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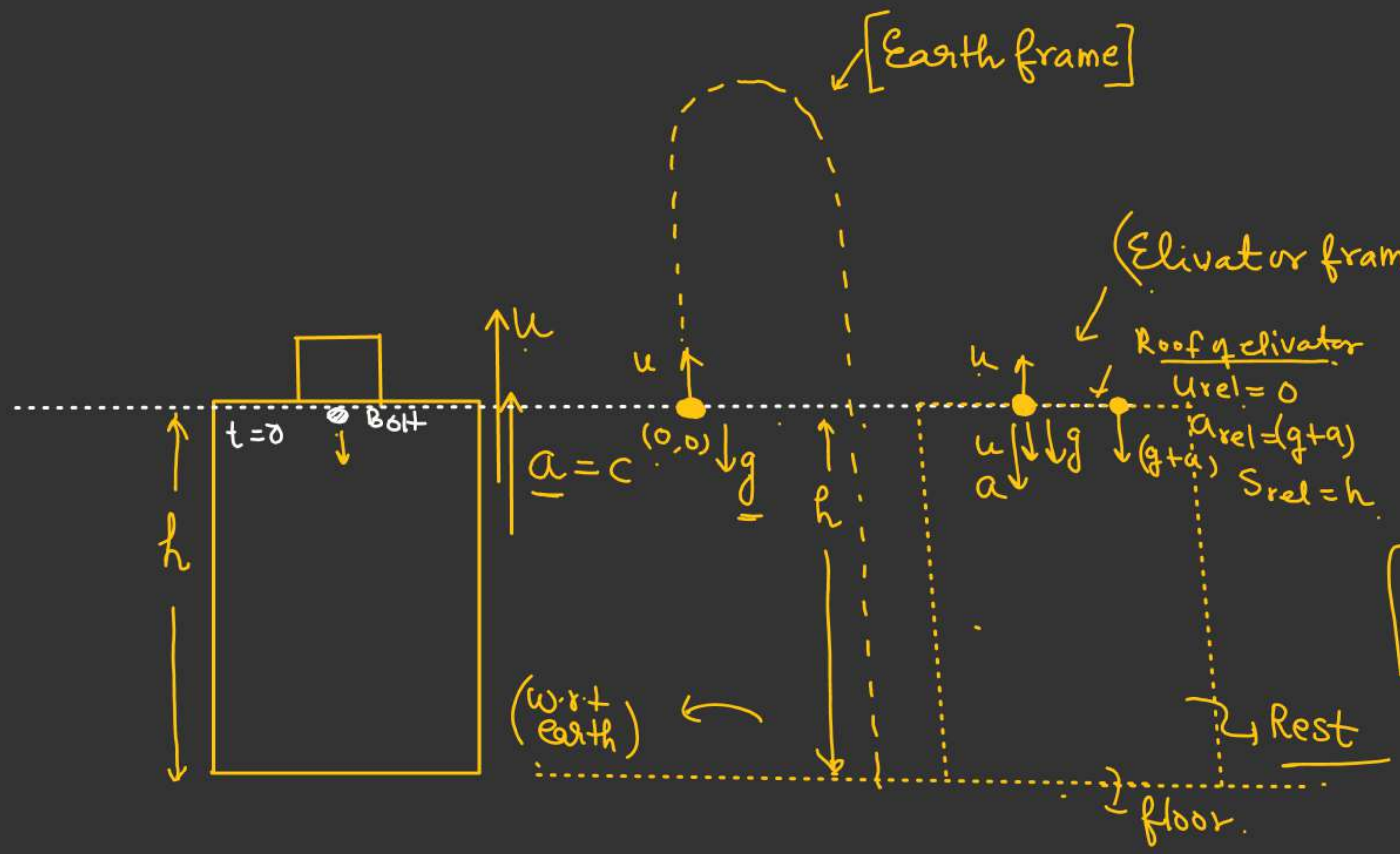
(*) Particle detached from an elivator (lift)

① Find the time when bolt hit the floor of the elivator.

② Distance and displacement of bolt w.r.t earth.



$$S_{rel} = \cancel{u_{rel}}\, t + \frac{1}{2} a_{rel}\, t^2 \quad (u_{rel} \to 0)$$

$$\Downarrow$$

$$-h = \frac{1}{2}\left(-(g+a)\right) t^2$$

$$\left[\, t = \sqrt{\frac{2h}{g+a}} \,\right] \checkmark$$

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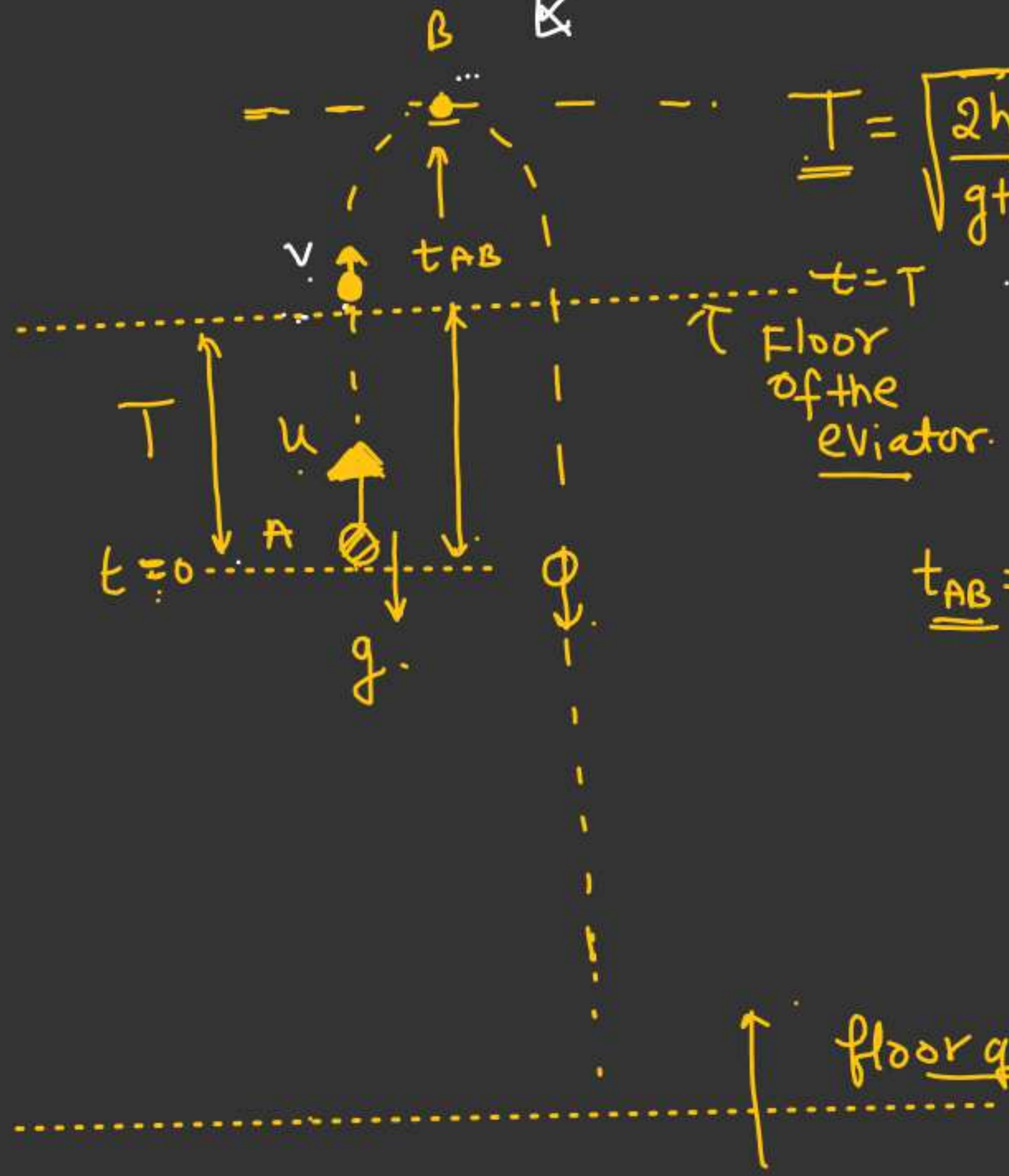
(*) Distance and displacement of bolt w.r.t earth :→

$t_{AB} = \frac{u}{g}$ ✓

$T = \sqrt{\frac{2h}{g+a}}$



$\boxed{\text{if } T < t_{AB}}$ ✓

↳ Distance and displacement w.r.t earth same.

$S = \left[uT - \frac{1}{2}gT^2\right]$

$\boxed{\text{if } T > t_{AB}}$

$t_{AB} = \frac{u}{g}$

$\left[h_{max} = \frac{u^2}{2g}\right]$

$\Downarrow$

S_{AB}

BC

↳ $t_{BC} = T - t_{AB}$

$= \left(\sqrt{\frac{2h}{g+a}} - \frac{u}{g}\right)$

$S_{BC} = \frac{1}{2}g(t_{BC})^2$

$= \frac{1}{2}g\left(\sqrt{\frac{2h}{g+a}} - \frac{u}{g}\right)^2$

$\left[\text{Total distance} = S_{AB} + S_{BC}\right.$

$= \frac{u^2}{2g} + \frac{g}{2}\left(\sqrt{\frac{2h}{g+a}} - \frac{u}{g}\right)^2$

Displacement

$= |S_{BC} - S_{AB}|$

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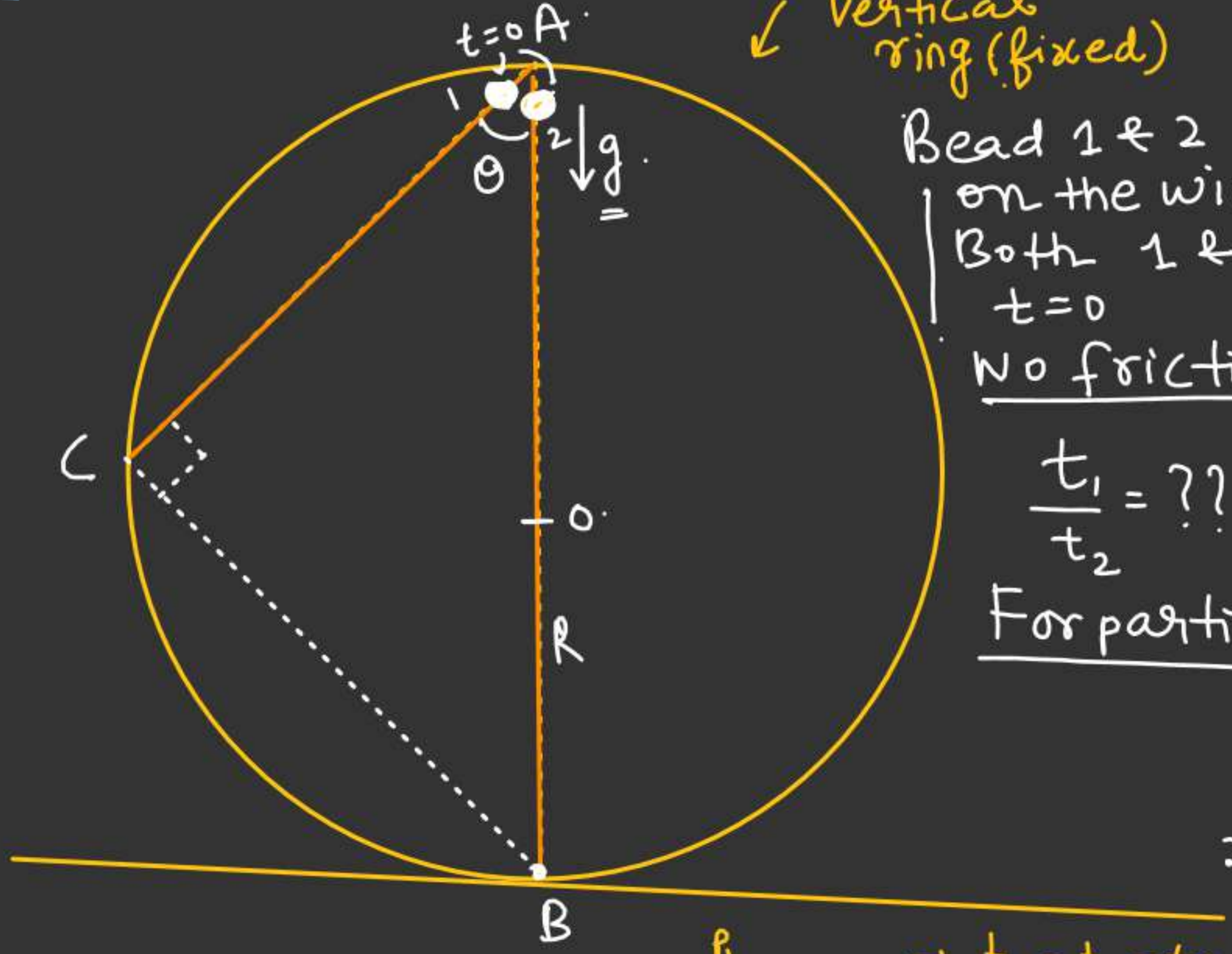
#



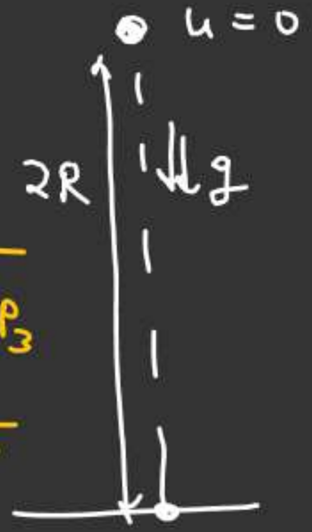
vertical ring (fixed)

Bead 1 & 2 move on the wire AC and AB.
Both 1 & 2 released at $t=0$

No friction.

$$\frac{t_1}{t_2} = ??$$

For particle-2

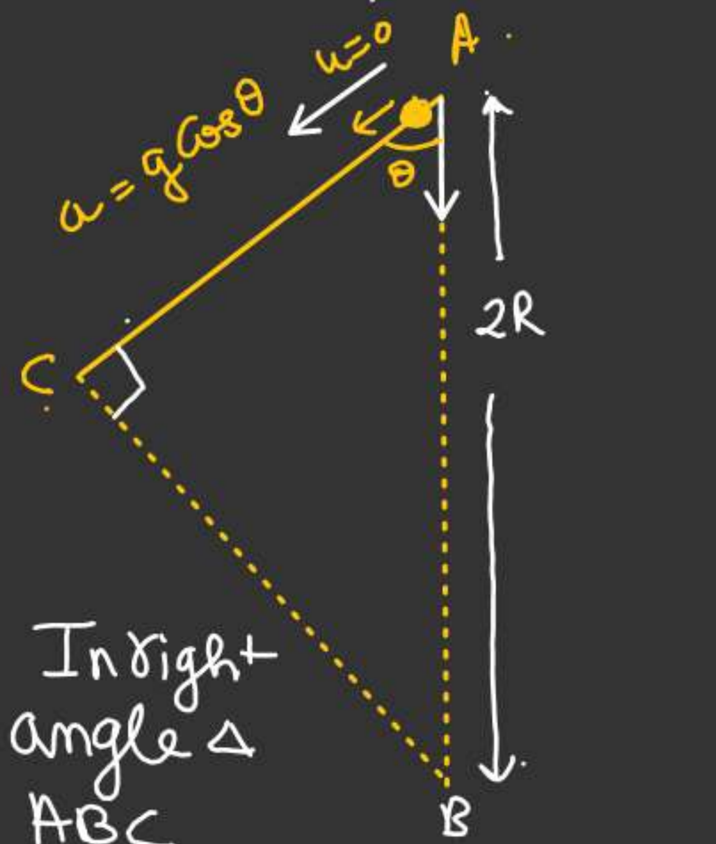


$$S = \underset{0}{u}t + \frac{1}{2}\underset{g}{a}t^2$$

$$2R = \frac{1}{2} g t_2^2$$

$$t_2 = \sqrt{\frac{4R}{g}}$$

$$\boxed{t_1 = t_2}$$



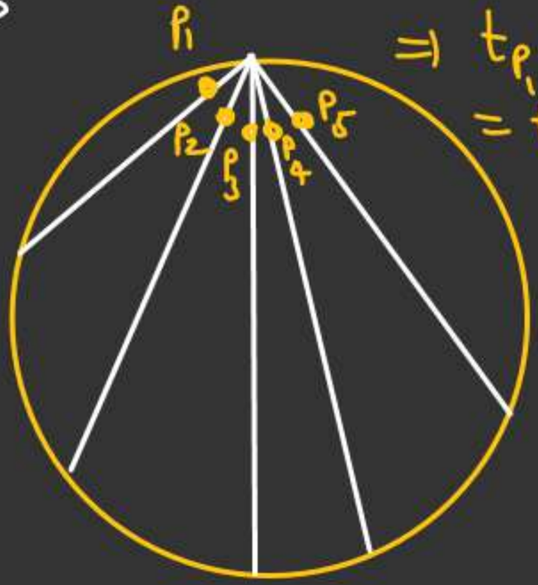
In right angle △ ABC

$$\cos\theta = \frac{AC}{AB} = \frac{AC}{2R}$$

$$AC = (2R\cos\theta)$$

$$2R\cancel{\cos\theta} = \frac{1}{2}(g\cancel{\cos\theta})t_1^2$$

$$t_1 = \sqrt{\frac{4R}{g}}$$



$$\Rightarrow t_{P_1} = t_{P_2} = t_{P_3} = t_{P_4} = t_{P_5}$$

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(*) Concept of Maxima and Minima.

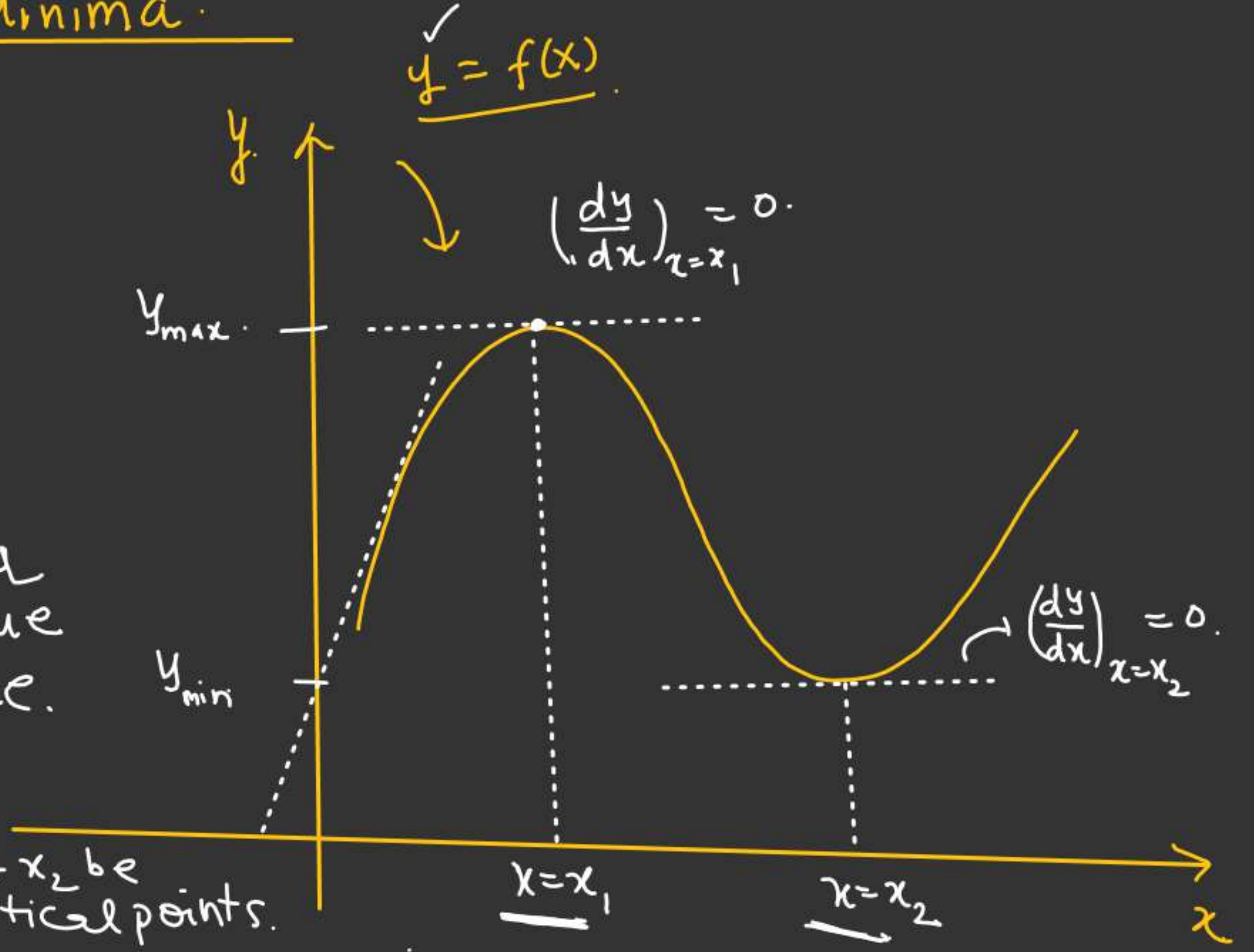
if $y = f(x)$

then for Maxima or minima of a function

$$\boxed{\frac{dy}{dx} = 0}$$

$\Rightarrow$

For Critical points $\rightarrow$ where function either takes maximum value or minimum value.



① For Critical points $\Rightarrow \dfrac{dy}{dx} = 0$, let x_1 & x_2 be critical points.

② For maxima

$$\left(\frac{d^2y}{dx^2}\right)_{x=x_1} < 0 \Rightarrow x_1 = \text{point of maxima.}$$

$$\Rightarrow \left(\frac{d^2y}{dx^2}\right)_{x=x_2} > 0 \Rightarrow \text{Point of Minima}$$

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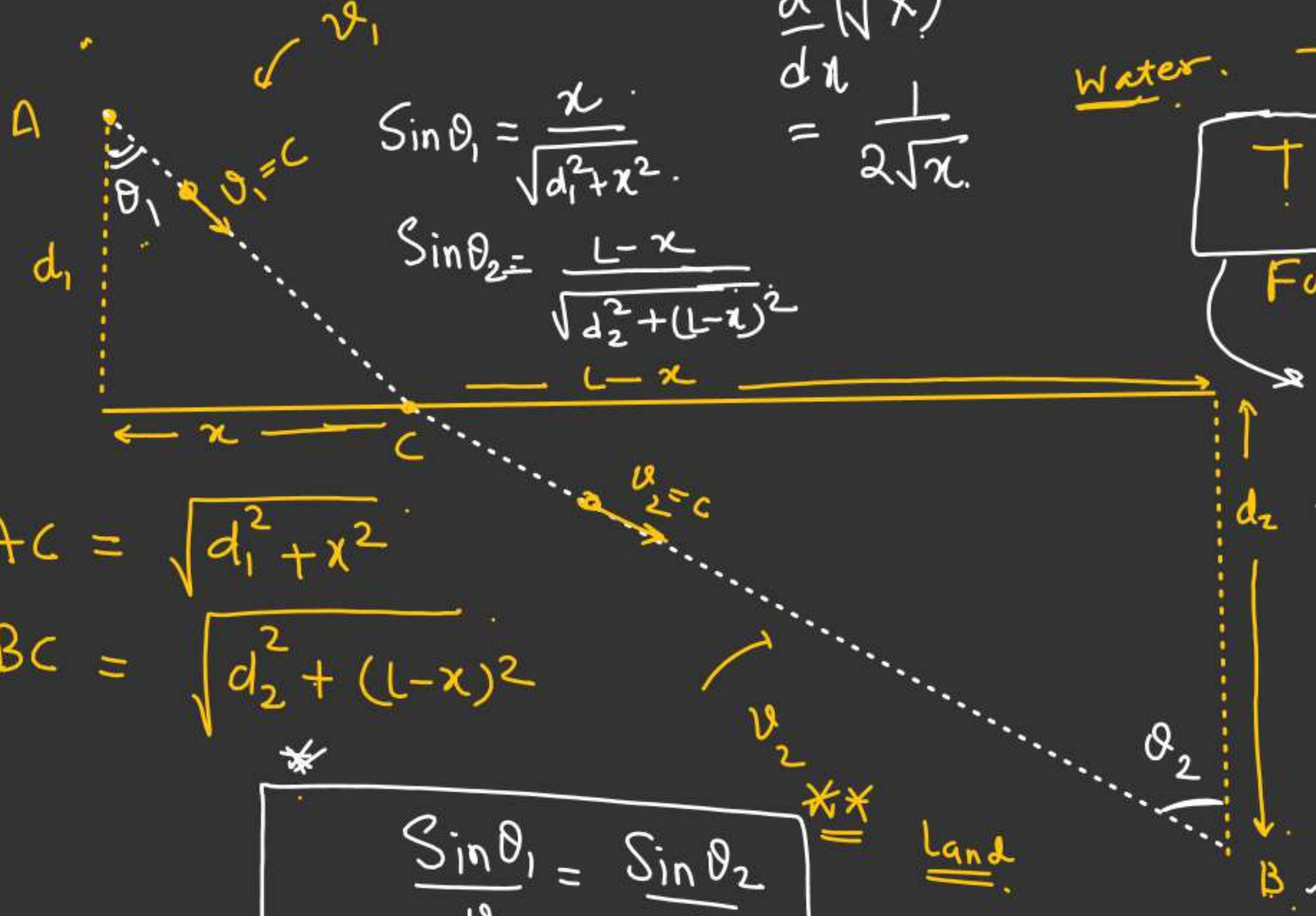
#.

⇒ A person wants to reach from A to B in minimum time.



$$\sin\theta_1 = \frac{x}{\sqrt{d_1^2+x^2}}$$

$$\sin\theta_2 = \frac{L-x}{\sqrt{d_2^2+(L-x)^2}}$$

$$\frac{d}{dx}\left(\sqrt{x}\right) = \frac{1}{2\sqrt{x}}$$

$$AC = \sqrt{d_1^2+x^2}$$

$$BC = \sqrt{d_2^2+(L-x)^2}$$

*

$$\boxed{\frac{\sin\theta_1}{\vartheta_1} = \frac{\sin\theta_2}{\vartheta_2}}$$ **

↳ Condition to reach in min. time from A to B

$$T = t_{AC} + t_{BC}$$

$$\boxed{T = \frac{\sqrt{d_1^2+x^2}}{\vartheta_1} + \frac{\sqrt{d_2^2+(L-x)^2}}{\vartheta_2}}$$

For T to be minimum, $\frac{dT}{dx} = 0$.

$$\frac{dT}{dx} = 0.$$

$$\frac{1}{\vartheta_1}\frac{d}{dx}\left(\sqrt{d_1^2+x^2}\right) + \frac{1}{\vartheta_2}\frac{d}{dx}\left[\sqrt{d_2^2+(L-x)^2}\right] = 0.$$

$$\frac{1}{\vartheta_1}\left(\frac{1}{2\sqrt{d_1^2+x^2}}\right)\frac{d}{dx}(d_1^2+x^2) + \frac{1}{\vartheta_2}\left[\frac{1}{2\sqrt{d_2^2+(L-x)^2}}\right]\frac{d}{dx}\left(d_2^2+(L-x)^2\right) = 0.$$

$$\frac{1}{\cancel{2}\vartheta_1\sqrt{d_1^2+x^2}} \times \cancel{2}x + \frac{1}{\cancel{2}\vartheta_2\sqrt{d_2^2+(L-x)^2}}\cancel{2}(L-x)(-1) = 0.$$

$$\underbrace{\left(\frac{x}{\sqrt{d_1^2+x^2}}\right)}_{\sin\theta_1}\frac{1}{\vartheta_1} = \frac{1}{\vartheta_2}\underbrace{\left(\frac{L-x}{\sqrt{d_2^2+(L-x)^2}}\right)}_{\sin\theta_2}$$

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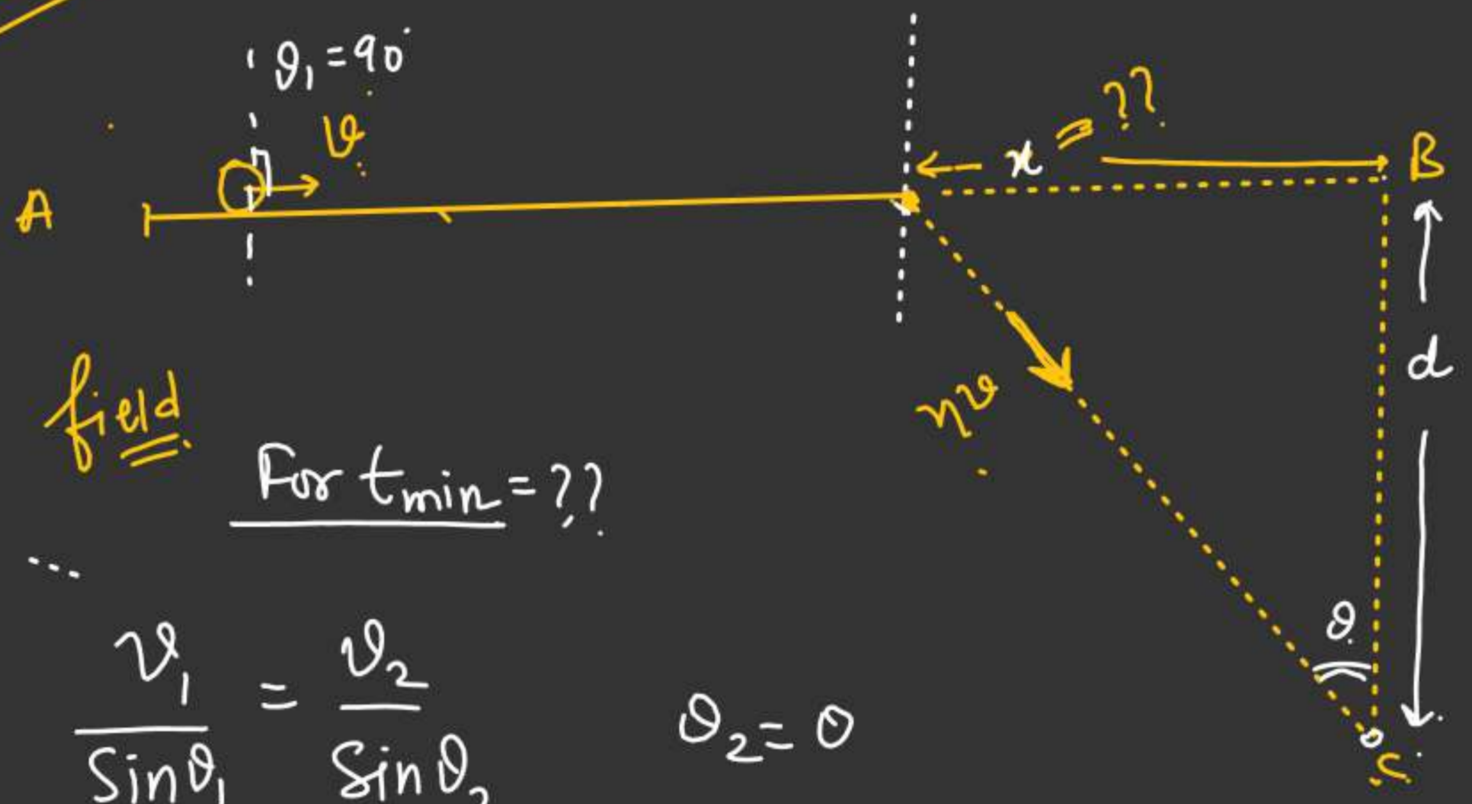
Irodov.

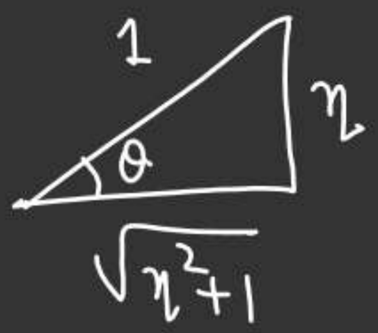


field

For $t_{min} = ??$

$$\frac{v_1}{\sin\theta_1} = \frac{v_2}{\sin\theta_2} \qquad \theta_2 = \theta$$

$$\frac{v}{\sin 90^\circ} = \frac{\eta v}{\sin\theta} \Rightarrow \sin\theta = \eta$$



$$\tan\theta = \frac{x}{d}$$

$$x = d\tan\theta$$

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