

# YAKEEN NEET 2.0

2026

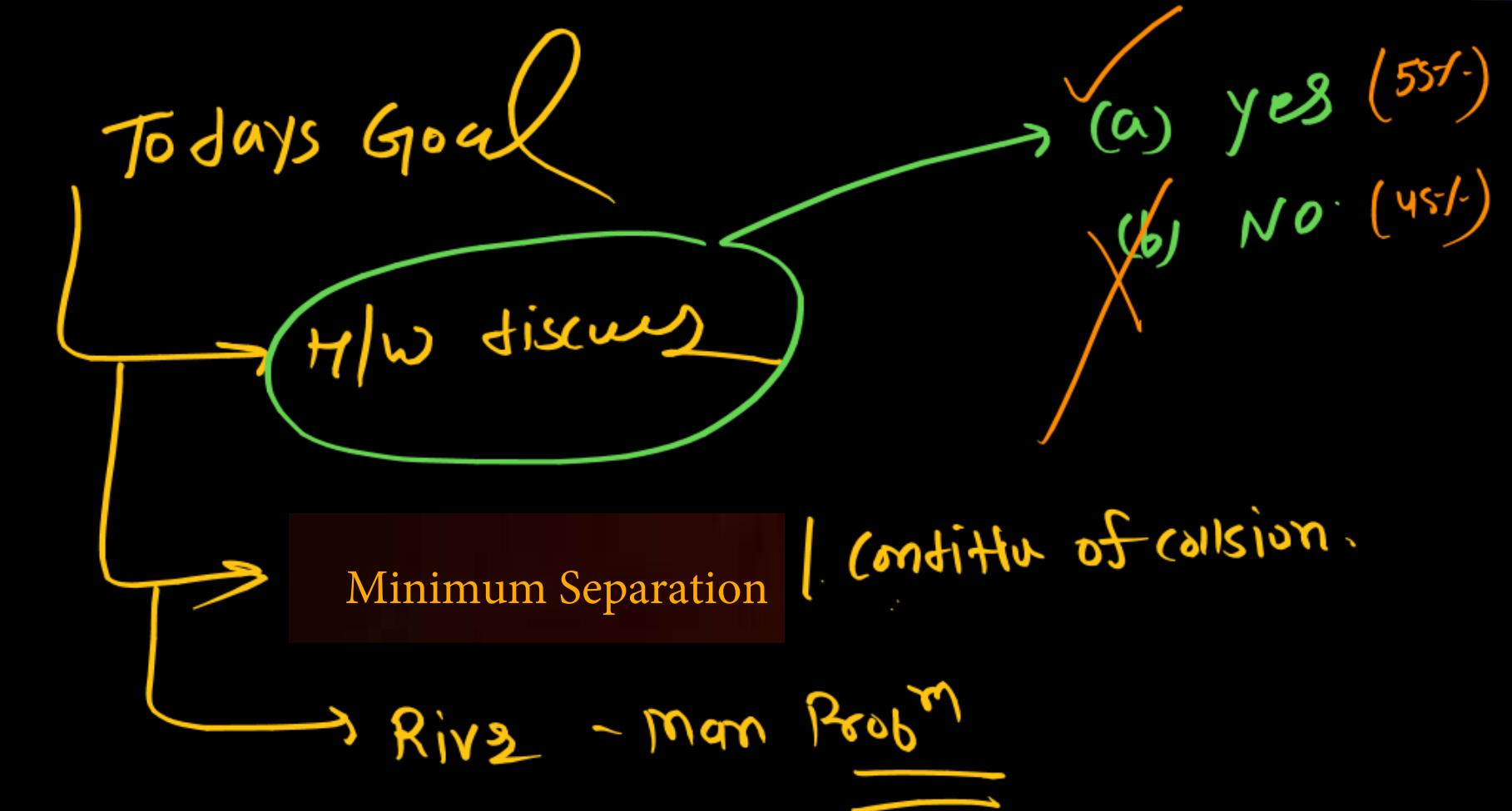
Motion in a Plane

Physics

Lecture - 9

By- Manish Raj (MR Sir)

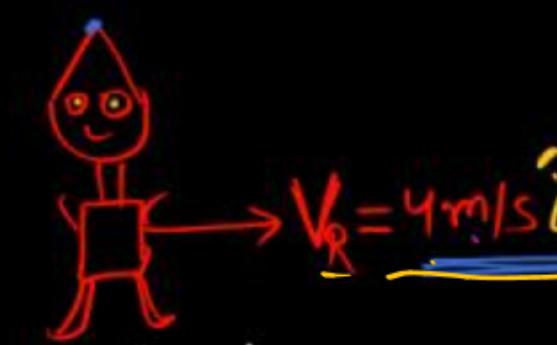
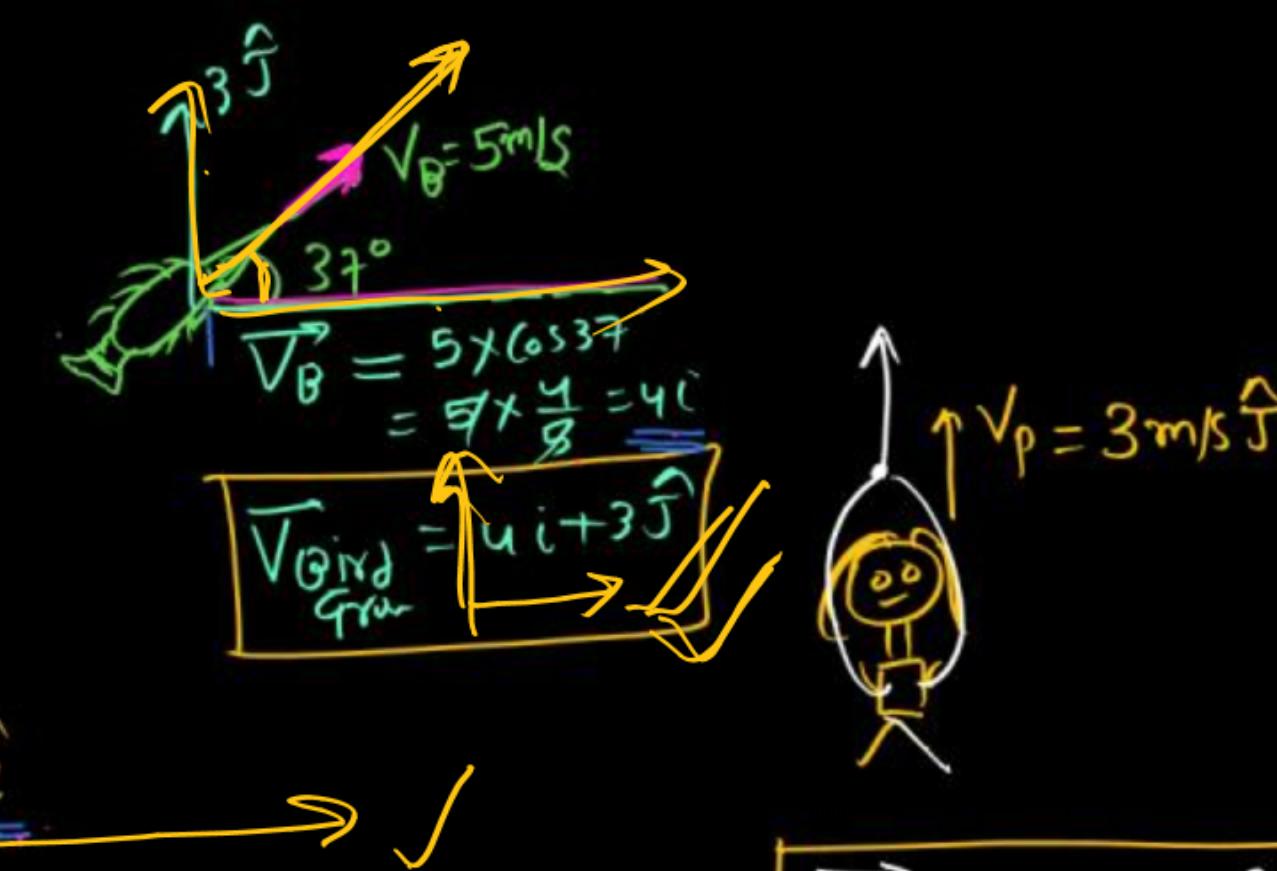




MRA



$$\boxed{V_B(MR) = 4i + 3j}$$



Ramlu

$$\boxed{\vec{V}_{Rg} = 4i + 0j}$$

✓

$$\boxed{\vec{V}_p = 0i + 3j}$$

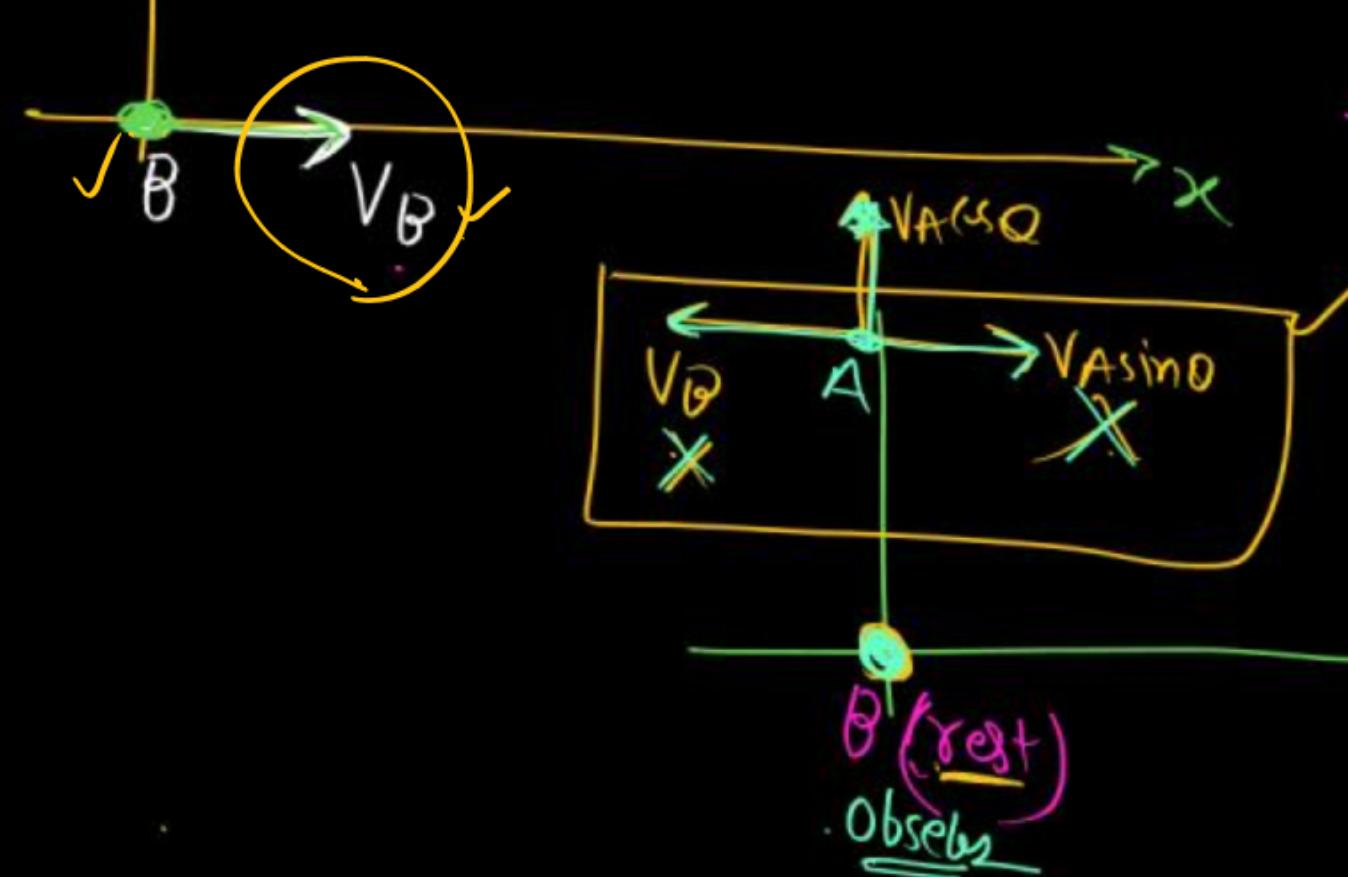
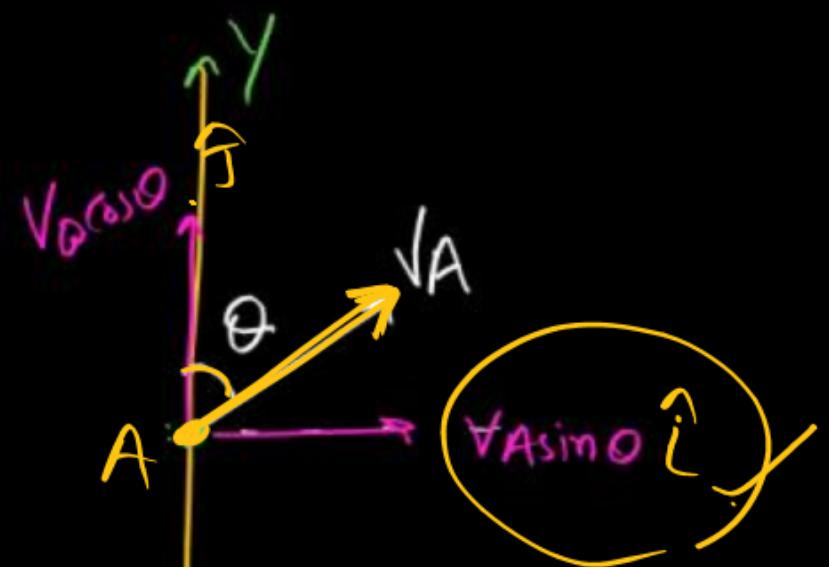
$$\boxed{\vec{U}_{\text{pink w.r.t. Dir.}} = -4i}$$

$$\begin{aligned}\vec{U}_{\text{B Pink}} &= \vec{V}_B - \vec{V}_p \\ &= 4i + 3j - 3j\end{aligned}$$

$$\begin{aligned}\vec{U}_{\text{B Ramlu}} &= \vec{V}_B - \vec{V}_R \\ &= 4i + 3j - 4i \\ \vec{U}_{\text{B Ramlu}} &= 3j \\ \vec{U}_{\text{Ramlu B}} &= -3j\end{aligned}$$

$$\boxed{\vec{V}_{\text{B Ind. (pink)}} = 4i}$$

AIEEE (JEE Main)



find  $\frac{V_A}{V_B}$  so that  
A appears to move  
in vertical upward  
w.r.t B

Soln  $\Rightarrow V_A \sin \theta = V_B$

$$\frac{V_A}{V_B} = \left( \frac{1}{\sin \theta} \right) = \csc \theta$$

Ans

H/ω

## Question

A bird is flying with a speed of  $40 \text{ km/hr}$ . in the north direction. A train is moving with a speed of  $40 \text{ km/hr}$ . in the west direction. A passenger sitting in the train will see the bird moving with velocity :-

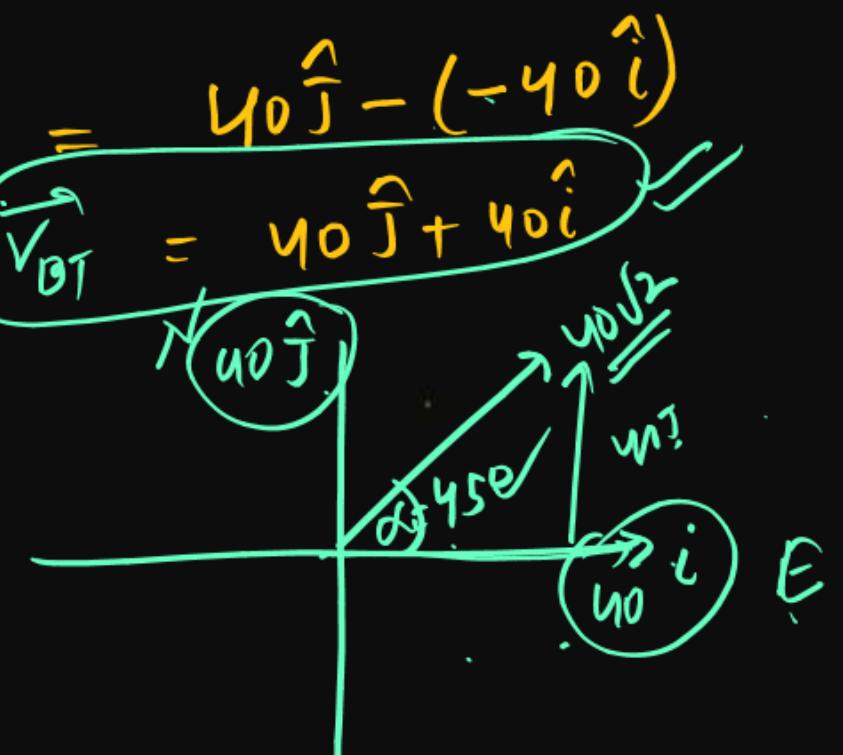
- 1** 40 km/hr in NE direction
  - 2** ✓ 40 $\sqrt{2}$  km/hr in NE direction
  - 3** 40 km/hr in NW direction
  - 4** 40 $\sqrt{2}$  km/hr in NW direction

$$\underline{\text{Soln}} \quad \vec{V}_B = 40 \hat{J} \quad \begin{matrix} \leftarrow \\ \text{N} \end{matrix} \quad \begin{matrix} \uparrow \\ E \end{matrix}$$

$$\vec{V_T} = -40 \hat{i} (\text{m/s})$$

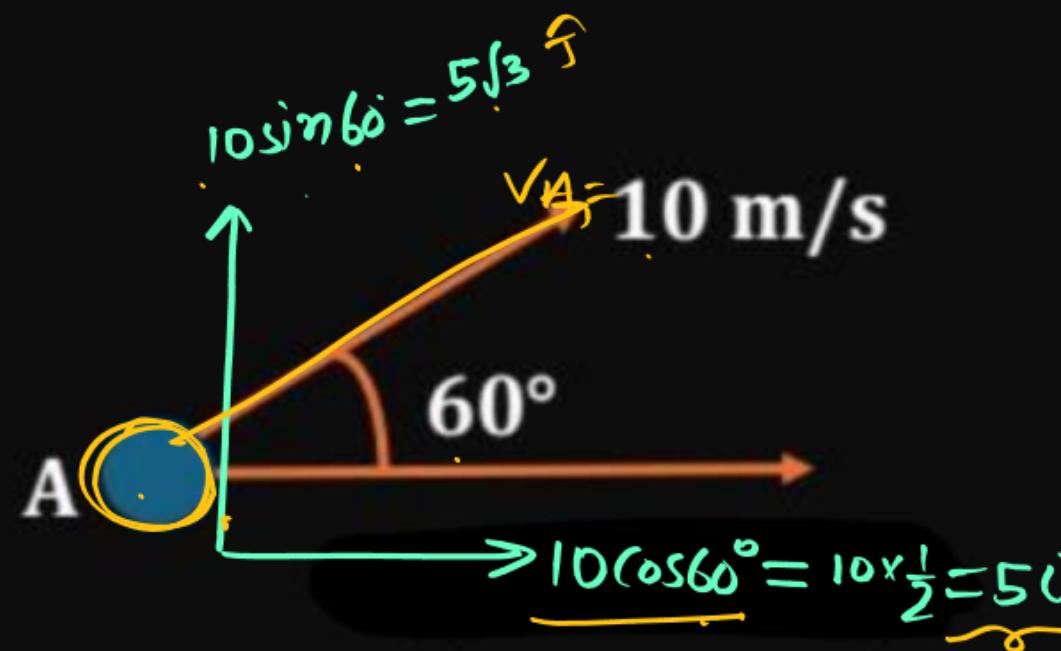
$$\vec{V}_{BT} = \vec{V_B} - \vec{V_T} = \underline{40\hat{j} - (-40\hat{i})}$$

$$\vec{V}_{BT} = \underline{40\hat{j} + 40\hat{i}}$$



## Question

Find velocity of A with respect to B.



$\checkmark \quad \vec{v}_A = 5\hat{i} + 5\sqrt{3}\hat{j} \quad \checkmark$

$$\begin{aligned}\vec{v}_{AB} &= \vec{v}_A - \vec{v}_B \\ &= 5\hat{i} + 5\sqrt{3}\hat{j} - 5\hat{i}\end{aligned}$$

$\boxed{\vec{v}_{AB} = 5\sqrt{3}\hat{j}}$

Must  
H/W

## Question

Velocity of Ramlal  $\vec{V}_R = -3\hat{i} + 4\hat{j}$  and velocity of Pinky  $\vec{V}_P = 4\hat{i} + 3\hat{j}$  then find velocity of Ramlal with respect to Pinky.

H/w

$$\begin{aligned}\vec{V}_{RP} &= \vec{V}_R - \vec{V}_P \\ &= -3\hat{i} + 4\hat{j} - (4\hat{i} + 3\hat{j}) \\ &= -3\hat{i} + 4\hat{j} - 4\hat{i} - 3\hat{j} \\ &= \underbrace{-7\hat{i} + \hat{j}}\end{aligned}$$

HOME

## Question

Car is moving with 30 m/s along east and truck is moving with speed 40 m/s at 30° N of E w.r.t. car then find velocity of truck.

Method 1

$$\vec{v}_c = 30 \hat{i}$$

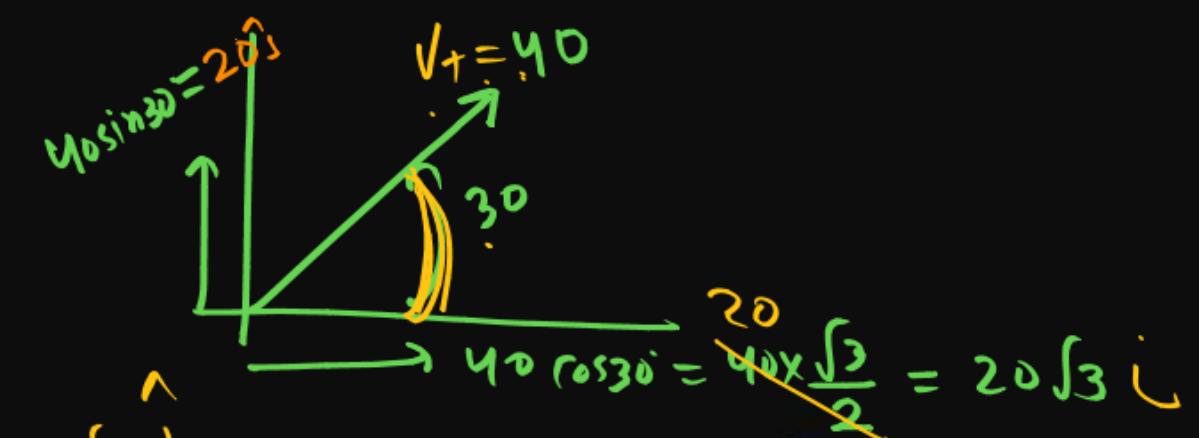
$$20\sqrt{3} \hat{i} + 20 \hat{j} = \vec{v}_t - 30 \hat{i}$$

$$\vec{v}_t = 20\sqrt{3} \hat{i} + 30 \hat{i} + 20 \hat{j}$$

Ans

$$\vec{v}_c = 30 \hat{i} \quad \text{--- ①}$$

$$\vec{v}_{tc} = 40 \text{ m/s} \quad 30^\circ \text{ N of E}$$



$$\vec{v}_{tc} = 20\sqrt{3} \hat{j} + 20 \hat{i}$$

## Question

A man 'A' moves in the north direction with a speed 10 m/s and another man B moves in E- $30^\circ$ -N with 10 m/s. Find the relative velocity of B w.r.t. A.

~~कोर्स से~~  
Vector में discuss

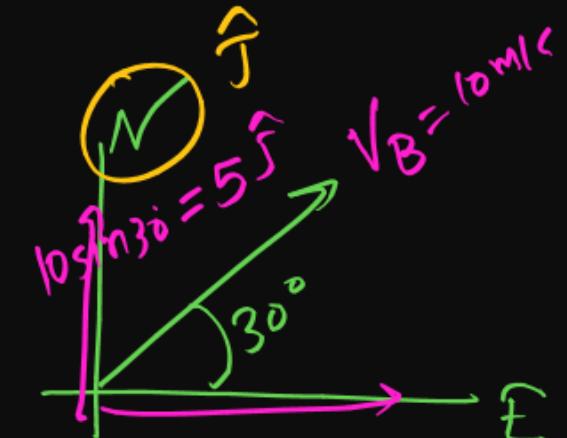
E -  $30^\circ$  - N  
# East से  $30^\circ$  North

#  $30^\circ$  East of North

(North से  $30^\circ$  East)

$$\vec{V}_A = 10 \hat{j}$$

$$V_B = 10 \text{ m/s}$$



M/W

$$\begin{aligned} V_{BA} &= 10 \cos 30 = 10 \times \frac{\sqrt{3}}{2} \\ &= 5\sqrt{3} i \end{aligned}$$

$$\vec{V}_B = 5\sqrt{3} i + 5 \hat{j}$$

$$\vec{V}_A = 10 \hat{j}$$

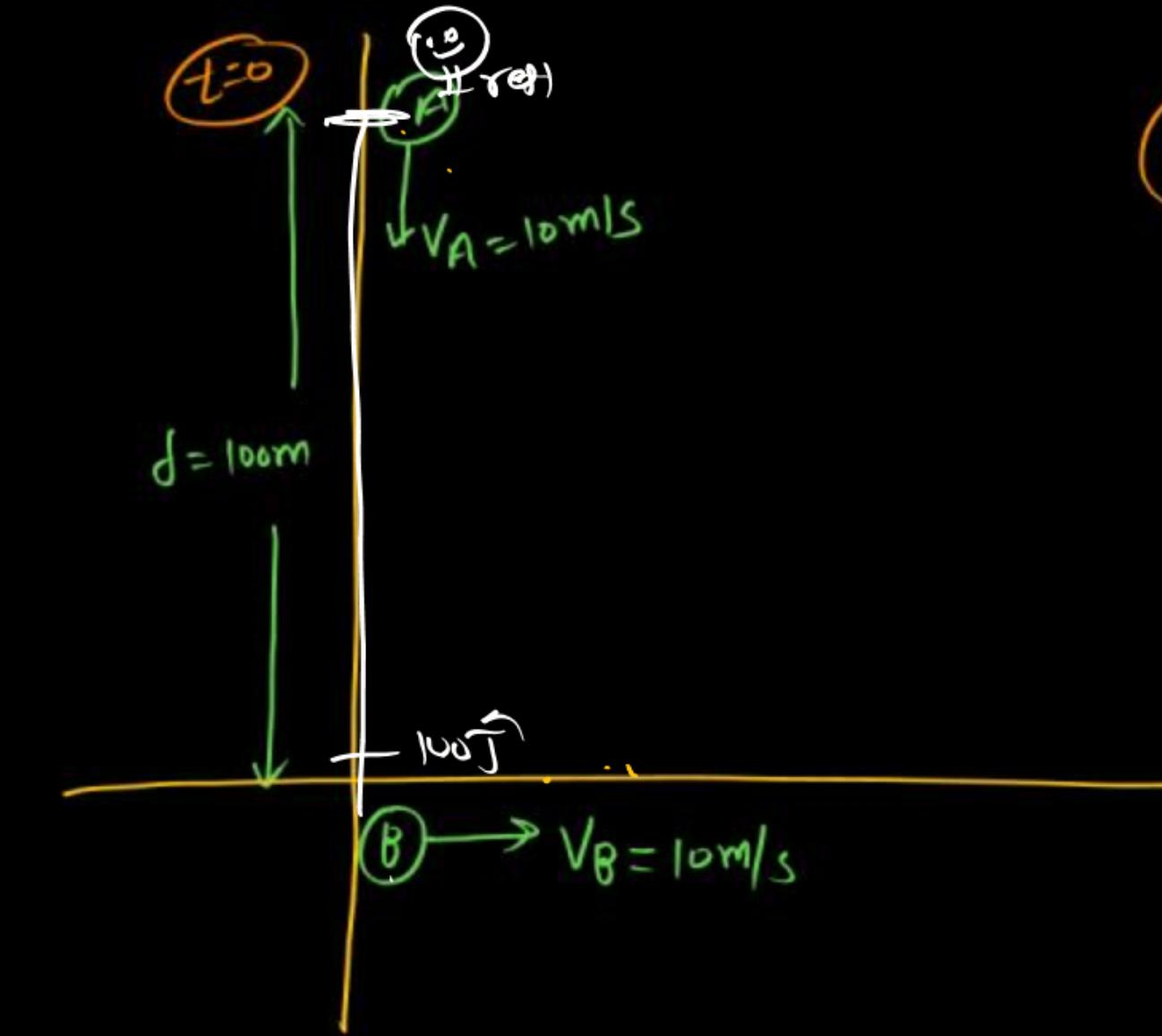
$$\vec{V}_{BA} = \vec{V}_B - \vec{V}_A = \underline{\underline{5\sqrt{3}i + 5\hat{j} - 10\hat{j}}}$$

Q) Minimum separation

Position and velocity of A & B  
at  $t=0$  shown in fig.

then find minimum  
Separation b/w A & B

$\rightarrow$  See on  
next page



$$\vec{v}_{BA} = v_B - v_A = 10\hat{i} + 10\hat{j}$$

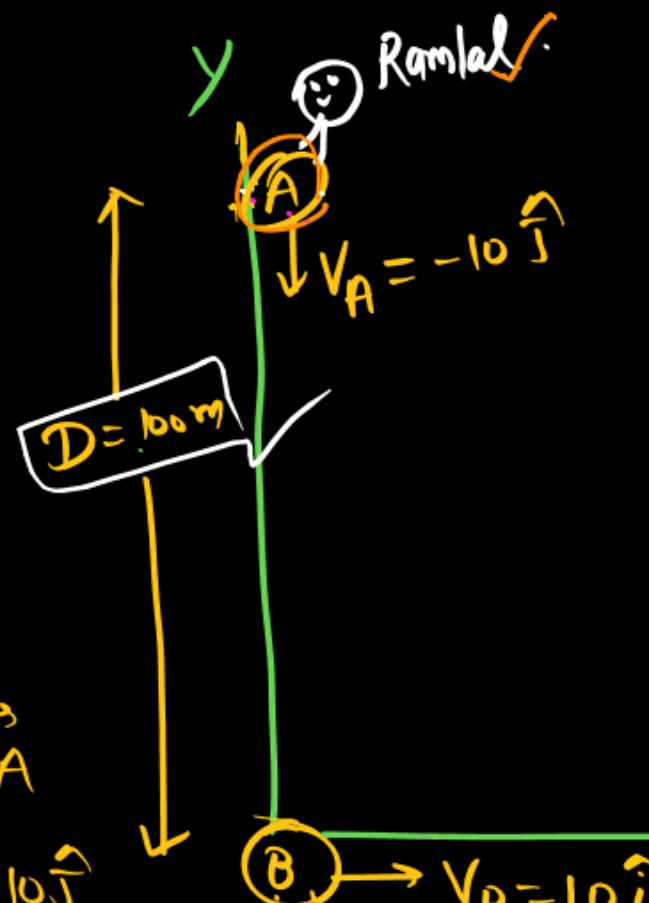
$$\left( \frac{dr}{dt} \right)_{t=0} = \vec{v}_{BA}$$

H/w

must try

## minimum separation

MR\* → kisi ek par Ramlal ko bitha ke dusre object ka relative velocity likho; 2<sup>nd</sup> object rest me hoga other relative velocity Ke dirn me move karega



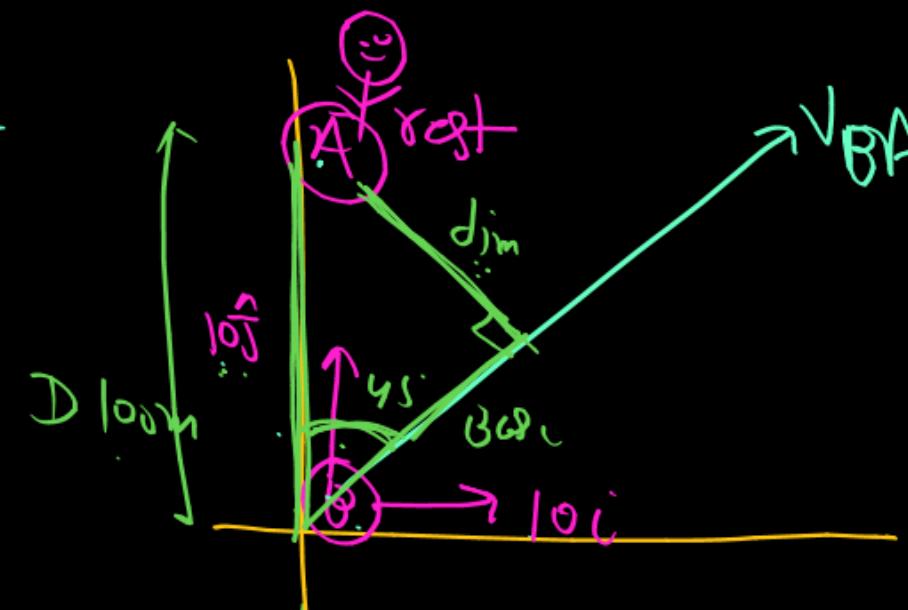
$$\begin{aligned}\vec{V}_{BA} &= \vec{V}_B - \vec{V}_A \\ &= 10i - (-10j) \\ \vec{V}_{BA} &= 10i + 10j\end{aligned}$$

$\vec{V}_{BA} = 10\sqrt{2}$

in Triangle  $(OAB)$

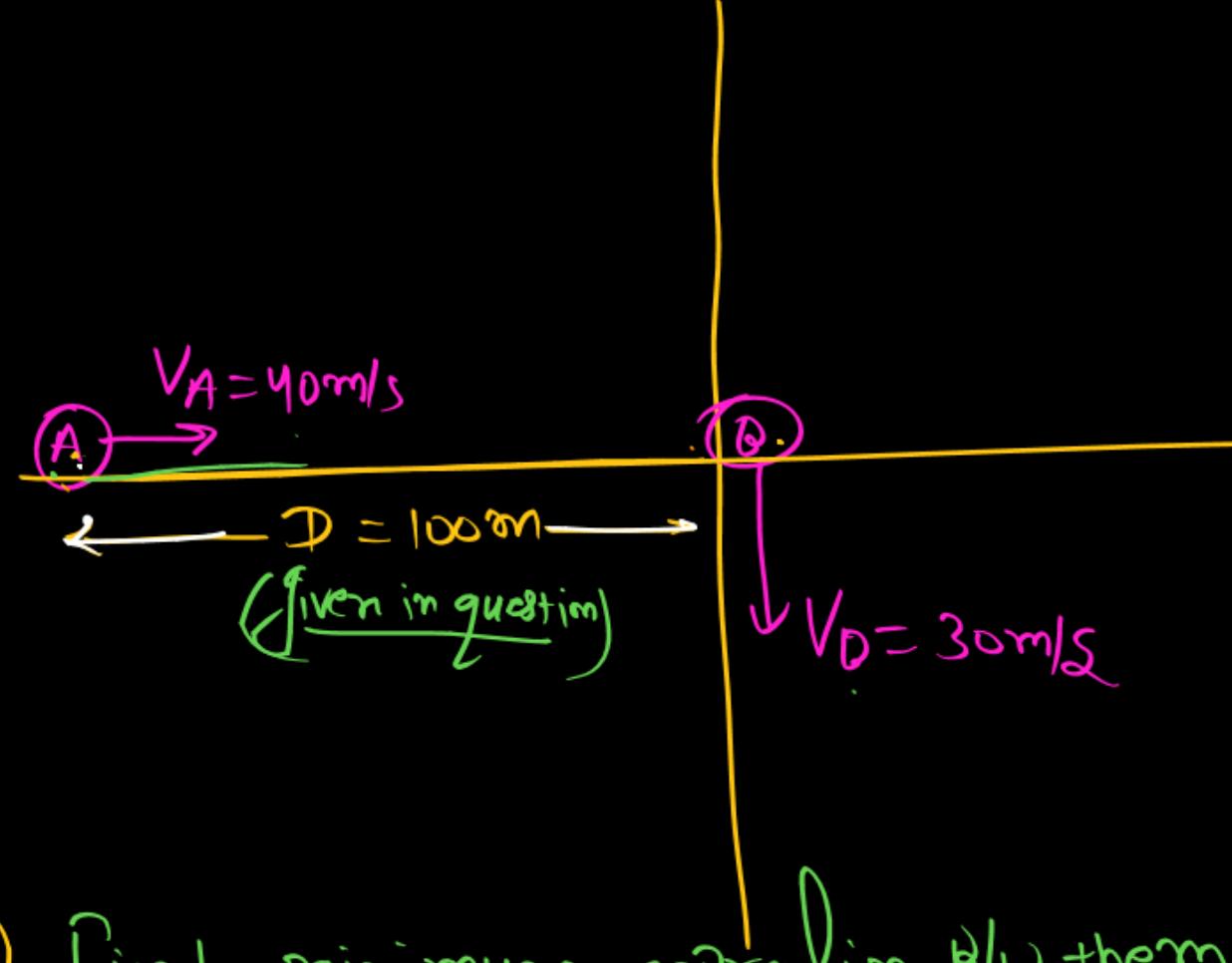
$$\sin 45^\circ = \frac{d_{min}}{D}$$

$$d_{min} = \frac{D}{\sqrt{2}} = \frac{100}{\sqrt{2}} = \frac{50\sqrt{2}}{\sqrt{2}} = 50\sqrt{2}$$



- # find time after which they are at min<sup>m</sup> separation (dist)

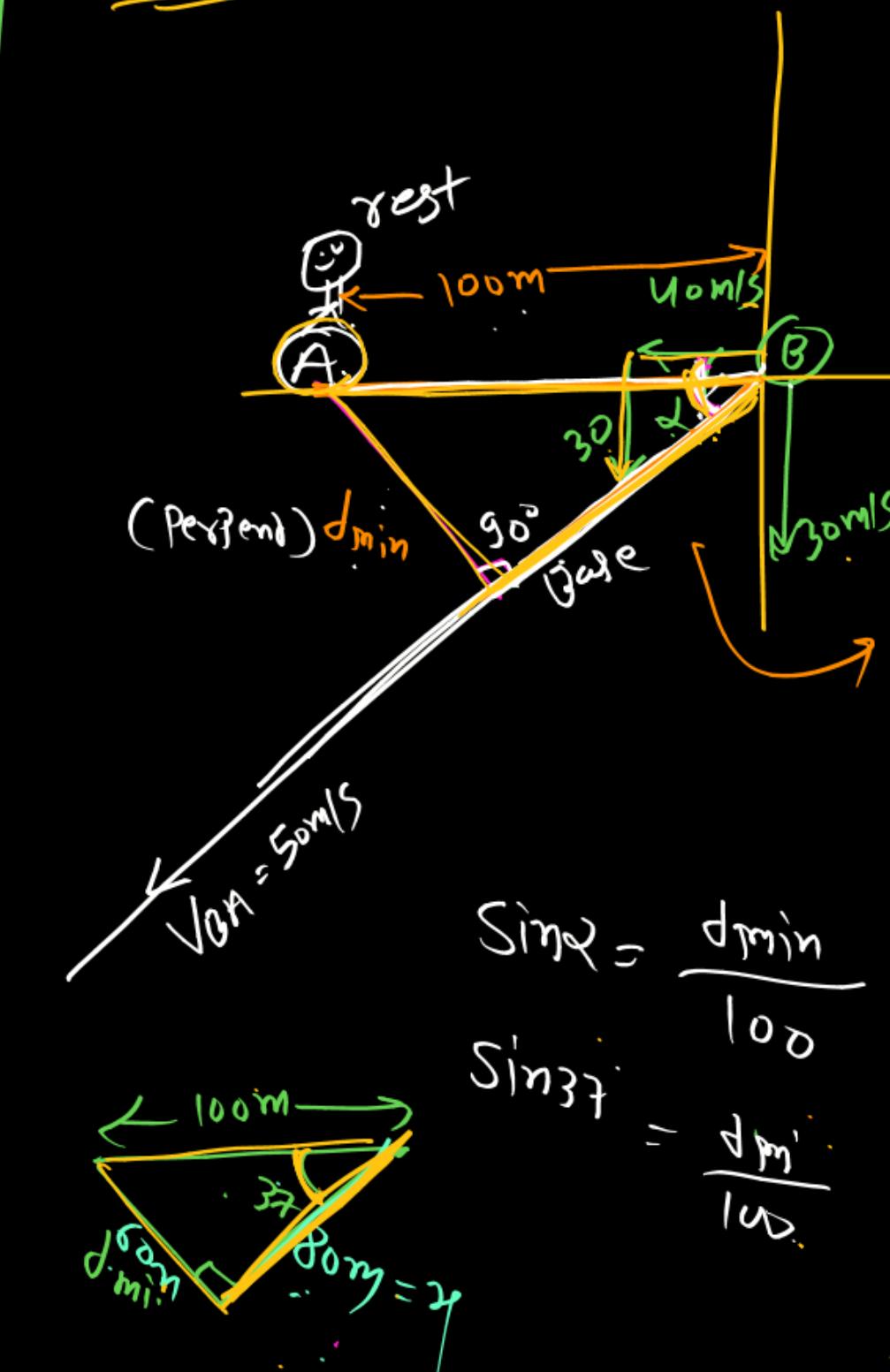
$$\begin{aligned}t &= \frac{dist}{speed} = \frac{O\vartheta}{(V_{BA})} \\ &= \frac{10\vartheta}{\sqrt{2} \times 10\sqrt{2}} = \frac{10}{2} = 5 \text{ sec}\end{aligned}$$



(Q) find minimum separation b/w them :-

$$\text{time} = \frac{80}{50} = \frac{8}{5} \text{ sec}$$

Soln



$$\sin \alpha = \frac{d_{min}}{100}$$

$$\sin 37^\circ = \frac{d_{min}}{100}$$

$$d_{min} = 100 \times \frac{3}{5} = 60 \text{ m}$$

$$\vec{V}_{BA} = -40 \hat{i} - 30 \hat{j}$$

$$|V_{BA}| = \sqrt{(40)^2 + (30)^2} = 50 \text{ m/s}$$

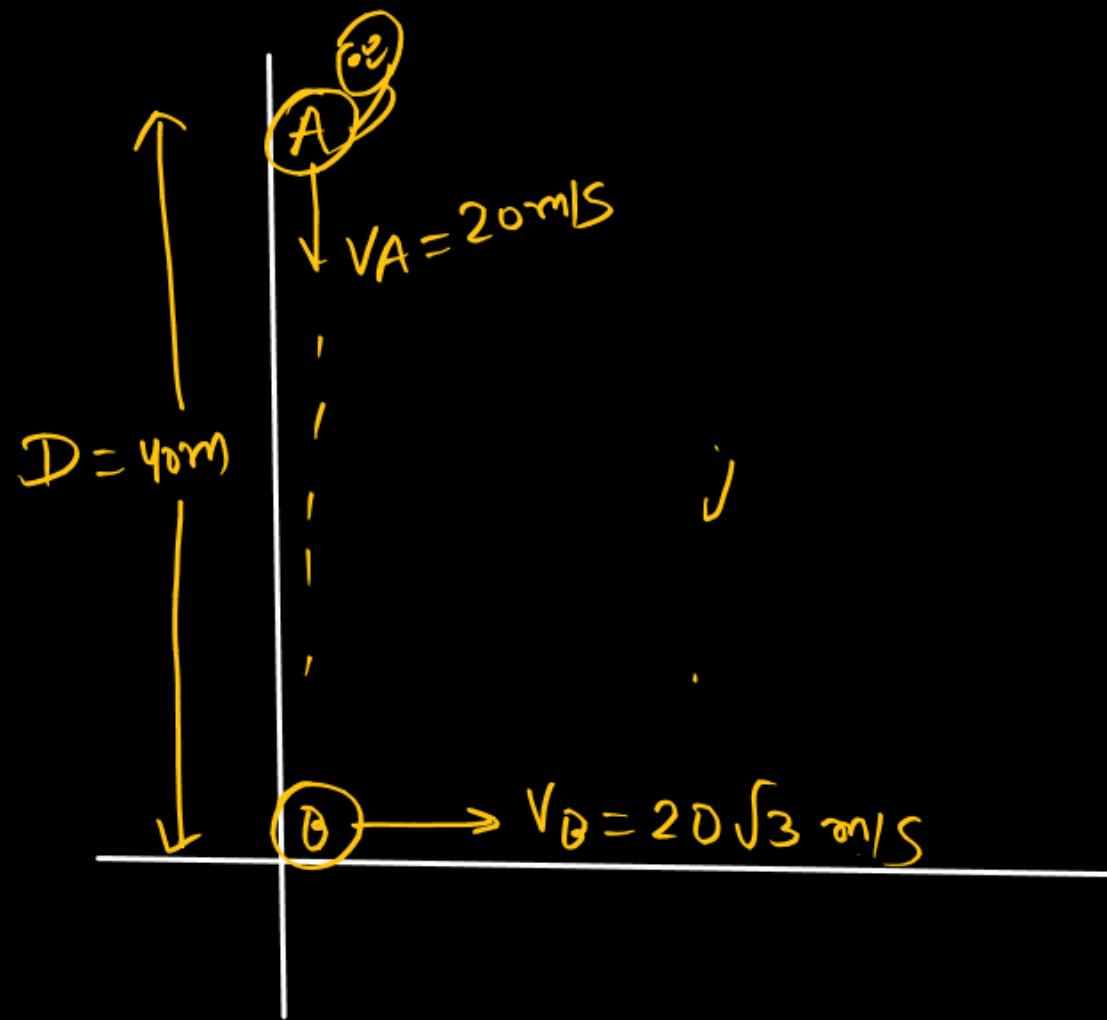
$$\tan \alpha = \frac{3}{4}$$

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

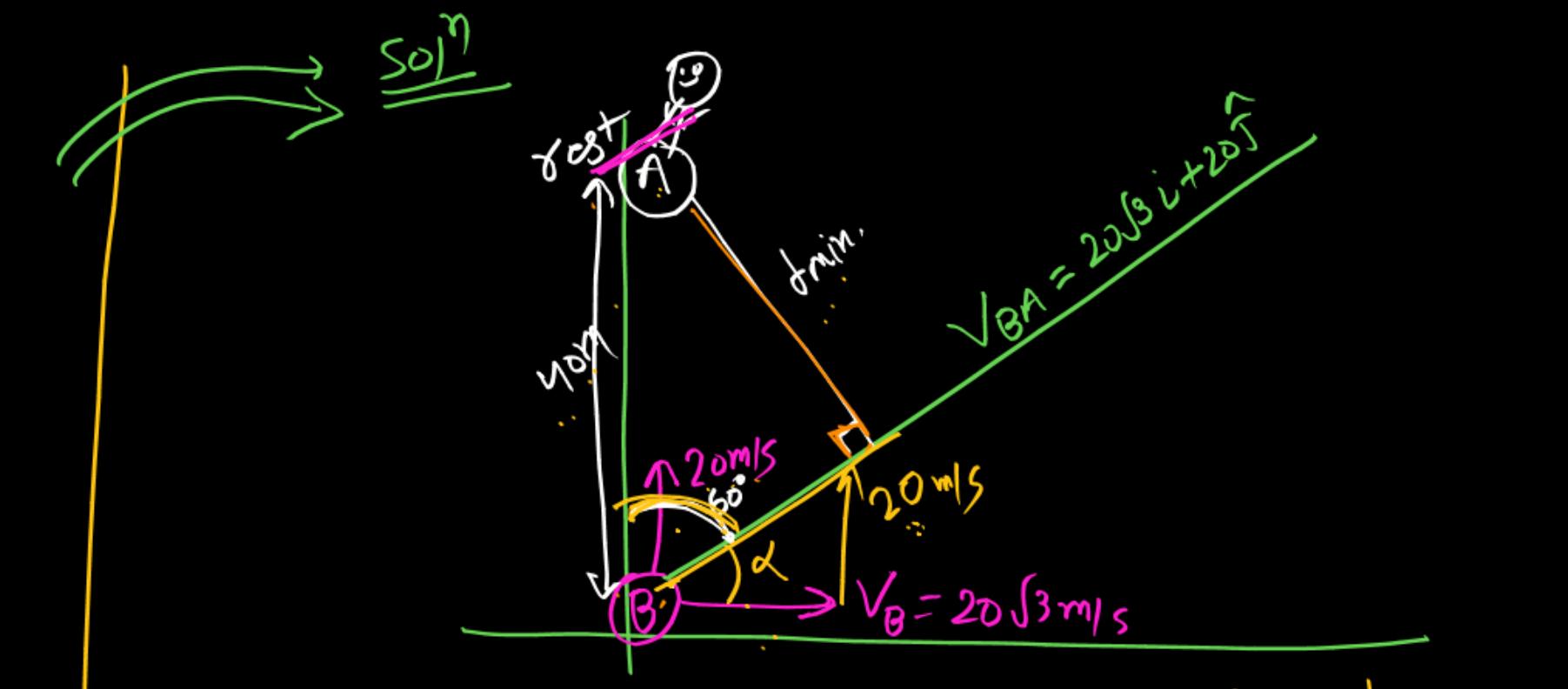
$$\alpha = 37^\circ$$

$$d_{min} = 100 \times \frac{3}{5} = 60 \text{ m}$$

①



② find Min<sup>m</sup> sep<sup>n</sup> B/w (A)-(B)  
objects are moving on Horizontal plane



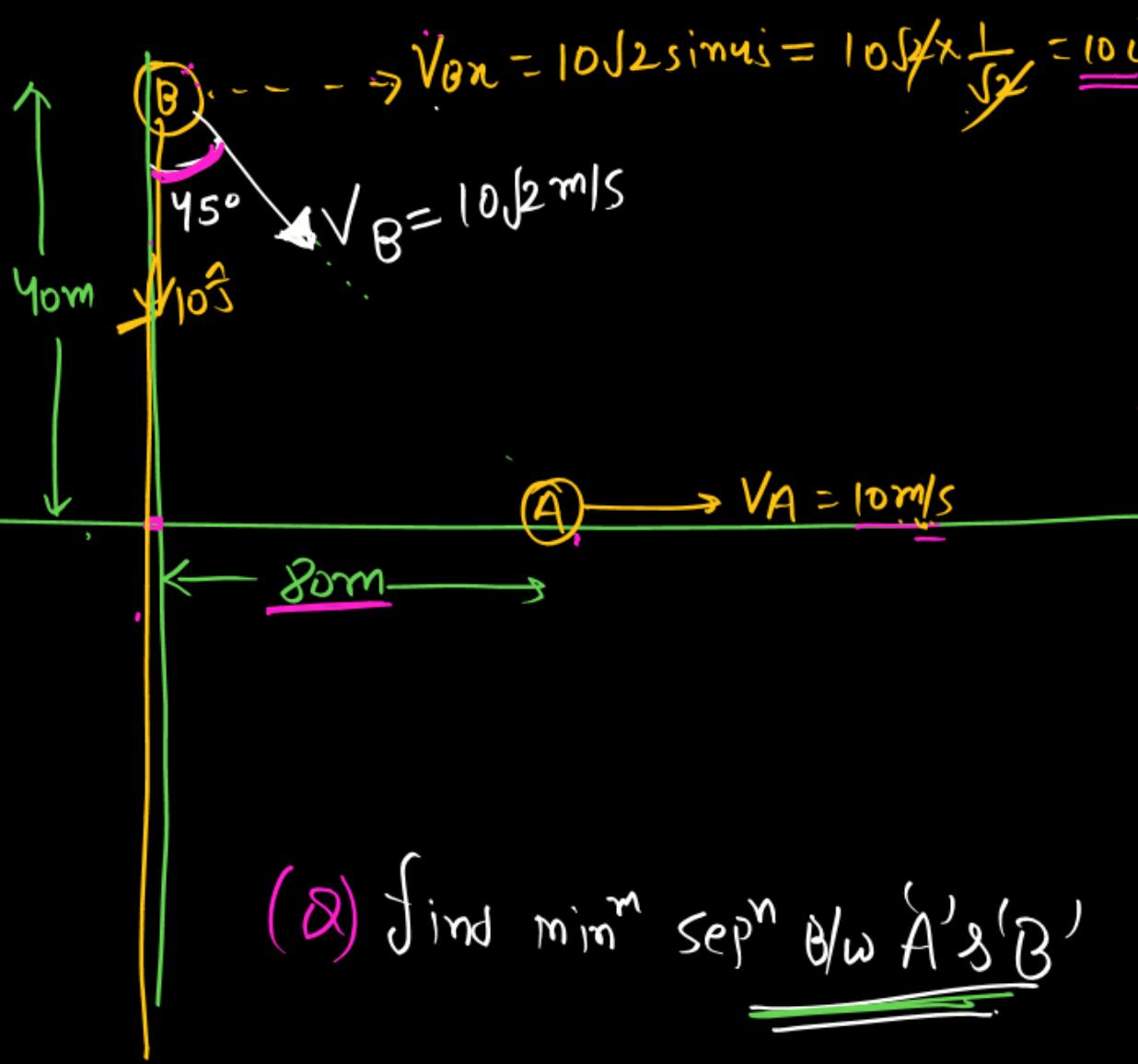
$$\sin 60^\circ = \frac{d_{\min}}{40}$$

$$d_{\min} = \frac{\sqrt{3}}{2} \times 40 \times 20$$

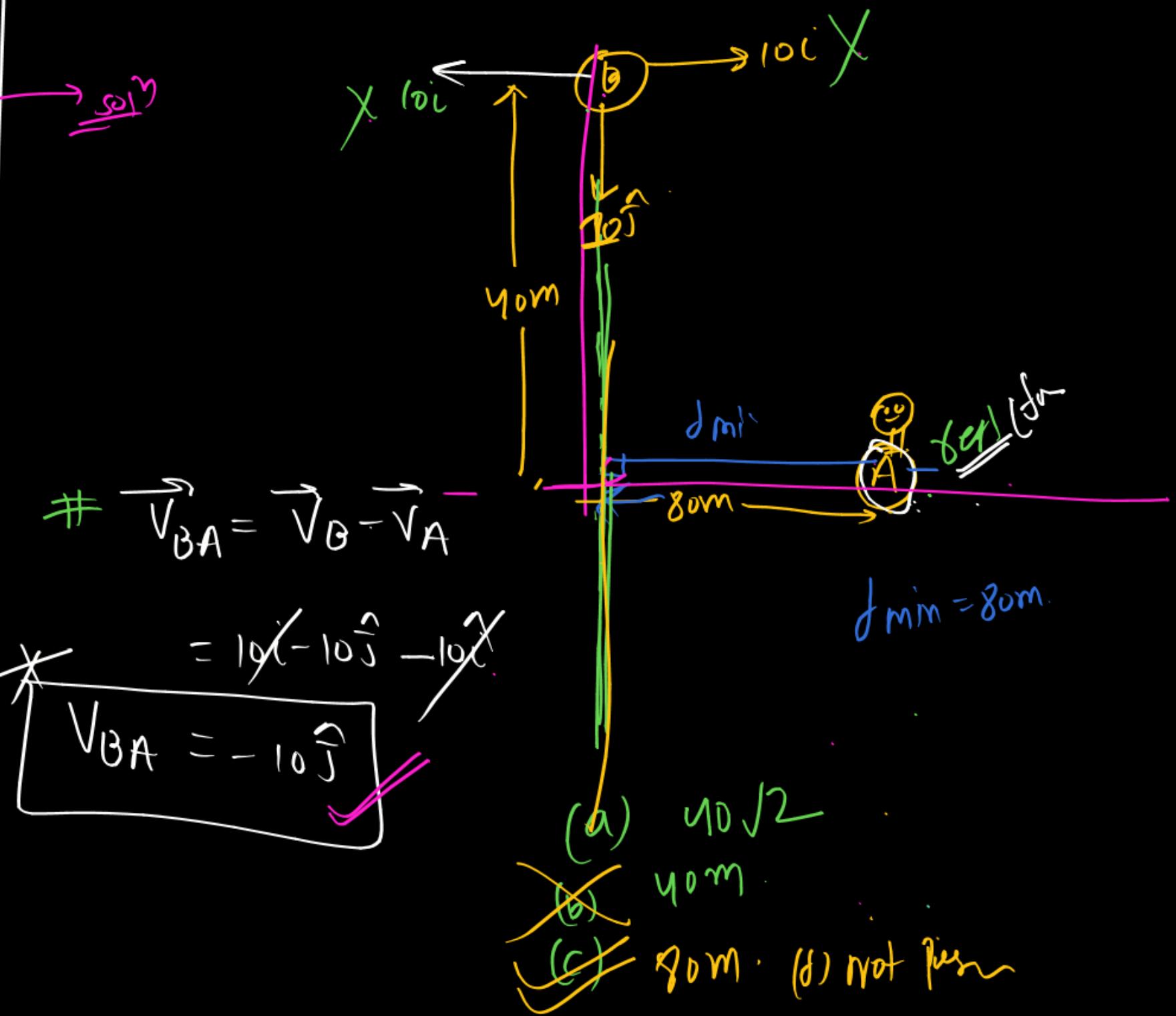
$$d_{\min} = 20\sqrt{3} \quad \checkmark$$

$$\tan \alpha = \frac{20}{20\sqrt{3}} = \frac{1}{\sqrt{3}} \quad \checkmark$$

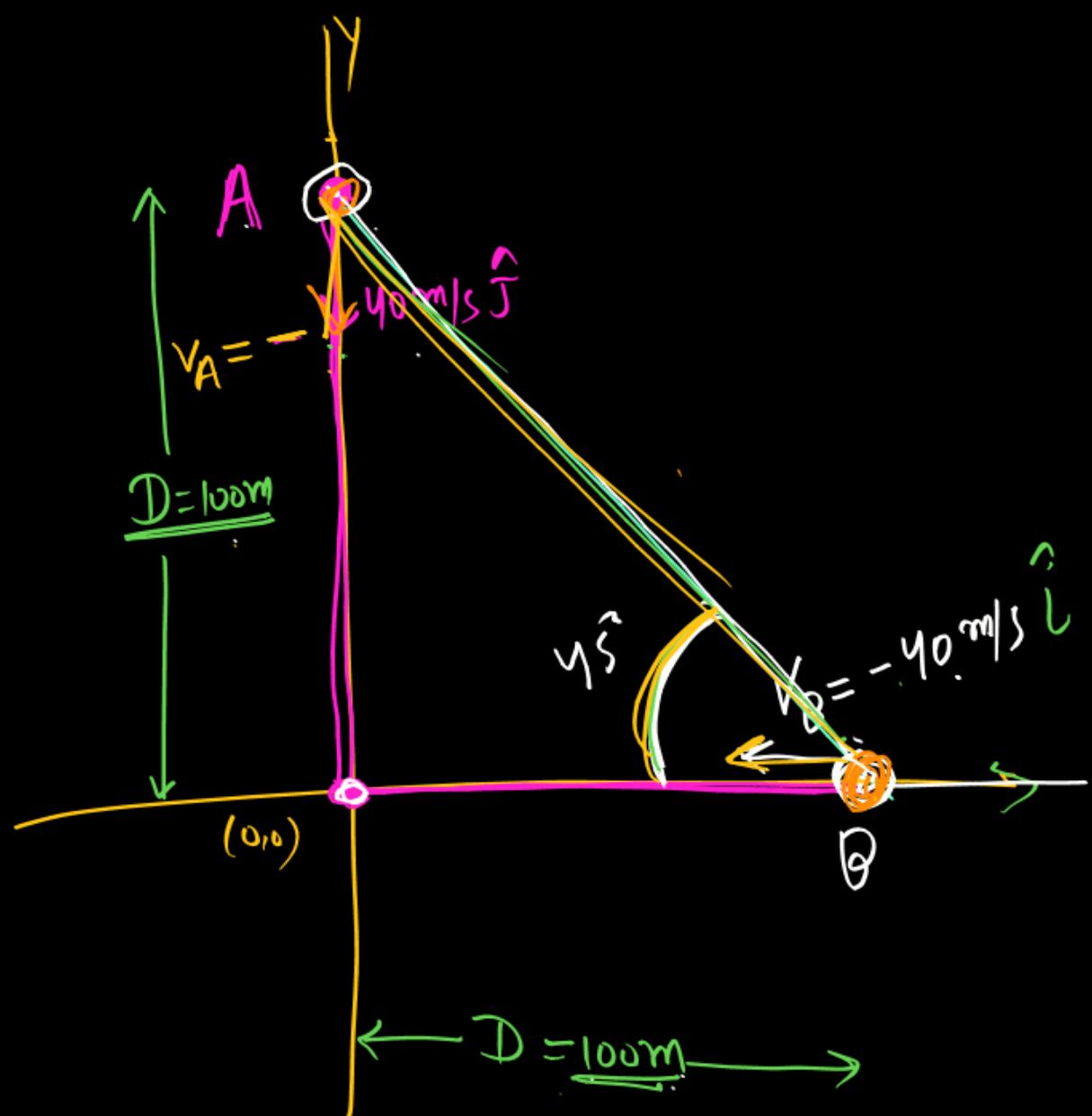
$$\alpha = 30^\circ \quad \checkmark$$



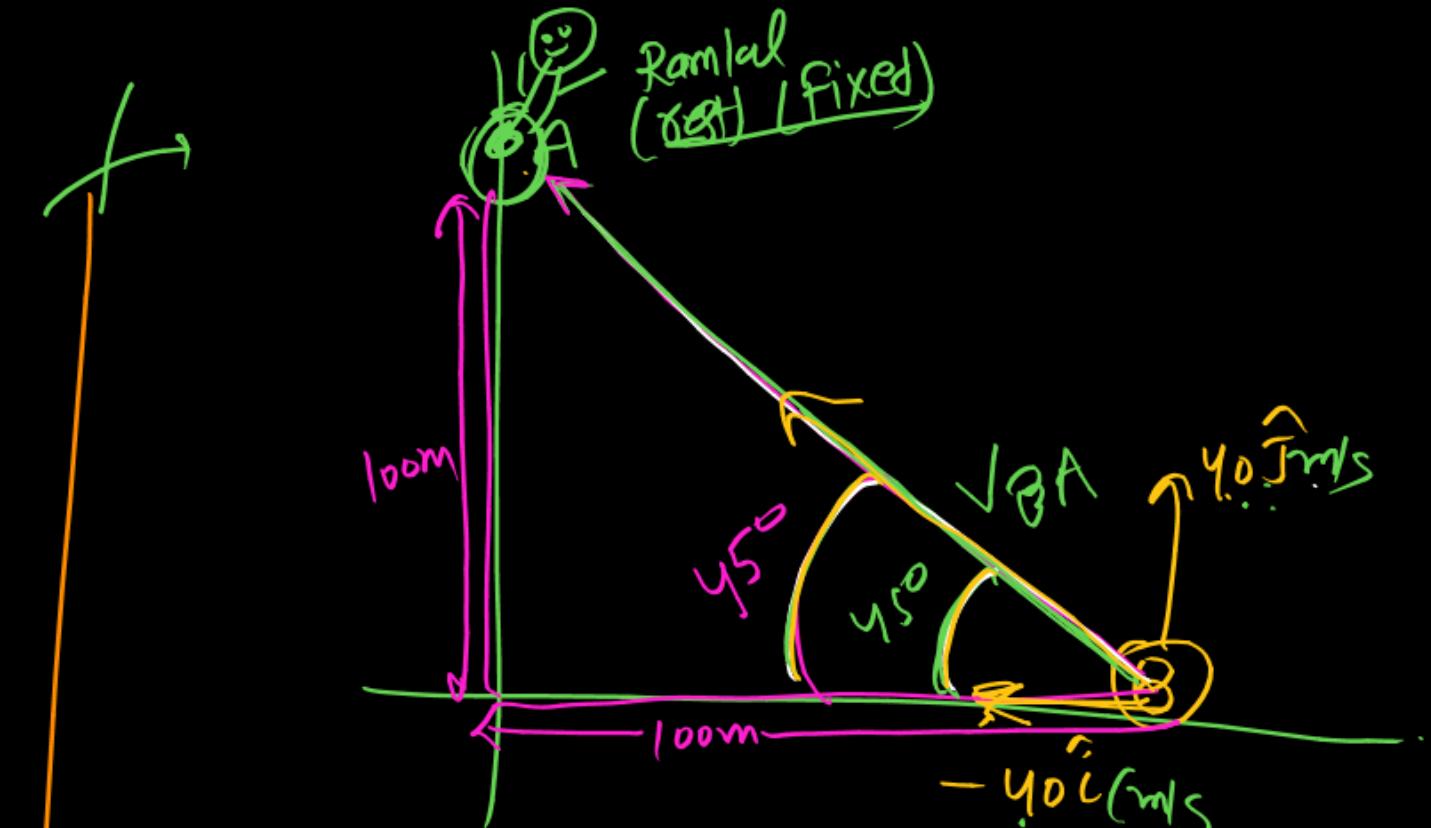
(Q) Find min sep  $\theta$  w/o A's B'



#



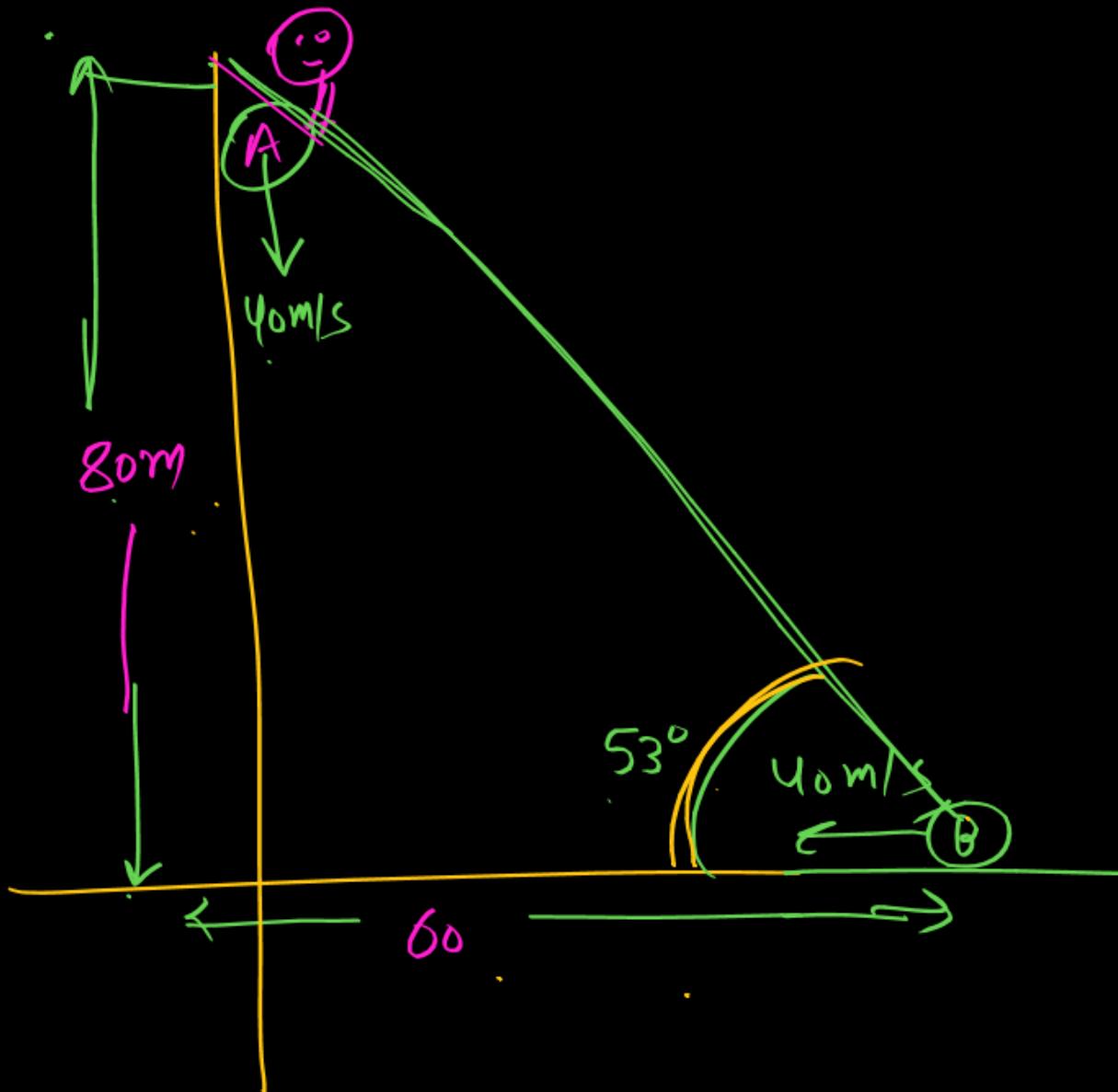
(Q) Min<sup>n</sup> sep<sup>n</sup> b/w them (initial pos)



$$\begin{aligned}
 \vec{V}_{BA} &= \vec{V}_B - \vec{V}_A \\
 &= -40\hat{i} - (-40\hat{j}) \\
 &= 40\hat{i} + 40\hat{j}
 \end{aligned}$$

relative Velocity along the line joining of A & B  
 $d_{min} = 0$

①

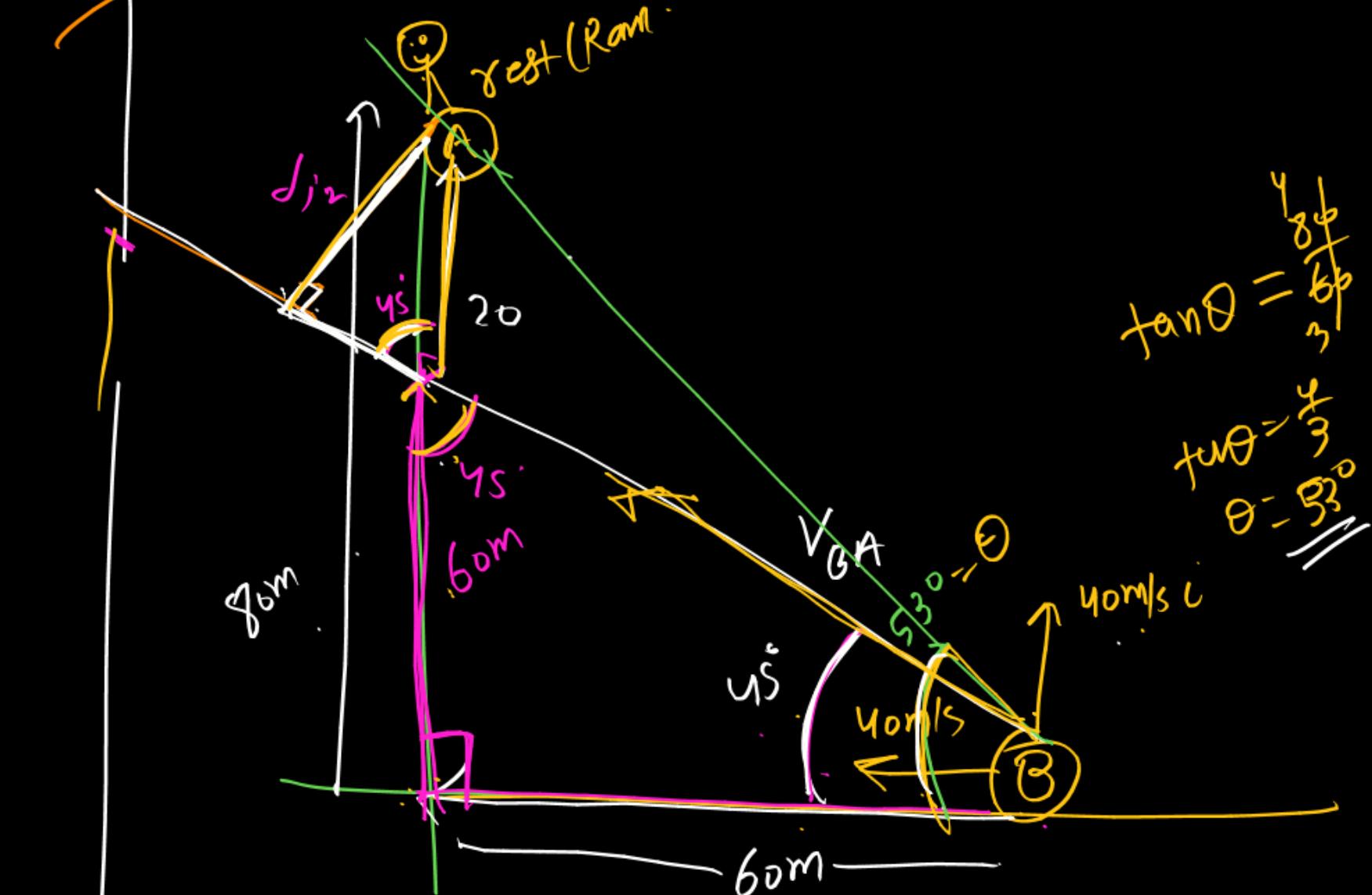


② They will collide or not

$$\tan \theta = \frac{80}{60} = \frac{4}{3}$$

$$\theta = 53^\circ$$

min distn  $\theta$  w them



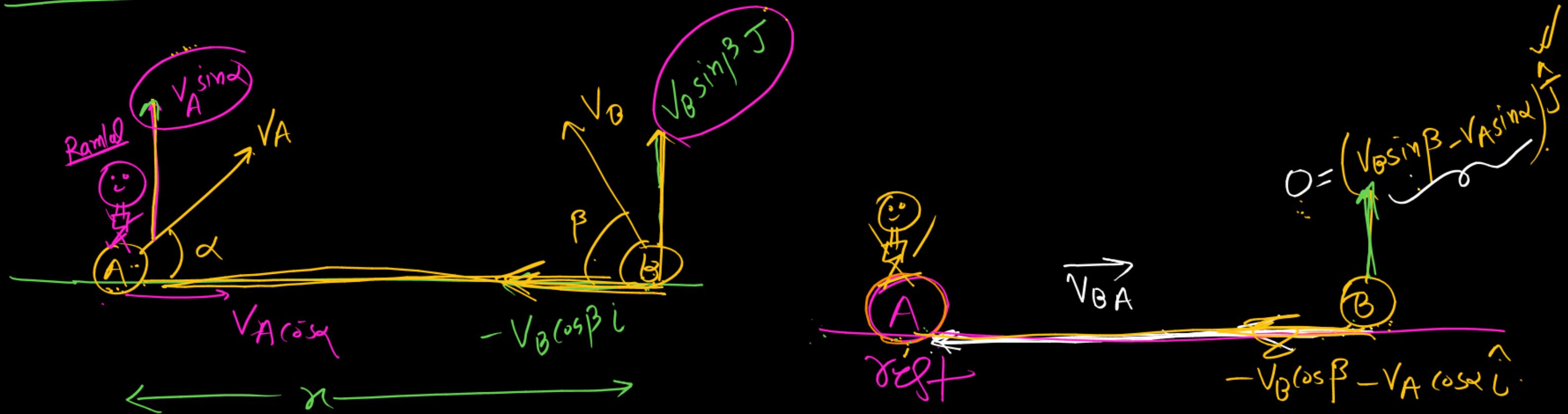
$$\sin 45^\circ = \frac{d_{\min}}{20}$$

$$d_{\min} = 20 \times \frac{1}{\sqrt{2}} \text{ m}$$

$$\begin{aligned}\tan \theta &= \frac{80}{60} \\ \theta &= 53^\circ \\ \sin \theta &= \frac{4}{5} \\ \cos \theta &= \frac{3}{5}\end{aligned}$$

## Condition of Collision

Horizontal plane



if  $V_B \sin \beta - V_A \sin \alpha = 0$

$V_B \sin \beta = V_A \sin \alpha$

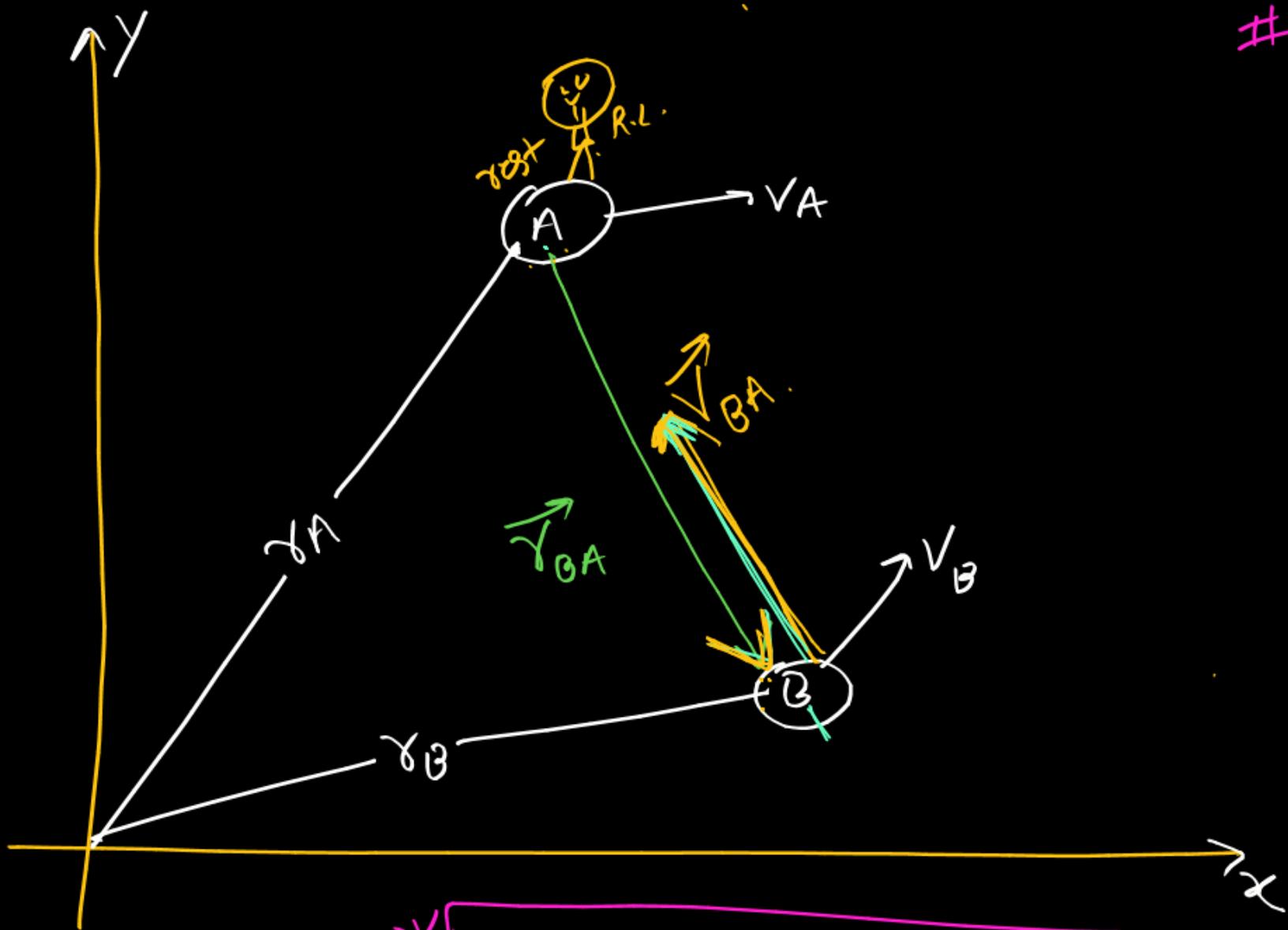
## Cond' of collision

Jab relative velocity

line joining ke along  
ek dusre ke taraf ho

Component of Velocity Perpendicular to line Join is  
Same

## # Condition of Collision (AIMPT-2015)



\* Relative velocity must be zero  $\perp$  to line joining

# Cond'n of Collision  $\rightarrow$   
relative velocity must be  
along line joining of two  
object

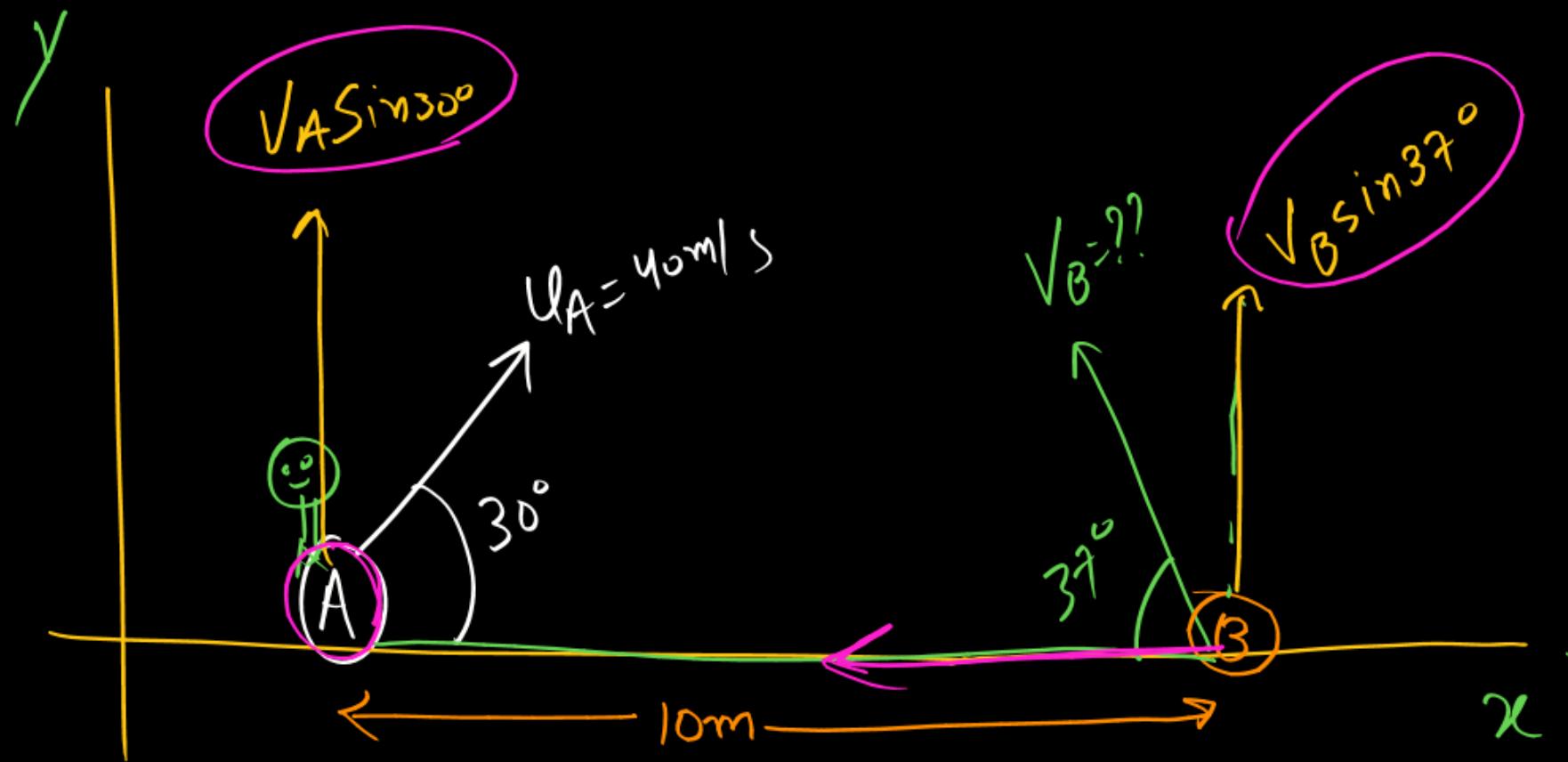
$$\vec{V}_{BA} = \text{ka direction} = -\hat{\gamma}_{BA}$$

ke along दोनों वाले

$$\hat{V}_{BA} = -\hat{\gamma}_{BA}$$

\* 
$$\frac{\vec{V}_B - \vec{V}_A}{|\vec{V}_B - \vec{V}_A|} = - \frac{\vec{\gamma}_B - \vec{\gamma}_A}{|\vec{\gamma}_B - \vec{\gamma}_A|}$$

## Projectile motion



find  $\theta$  so that  
they will collide  
in air

$$a_{BA} = 0 \quad \checkmark$$

$$\sqrt{0} \sin 37^\circ = \sqrt{A} \sin 30^\circ$$

$$\sqrt{0} \times \frac{3}{5} = 40 \times \frac{1}{2}$$

$$\sqrt{B} = \left(\frac{100}{3}\right) \text{ m/s}$$

A

## Question

⑥

Two particles A and B are projected from the ground simultaneously in the directions shown in the figure with initial velocities  $v_A = 20 \text{ m/s}$  and  $v_B = 10 \text{ m/s}$  respectively. They collide after 0.5 s. Find out the angle  $\theta$  and the distance x.

Component of velocity must be same  
perpendicular to line going

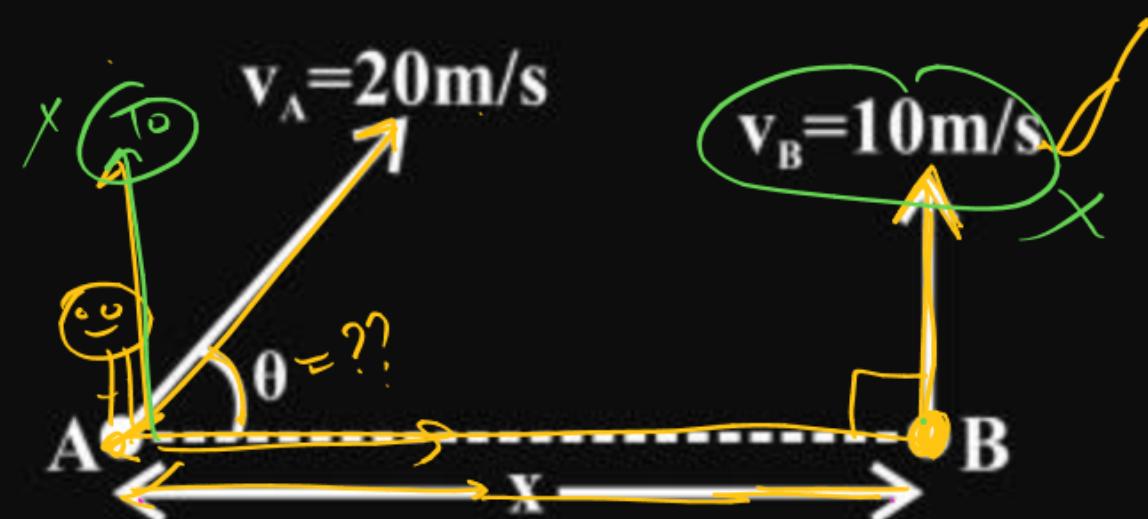
$$v_A \sin \theta = v_B$$

$$20 \sin \theta = 10$$

$$\sin \theta = \frac{1}{2}$$

$$\theta = 30^\circ$$

As



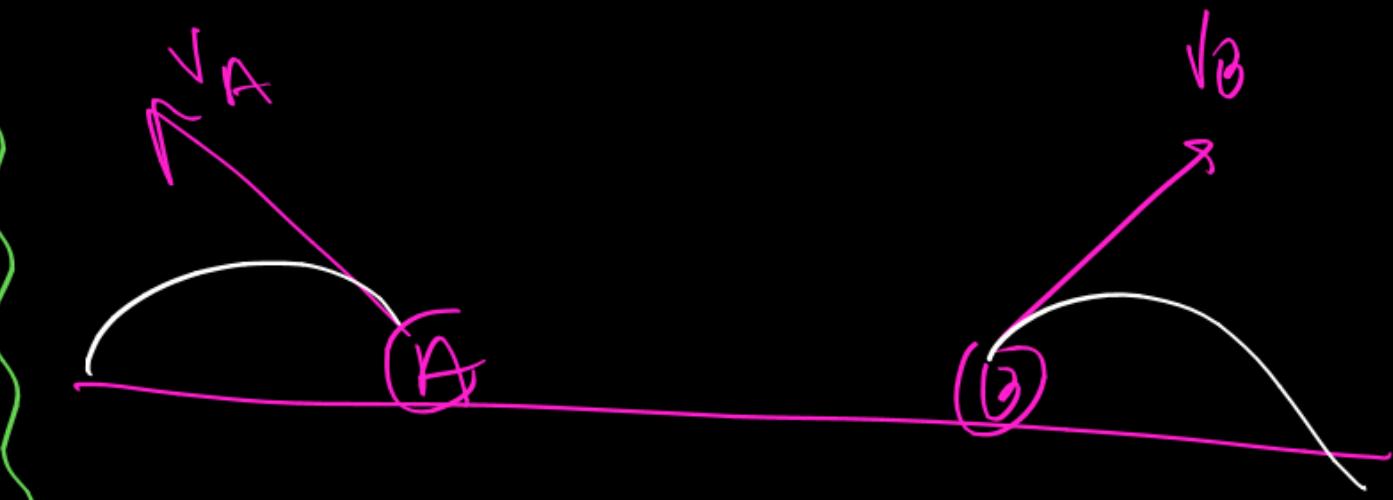
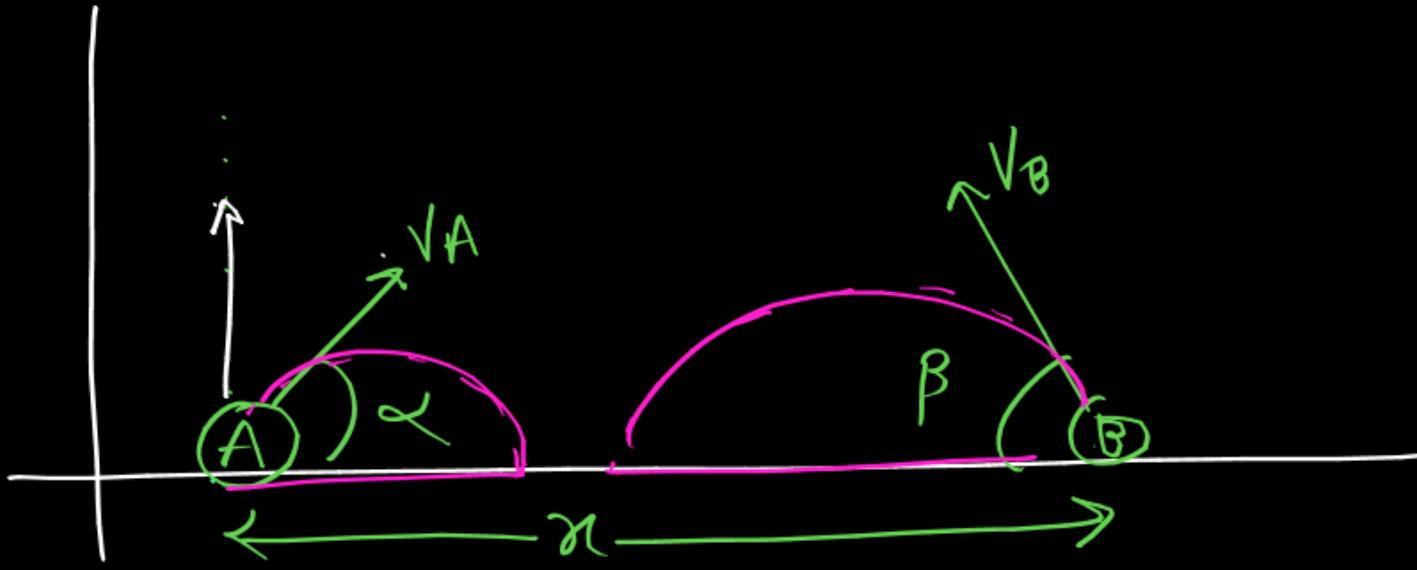
$$v_{An} = v_A \cos \theta$$

$$= 20 \times \cos 30^\circ$$

$$= 20 \times \frac{\sqrt{3}}{2} = 10\sqrt{3}$$

# Sirf x & t motn. का कर  
 $x = v \times t$   
 $x = 10\sqrt{3} \times \frac{1}{2} = 5\sqrt{3} \text{ m}$

## # Condition of collision in Projectile Motion



No collision

### # Condition of collision

(I)  $V_A \sin \alpha = V_B \sin \beta$

$$R_1, R_2 = \text{Range}$$

(II)  $\alpha \leq (R_1 + R_2)$

(III)  $\alpha > (R_1 + R_2) \rightarrow \underline{\text{No collision}}$

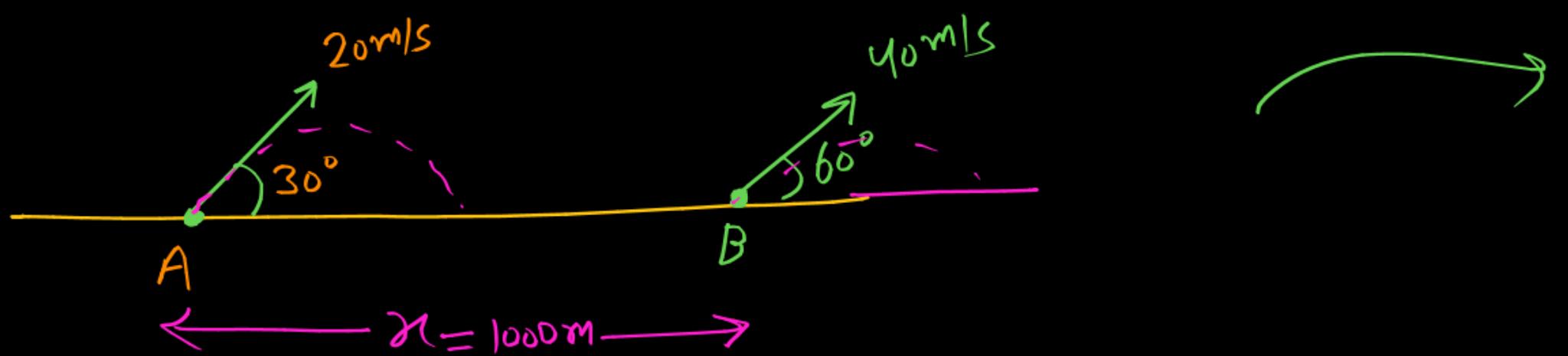
$a_{AB} = 0$

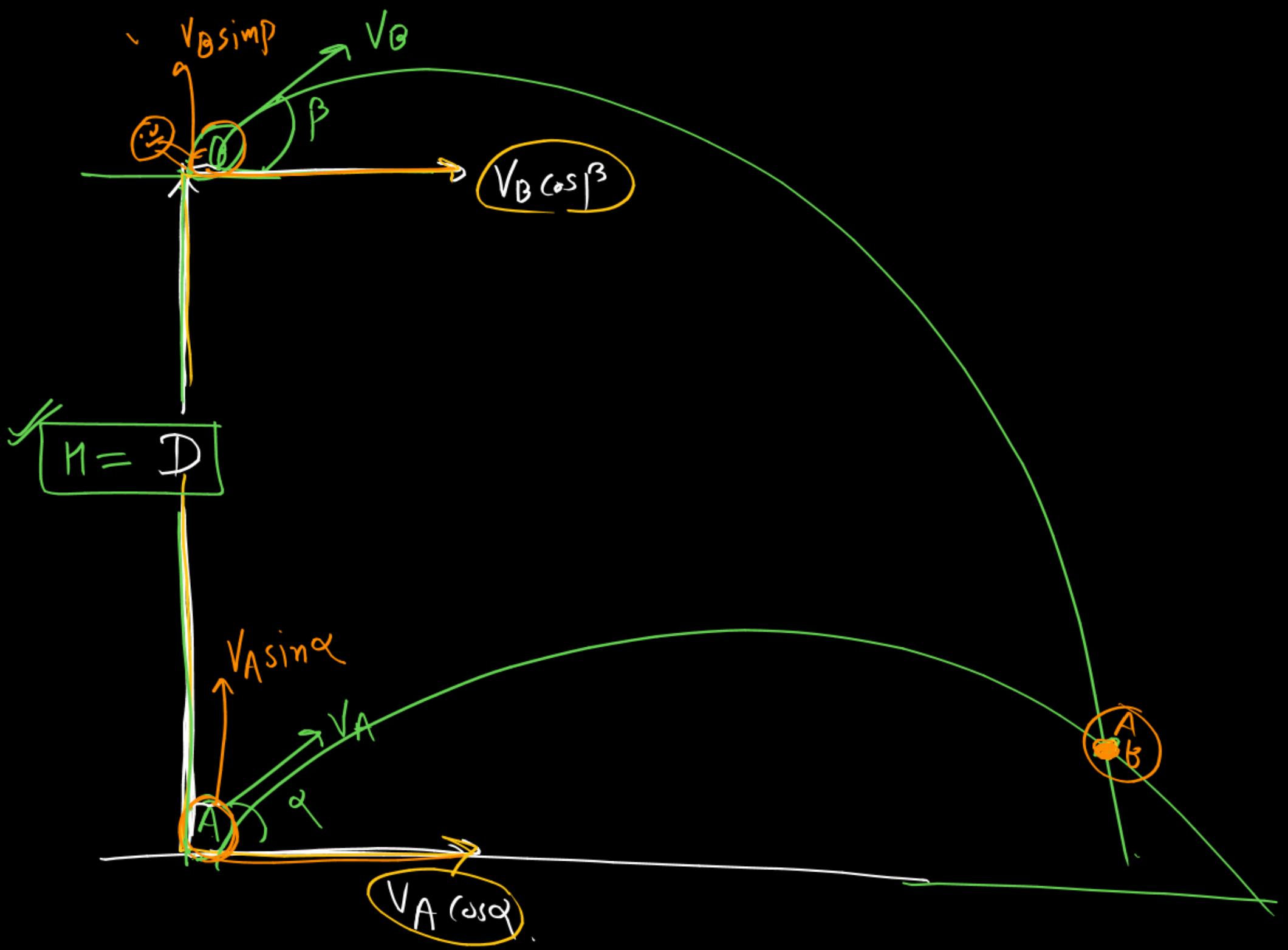
relative accn is zero

$V_{AB} = \text{const}$

They will collide or not ??

Ans No





$$\boxed{v_A \cos \alpha = v_B \cos \beta}$$

time of collision = ??

# Consider mot<sup>n</sup> in y-axis

rest (B)

$$t = \frac{D}{v_A \sin \alpha - v_B \sin \beta}$$

Same as mot<sup>n</sup> under gravity

$$u_{AB} = (v_A \sin \alpha - v_B \sin \beta)$$

$a_{AB} = 0$

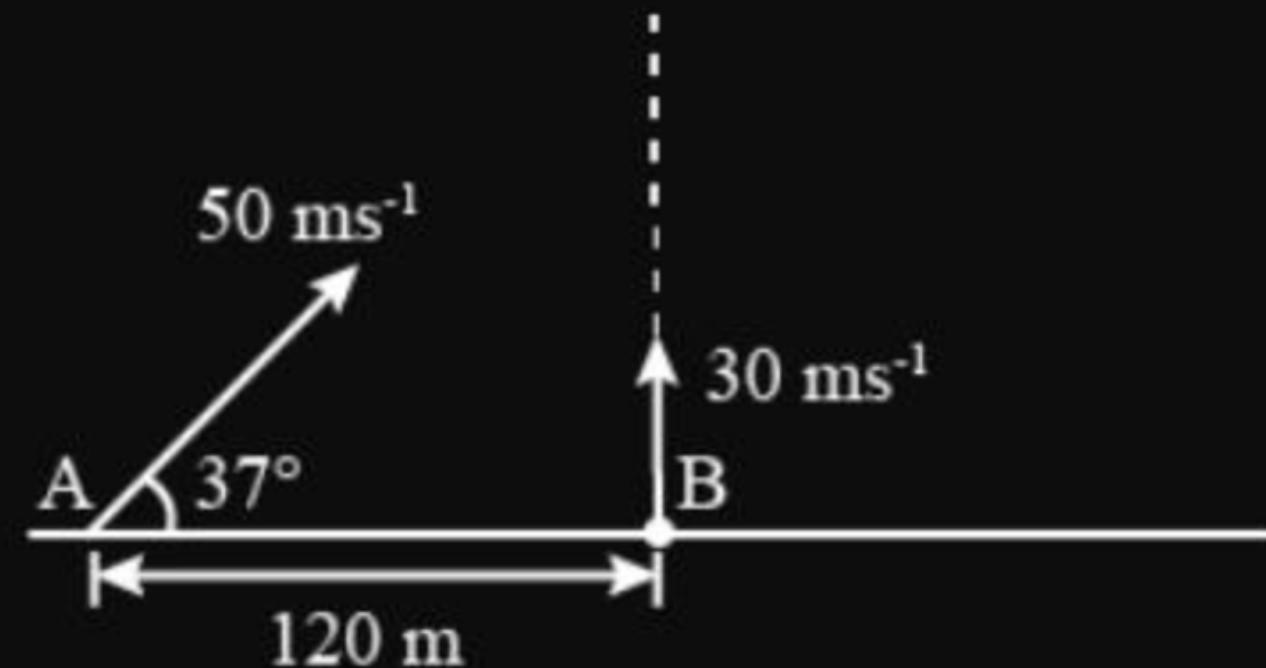
relat all<sup>n</sup>

## Question

Balls A and B are thrown from two points lying on the same horizontal plane separated by a distance of 120 m. Which of the following statements is correct?

- 1** The balls can never meet.
- 2** The balls can meet if the ball B is thrown 1 s later.
- 3** ~~(✓)~~ The two balls meet at a height of 45 m.
- 4** None of the above

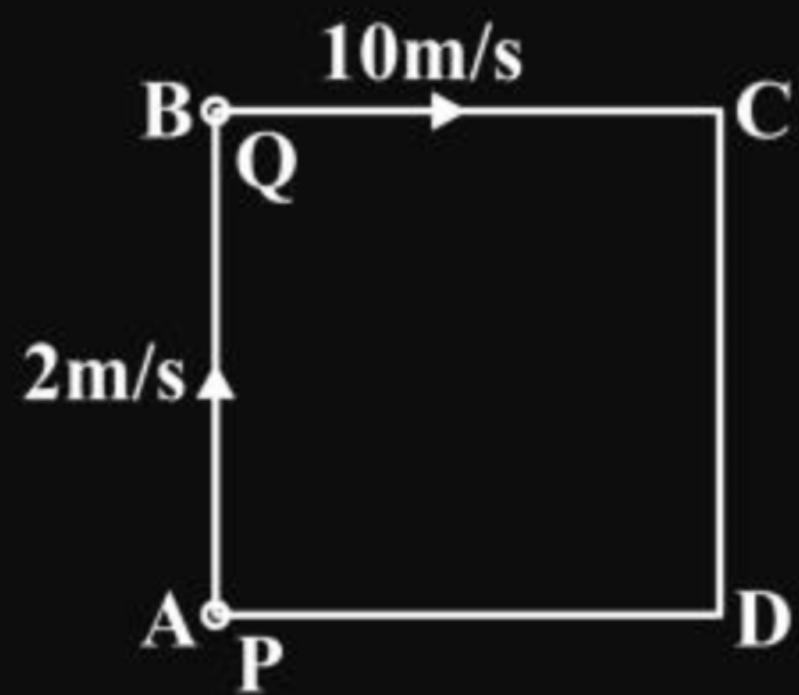
H/5



## Question

Two men P & Q are standing at corners A & B of square ABCD of side 8 m. They start moving along the track with constant speed 2 m/s and 10 m/s respectively. Find the time when they will meet for the first time.

- 1** 2 s
- 2** 3 s
- 3** 1 s
- 4** 6 s



W/W



**THANK  
YOU**