YAKEEN NEET 2.0

2026

Motion in a Plane

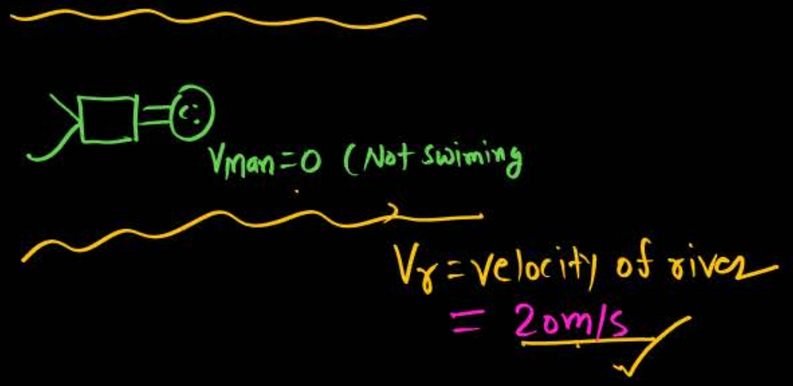
Physics | Lecture - 8

By- Manish Raj (MR Sir)

Topics to be covered

1. # ✓ Relative motion in Motion under gravity →
2. ✓ feel of 2-D Relative motn.
3. ✓ Mininimum sepn
   ✓ Condition of collision
4.

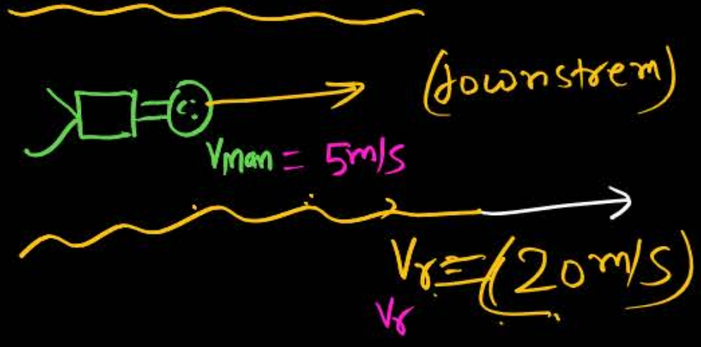
Case-1



$$V_{man(river)} = 0$$

$$V_{man(ground)} = 0 + 20 = 20\,m/s$$

Case-2



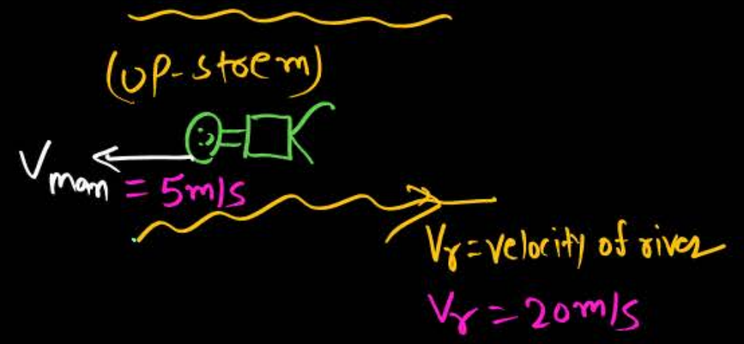
$$V_{man(river)} = 5\,m/s$$

$$V_{man(Ground)} = 25\,m/s$$

MR Box

Velocity by which man can swim = velocity of man w.r.t river = velocity of man w.r.t still water

Case-3 लिखना है।



$$V_{man(river)} = -5\,m/s$$

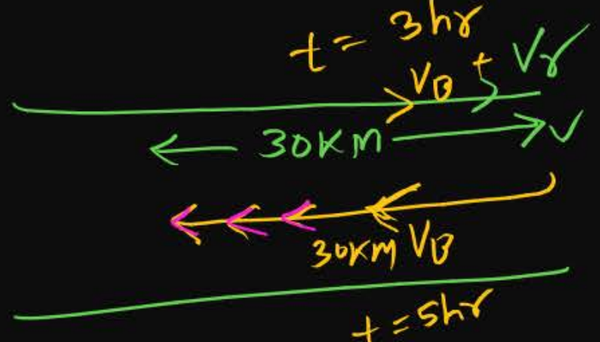
$$V_{man(Ground)} = 20 - 5 = 15\,m/s$$

Question

Likho

A boat (man) travelled 30 km downstream (dirn of flow of river) in 3 hours and made the upstream trip in 5 hours. Find the speed of the boat in still water.

1. 8 km/hr
2. 12 km/hr
3. 6 km/hr
4. 10 km/hr



Backward motn only Possib ($V_B > V_r$)

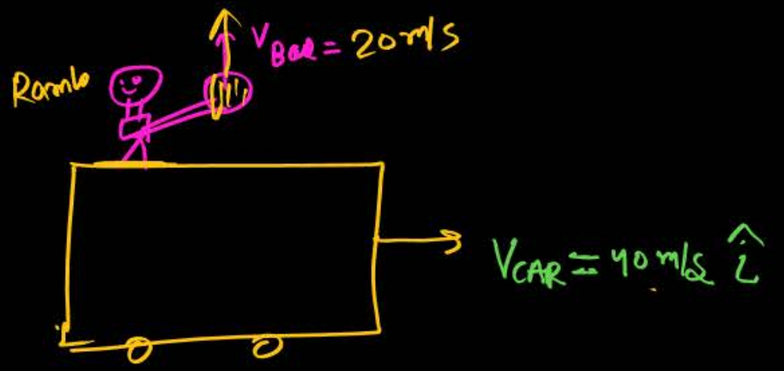
Case-1 $V_{Boat\,Grnd} = V_B + V_r = \frac{30\,km}{3\,hr}$ - (I)

Case-2 $V_B - V_r = \frac{30\,km}{5\,hr}$ - (II)

$2V_B = 10 + 6$

$2V_B = 16$

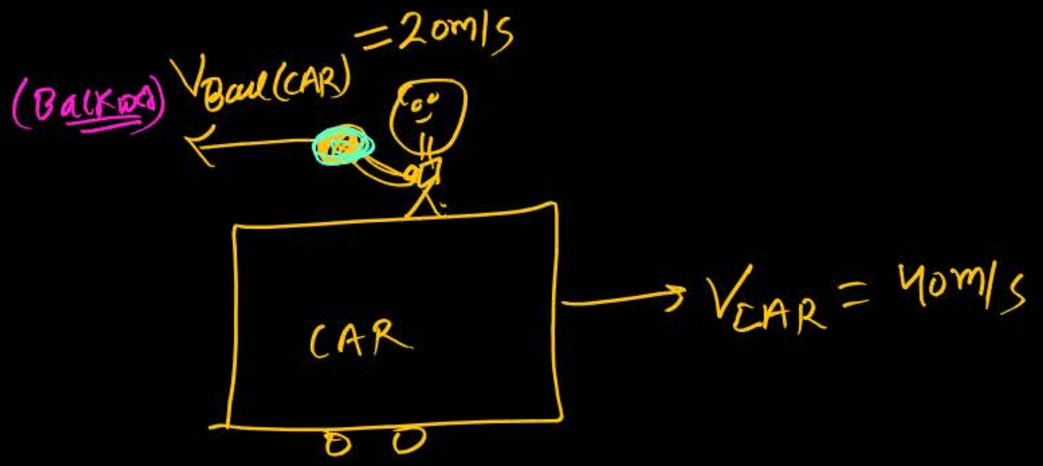
$V_B = 8\ km/hr$



$$\vec{V}_{Ball/Ground} = 20\hat{j} + 40\hat{i} \quad (60) \times \text{wrong}$$

$V_{Ball(CAR)} = 20 m/s \hat{j}$ (20) ✓

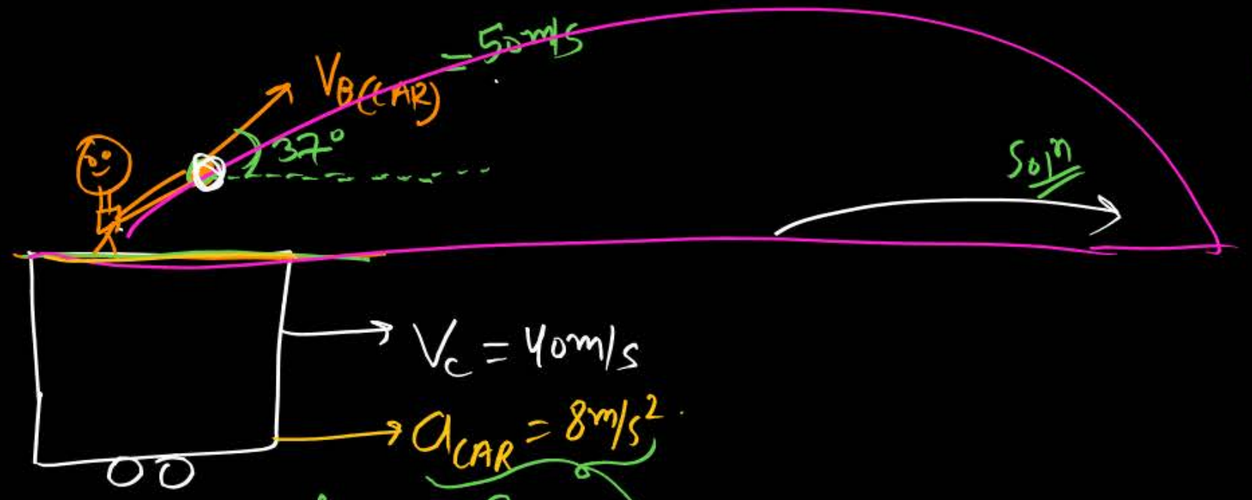
Path of Ball w.r.t (Ramlu) or CAR
" " " w.r.t Ground = Parabola is straight line



$$\vec{V}_{Ball(CAR)} = -20 m/s$$

$$\vec{V}_{Ball(Ground)} = 40\hat{i} - 20\hat{i} = 20\hat{i}$$ ✓

Q



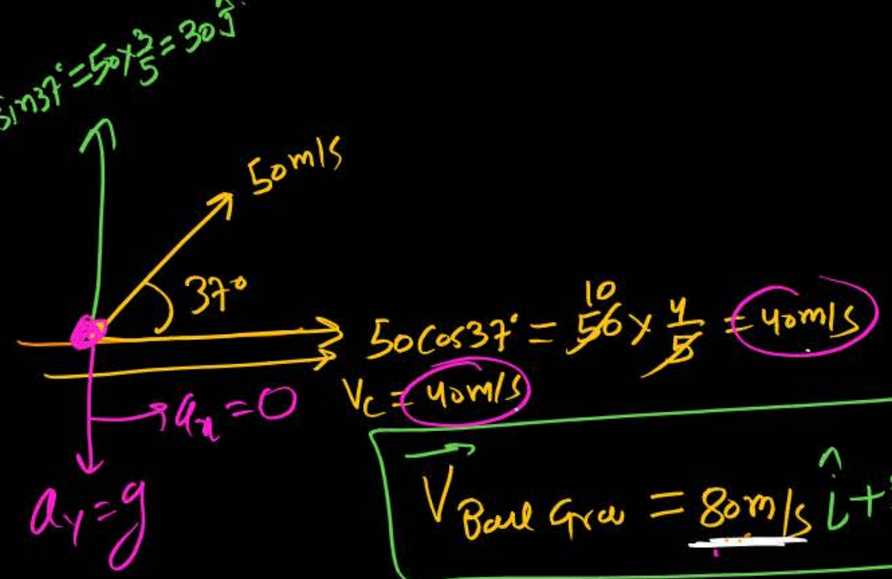
Jab object ko Bahr bhek denge. frame ka acc^n object Nahi leta hai

find Range of Ball.

$T_f = ??$

$H_{max} = ??$

Height of CAR is negligible



$\vec{V}_{Ball\ Grou} = 80 m/s\ \hat{i} + 30 \hat{j}$

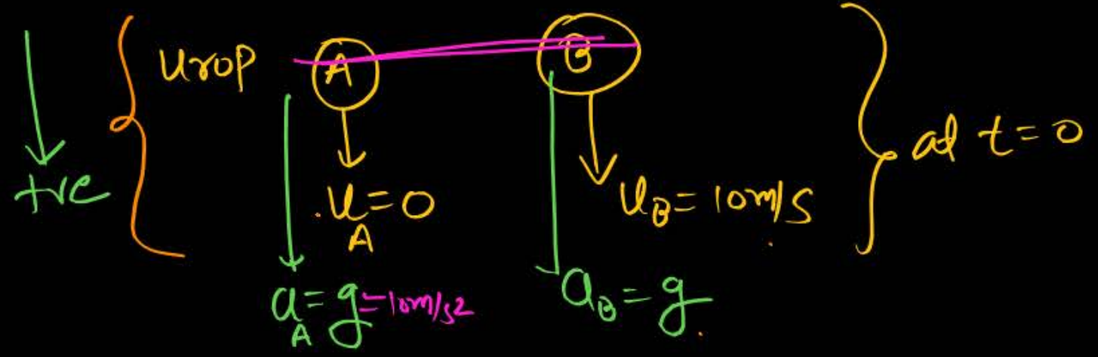
$T_f = \frac{2u_y}{g} = \frac{2 \times 30}{10} = 6 sec$

$H = \frac{u_y^2}{2g} = 45 m$

$R = \frac{2u_x u_y}{g} = u_x T_f$

$= \frac{2 \times 80 \times 30}{10} = 480 m$

Relative motion under gravity



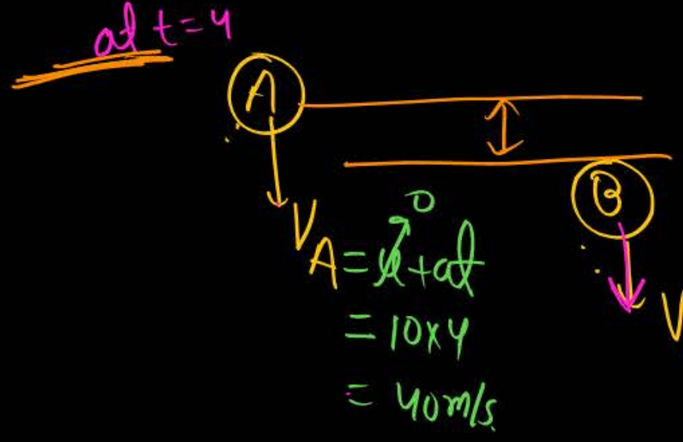
find velocity of B w.r.t A at $t = 4$ sec

at $t = 0$

$V_{BA} = V_B - V_A$

$= 10 m/s$

Why relative velocity is constant here, velocity of A is increasing velocity of B is increasing



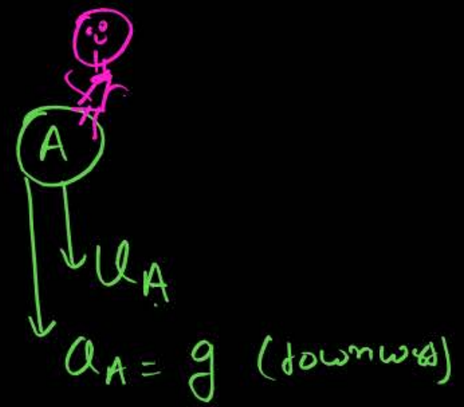
$V_B = u + at = 10 + 10 \times 4$

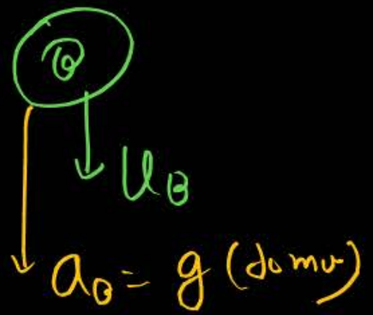
$= 50 m/s$

$\Rightarrow \vec{V}_{BA} = \vec{V}_B - \vec{V}_A$

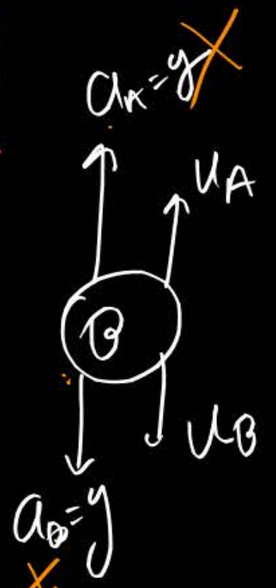
$= 50 - 40$

$= 10 m/s$





Relative motⁿ under gravity :



$\vec{a}_{BA} = g - g = 0$ (relative acc^n = 0)

$\vec{u}_{BA} = \vec{u}_B - \vec{u}_A$ = relative velocity = constant

relative motⁿ uniform.

$\vec{s}_{BA} = u_{BA}\,t + \frac{1}{2} a_{BA}\,t^2$ ($a_{BA} = 0$)

$\vec{s}_{BA} = u_{BA}\,t$

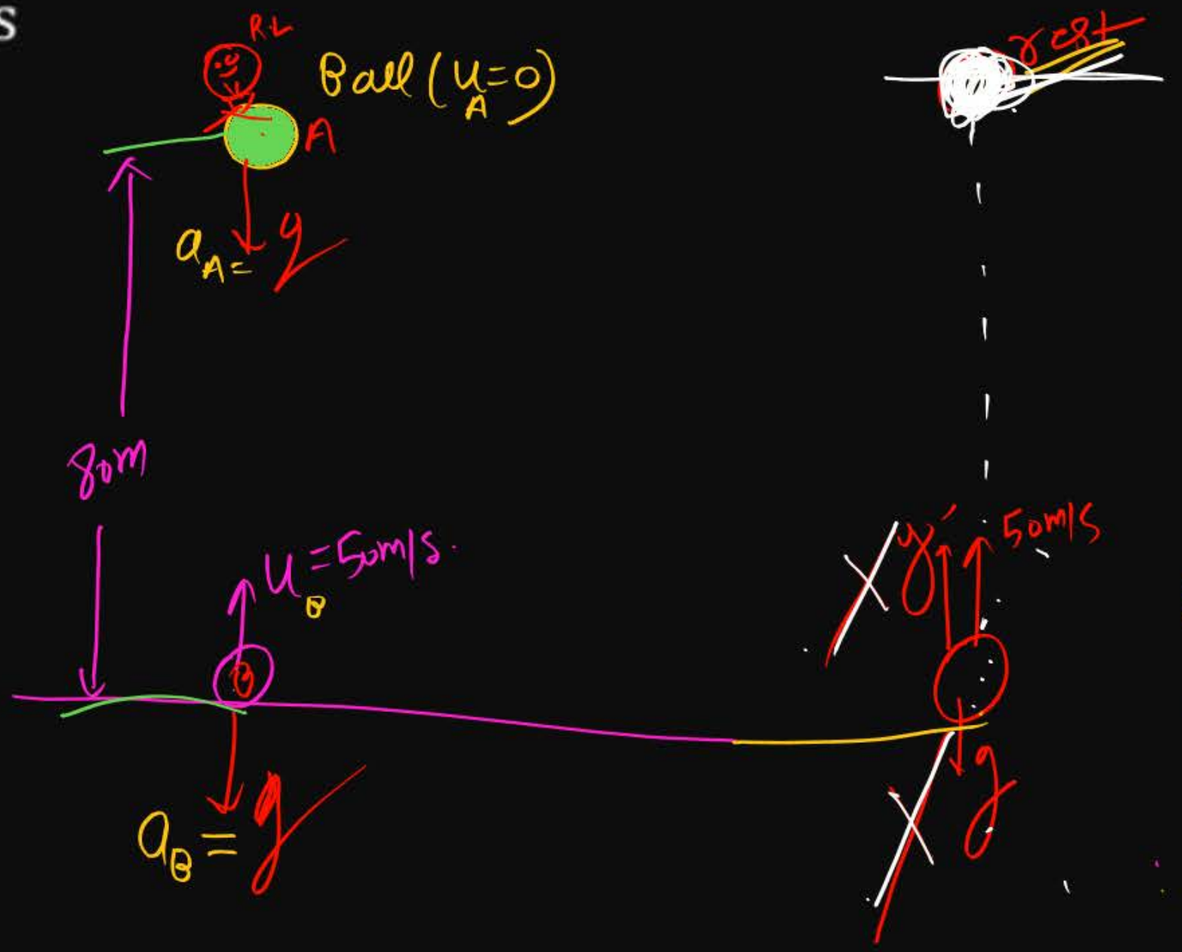
mⁿ box

Motion under gravity (free-fall) is non-uniform motⁿ (v = variable) but motⁿ under gravity of one object w.r.t other object also in motⁿ under gravity is uniform motion ($a_{AB} = 0$)

Question

A ball is dropped from the top of a building of height 80 m. At same instant another ball is thrown upwards with speed 50 m/s from the bottom of the building. The time at which balls will meet is

1. 1.6 s
2. 5 s
3. 8 s
4. 10 s



$a_{BA} = 0$ ✓

$u_{BA} = 50$m/s $= u$ ✓

$S_{BA} = 80$m

$S_{BA} = V_{BA}\, t$

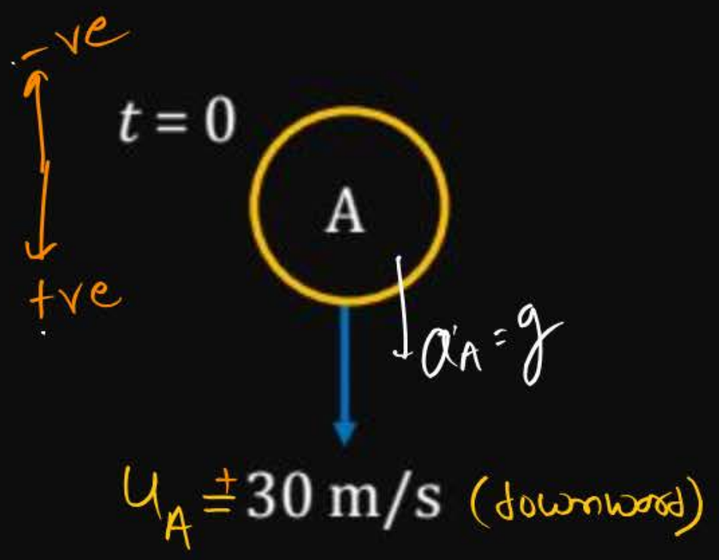
$80 = 50\, t$

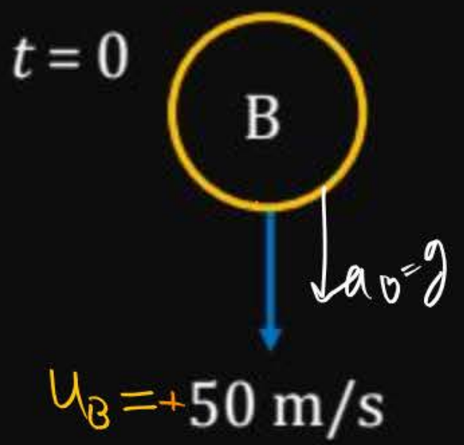
$t = 1.6$sec

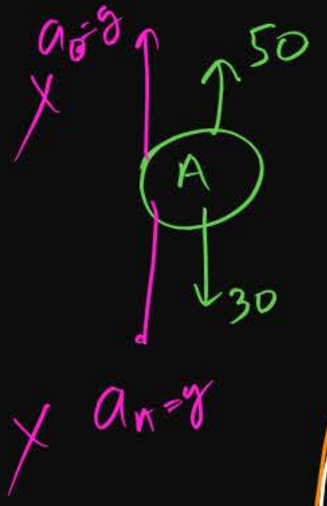
Question

Likho

Find relative velocity of A w.r.t. B after 4 sec and distance between them.







$\vec{u}_{AB} = \vec{u}_A - \vec{u}_B$

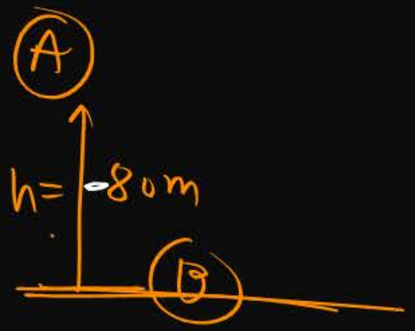
$= 30 - 50$

$= -20$ m/s

(upward)

$S_{AB} = u_{AB} \times t$

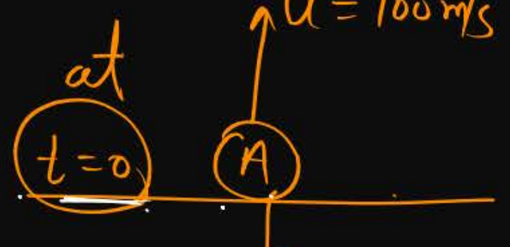
$= -20 \times 4 = -80$ m



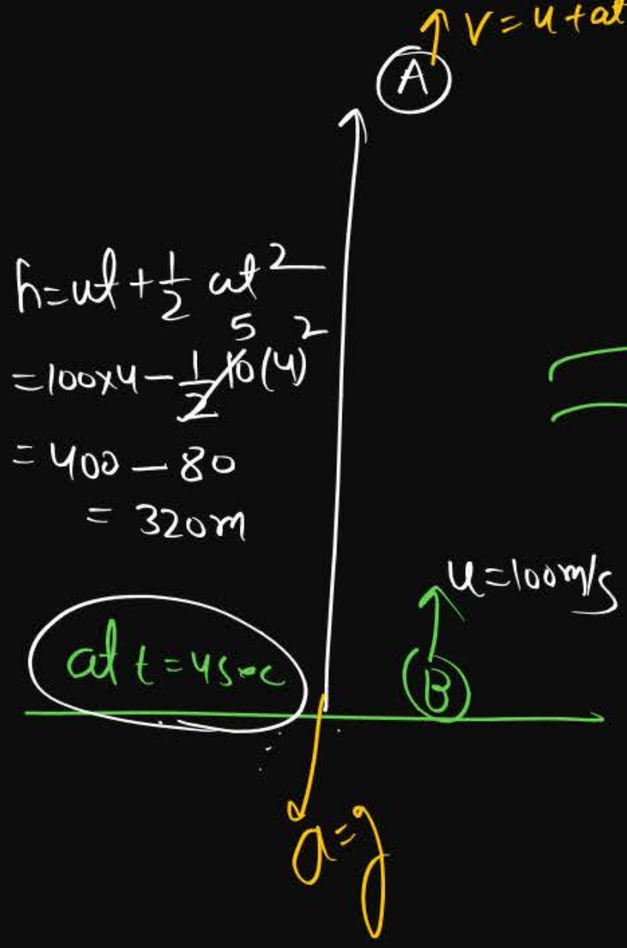
Question

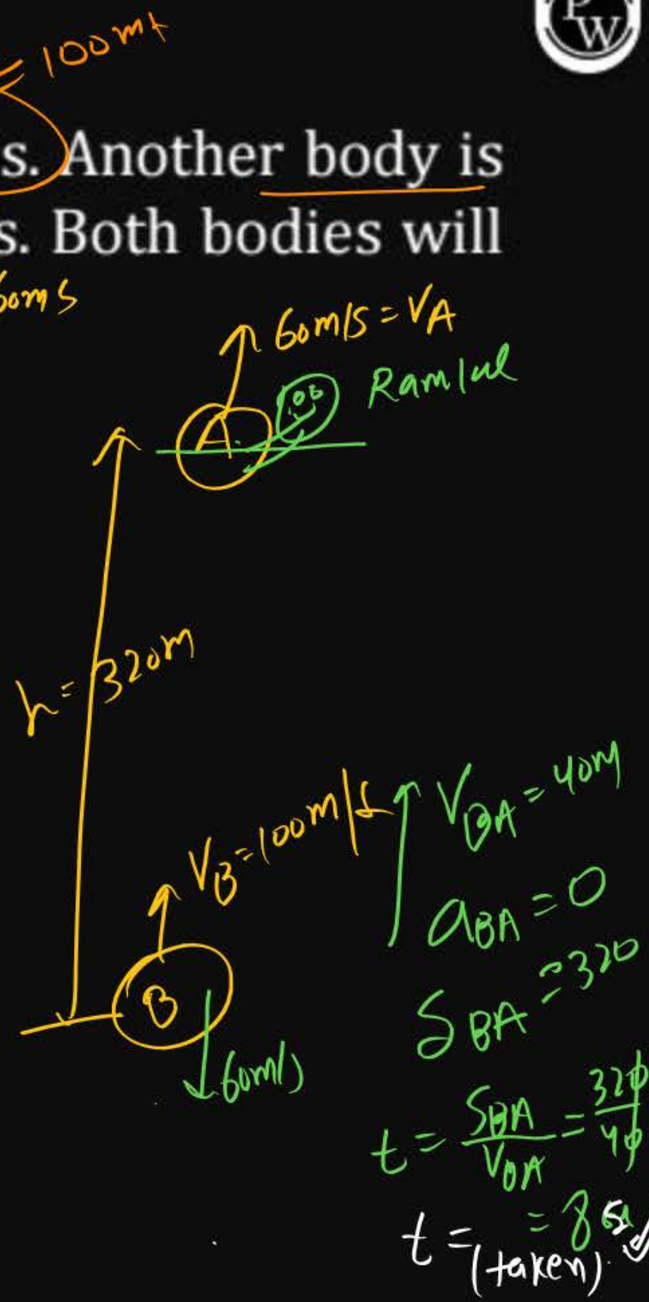
A body is projected vertically up at $t = 0$ with a velocity of 98 m/s. Another body is projected from the same point with same velocity after 4 seconds. Both bodies will meet at $t =$

1. 6 s
2. 8 s
3. 10 s
4. 12 s

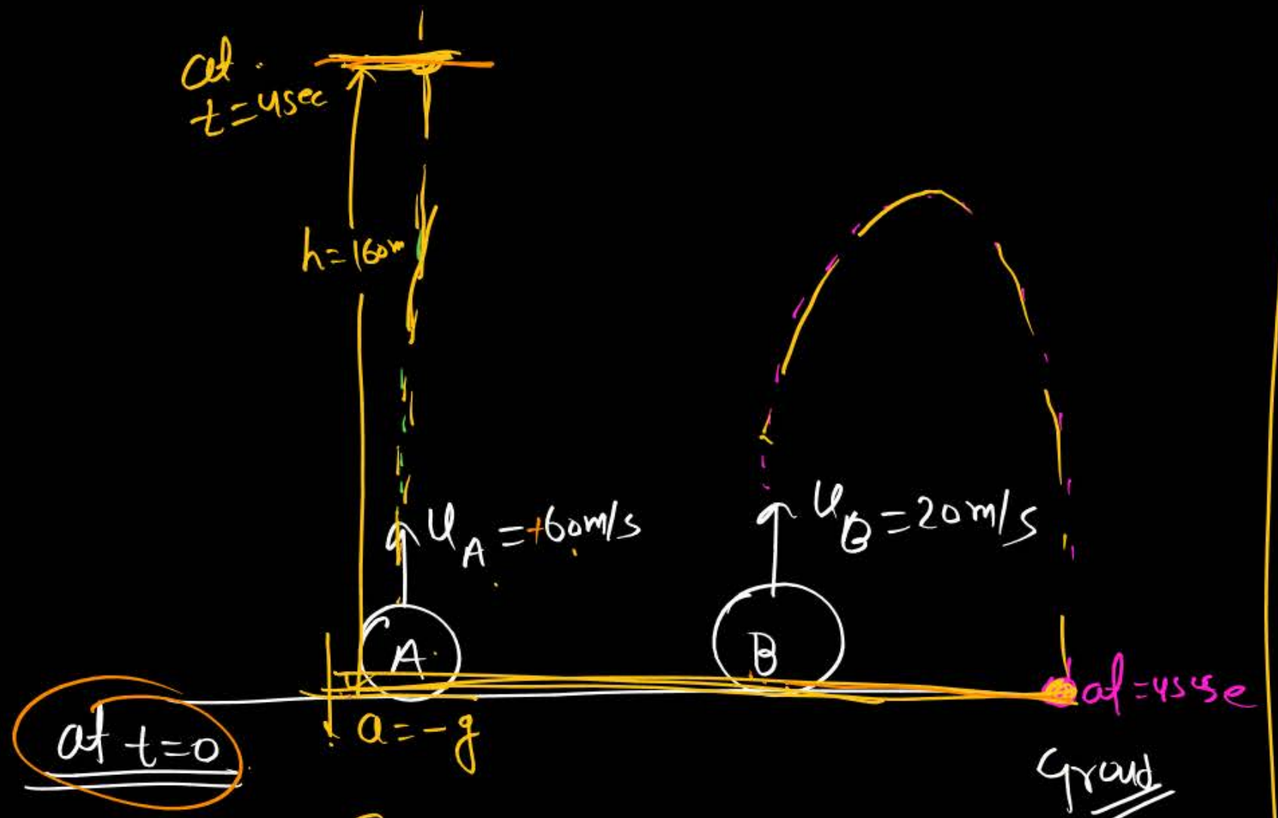


Final time = 4 + 8
= 12 sec





easy



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

$$= 60 \times 4 - \frac{1}{2} \times 10 (4)^2$$

$$= 240 - 5 \times 16$$

$$= 240 - 80 = 160m$$

find dist^n B/w them aft 2 4sec

direct relative

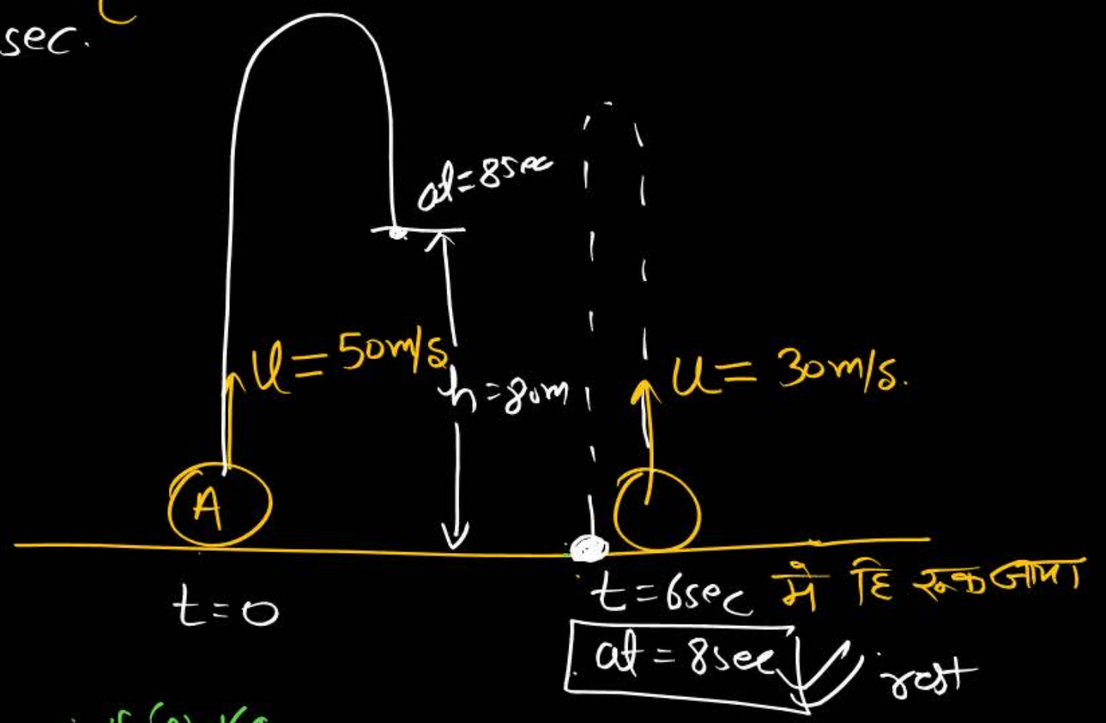
$$u_{AB} = 60 - 20 = 40 m/s.$$

$$S_{AB} = u_{AB} \times 4 = 40 \times 4$$

$$= 160 m$$

Beauty

(a) distⁿ b/w them aft 8-sec. (level up)



Sirif 'A' Ka

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

$$= 50\times 8 - \frac{1}{2}\times 10\times (8)^2$$

$$= 400 - 64\times 5$$

$$= 400 - 320$$

$$= 80m$$

Soln

$$u_{AB} = 50 - 30 = 20 m/s$$

$$a_{AB} = 0$$

MR Scam

$$S_{AB} = u_{AB}\times t$$

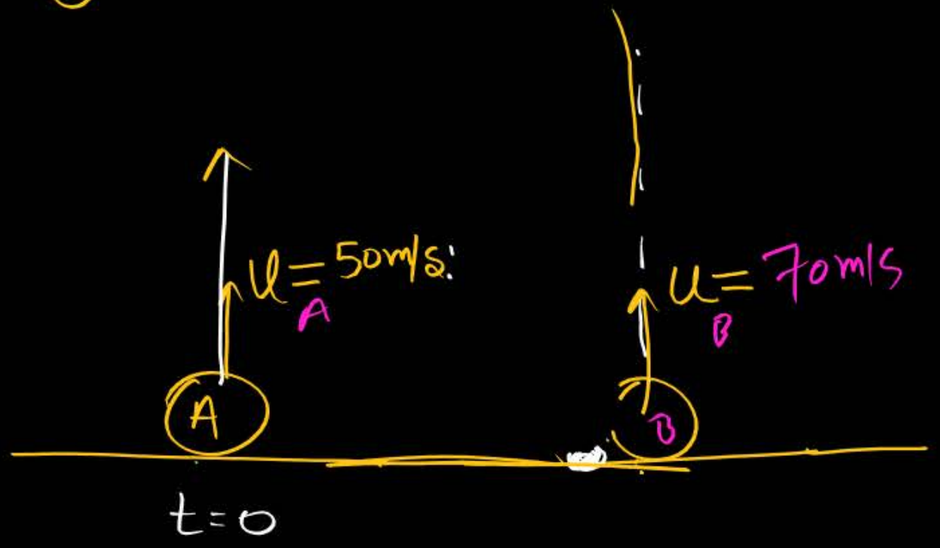
$$= 20\times 8$$

$$= 160m.$$

Reason → t=0 to t=8sec tak relative a_{BA} zero nahi hai

distance = 80m b/w them

(a) distⁿ b/w them aft 8-sec. (level up)



Soln

$u_{BA} = 70 - 50$

$= 20$ m/s

$S_{BA} = u_{BA}\, t$

$= 20 \times 8$

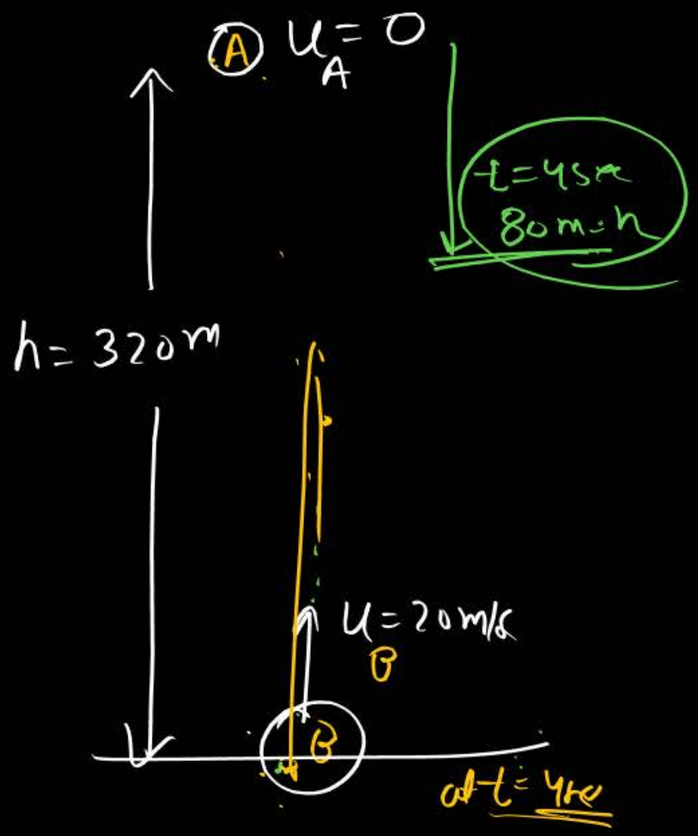
$= 160$ m

correct

IMP Box

relative motⁿ tabi lagega jab question me given time t done ka time of flight se kam ho.

(Q) Ball is drope from Height 320 m/s, other is Projected up with 20 m/s. then first time when it will collide in air.



Soln

MR Scam ✓

$a_{BA} = 0$

$u_{BA} = 20$

$t = \frac{h}{u_{BA}} = \frac{32\phi}{2\phi}$

$= 16sec$

case question

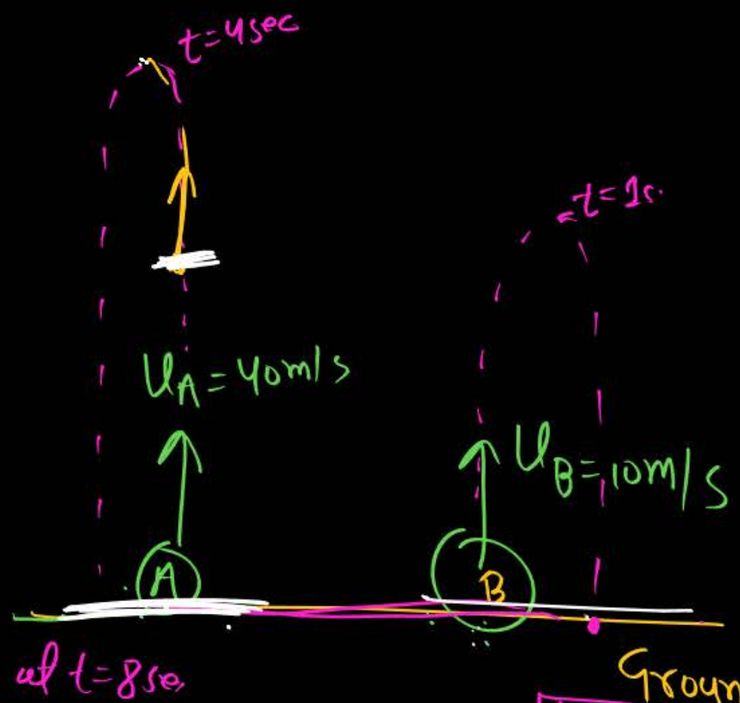
me option se khelenge

they will not collide in air

→ They can collide at ground at $t = 8sec$

JEE-Adv

Q



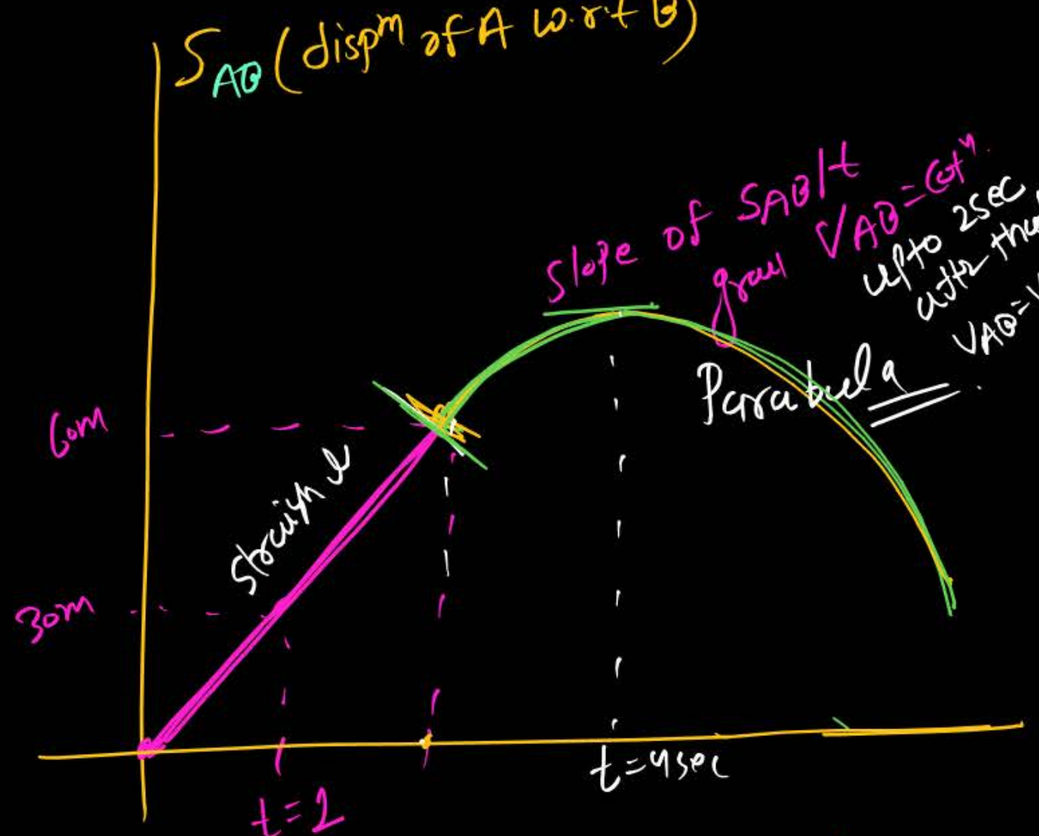
Soln

relative motion

$a_{AB} = 0$

$v_{AB} = 40 - 10 = 30 m/s$

$S_{AB} = v_{AB} \times t = 30t$



at t=2sec B comes to at rest.

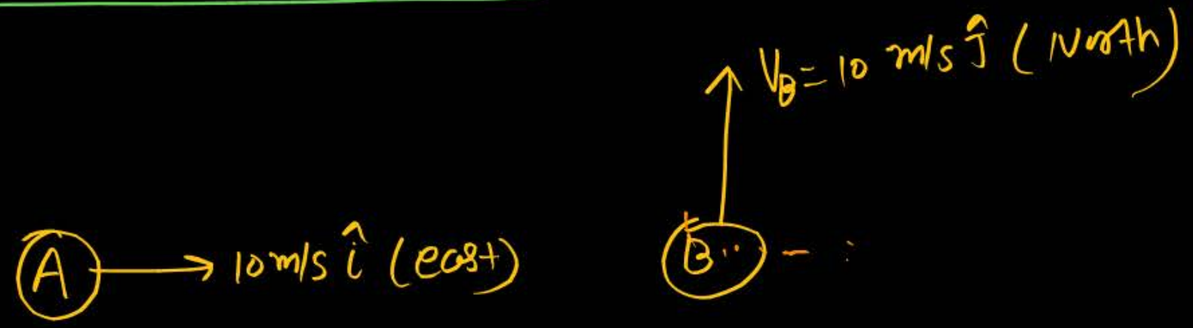
$u_B = 0$, $a_B = 0$ } w.r.t Ke Bad:

after t=2sec only A is moving

$u_A \underset{t=2}{=} +20 m/s$

$a_{ec^n}{}_A = -g\ m/s^2$

Relative motion in 2-D (vector subtract)



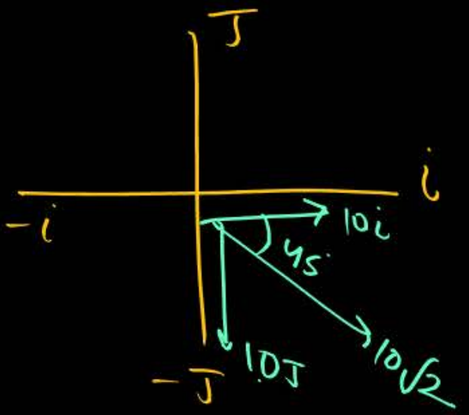
$\vec{v}_{AB} = ??$ $\vec{v}_{BA} = ??$

Soln $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$

$\vec{v}_{AB} = 10\hat{i} - 10\hat{j}$

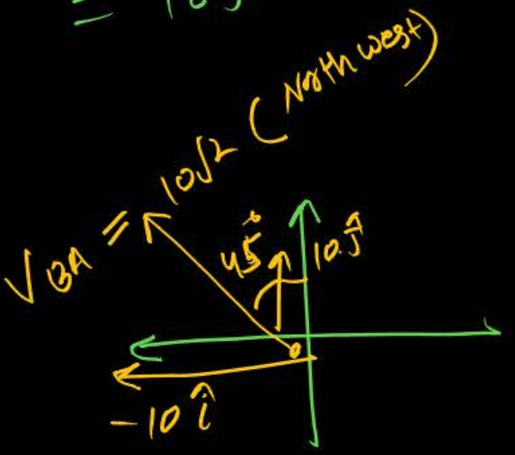
$|\vec{v}_{AB}| = 10\sqrt{2}$

South east

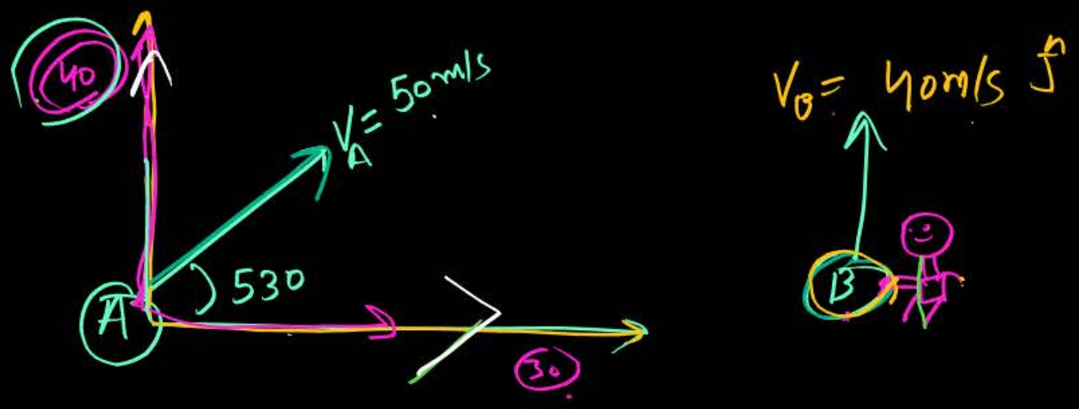


$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$

$= 10\hat{j} - 10\hat{i}$



Q)



find V_{AB} = ??

Soln

$$\vec{V}_A = V_A \cos 53^\circ \hat{i} + V_A \sin 53^\circ \hat{j}$$

$$= 50 \times \frac{3}{5} i + 50 \times \frac{4}{5} \hat{j}$$

$$\vec{V}_A = 30i + 40\hat{j}$$

$$\vec{V}_B = 40\hat{j}$$

$$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$$

$$= 30i + 40\hat{j} - 40\hat{j}$$

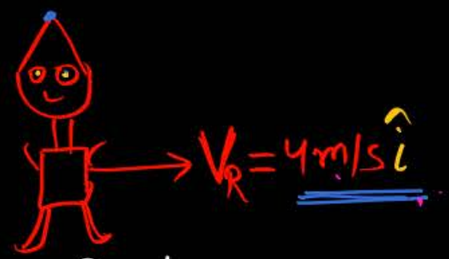
$$\vec{V}_{AB} = 30\hat{i}$$

Velocity of A w.r.t B

$$\vec{V}_{BA} = -\vec{V}_{AB} = -30\hat{i} \text{ m/s}$$

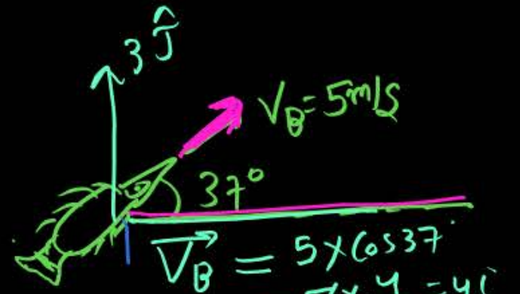
MRB

$\vec{V}_{B(MR)} = 4\hat{i} + 3\hat{j}$



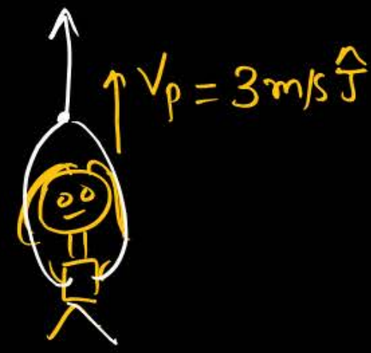
$V_R = 4\,m/s\,\hat{i}$

$\vec{V}_{R_G} = 4\hat{i} + 0\hat{j}$



$\vec{V}_B = 5\cos 37 = 5 \times \frac{4}{5} = 4\hat{i}$

$\vec{V}_{Bird_{Grw}} = 4\hat{i} + 3\hat{j}$



$V_P = 3\,m/s\,\hat{j}$

$\vec{V}_{P_G} = 0\hat{i} + 3\hat{j}$

#

$\vec{u}_{B\,Ramlu} = \vec{V}_B - \vec{V}_R$

$= 4\hat{i} + 3\hat{j} - 4\hat{i}$

$\vec{u}_{B\,(Ramlu)} = 3\hat{j}$ ↑ $\vec{V}_{BR}$

$\vec{u}_{Ramlu\,Bird} = -3\hat{j}$ ↓

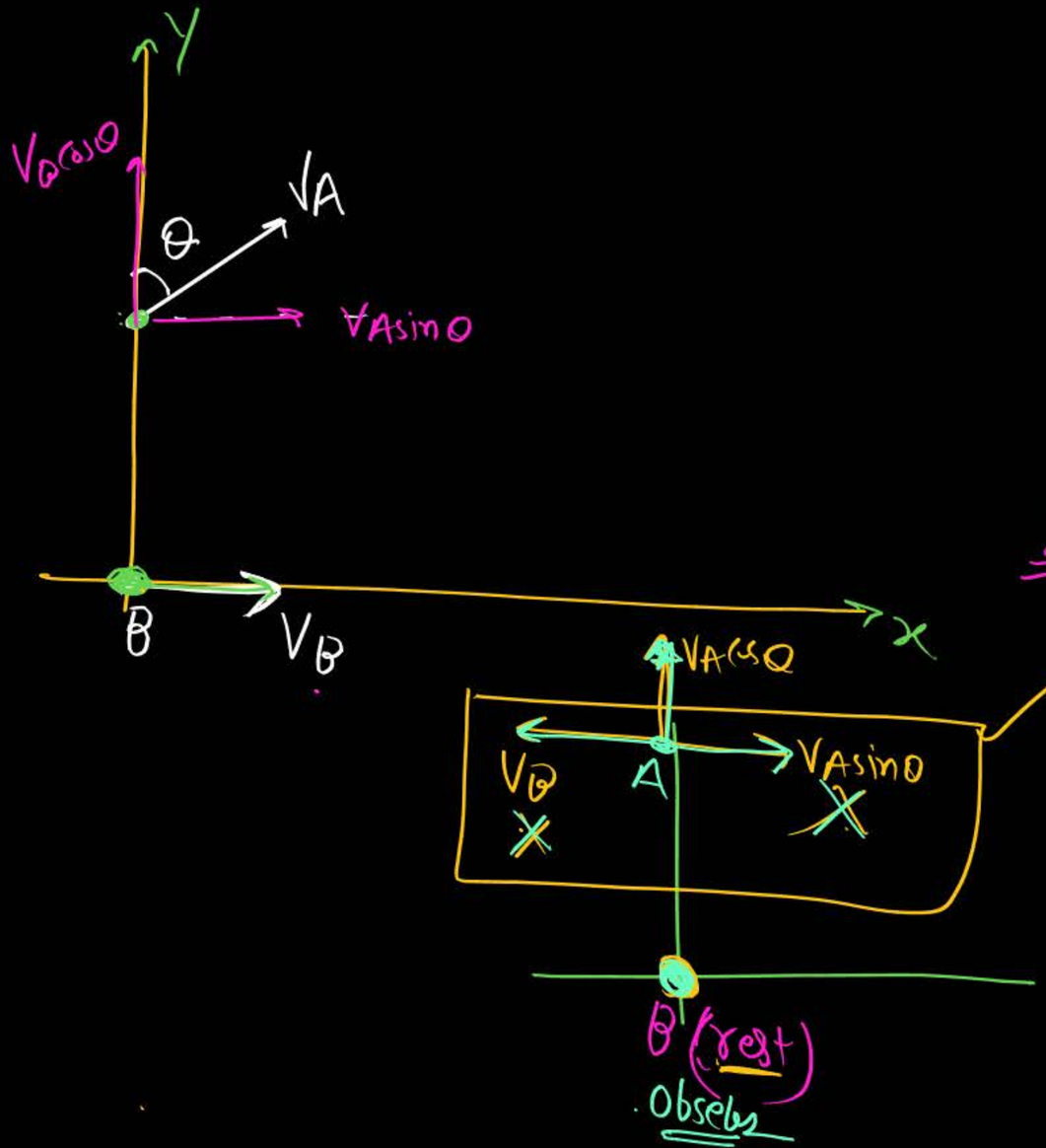
$\vec{u}_{B\,pinky} = \vec{V}_B - \vec{V}_P$

$= 4\hat{i} + 3\hat{j} - 3\hat{j}$

$\vec{V}_{Bird\,(pinky)} = 4\hat{i}$ → $\vec{V}_{BP}$

$u_{pinky\ w.r.t\ Bird} = -4\hat{i}$

AIEEE (JEE Main)



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

Soln

"$V_A \sin\theta$" = "V_B"

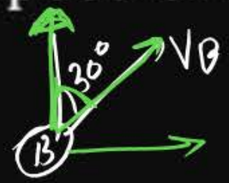
$$\frac{V_A}{V_B} = \left(\frac{1}{\sin\theta}\right) = \text{cosec}\,\theta$$

Ans

Question

A ship is travelling due east at 10 km/h. A ship heading 30° east of north is always due north from the first ship. The speed of the second ship in km/h is:

other

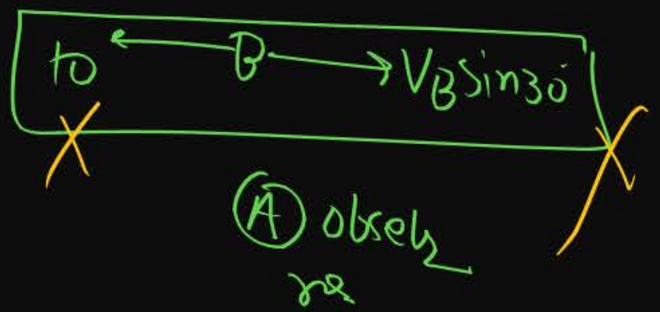


1. $20\sqrt{2}$
2. $20\sqrt{3/2}$
3. 20
4. $20/\sqrt{2}$

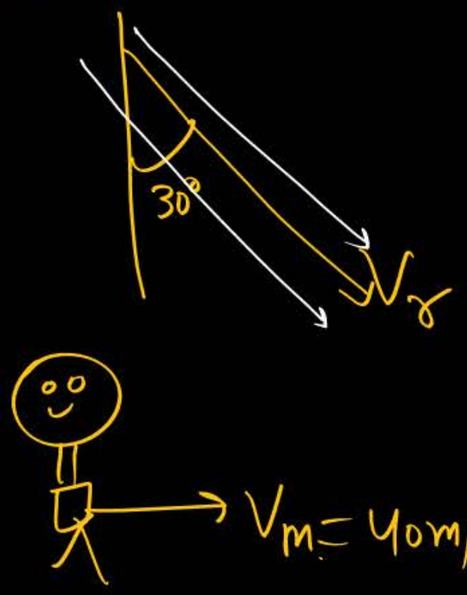
$(V_{BA}) = 0$ in east

$V_B \times \frac{1}{2} = 10$

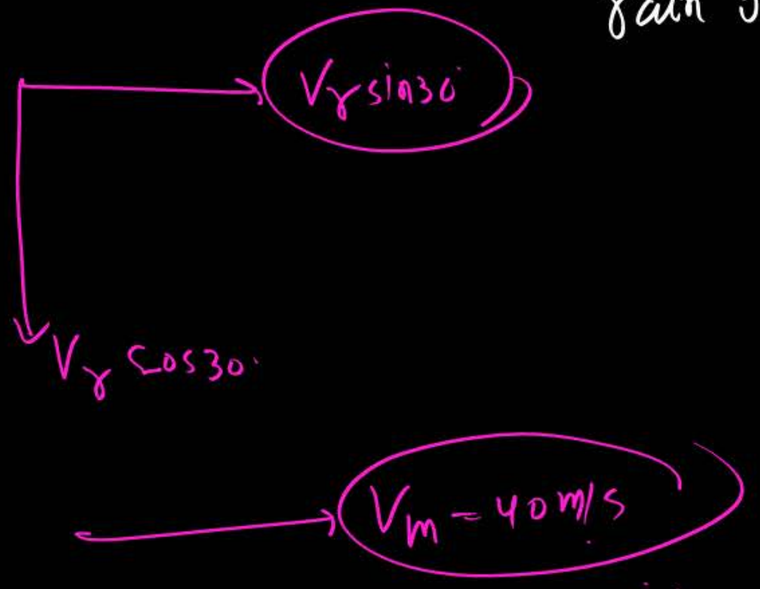
$V_B = 20$ km/hr



Rain man Prob^n



rain fallig at angle 30° from vertical (as shown in fig) find V_r so that rain fallig vertical downward w.r.t man.



(rain apper to fall vertically down woard w.r.t man)

$$V_r \frac{1}{2} = 40$$

$$V_r = 2 \times 40 = 80 \text{ m/s}$$

Question

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

H/W must TRY

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

Question

Find velocity of A with respect to B.

Question

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

M/W

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.

Question

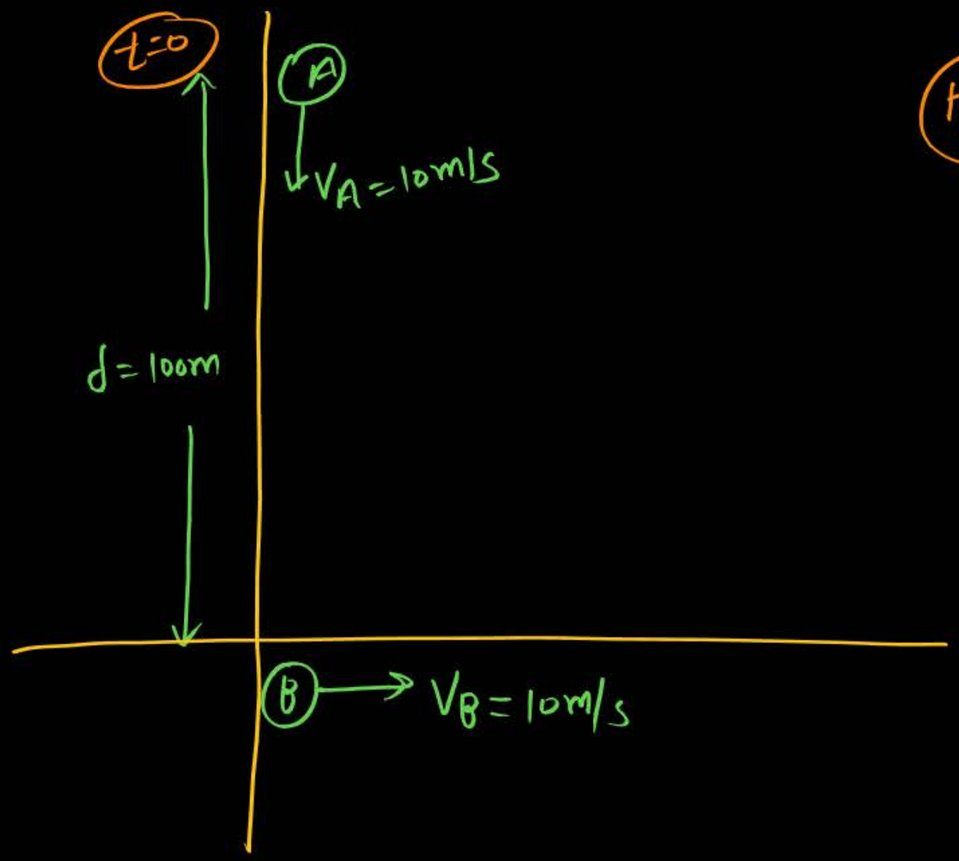
A man 'A' moves in the north direction with a speed 10 m/s and another man B moves in E-30°-N with 10 m/s. Find the relative velocity of B w.r.t. A.

H/W

Minimum separation

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

then find minimum Separation b/w A & B



H/W

must Try

- Velocity of man with respect to river
- Velocity of man with respect to still water
- Velocity of man by which he can swim

All are same.

{MR* Boy}

THANK YOU