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$$\boxed{\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B}$$

$\vec{v}_{A/B}$: Relative Velocity of A w.r.t B

$\vec{v}_A$: velocity of A w.r.t earth

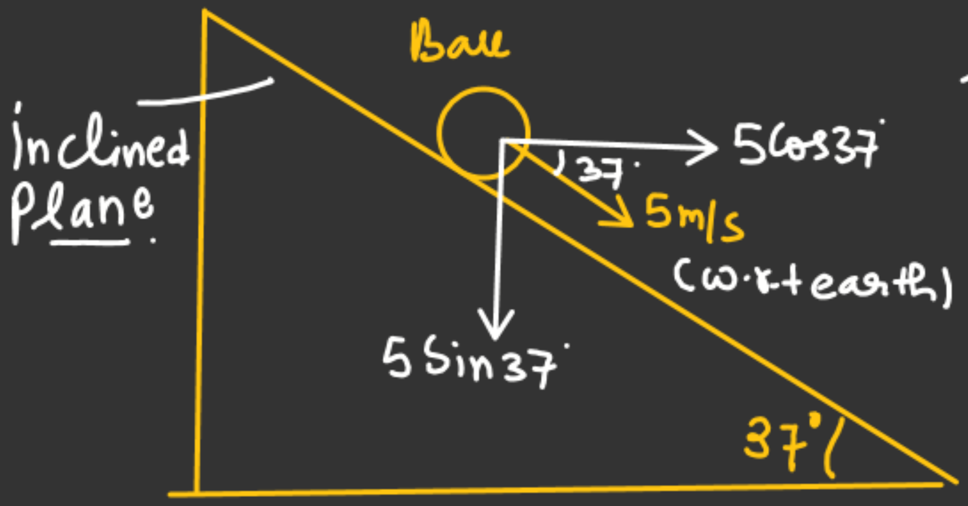
$\vec{v}_B$: velocity of B w.r.t earth

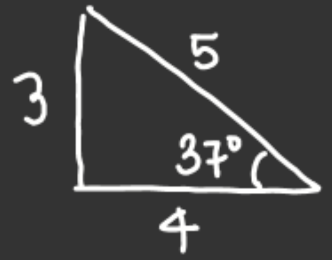
$$\left[\begin{array}{l} \vec{v}_{A/E} = \vec{V}_A \\ \vec{V}_{B/E} = \vec{V}_B \end{array}\right.$$

$$\vec{V}_{B/A} = \vec{V}_B - \vec{V}_A$$

$$\boxed{\vec{V}_A = \vec{V}_{A/B} + \vec{V}_B}$$

Find velocity of ball w.r.t trolley = ??





$$\left[\begin{array}{l} \vec{V}_{ball/E} = 5\cos37^\circ\hat{i} - 5\sin37^\circ\hat{j} \\ \qquad\quad = 4\hat{i} - 3\hat{j} \\ \vec{V}_{trolley/E} = 15\hat{i} \end{array}\right.$$

$$\vec{V}_{ball/trolley} = \vec{V}_{ball/E} - \vec{V}_{trolley/E}$$

$$= 4\hat{i} - 3\hat{j} - 15\hat{i}$$

$$= -11\hat{i} - 3\hat{j}$$

$$|\vec{V}_{ball/trolley}| = \sqrt{(11)^2+(3)^2} = \sqrt{121+9} = \sqrt{30}\ \text{m/s}$$

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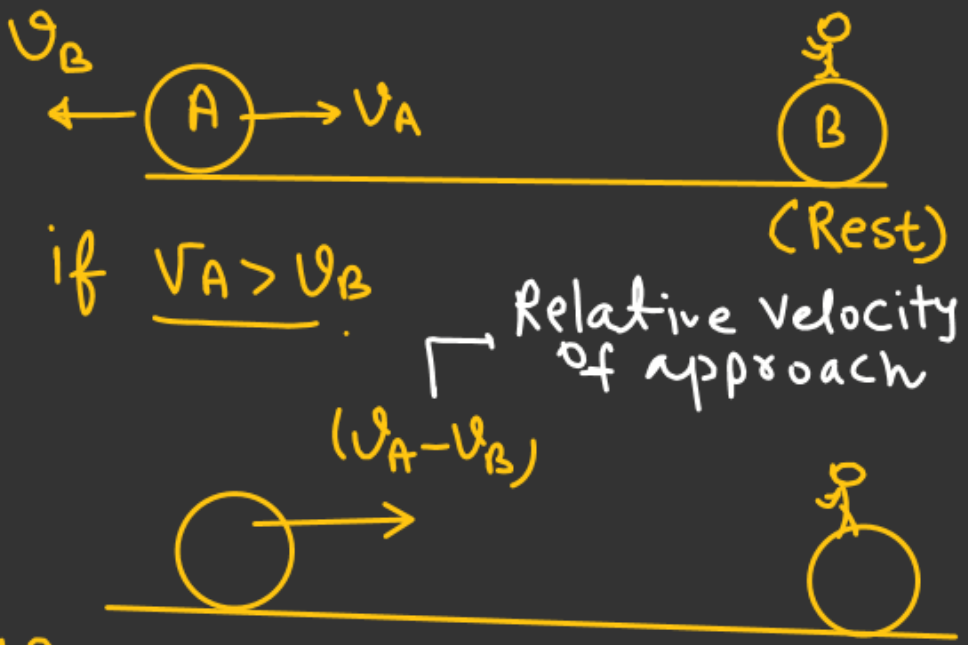
$$\vec{v}_A = \vec{v}_{A/E} = v_A\hat{i}$$

$$\vec{v}_{B/E} = v_B\hat{i}$$

$$\vec{v}_{A/B} = \vec{v}_{A/E} - \vec{v}_{B/E}$$ if $v_A > v_B$

$$= v_A\hat{i} - v_B\hat{i}$$

$$= (v_A - v_B)\hat{i}$$



Relative velocity of approach

$v_B > v_A$

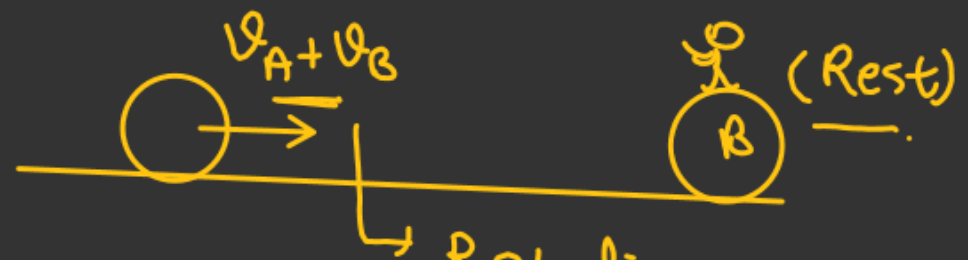
Relative speed of seperation

In opposite direction

$$\vec{v}_{A/B} = \vec{v}_{A/E} - \vec{v}_{B/E}$$

$$= v_A\hat{i} - (-v_B\hat{i})$$

$$= (v_A + v_B)\hat{i}$$



Relative Velocity of approach

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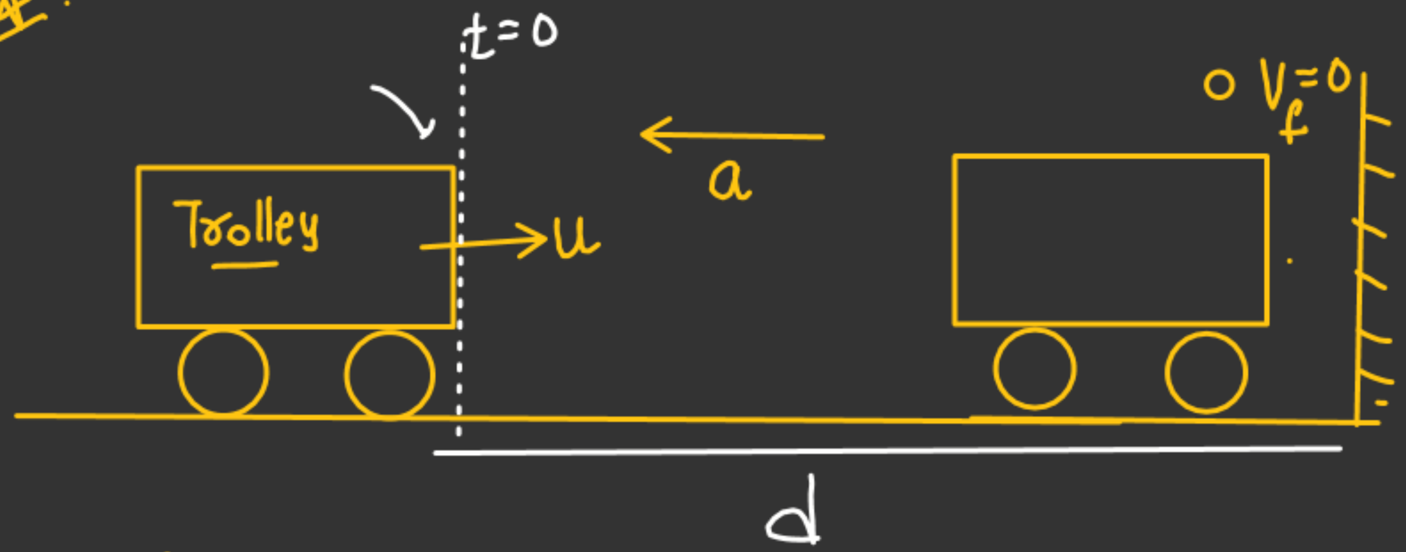
Minimum Stopping distance.

4.



Find the retardation of trolley So that it doesn't Collide with the wall.

Sol^n:- $t=0 \Rightarrow$ Moment at which driver apply break to avoid Collision

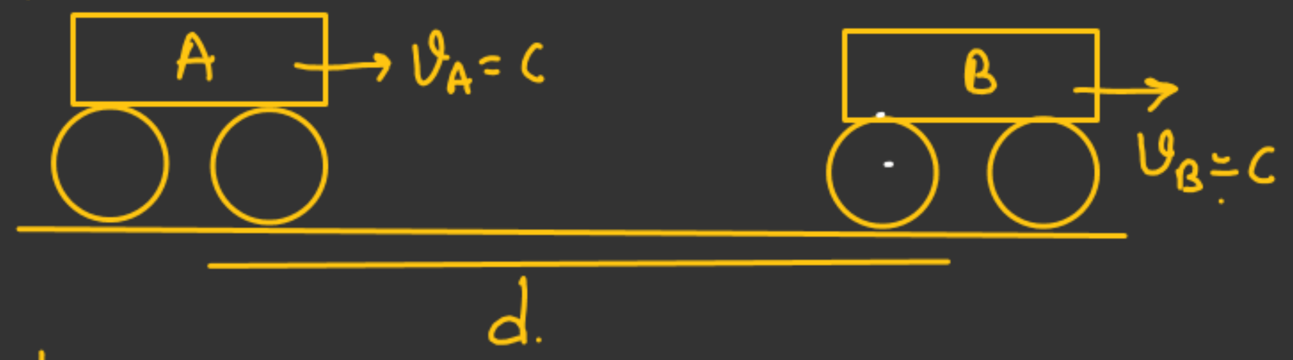
$V_f = 0$

$V_f^2 = (u^2 - 2ad)$

$u^2 = 2ad.$

$$\boxed{a = \frac{u^2}{2d}}$$

$v_A > v_B$

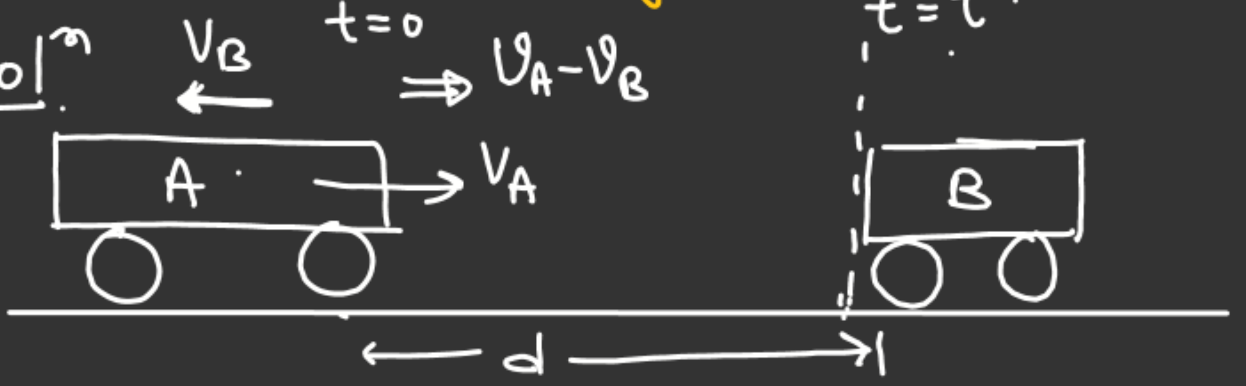


Find.

① Time of Collision. ⟶ (Apply Relative)

② Distance Covered by A

Sol^n



$d = (v_A - v_B)\,t$

$t = \left(\frac{d}{v_A - v_B}\right)$

⇓

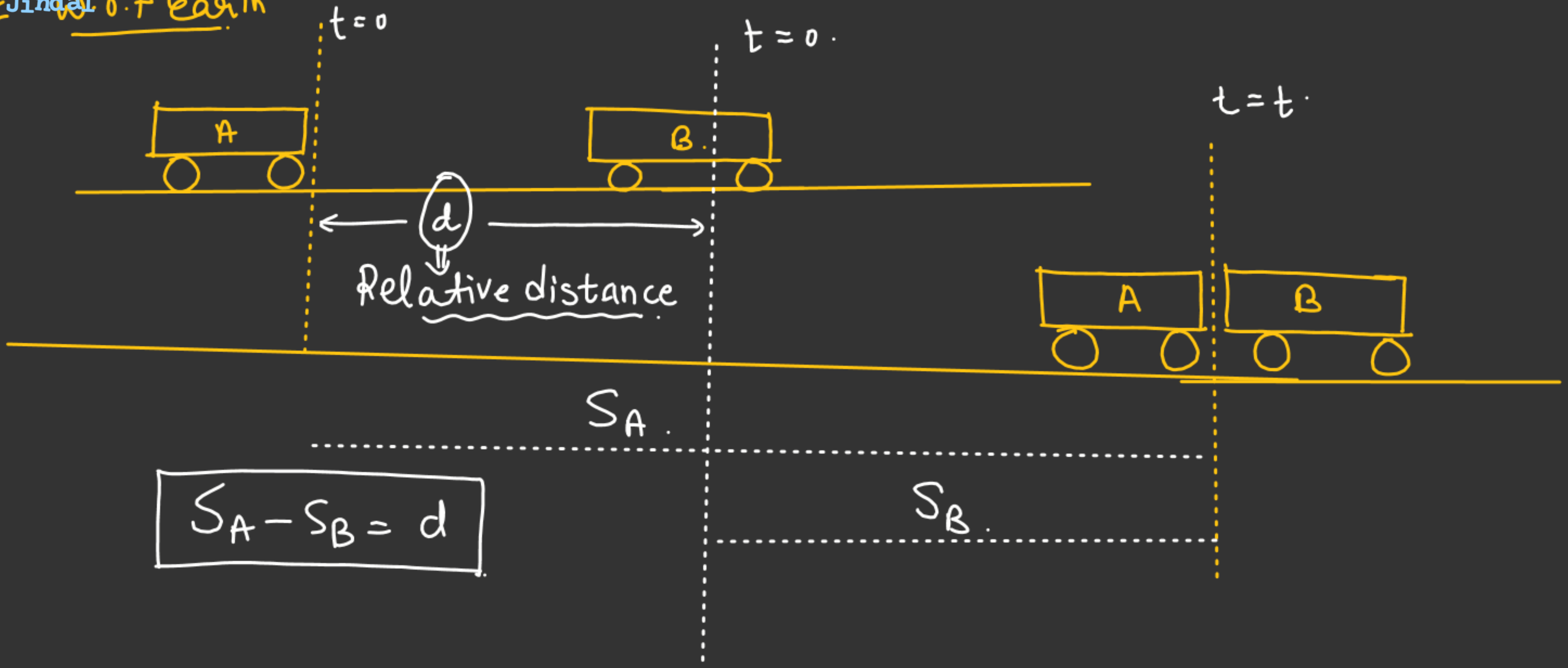
Collision time

$S_A = v_A \times \frac{d}{v_A - v_B}$

$S_A = \frac{d\,v_A}{v_A - v_B}$ ✓

$S_B = \frac{v_B\,d}{v_A - v_B}$ ✓

w.r.t Earth



$$\boxed{S_A - S_B = d}$$

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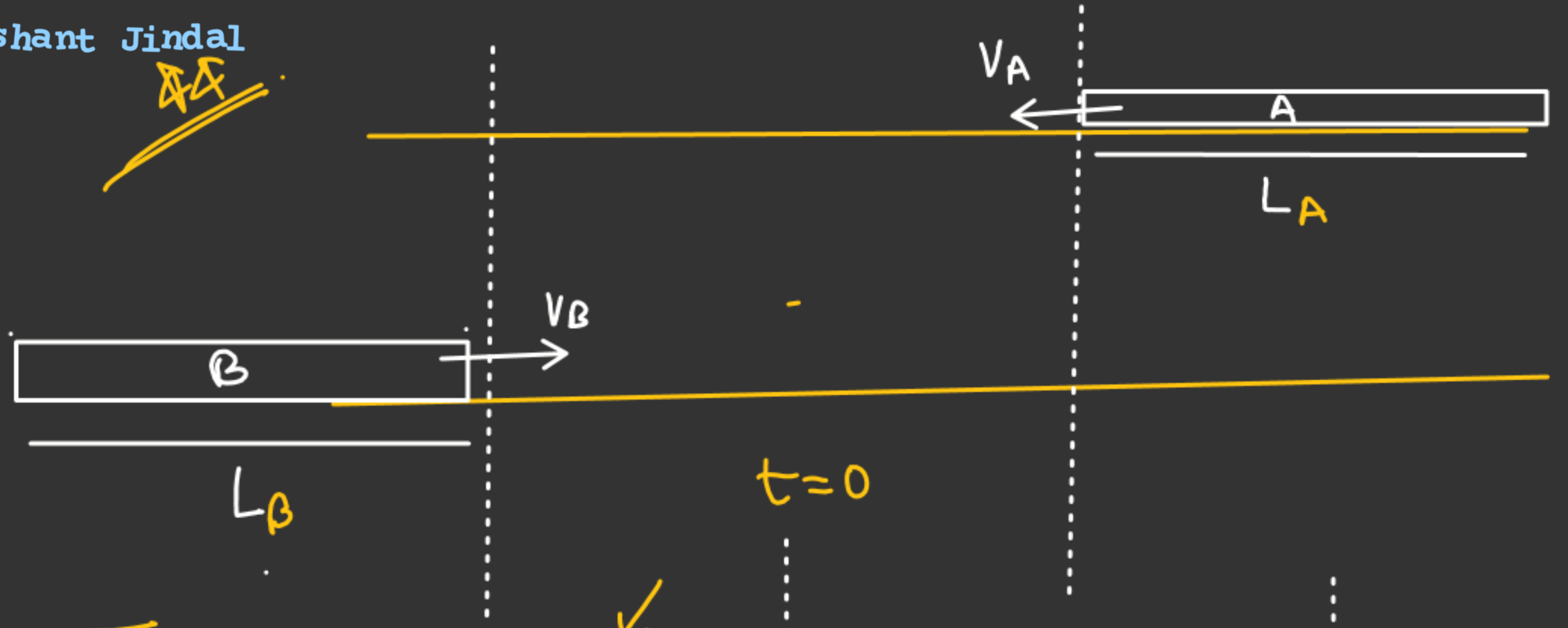
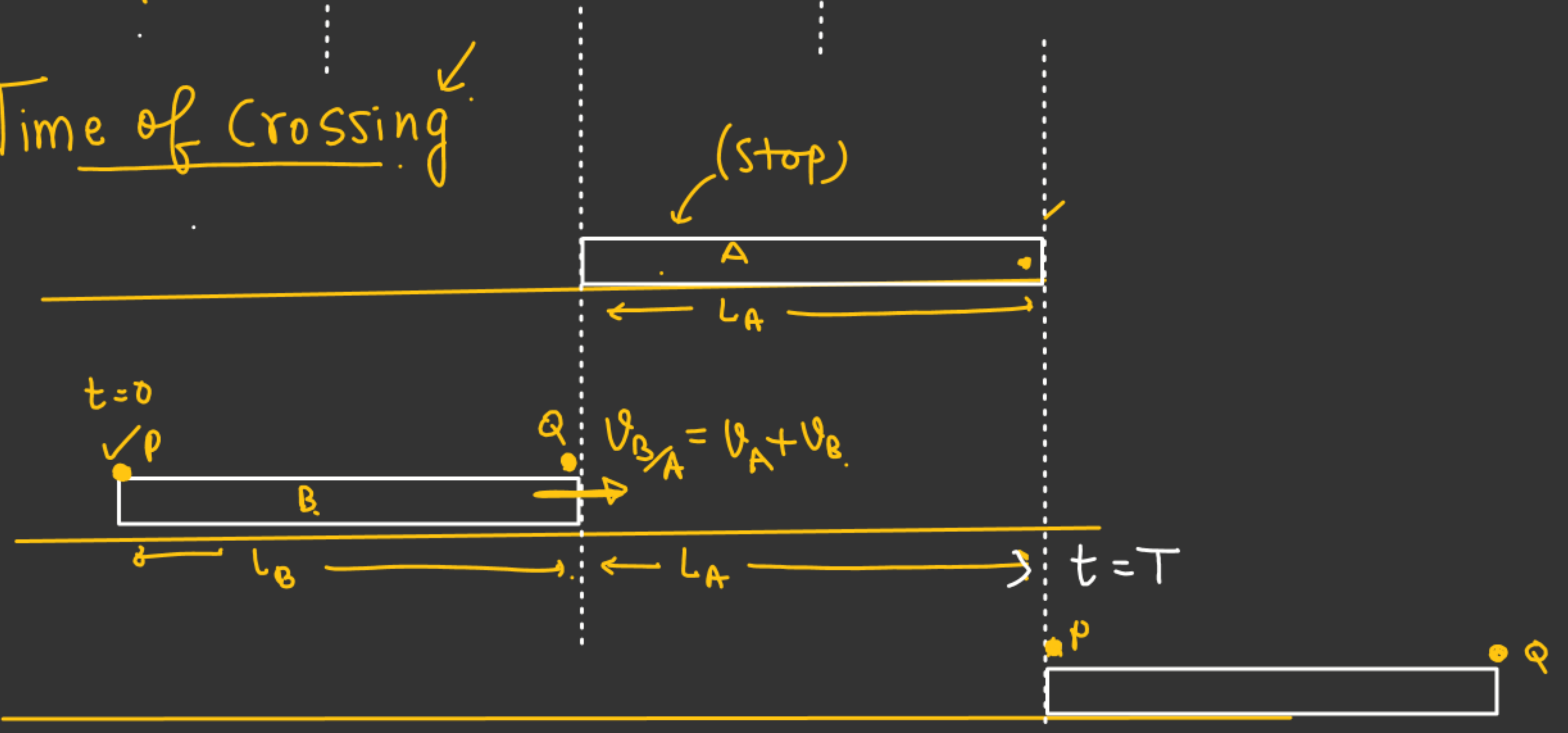


T = Time of Crossing

$$T = \left(\frac{L_A + L_B}{v_A + v_B}\right)$$

Time of Crossing



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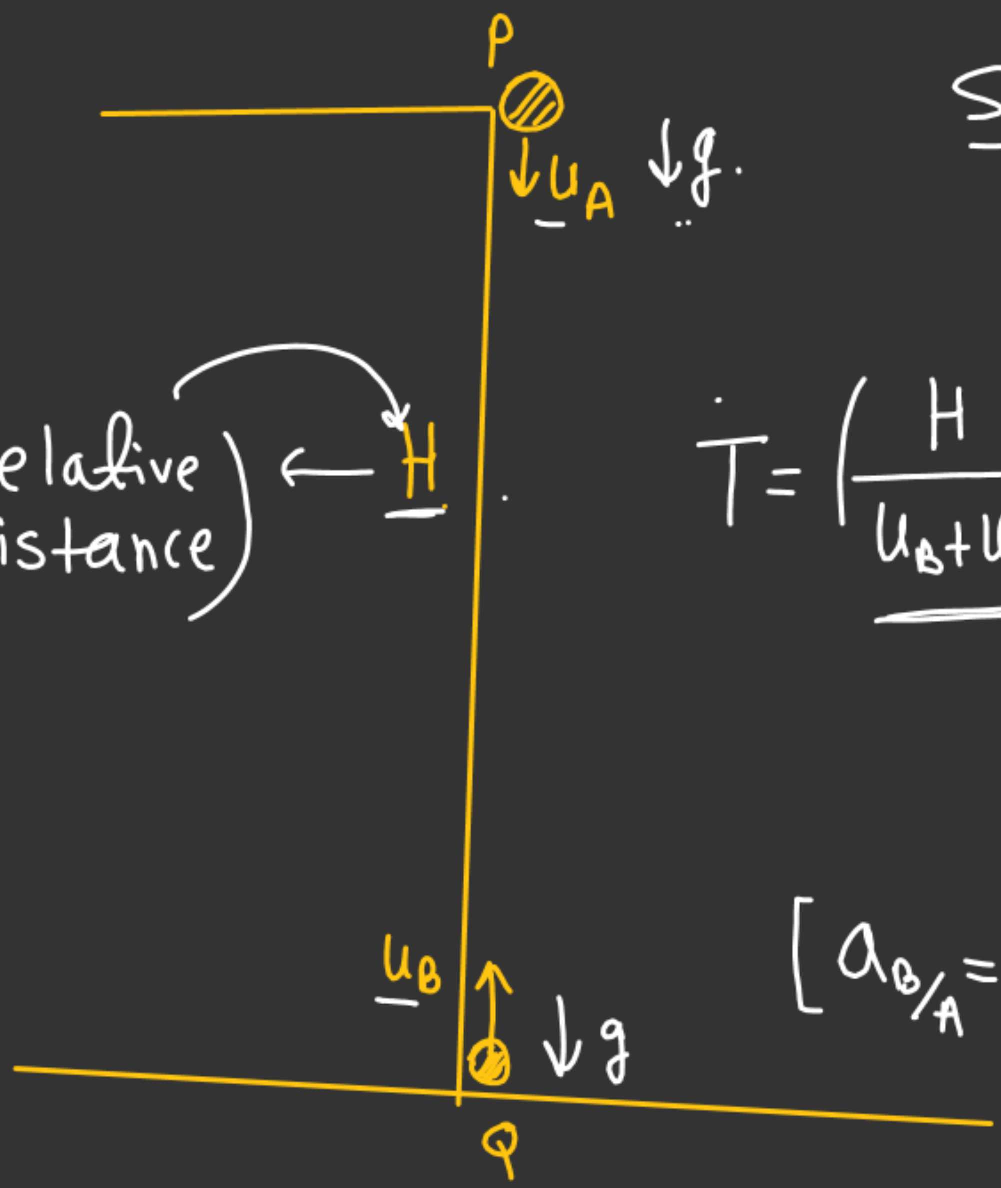
#. At what distance from top of the tower A and B collide.

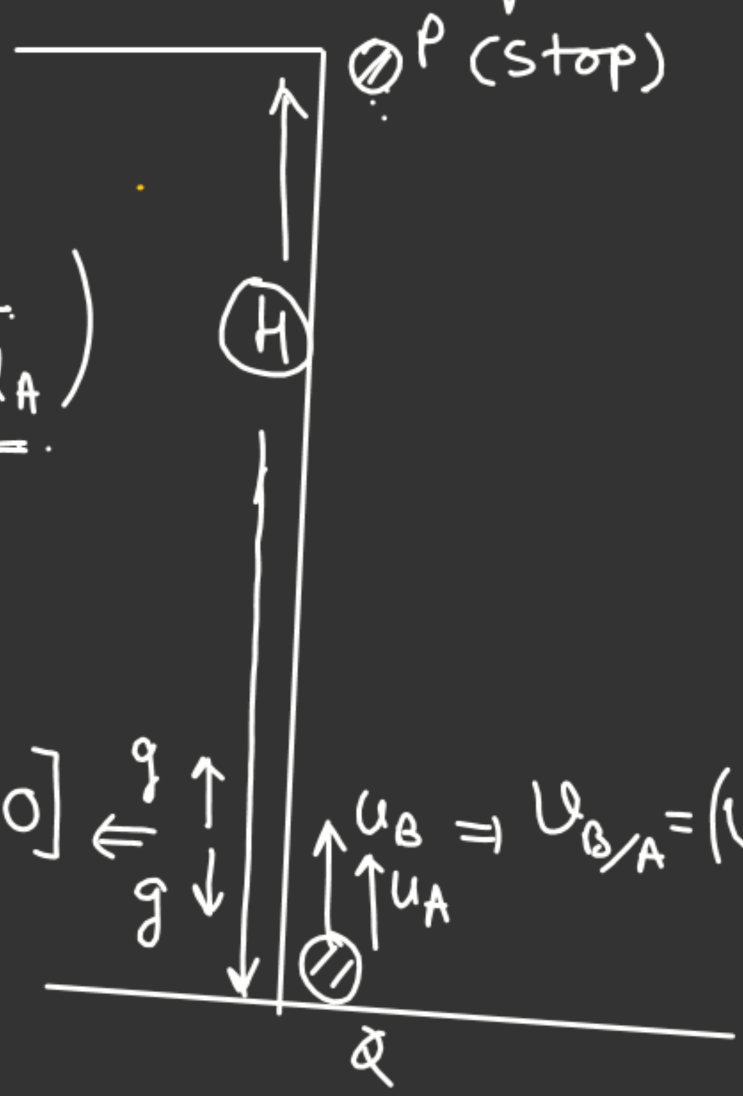


(Relative distance) ← H

Sol^n: – Time of Collision → ??

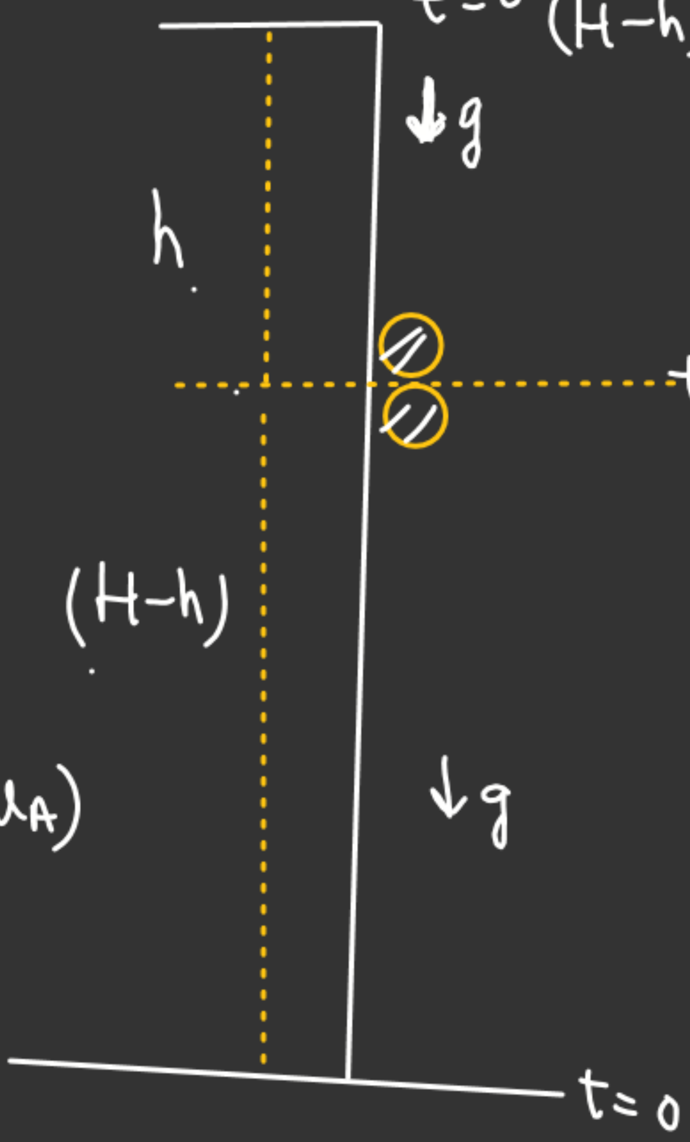
$$T = \left(\frac{H}{u_B + u_A}\right)$$

$[a_{B/A} = 0]$



$u_B \Rightarrow v_{B/A} = (u_B + u_A)$

[w.r.t earth]



$$h = u_A T + \frac{1}{2} g T^2 \quad \text{—} ①$$

$$(H-h) = u_B T - \frac{1}{2} g T^2 \quad \text{—} ②$$

① + ②

$$H = (u_A + u_B) T$$

$$T = \left(\frac{H}{u_A + u_B}\right)$$

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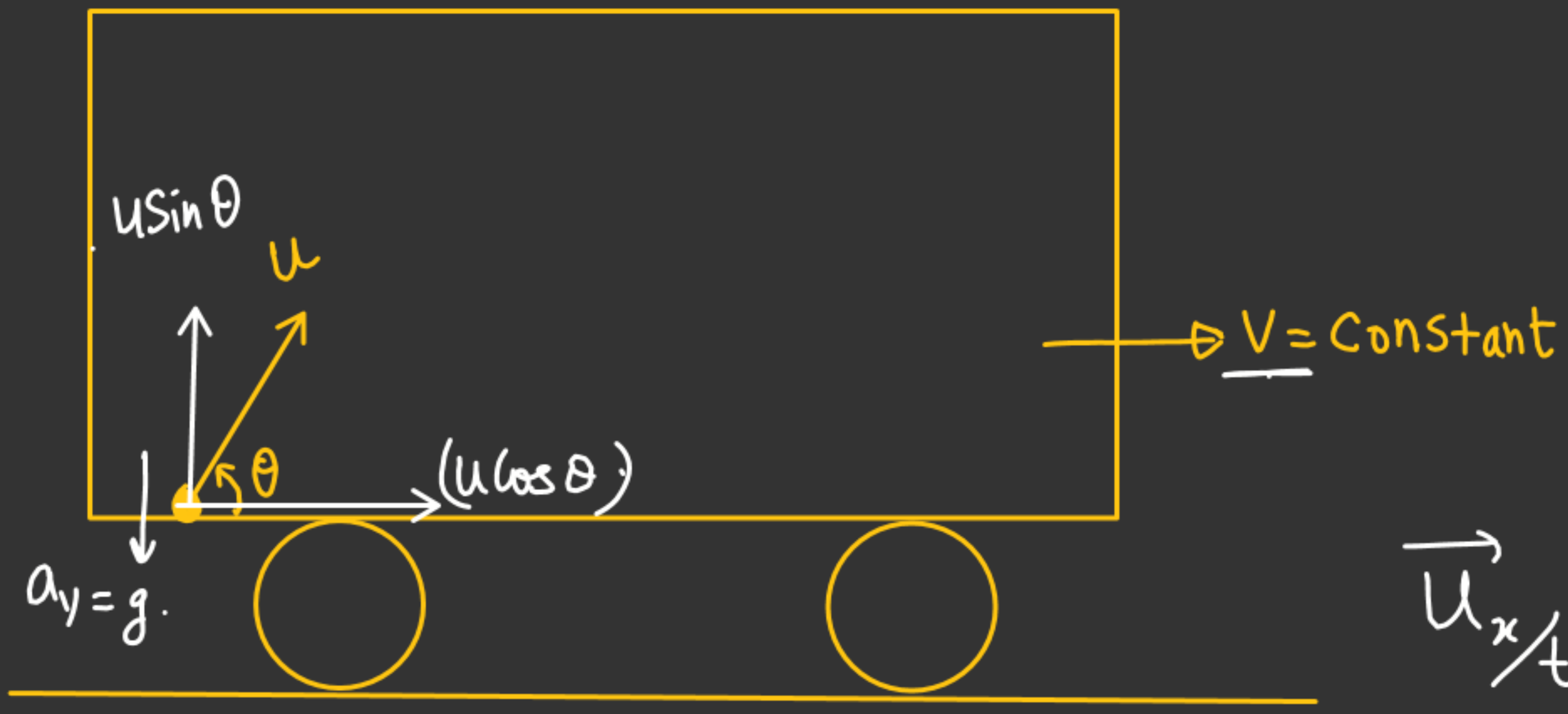
Projectile is projected with u m/s as shown in fig.

T, H, R = ??



Solⁿ:- In y-direction no relative motion b/w projectile and trolley or in y-direction trolley acts as a earth frame.

$$T = \frac{2u\sin\theta}{g}, \quad H = \left(\frac{u^2\sin^2\theta}{2g}\right)$$

Range = $(U_{x/\text{trolley}}) \times T$

$$\vec{U}_{x/\text{trolley}} = \vec{U}_{x/E} - \vec{v}_{\text{Trolley}/E}$$

$$= (u\cos\theta - v)\hat{i}$$

$$R = (u\cos\theta - v) \times T$$