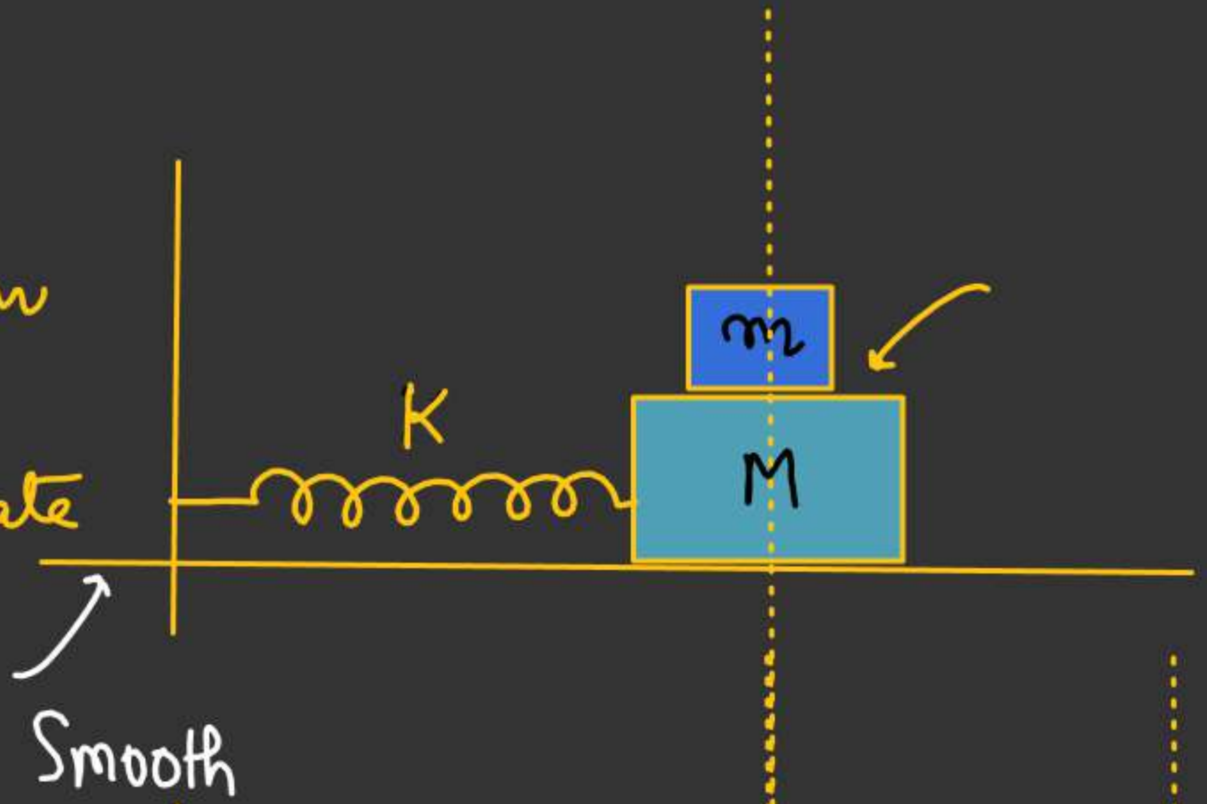
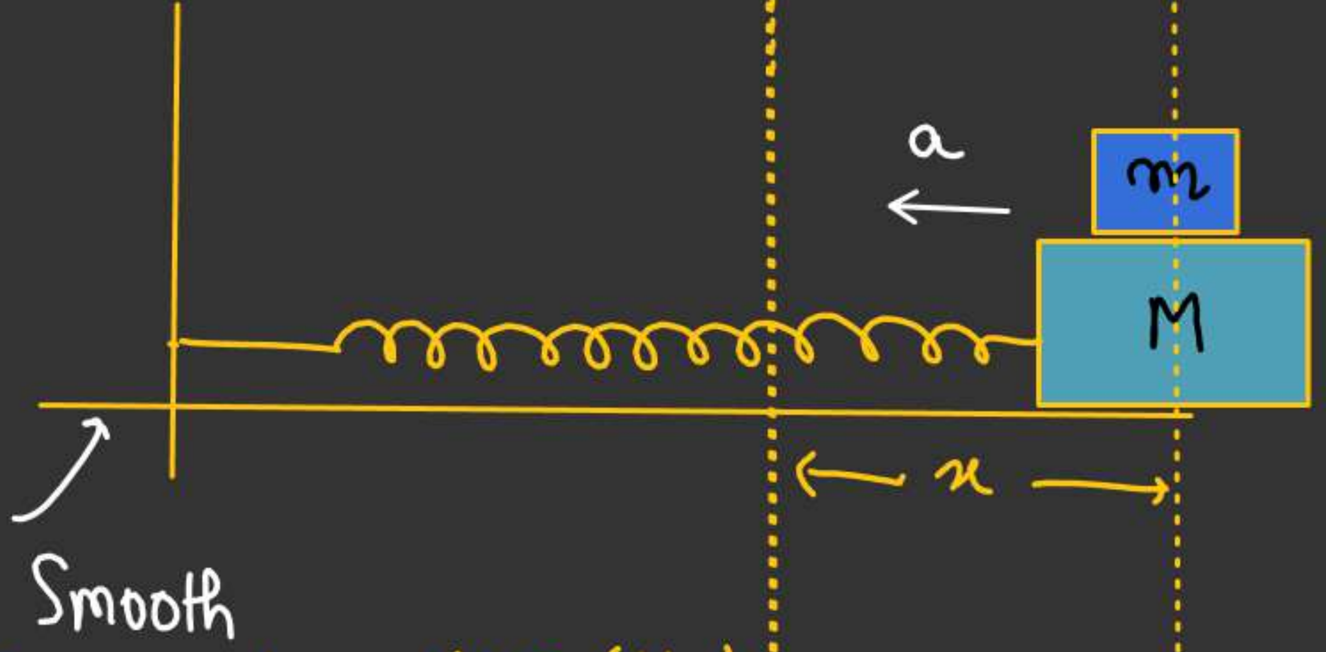
Nishant Jindal

\# No relative slipping b/w both the blocks.

a) Find friction when both the blocks at a distance $x$ from mean position

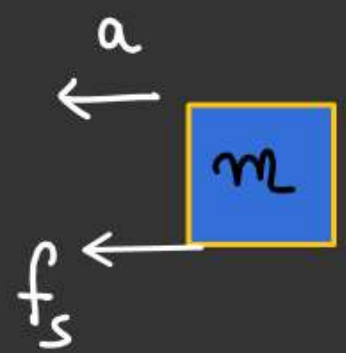
b) For what maximum amplitude blocks osscillate together.




Sol$^n$

$a = \omega^2 x$ $\qquad \omega = \sqrt{\dfrac{K}{M+m}}$




$f_s = ma$

$$\boxed{f_s = m\omega^2 x}$$

At extreme position

$a \to a_{max} = \omega^2 A$

$\omega^2 A = f_s \quad \Rightarrow f_s \leq (f_s)_{max}$

$\omega^2 A \leq \mu m g \quad \Rightarrow A \leq \left(\dfrac{\mu m g}{\omega^2}\right) \Rightarrow A \leq \dfrac{\mu m g (M+m)}{K}$

Nishant Jindal

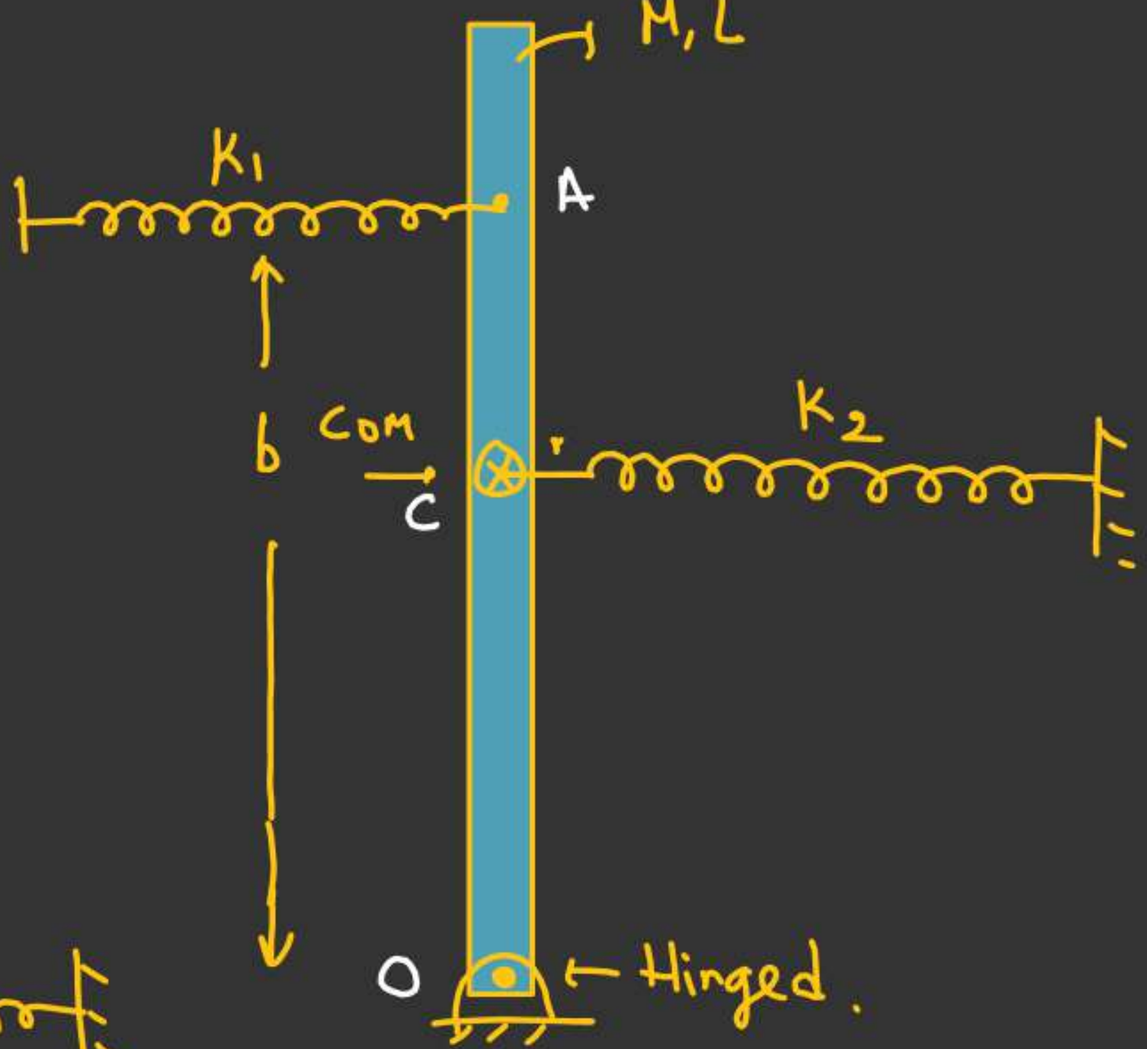
# ANGULAR S.H.M

→ $\tau_{res} \propto \theta$

→ $\alpha = \frac{\tau_{res}}{I}$

→ $\alpha = -\omega^2 \theta$

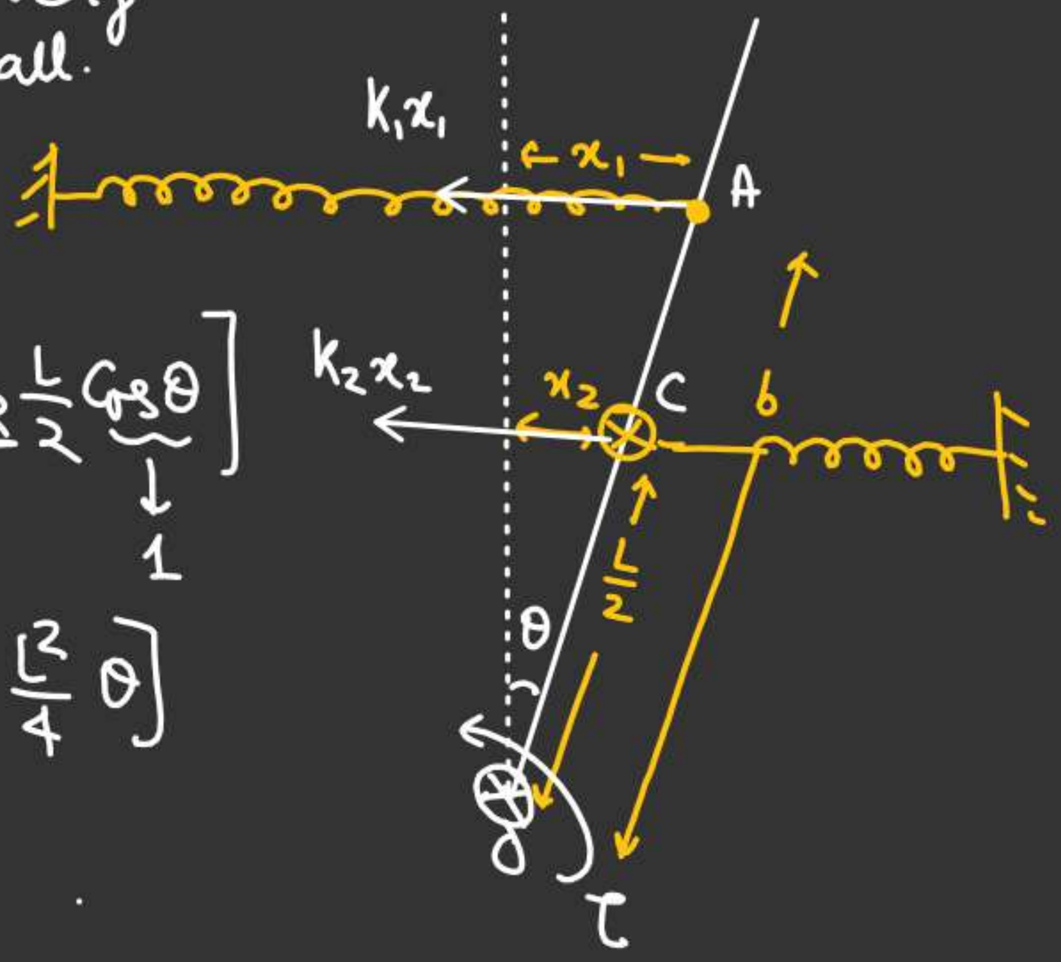
The whole system is on a smooth horizontal table. Both the springs at its natural length when rod is vertical. Find time period = ??




$\theta \rightarrow$ is very small.

$x_1 = b\sin\theta \simeq b\theta$

$x_2 = \frac{L}{2}\sin\theta \simeq \frac{L}{2}\theta$




$$\tau_r = -\left[K_1 x_1 (b\underbrace{\cos\theta}_{1}) + K_2 x_2 \frac{L}{2}\underbrace{\cos\theta}_{1}\right]$$

$$\tau_r = -\left[K_1 b(b\theta) + K_2 \frac{L^2}{4}\theta\right]$$

$$\tau_r = -\left[K_1 b^2 + \frac{K_2 L^2}{4}\right]\theta$$

Nishant Jindal

Ak :

$$\tau_r = -\left[K_1 b^2 + \frac{K_2 L^2}{4}\right]\theta$$

$$\alpha = \frac{\tau_r}{I}$$

$$\alpha = -\left[\frac{K_1 b^2 + \frac{K_2 L^2}{4}}{\frac{ML^2}{3}}\right]\theta$$

$$\alpha = -3\left[\frac{4K_1 b^2 + K_2 L^2}{4ML^2}\right]\theta$$

$$\alpha = -\left[\frac{12K_1 b^2 + 3K_2 L^2}{4ML^2}\right]\theta$$

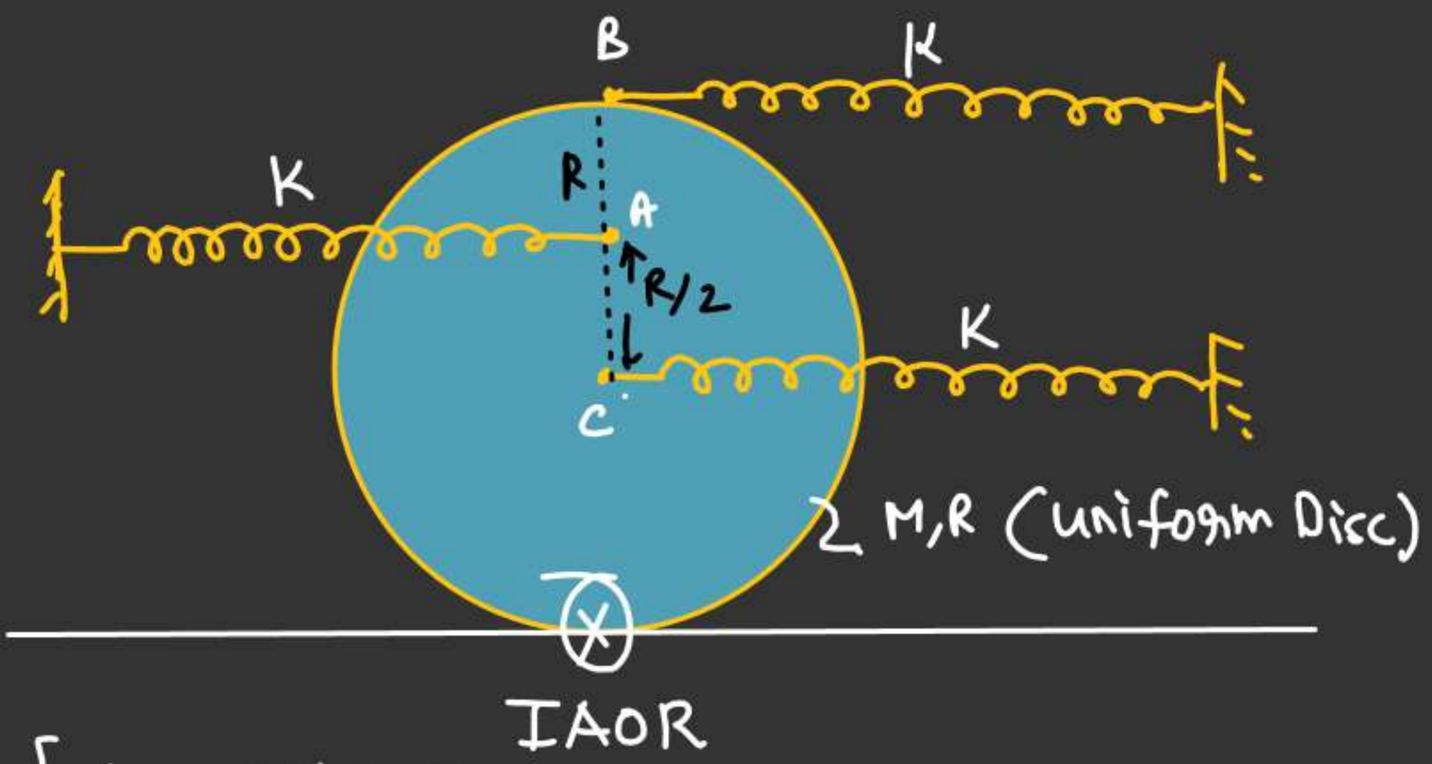
$$\alpha = -\omega^2\theta$$

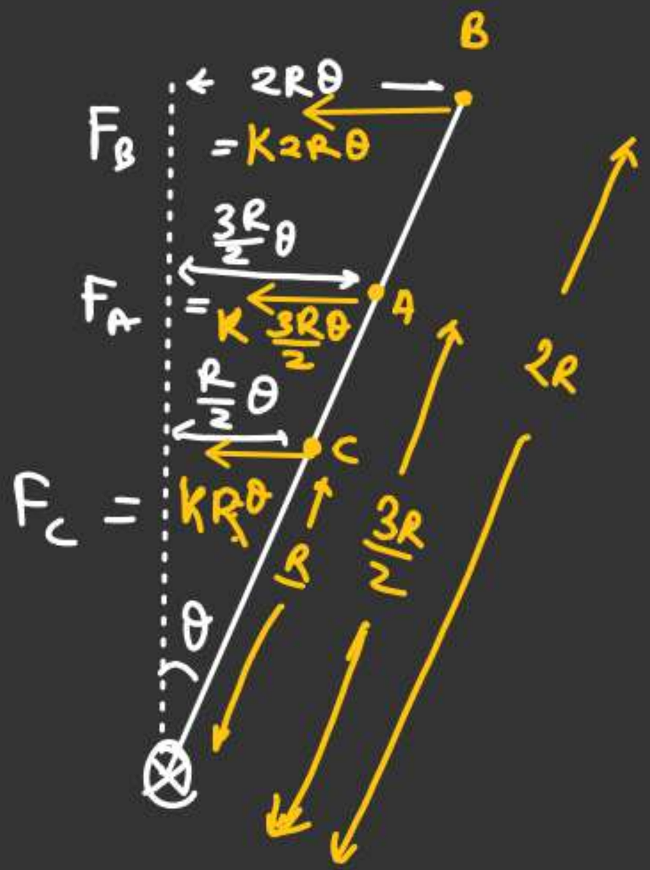
$$\omega = \sqrt{\frac{12K_1 b^2 + 3K_2 L^2}{4ML^2}}$$

$$T = 2\pi\sqrt{\frac{4ML^2}{12K_1 b^2 + 3K_2 L^2}} \checkmark$$

Nishant Jindal

# If Disc is slightly displaced, find it's time period. No relative slipping b/w disc and ground.




$$\tau_r = -\left[(K2R\theta)(2R\underbrace{\cos\theta}_{1}) + \frac{3KR}{2}\theta\cdot\left(\frac{3R}{2}\underbrace{\cos\theta}_{1}\right) + \frac{KR}{2}\theta\cdot\left(\frac{R}{2}\underbrace{\cos\theta}_{1}\right)\right]$$

$$\tau_r = -\left[K4R^2 + \frac{9R^2}{4}K + \frac{R^2}{4}K\right]\theta$$

$$\tau_r = -\left[\frac{29KR^2}{4}\right]\theta$$

$$\alpha = -\left(\frac{\frac{29KR^2}{4}}{\frac{3}{2}MR^2}\right)\theta$$

$$\alpha = -\left(\frac{29K}{6M}\right)\theta$$

$$\alpha = -\omega^2\theta$$

$$T = 2\pi\sqrt{\frac{6M}{29K}}$$

Nishant Jindal

# Simple pendulum.

$$\tau_r = -(mg\sin\theta)\,l \qquad \sin\theta \simeq \theta$$

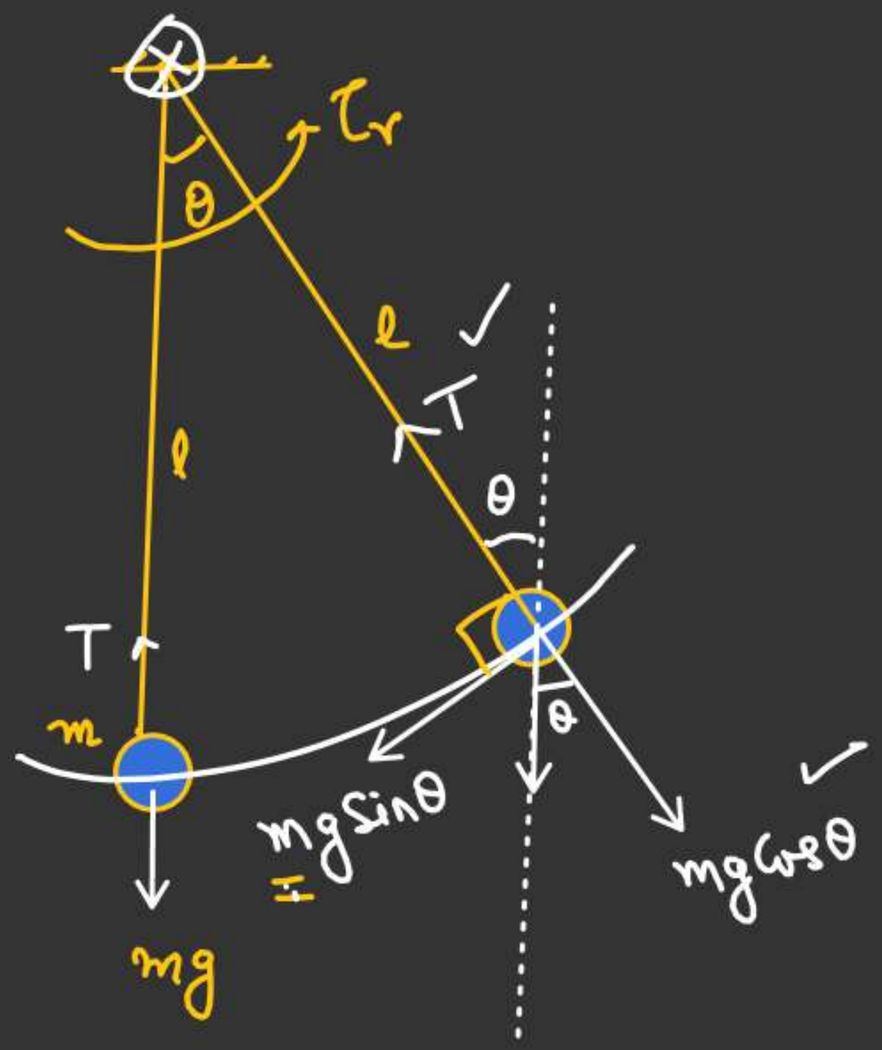
$$\tau_r = -mgl\theta$$

$$\alpha = -\frac{mgl}{ml^2}\theta$$

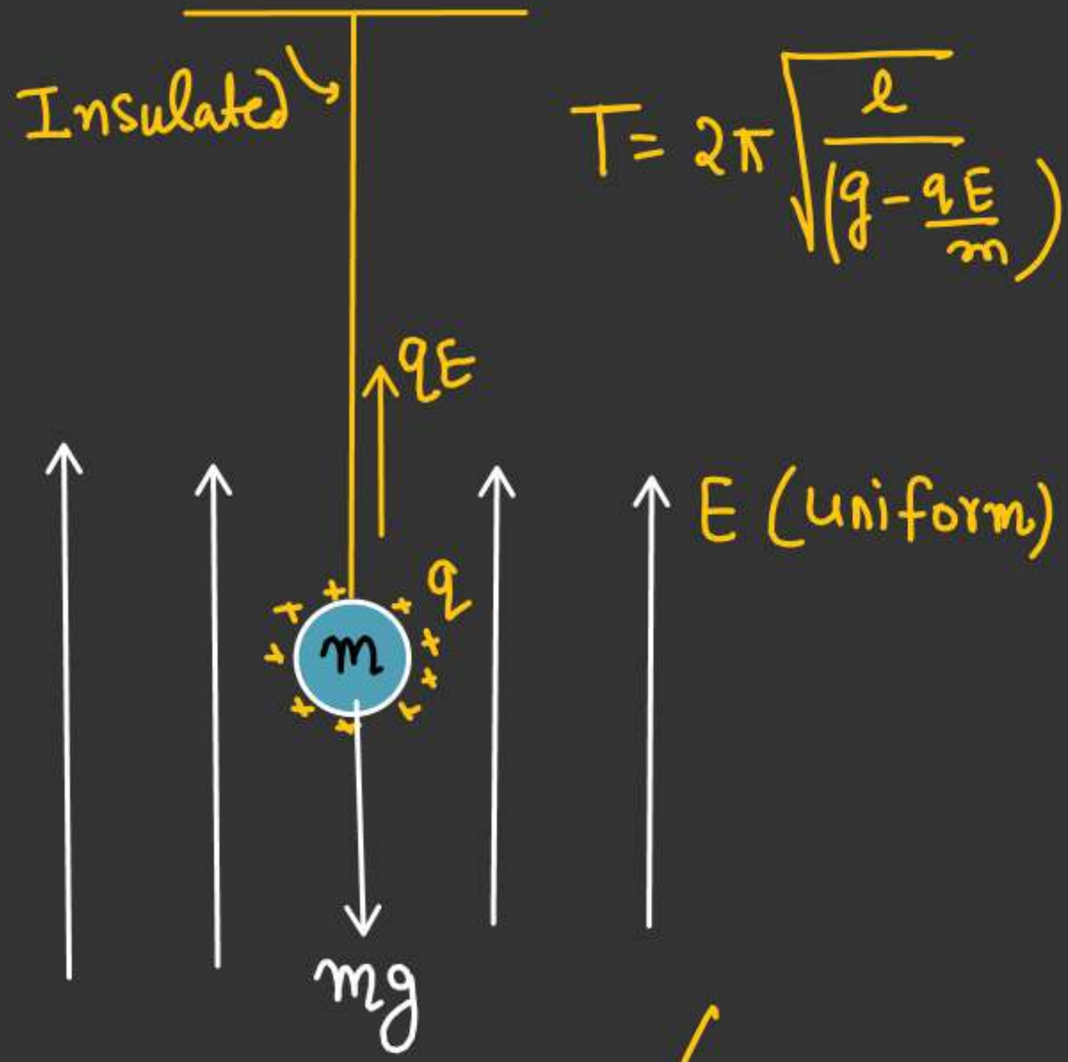
$$\alpha = -\frac{g}{l}\theta$$

$$\alpha = -\omega^2\theta$$

$$\omega^2 = g/l \qquad \boxed{T = 2\pi\sqrt{\frac{l}{g}}}$$

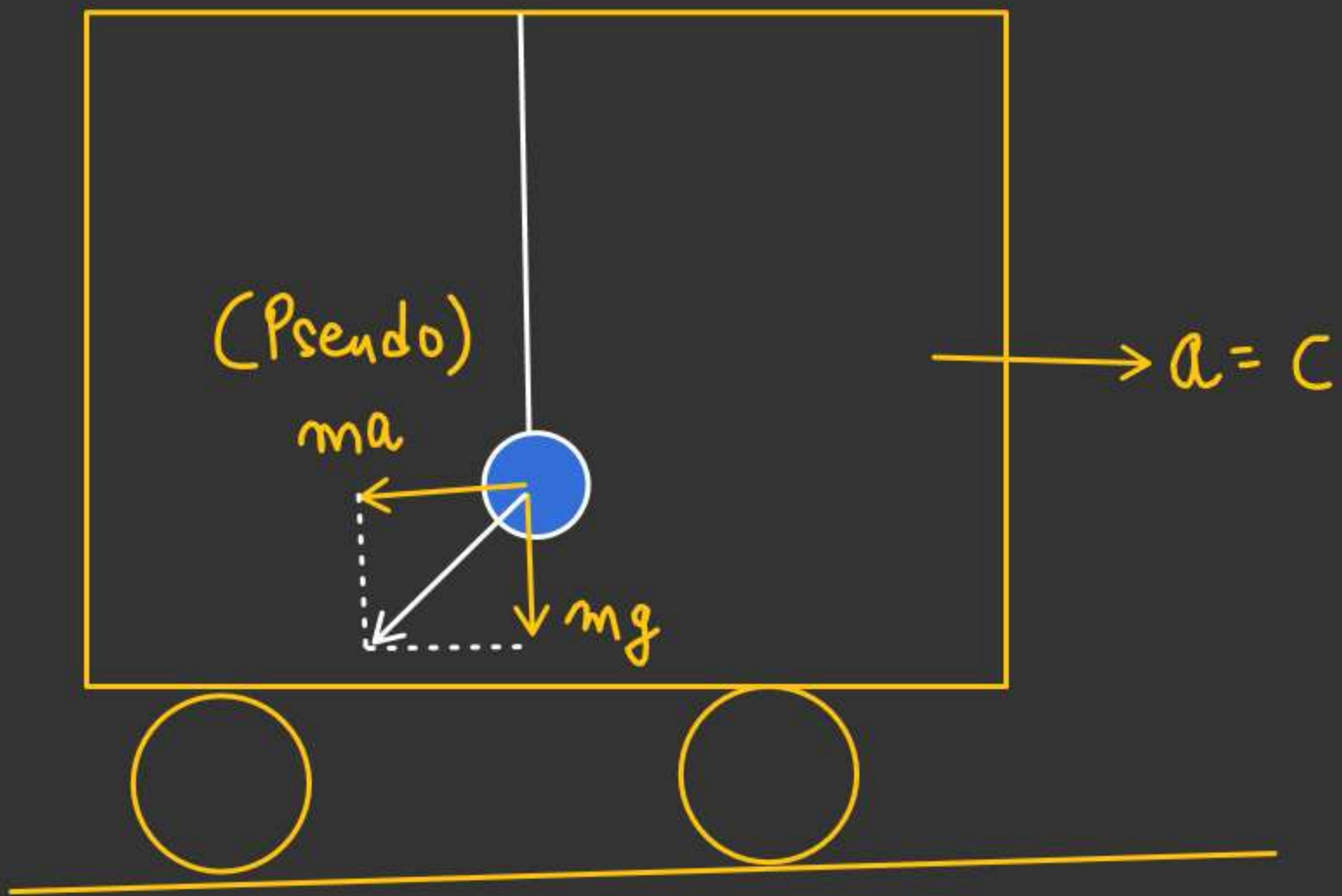


#




$$T = 2\pi\sqrt{\frac{l}{\left(g - \frac{qE}{m}\right)}}$$

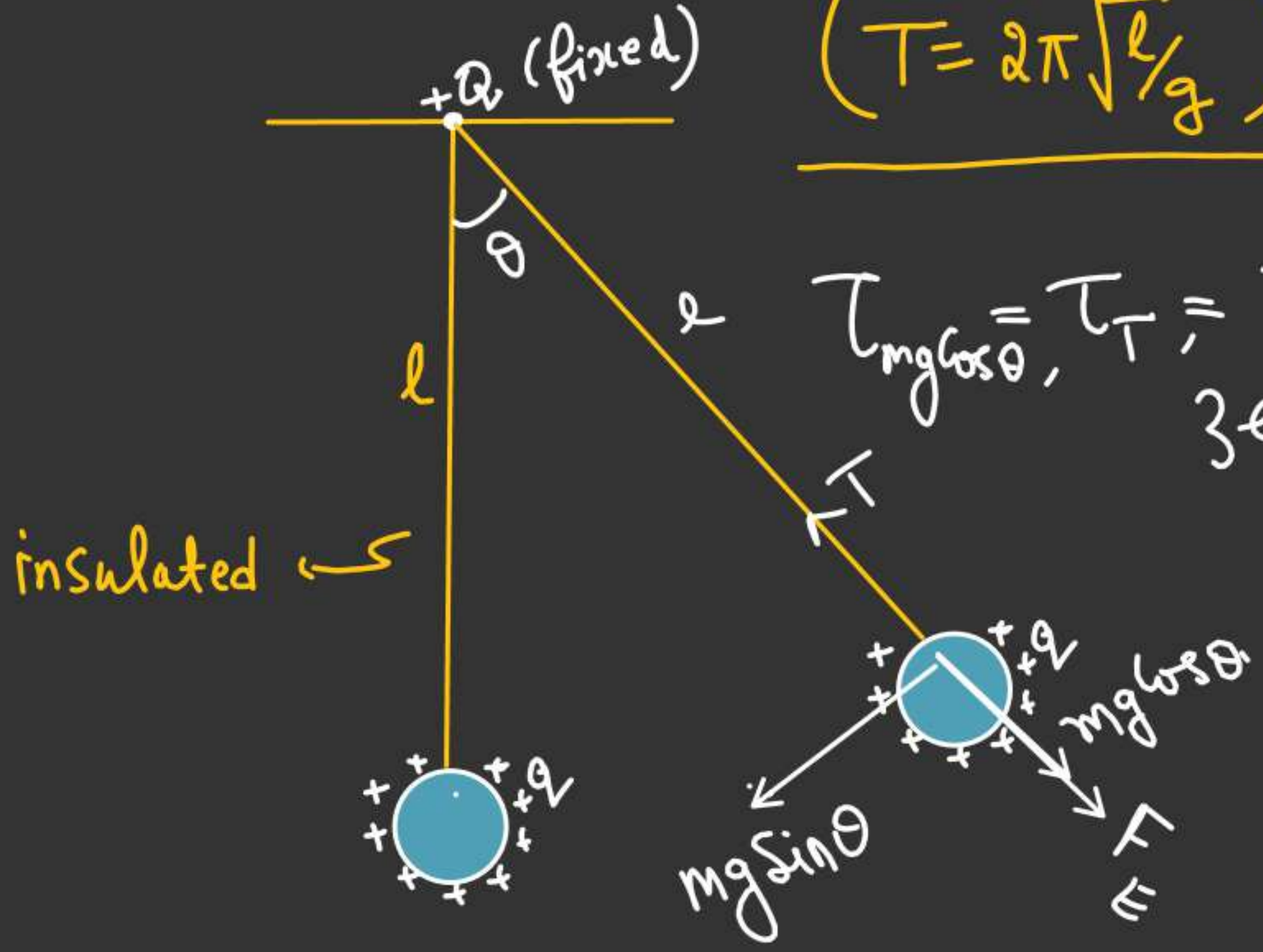
$$g_{eff} = \left(g - \frac{qE}{m}\right)$$




$$g_{eff} = \sqrt{g^2 + a^2}$$

$$T = 2\pi\sqrt{\frac{l}{\sqrt{g^2 + a^2}}}$$

Nishant Jindal




$$\left(T = 2\pi\sqrt{l/g}\right)$$

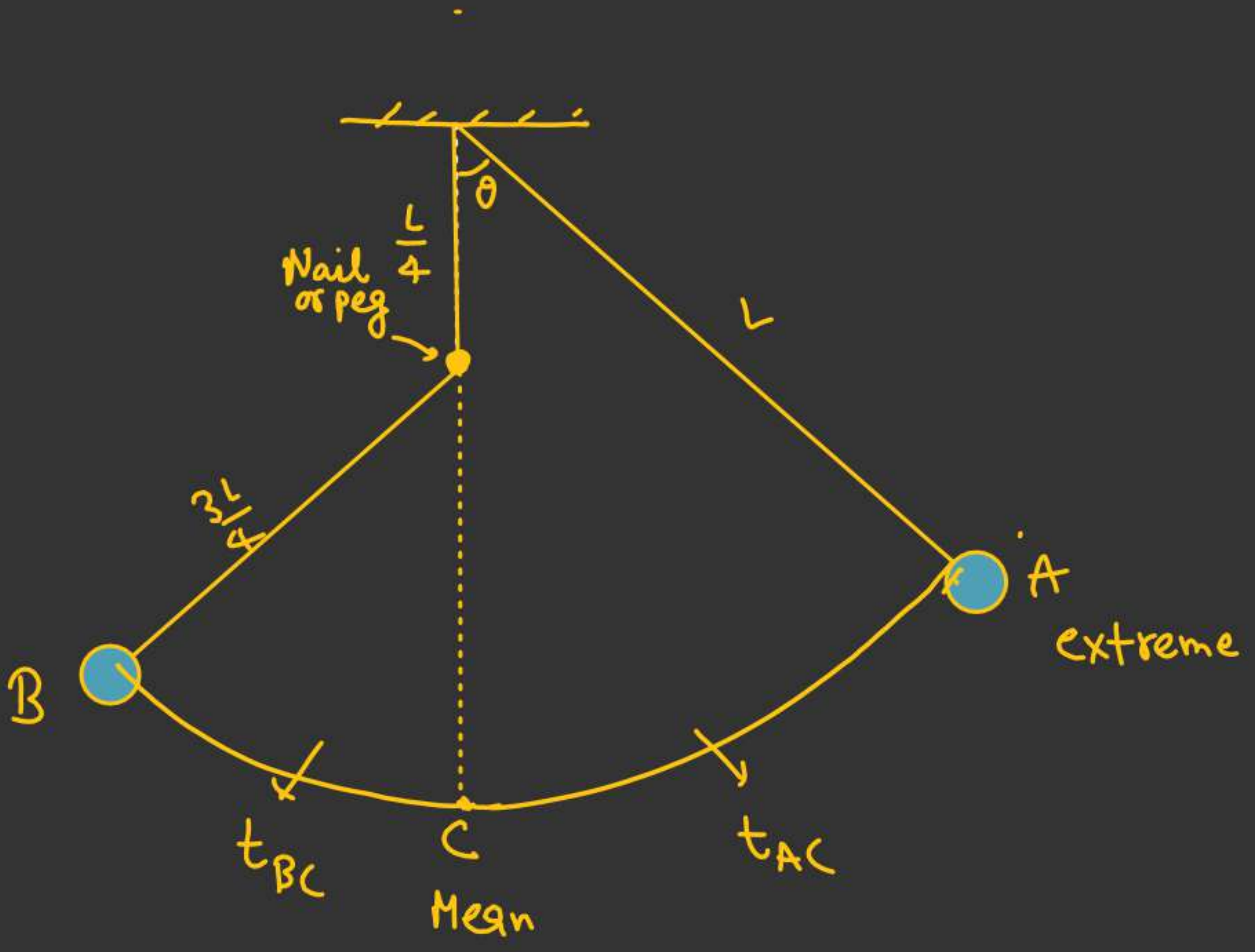
$\tau_{mg\cos\theta}$, $\tau_T$, $\tau_{F_E}$ at suspension is zero.

$$\tau_r = -(mg\sin\theta\, L)$$

$$\tau_r = -\, mgL\,\theta$$

Nishant Jindal

Pendulum is released from it's extreme position. Find the time period of the string-bob system.




$$T = 2(t_{AC} + t_{BC})$$

$$t_{AC} = \frac{T_{AC}}{4} = \frac{1}{4}\, 2\pi\sqrt{\frac{L}{g}}$$

$$= \frac{\pi}{2}\sqrt{\frac{L}{g}}$$

$$t_{BC} = \frac{T_{BC}}{4} = \frac{1}{4} \times 2\pi\sqrt{\frac{3L}{4g}}$$

$$= \frac{\pi}{2}\sqrt{\frac{3L}{4g}}$$

$$T = 2\left(\frac{\pi}{2}\sqrt{\frac{L}{g}} + \frac{\pi}{2}\sqrt{\frac{3L}{4g}}\right) = \pi\sqrt{\frac{L}{g}}\left(1 + \frac{\sqrt{3}}{2}\right)$$

Nishant Jindal

$\beta \rightarrow$ Inclination of wall from vertical.

Find time period of the pendulum

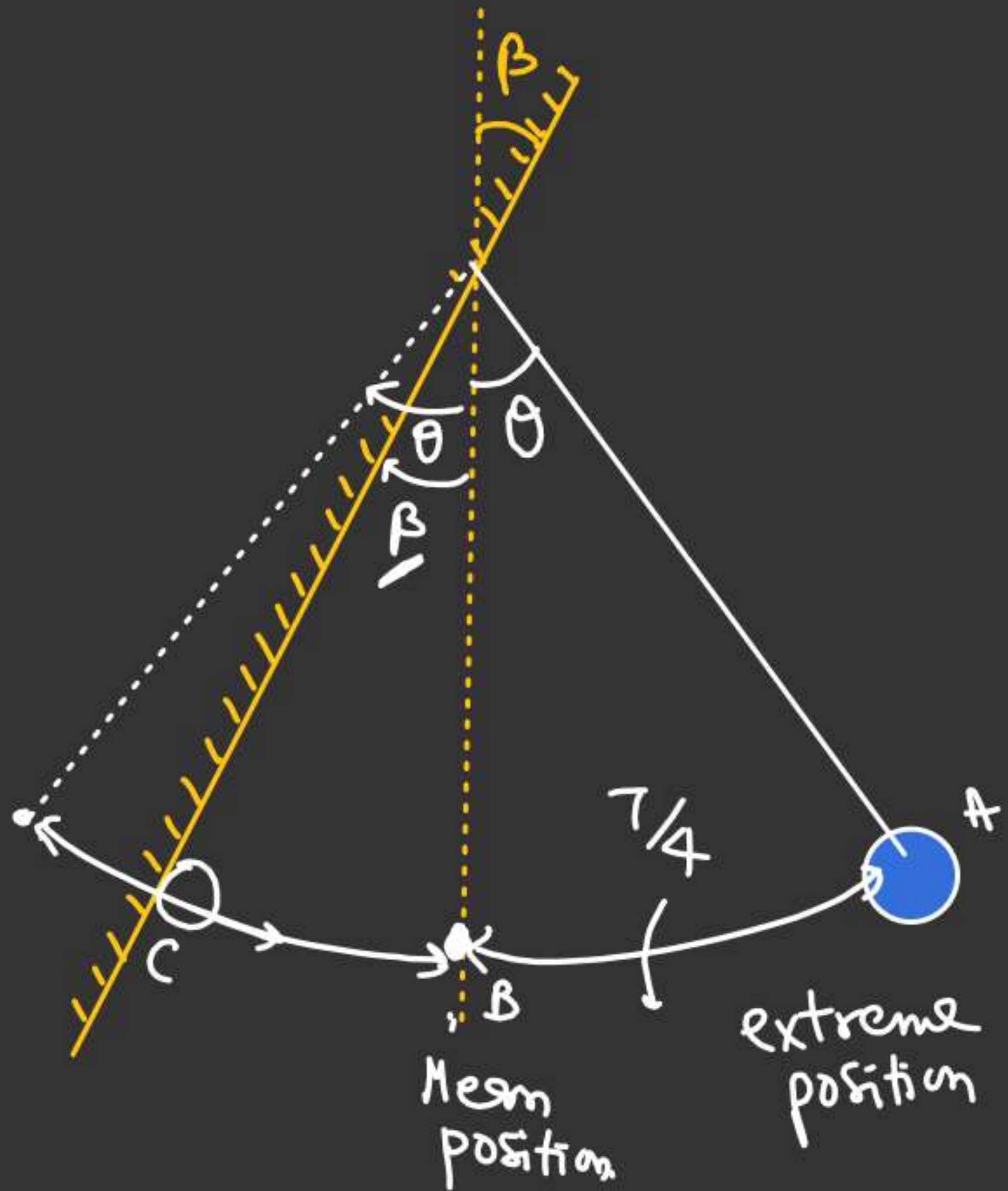
if 1) $\theta < \beta \longrightarrow T = 2\pi\sqrt{l/g}$

2) $\theta > \beta$.

Collision of bob with wall is perfectly elastic

$\omega^2 = \frac{g}{l}$

$\omega = \sqrt{g/l}$




(2) $\underline{\theta > \beta}$

$t_{AB} = \frac{T}{4} \checkmark = \frac{1}{4} \times 2\pi\sqrt{l/g}$

$= \frac{\pi}{2}\sqrt{l/g}$

$\beta = \theta \sin \omega t_{BC}$

$t_{BC} = \frac{1}{\omega} \sin^{-1}\left(\frac{\beta}{\theta}\right)$

$T = 2(t_{BC} + t_{AB})$

$= 2\left[\sqrt{\frac{l}{g}} \sin^{-1}\left(\frac{\beta}{\theta}\right) + \frac{\pi}{2}\sqrt{\frac{l}{g}}\right] = 2\sqrt{\frac{l}{g}}\left[\frac{\pi}{2} + \sin^{-1}\left(\frac{\beta}{\theta}\right)\right]$