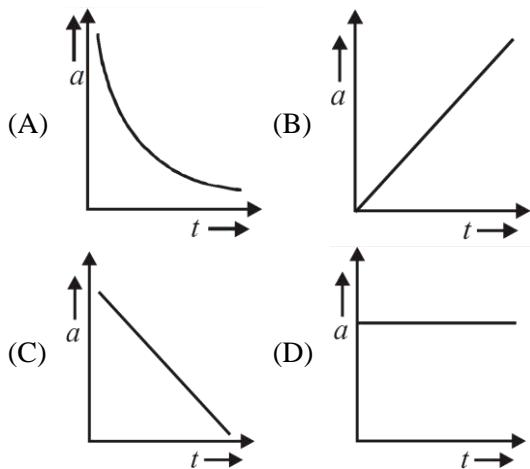
[Main Online April 15, 2018]

(A) 337.5 m and 25 s  
 (B) 225.5 m and 10 s  
 (C) 112.5 m and 22.5 s  
 (D) 11.25 m and 15 s

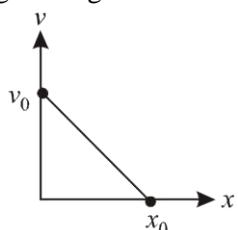
8. Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?  
**[Main Online April 8, 2017]**



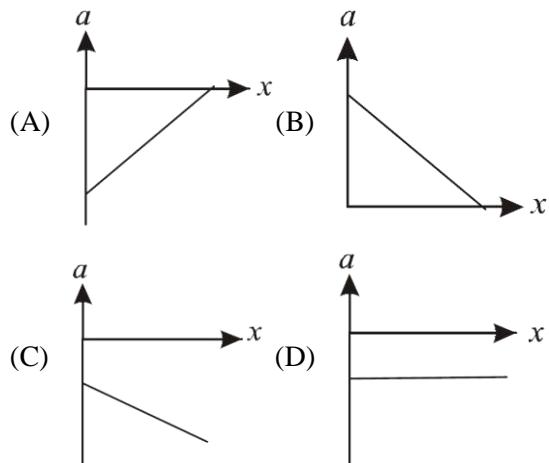
9. The distance travelled by a body moving along a line in time  $t$  is proportional to  $t^3$ . The acceleration-time ( $a, t$ ) graph for the motion of the body will be  
**[Main Online May 12, 2012]**



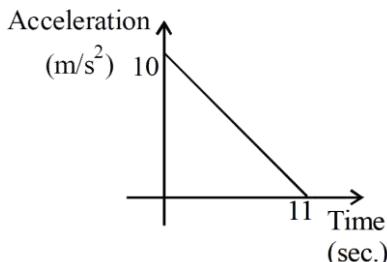
10. The velocity-displacement graph of a particle moving along a straight line is shown  
**[2005S]**



The most suitable acceleration -displacement graph will be

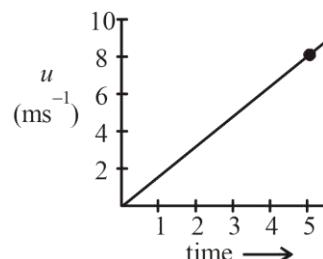


11. A body starts from rest at time  $t = 0$ , the acceleration time graph is shown in the figure. The maximum velocity attained by the body will be  
**[2004 S]**



- (A) 110 m/s      (B) 55 m/s  
(C) 650 m/s      (D) 550 m/s

12. The speed verses time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval  $t = 0$  to  $t = 5$  s will be \_\_\_\_\_.  
**[Main 4 Sep. 2020 (II)]**



13. The distance  $x$  covered by a particle in one dimensional motion varies with time  $t$  as  $x^2 = at^2 + 2bt + c$ . If the acceleration of the particle depends on  $x$  as  $x^{-n}$ , where  $n$  is an integer, the value of  $n$  is  
**[Main 9 Jan 2020 (I)]**

14. Train A and train B are running on parallel tracks in the opposite directions with speeds of 36 km/hour and 72 km/hour, respectively. A person is walking in train A in the direction opposite to its motion with a speed of 1.8 km/hour. Speed (in  $\text{ms}^{-1}$ ) of this person as observed from train B will be close to : (take the distance between the tracks as negligible)

[Main 2 Sep. 2020(I)]

- (A)  $29.5 \text{ ms}^{-1}$       (B)  $28.5 \text{ ms}^{-1}$   
 (C)  $31.5 \text{ ms}^{-1}$       (D)  $30.5 \text{ ms}^{-1}$

15. A car is standing 200 m behind a bus, which is also at rest. The two start moving at the same instant but with different forward accelerations. The bus has acceleration  $2 \text{ m/s}^2$  and the car has acceleration  $4 \text{ m/s}^2$ . The car will catch up with the bus after a time of :

[Main Online April 9, 2017]

- (A)  $\sqrt{110} \text{ s}$       (B)  $\sqrt{120} \text{ s}$   
 (C)  $10\sqrt{2} \text{ s}$       (D)  $15 \text{ s}$

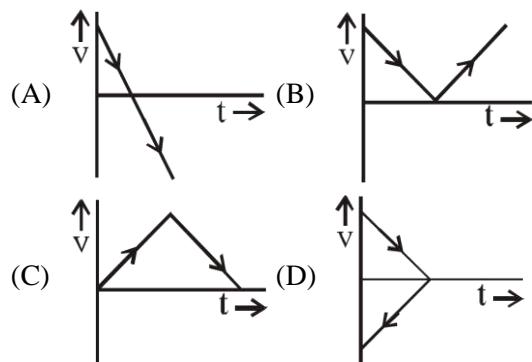
16. A helicopter rises from rest on the ground vertically upwards with a constant acceleration  $g$ . A food packet is dropped from the helicopter when it is at a height  $h$ . The time taken by the packet to reach the ground is close to [ $g$  is the acceleration due to gravity] :

[Main 5 Sep. 2020 (I)]

- (A)  $t = \frac{2}{3}\sqrt{\left(\frac{h}{g}\right)}$   
 (B)  $t = 1.8\sqrt{\frac{h}{g}}$   
 (C)  $t = 3.4\sqrt{\left(\frac{h}{g}\right)}$   
 (D)  $t = \sqrt{\frac{2h}{3g}}$

17. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time?

[Main 2017]



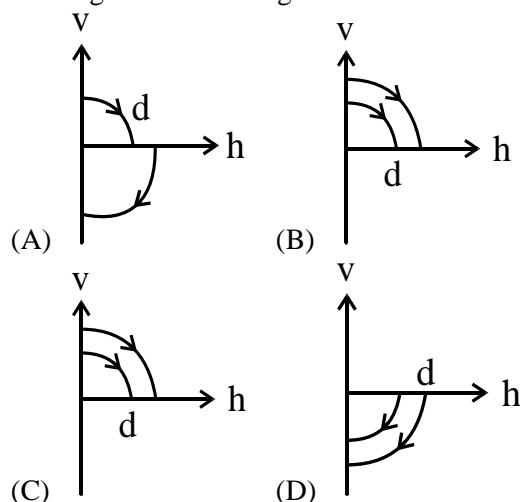
18. From a tower of height  $H$ , a particle is thrown vertically upwards with a speed  $u$ . The time taken by the particle, to hit the ground, is  $n$  times that taken by it to reach the highest point of its path. The relation between  $H$ , and  $n$  is:

[Main 2014]

- (A)  $2gH = n^2 u^2$   
 (B)  $gH = (n - 2)^2 u^2 d$   
 (C)  $2gH = nu^2 (n - 2)$   
 (D)  $gH = (n - 2)u^2$

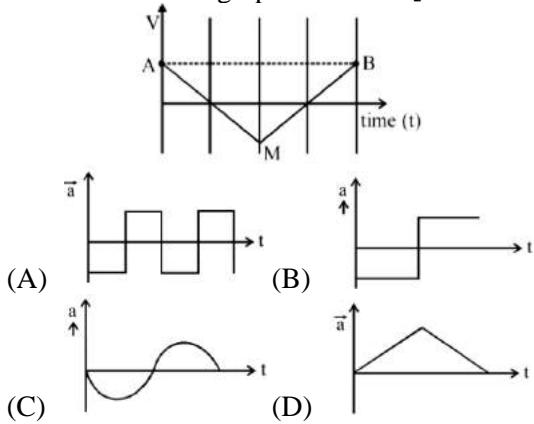
19. A ball is dropped vertically from a height  $d$  above the ground. It hits the ground and bounces up vertically to a height  $d/2$ . Neglecting subsequent motion and air resistance, its velocity  $v$  varies with the height  $h$  above the ground as

[2000S]



20. A ball is dropped from the top of a 100 m high tower on a planet. In the last  $\frac{1}{2} \text{ s}$  before hitting the ground, it covers a distance of 19 m. Acceleration due to gravity (in  $\text{ms}^{-2}$ ) near the surface on that planet is \_\_\_\_\_. [Main 8 Jan. 2020 (II)]

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



22. A particle is projected with velocity  $v_0$  along x-axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin i.e.,  $ma = -\alpha x^2$ . The distance at which the particle stops : [JEE Main 2021]

$$(A) \left( \frac{3v_0^2}{2\alpha} \right)^{\frac{1}{2}} \quad (B) \left( \frac{2v_0}{3\alpha} \right)^{\frac{1}{3}}$$

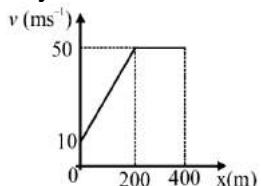
$$(C) \left( \frac{2v_0^2}{3\alpha} \right)^{\frac{1}{2}} \quad (D) \left( \frac{3v_0^2}{2\alpha} \right)^{\frac{1}{3}}$$

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

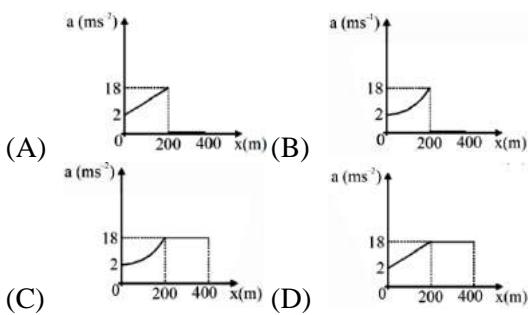
$$(A) \sqrt{\frac{v^2 + u^2}{2}} \quad (B) \frac{v-u}{2}$$

$$(C) \frac{u+v}{2} \quad (D) \sqrt{\frac{v^2 - u^2}{2}}$$

24. The velocity-displacement graph describing the motion of a bicycle is shown in the figure.



The acceleration-displacement graph of the bicycle's motion is best described by : [JEE Main 2021]



25. A mosquito is moving with a velocity  $\vec{v} = 0.5t^2\hat{i} + 3\hat{j} + 9\hat{k}$  m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2s ? [JEE Main 2021]

$$(A) \tan^{-1}\left(\frac{2}{3}\right) \text{ from } x\text{-axis}$$

$$(B) \tan^{-1}\left(\frac{2}{3}\right) \text{ from } y\text{-axis}$$

$$(C) \tan^{-1}\left(\frac{5}{2}\right) \text{ from } y\text{-axis}$$

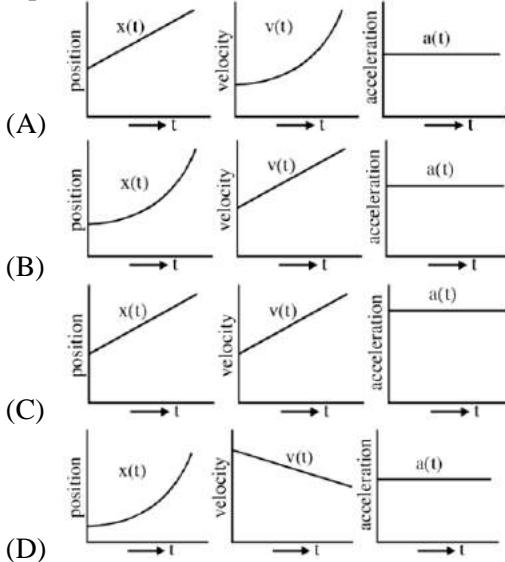
$$(D) \tan^{-1}\left(\frac{5}{2}\right) \text{ from } x\text{-axis}$$

26. The velocity of a particle is  $v = v_0 + gt + Ft^2$ . Its position is  $x = 0$  at  $t = 0$ ; then its displacement after time  $(t-1)$  is : [JEE Main 2021]

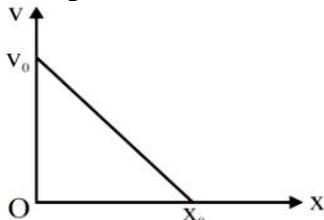
$$(A) v_0 + g + F \quad (B) V_0 + \frac{g}{2} + \frac{F}{3}$$

$$(C) V_0 + \frac{g}{2} + F \quad (D) v_0 + 2g + 3F$$

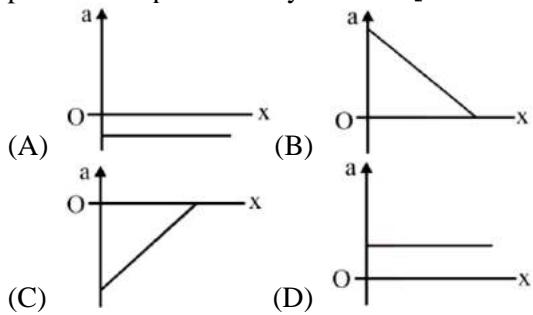
27. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by : [JEE Main 2021]



28. The velocity-displacement graph of a particle is shown in the figure.



The acceleration-displacement graph of the same particle is represented by : [JEE Main 2021]

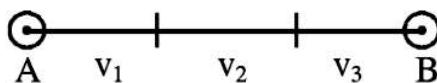


29. The instantaneous velocity of a particle moving in a straight line is given as  $v = \alpha t + \beta t^2$ , where  $\alpha$  and  $\beta$  are constants. The distance travelled by the particle between 1s and 2s is : [JEE Main 2021]

$$\begin{array}{ll} (\text{A}) \quad 3\alpha + 7\beta & (\text{B}) \quad \frac{3}{2}\alpha + \frac{7}{3}\beta \\ (\text{C}) \quad \frac{\alpha}{2} + \frac{\beta}{3} & (\text{D}) \quad \frac{3}{2}\alpha + \frac{7}{2}\beta \end{array}$$

30. A ball of mass 0.5 kg is dropped from the height of 10 m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is .....m. (Use  $g = 10 \text{ m/s}^2$ ) [JEE Main 2022]

31. A car covers AB distance with first one-third at velocity  $v_1 \text{ ms}^{-1}$ , second one-third at  $v_2 \text{ ms}^{-1}$  and last one-third at  $v_3 \text{ ms}^{-1}$ . If  $v_3 = 3v_1$ ,  $v_2 = 2v_1$  and  $v_1 = 11 \text{ ms}^{-1}$  then the average velocity of the car is .....  $\text{ms}^{-1}$ . [JEE Main 2022]



32. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in  $t \text{ s.}$ , the distance travelled by the toy in the next  $t \text{ s}$  will be : [JEE Main 2022]

$$\begin{array}{ll} (\text{A}) \quad 10 \text{ m} & (\text{B}) \quad 20 \text{ m} \\ (\text{C}) \quad 30 \text{ m} & (\text{D}) \quad 40 \text{ m} \end{array}$$



## Answer Key

- |          |            |
|----------|------------|
| 1. (B)   | 17. (A)    |
| 2. (B)   | 18. (C)    |
| 3. (B)   | 19. (A)    |
| 4. (A)   | 20. (8.00) |
| 5. (B)   | 21. (B)    |
| 6. (B)   | 22. (D)    |
| 7. (C)   | 23. (A)    |
| 8. (C)   | 24. (A)    |
| 9. (B)   | 25. (B)    |
| 10. (A)  | 26. (B)    |
| 11. (B)  | 27. (B)    |
| 12. (20) | 28. (C)    |
| 13. (3)  | 29. (B)    |
| 14. (A)  | 30. (5)    |
| 15. (C)  | 31. (18)   |
| 16. (C)  | 32. (C)    |