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$$\left(\vec{v}_{P/trolley}\right) = \vec{v}_{P/E} - \vec{v}_{trolley/E}$$

$$= u\cos\theta\,\hat{i} + u\sin\theta\,\hat{j} - V\hat{i}$$

$$\vec{v}_{P/trolley} = \boxed{(u\cos\theta - V)}\,\hat{i} + u\sin\theta\,\hat{j}$$

[Condition when projectile fall at the point of projection w.r.t trolley].

$\Downarrow$

For this $\left(\vec{v}_{P/trolley}\right)_x = 0$

$$\boxed{u\cos\theta - V = 0}$$

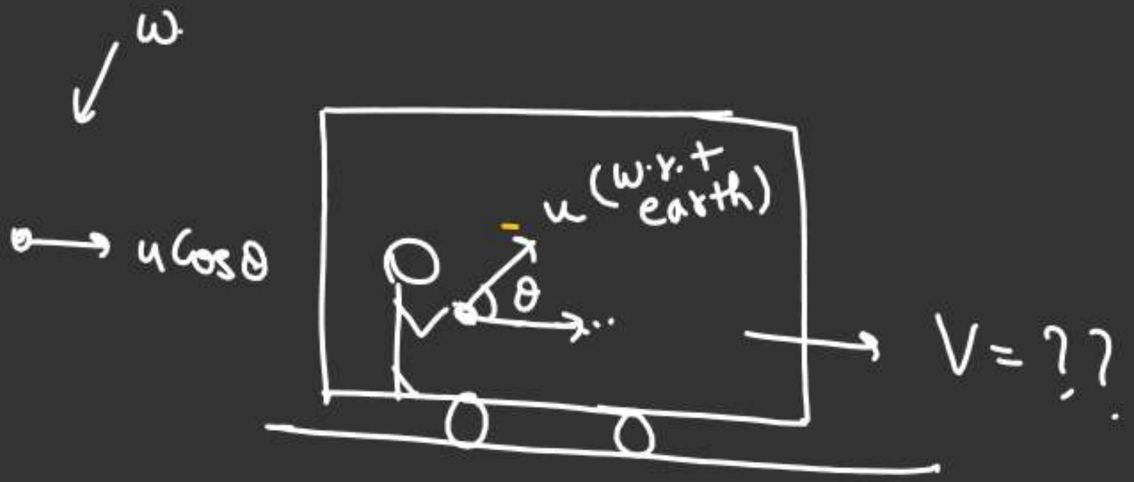
$$\boxed{V = u\cos\theta}$$

$$X_{rel} = (u\cos\theta - V)\times T$$

$\Downarrow$

$$0 = (u\cos\theta - V)\times T$$

$$V = u\cos\theta$$

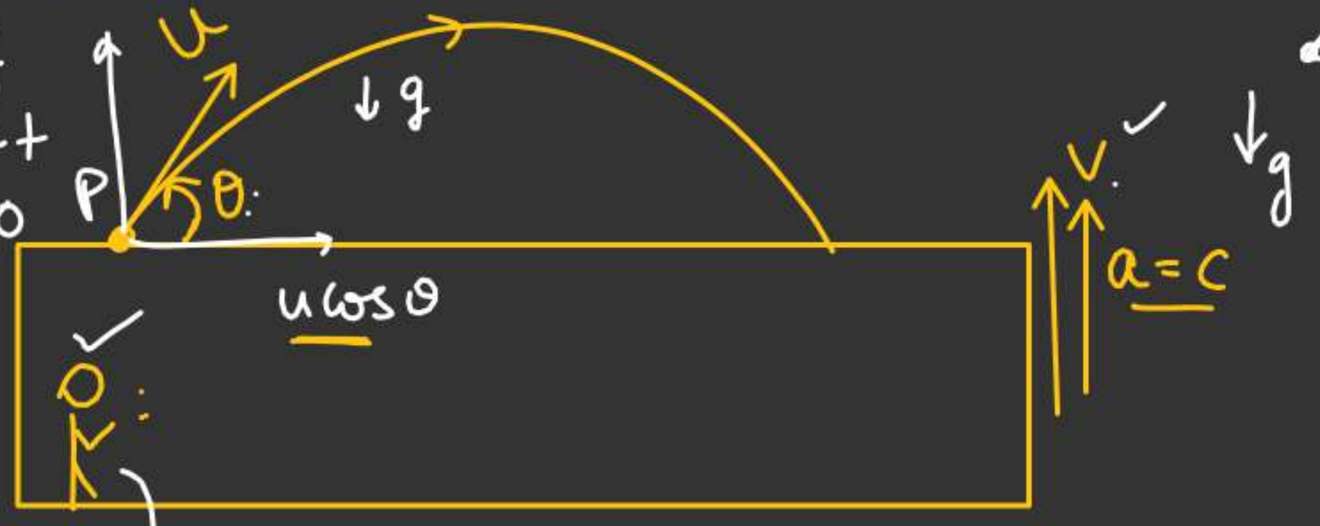


44. When projectile projected velocity of plank is v.

$T = ?$ $H = ?$, $R = ?$

(w.r.t earth) $u\sin\theta$

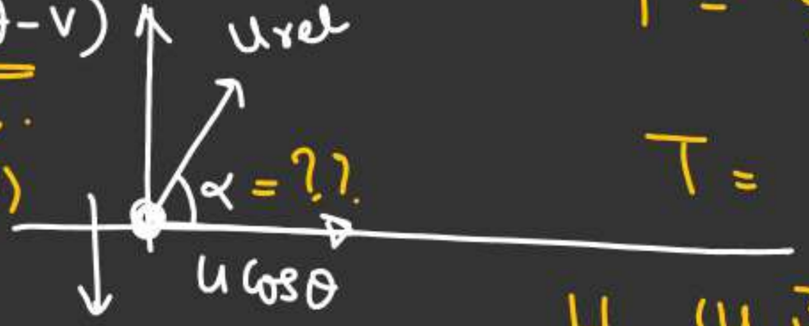
$\theta \rightarrow$ Angle of projection w.r.t earth



$(u\sin\theta - v)$

$\Downarrow$

$(u\sin\alpha)$



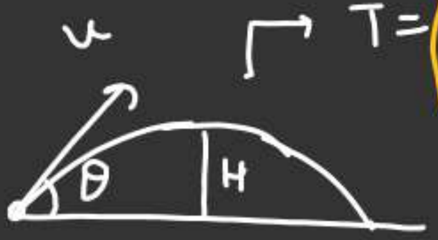
$g_{eff} = (g+a)$

$$T = \frac{2(u_y)_{rel}}{g_{eff}}$$

$$T = \frac{2(u\sin\theta - v)}{(g+a)}$$

$$H = \frac{(u_y)_{rel}^2}{2g_{eff}} = \frac{(u\sin\theta - v)^2}{2(g+a)}$$

W.r.t Earth



$$T = \frac{2u\sin\theta}{g}, \quad H = \frac{u^2\sin^2\theta}{2g}, \quad R = \frac{u^2\sin 2\theta}{g}$$

W.r.t plank

$$\vec{u}_{P/plank} = \vec{u}_{P/E} - \vec{u}_{plank/E}$$

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

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

$$\vec{a}_{P/plank} = \vec{a}_{P/E} - \vec{a}_{plank/E}$$

$$= -g\hat{j} - a\hat{j}$$

$$= -(g+a)\hat{j}$$

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Range w.r.t earth.

$$R = \left(\frac{u^2 \sin 2\theta}{g} \right)$$

Range w.r.t plank.

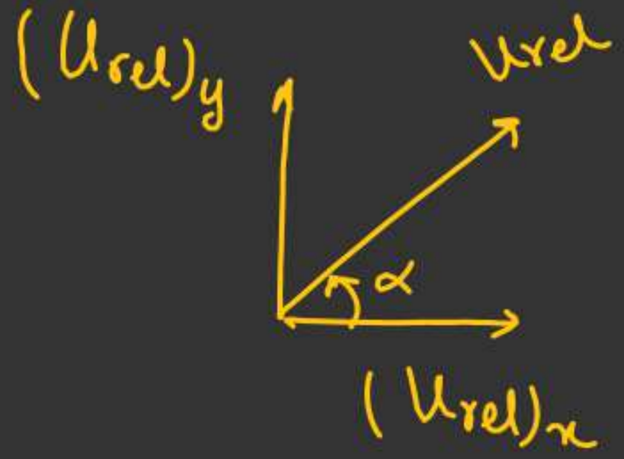
$$(a_{P/plank})_x = 0 \checkmark$$

$$\vec{u}_{P/plank} = (u\cos\theta)\hat{i}$$

$$R = (u\cos\theta) \times (T)_{w.r.t\ plant}.$$

$$R = (u\cos\theta) \times \left[\frac{2(u\sin\theta - v)}{(g+a)} \right]$$

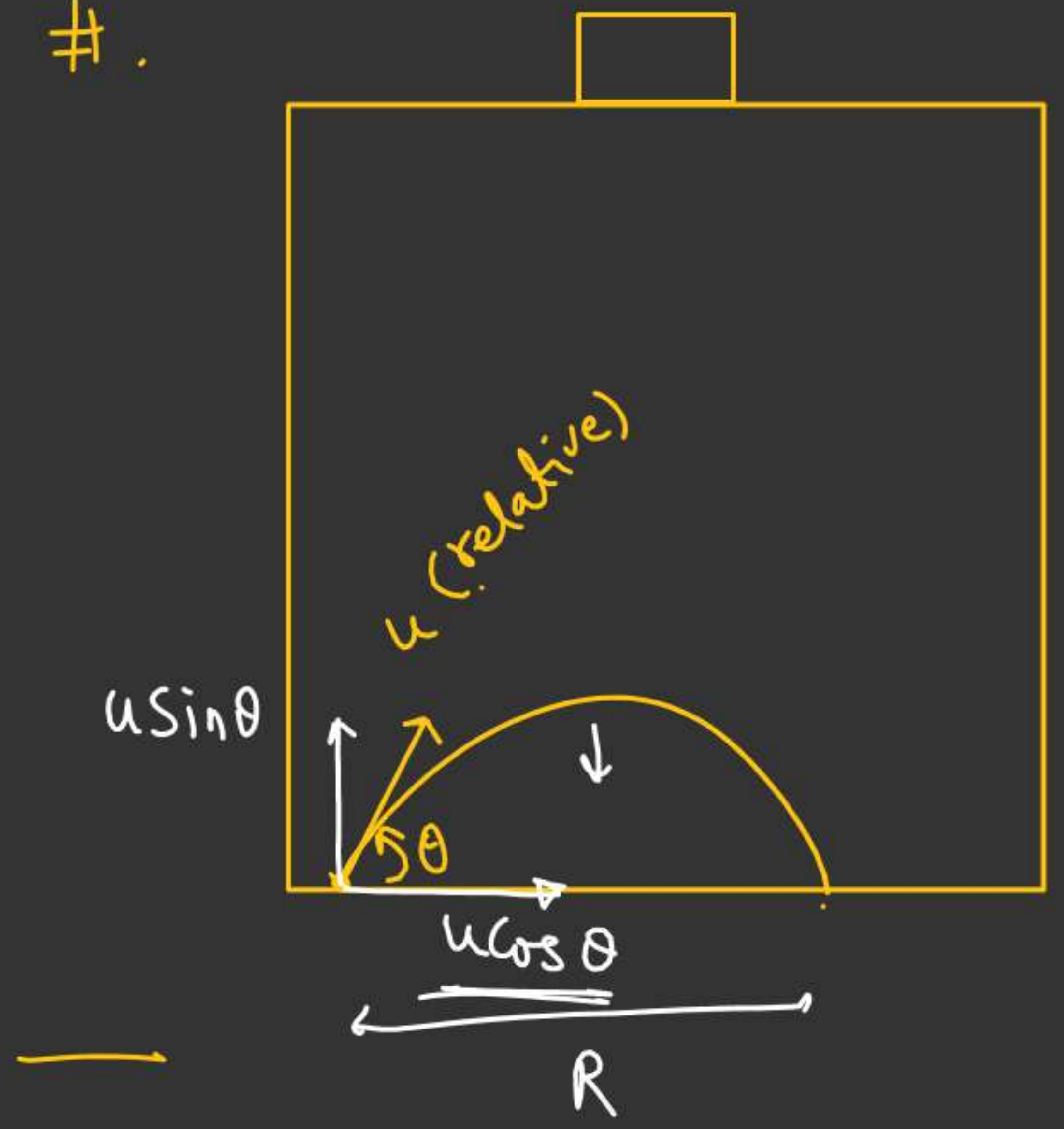
Angle of projection w.r.t plank.



$$\tan\alpha = \frac{(u_{rel})_y}{(u_{rel})_x}$$

$$\alpha = \tan^{-1}\left[\frac{(u_{rel})_y}{(u_{rel})_x} \right]$$

#.



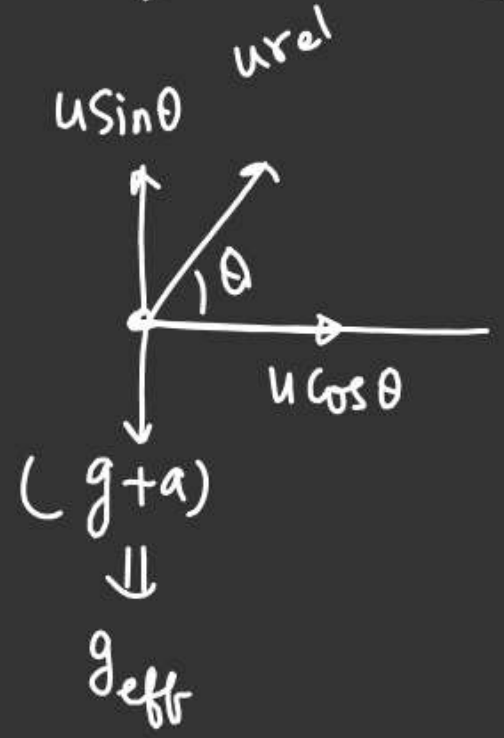
$\uparrow g = a$

W.r.t trolley

$T = ? = \left(\frac{2u\sin\theta}{g+g}\right) = \frac{u\sin\theta}{g}$ ✓,

$H = ?$

$R = ?$



$H_{max} = \frac{u^2\sin^2\theta}{2(2g)} = \frac{u^2\sin^2\theta}{4g}$

$R = \frac{u^2\sin 2\theta}{2g}$

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

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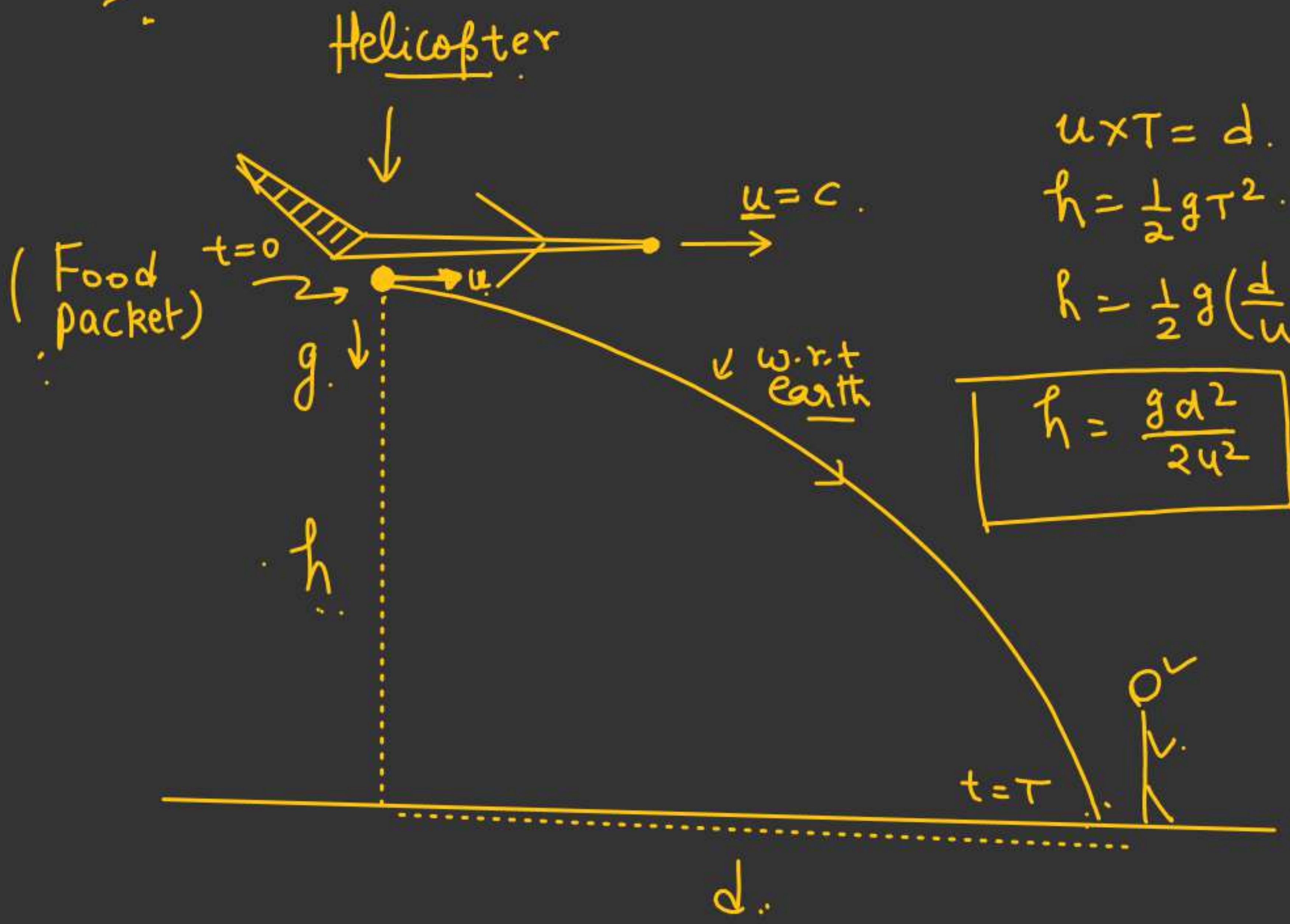

$$u \times T = d \Rightarrow T = \left(\frac{d}{u}\right)$$

$$h = \frac{1}{2} g T^2$$

$$h = \frac{1}{2} g \left(\frac{d}{u}\right)^2$$

$$\boxed{h = \frac{g d^2}{2u^2}}$$

w.r.t plane

$\vec{a}_{\text{food packet/plane}}$

$= \vec{a}_{\text{food Packet}/E} - \cancel{\vec{a}_{\text{plane}/E}}^{\,0}$

$= -g\hat{j}$

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#.

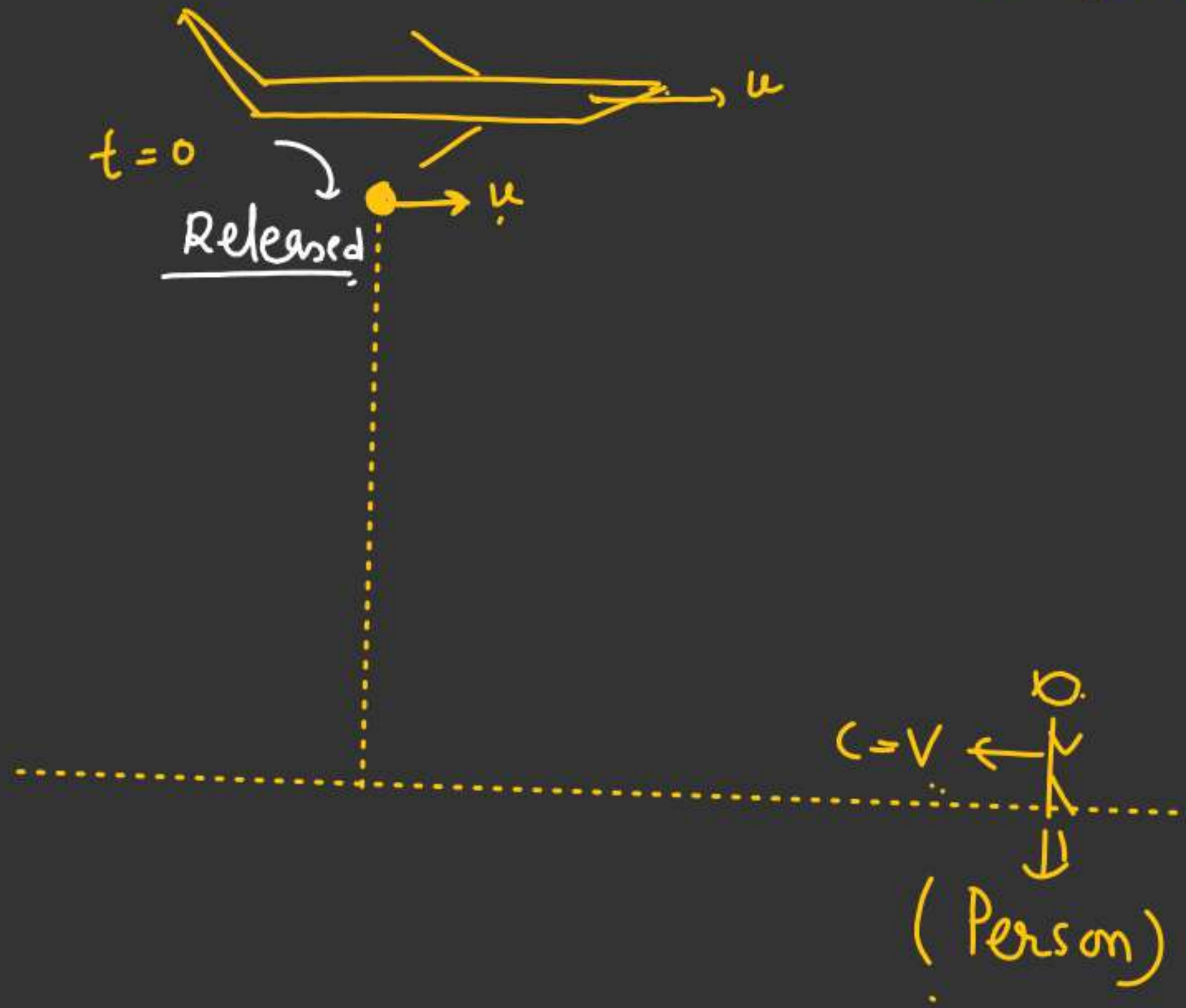
$\vec{v}_{P/Person} = \vec{v}_{P/g} - \vec{v}_{person/g}$

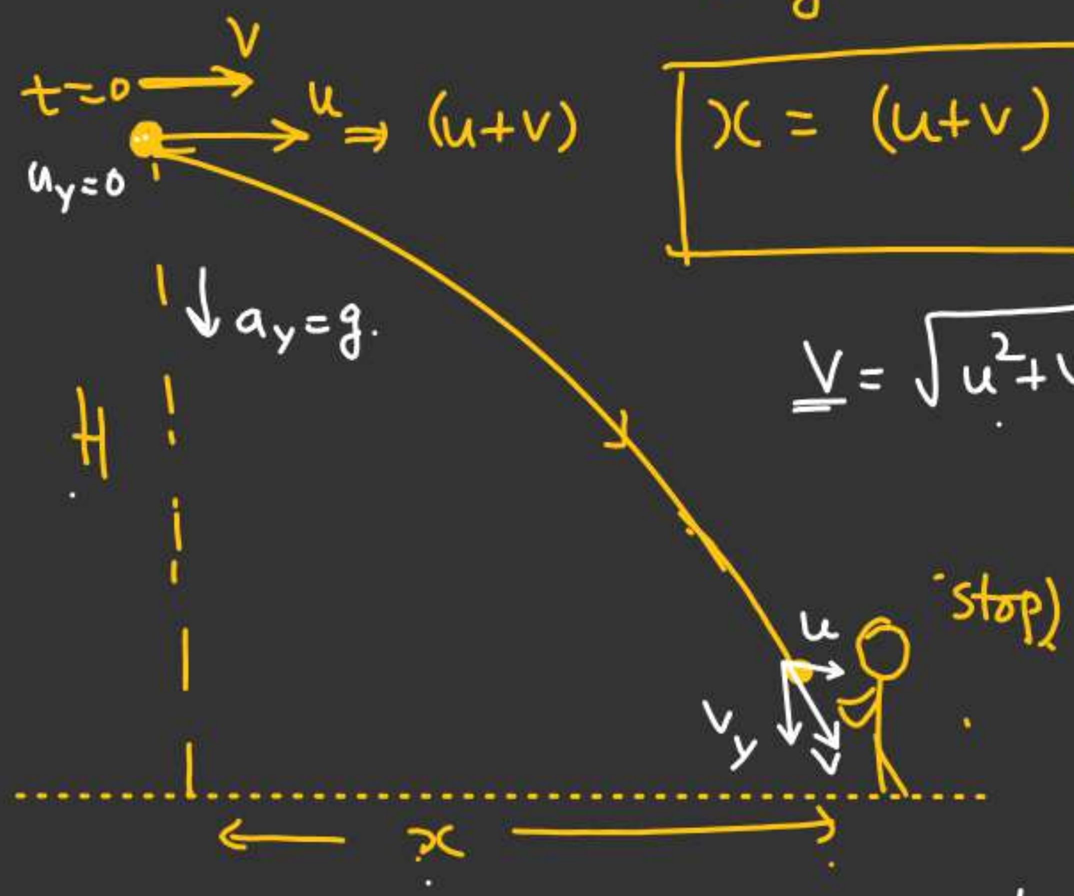
$= u\hat{i} - (-v)\hat{i}$

$= (u+v)\hat{i}$.

$-H = \cancel{u_y}T - \frac{1}{2}gT^2$ ($u_y = 0$)

$T = \sqrt{\frac{2H}{g}}$





$$\boxed{x = (u+v)\sqrt{\frac{2H}{g}}}$$

$\underline{V} = \sqrt{u^2 + v_y^2}$

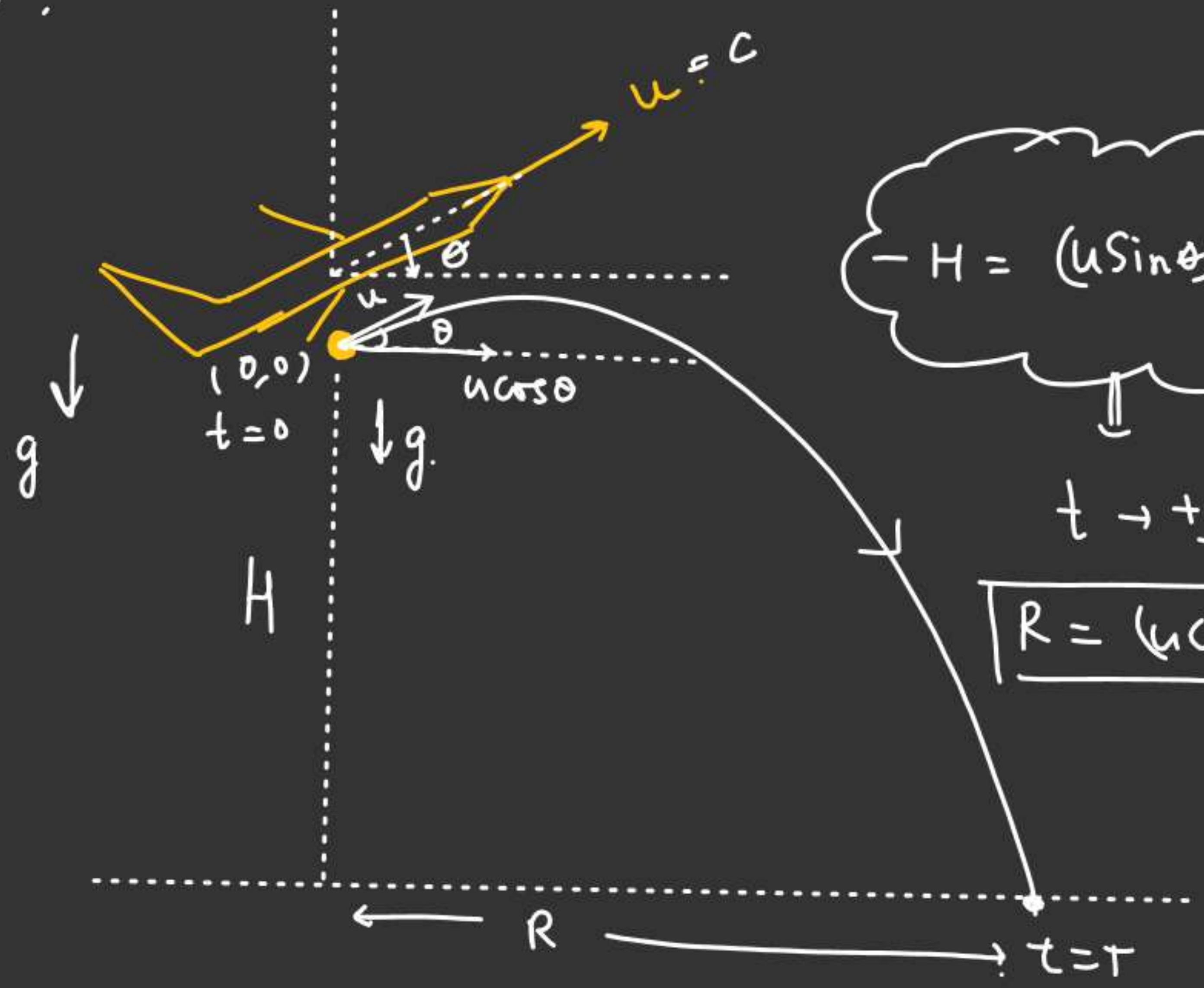
$v_y = g\sqrt{\frac{2H}{g}}$

$v_y = \sqrt{2gH}$

$\tan\theta = \left(\frac{v_y}{u}\right) = \left(\frac{\sqrt{2gH}}{u}\right)$

$\theta = \tan^{-1}\left(\frac{\sqrt{2gH}}{u}\right)$

#.



$$-H = (u\sin\theta)t - \frac{1}{2}gt^2$$

$$\Downarrow$$

$t \rightarrow$ +ve root

$$\boxed{R = (u\cos\theta)\times t}$$

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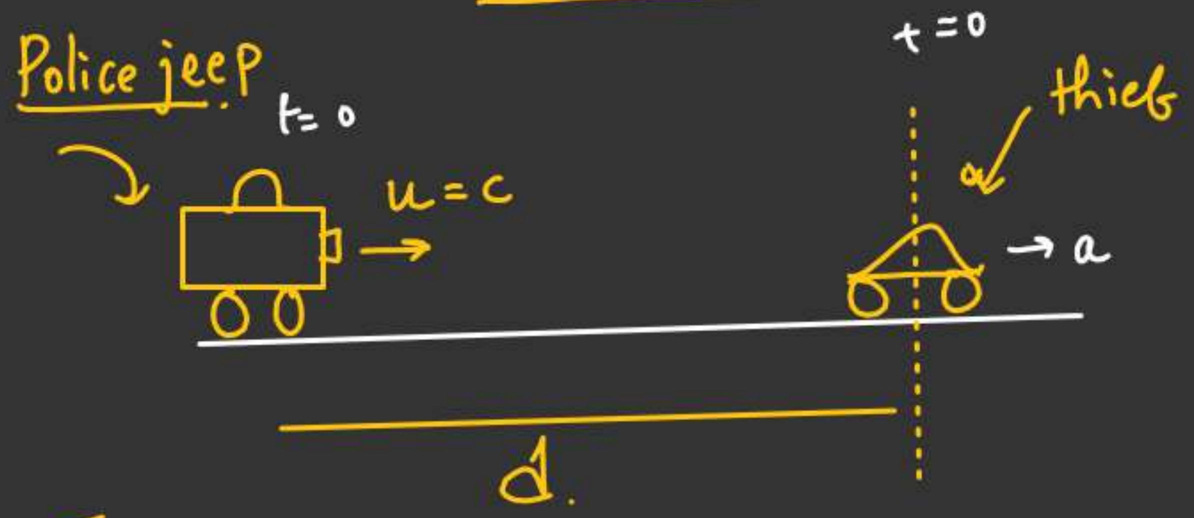
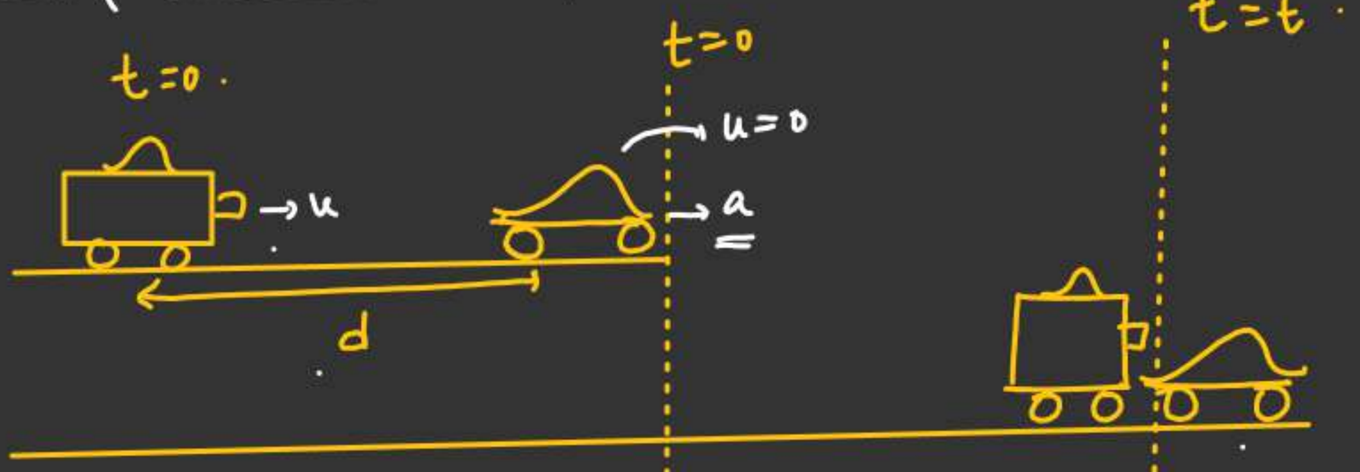
** Chasing problem :-



When police jeep at a distance 'd' apart from the theif. it starts its bike with constant accleration 'a'. what should be the min speed of police jeep to catch the thief.

M-1 (w.r.t earth frame.)



For police jeep

$$(d + x) = ut \quad - ①$$

For thief

$$x = \frac{1}{2}at^2 \quad - ②$$