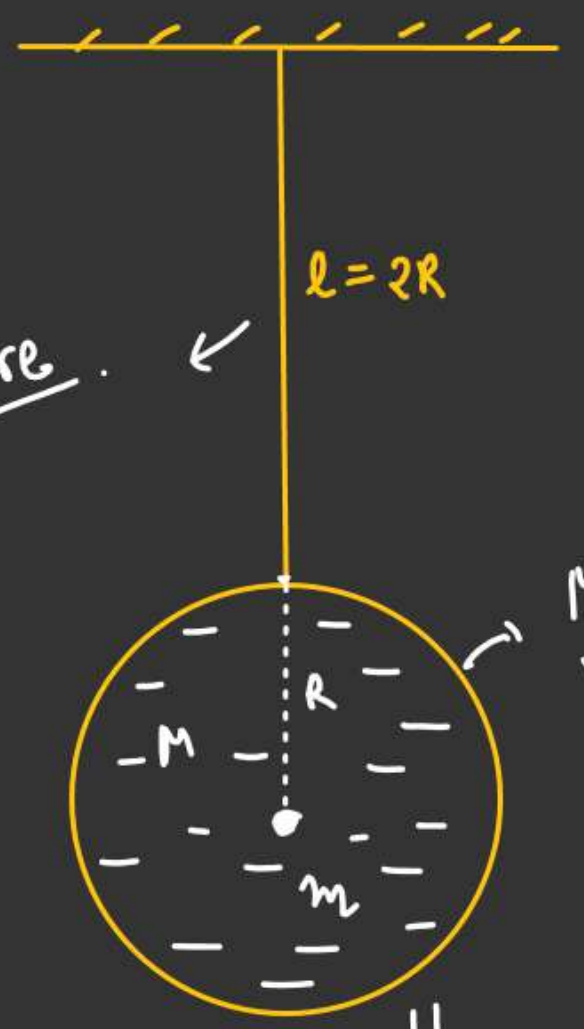
Nishant Jindal

Massless wire.



Mass of vessel negligible.

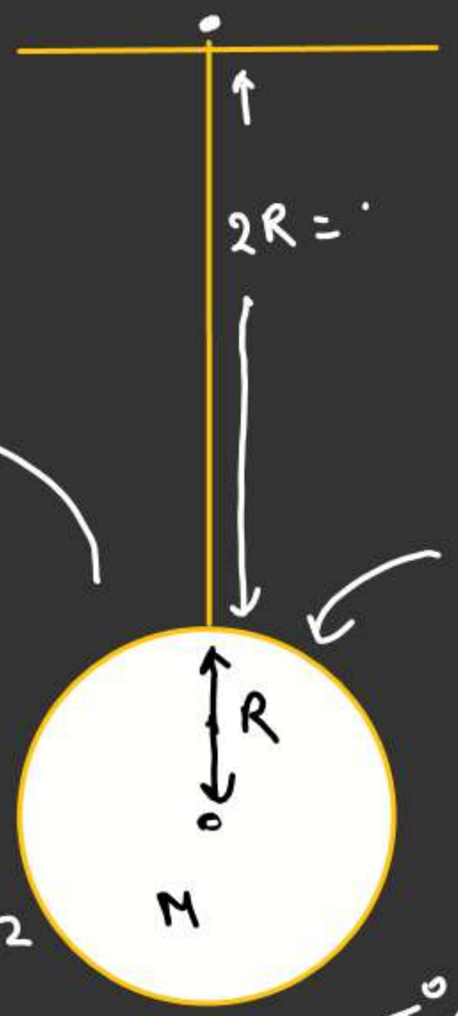
$\Downarrow$

Assume to be Simple pendulum

$l_{eff} = 3R.$

$$T = 2\pi\sqrt{\frac{3R}{g}}.$$

Physical pendulum



water freezes to ice.

$-T^\circ C$

$$T = 2\pi\sqrt{\frac{I}{Mgd}}$$

$$d = 3R$$

$$I = \frac{2}{5}MR^2 + M(3R)^2$$

About point of suspension

$$I = \frac{2}{5}MR^2 + 9MR^2$$

$$I = \left(\frac{47MR^2}{5}\right)$$

$$T = 2\pi\sqrt{\frac{47MR^2}{15MgR}} = 2\pi\sqrt{\frac{47R}{15g}}.$$

Nishant Jindal

Trolley can move horizontally on the parallel track

Find time period of string-bob system if.

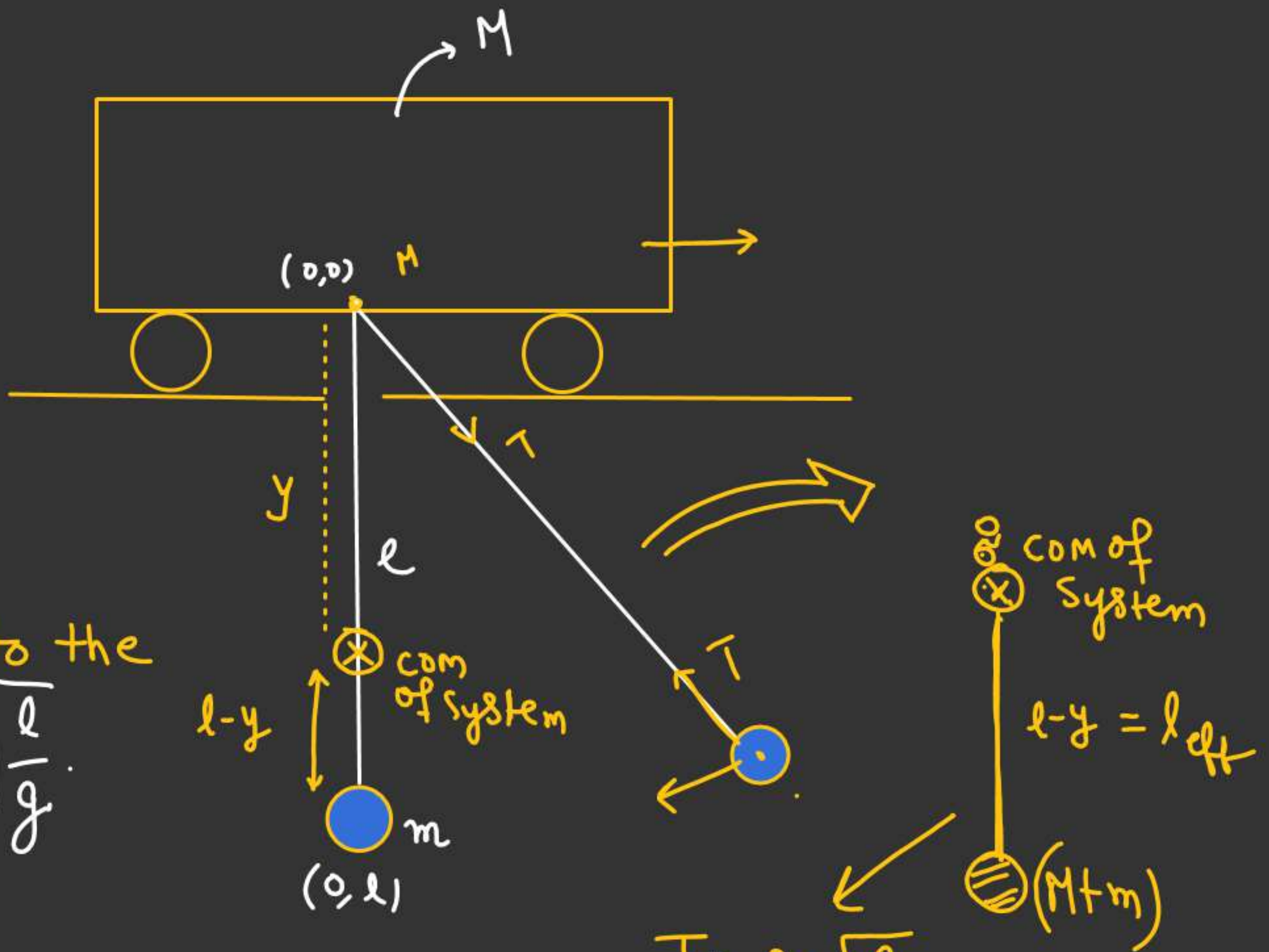
1) Bob oscillate along the plane of trolley. ✓

2) Bob oscillate perpendicular to the plane of trolley. $\longrightarrow T = 2\pi\sqrt{\frac{l}{g}}$.

COM of system $(\Delta X) = 0$

$$y = \left(\frac{ml}{M+m}\right)$$

$$\underbrace{l-y}_{l_{eff}} = l - \frac{ml}{M+m} = \left(\frac{Ml}{M+m}\right)$$



$$T = 2\pi\sqrt{\frac{l_{eff}}{g}}$$

$$T = 2\pi\sqrt{\frac{Ml}{(M+m)g}}$$

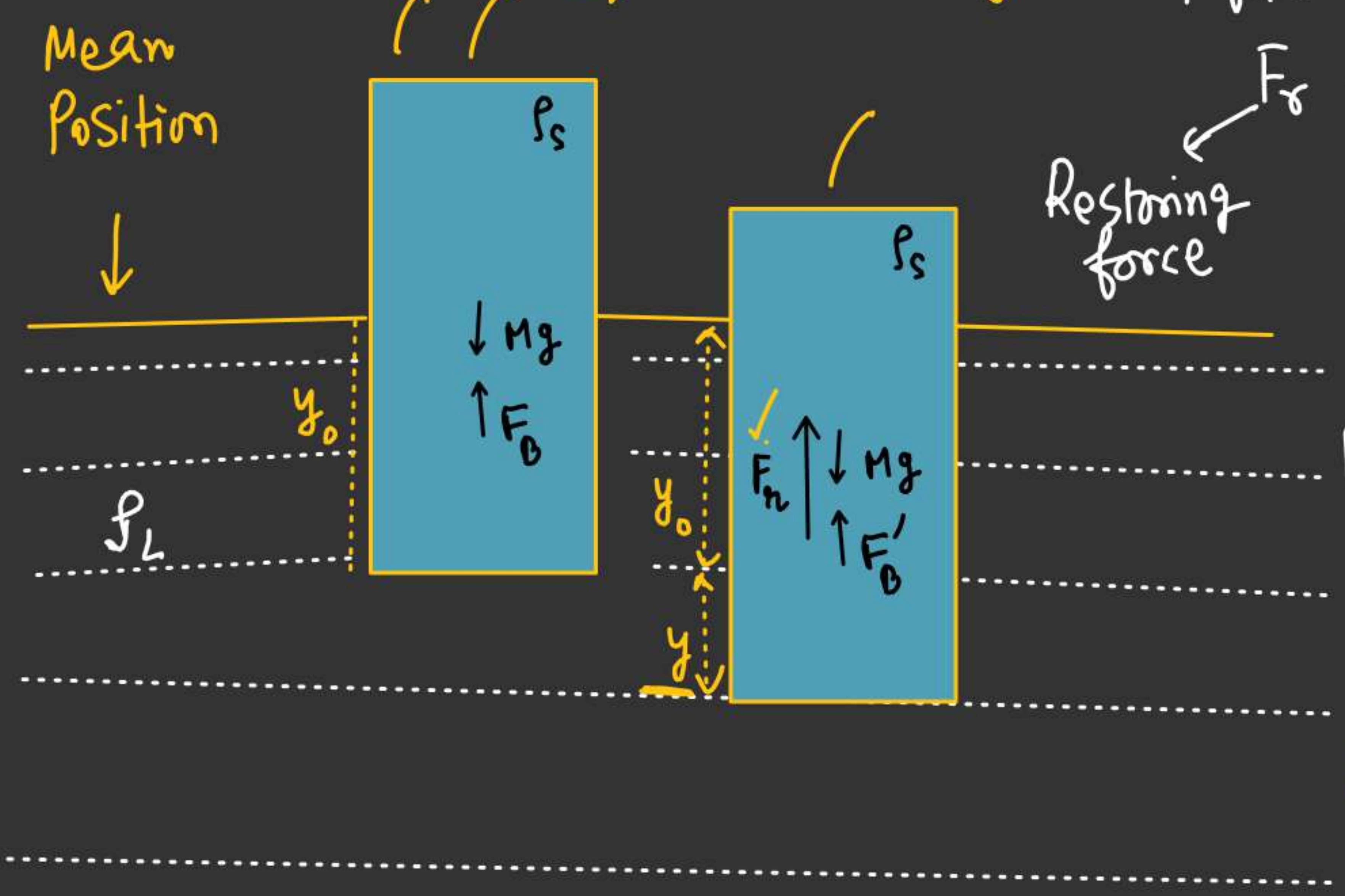
Nishant Jindal

S.H.M in Fluid.

Cylinder, M, h.

Equilibrium.

A = Crossectional Area of Cylinder.



At Equilibrium.

$$F_B = Mg \Rightarrow \rho_L A y_o g = (Ah)\rho_s g \quad (1)$$

After cylinder pushed extra y distance

Restoring force

$$F_r = -(F_B' - Mg)$$

$$F_r = -\left[\underbrace{A(y+y_o)}\rho_L g - Ah\rho_s g\right]$$

$$F_r = -\left[(A\rho_L g)y + \left(\cancel{Ay_o\rho_L g} - \cancel{Ah\rho_s g}\right)\right] \quad (2)$$

$$\underbrace{F_r} = -(\rho_L A g)y.$$

Extra buoyant force responsible for restoring.

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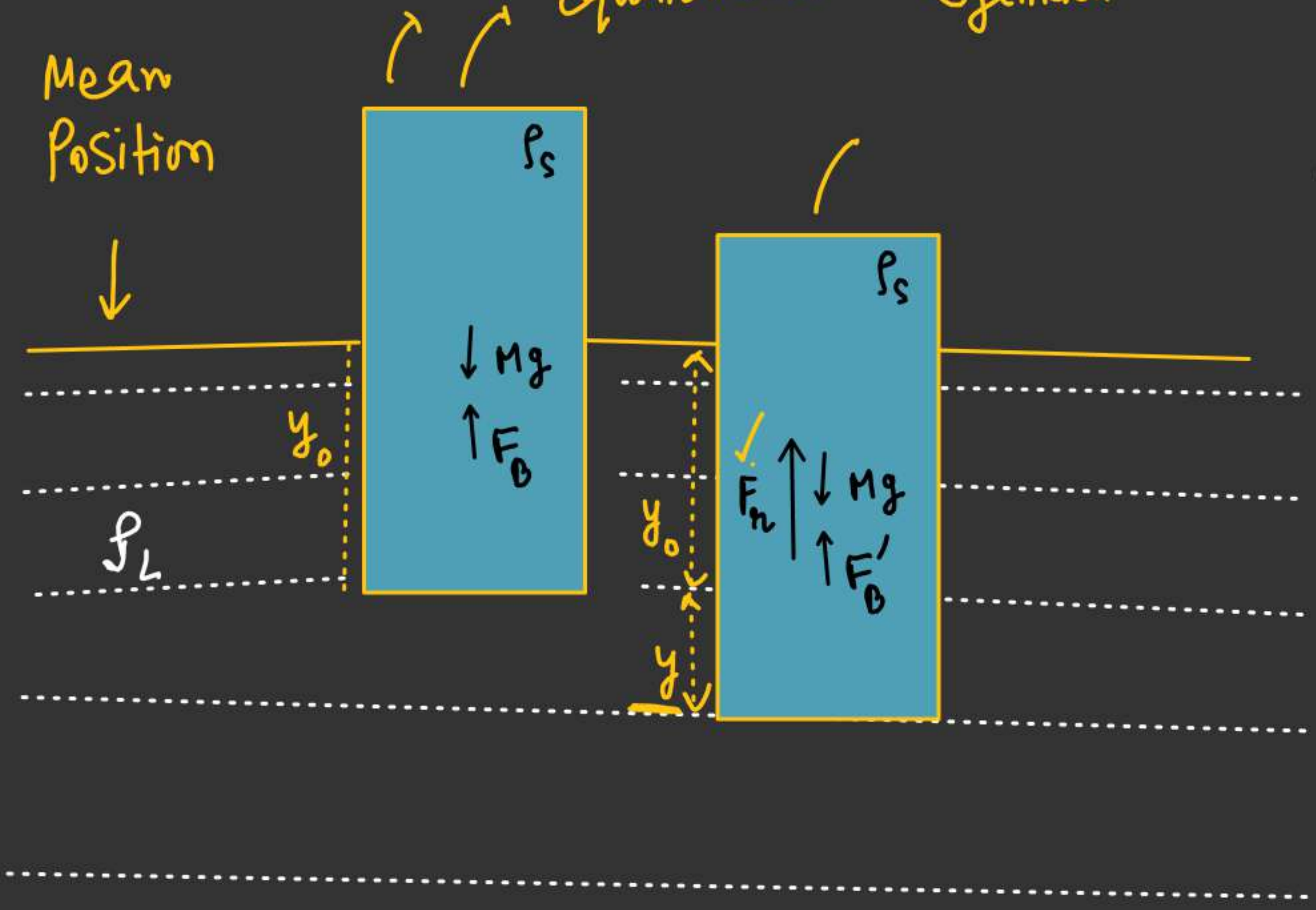
S.H.M in Fluid.

Cylinder, M, h.
Equilibrium.

A = Crossectional Area of Cylinder.



$$F_r = -(\rho_L A g)y.$$

$$a = -\frac{\rho_L A g y}{M}$$

$$a = -\frac{\rho_L \cancel{A} g y}{\rho_s \cancel{A} h}$$

$$a = -\frac{\rho_L g}{\rho_s h} y \rightarrow (4)$$

From (3) & (4)

$$a = -\left(\frac{g}{y_0}\right)y$$

$$a = -\omega^2 y$$

$$\omega = \sqrt{g/y_0}$$

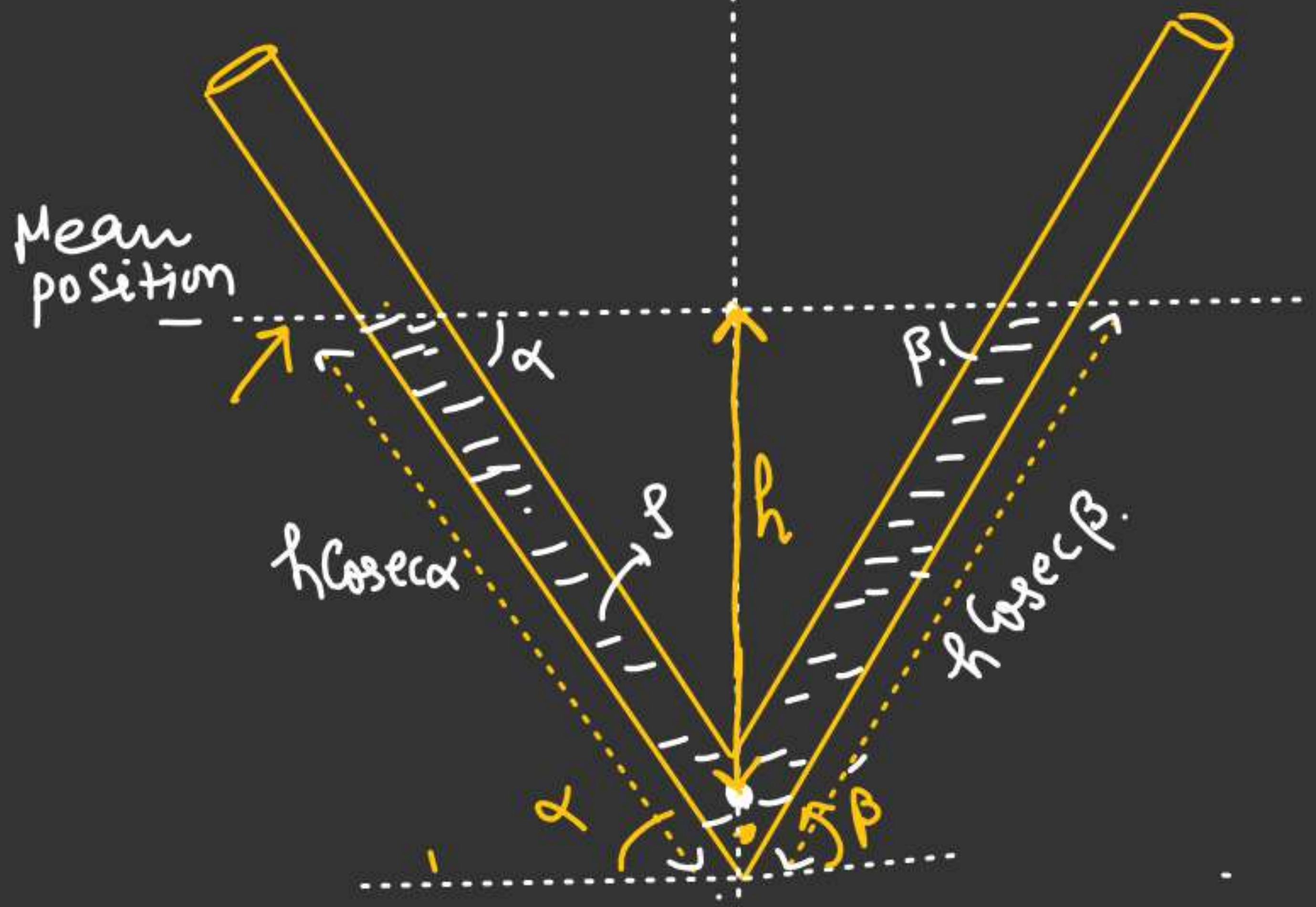
At Equilibrium

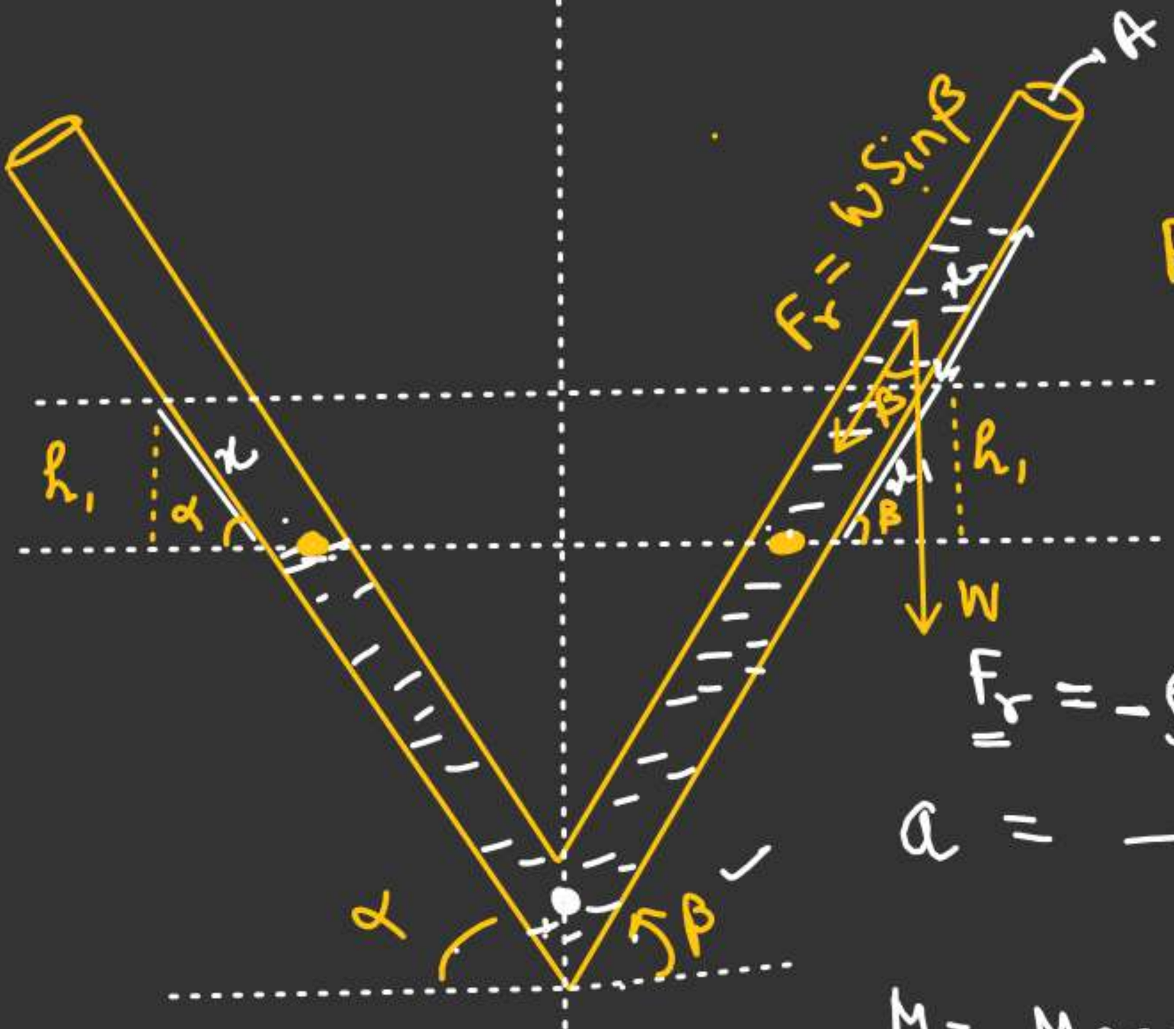
$$(y_0 A)\rho_L g = A h \rho_s g$$

$$\frac{\rho_L}{\rho_s h} = \frac{1}{y_0} \quad - (3)$$

$$\boxed{T = 2\pi\sqrt{\frac{y_0}{g}}}$$

Only depends on length of submerged part at Equilibrium





α & β inclination of both arm of tube from horizontal

$$M = \rho A(h\,\text{Cosec}\,\alpha + \text{Cosec}\,\beta)$$

$$M = \rho A h(\text{Cosec}\,\alpha + \text{Cosec}\,\beta)$$

F_r = Component of weight of $(x+x_1)$ length of the liquid along the tube.

$$F_r = -\rho A(x+x_1)g\sin\beta$$

$$a = -\frac{\rho A(x+x_1)g\sin\beta}{M} \quad (1)$$

M = Mass of liquid.

$$h_1 = x\sin\alpha = x_1\sin\beta$$

$$x_1 = \left(\frac{x\sin\alpha}{\sin\beta}\right) \rightarrow \text{put in (1)}$$

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$$F_r = -\rho A(x+x_1)\, g \sin\beta$$

$$a = -\frac{\rho A(x+x_1)\, g \sin\beta}{M} \quad \text{—(1)}$$

$M =$ Mass of liquid.

$$h_1 = x\sin\alpha = x_1 \sin\beta$$

$$x_1 = \left(\frac{x\sin\alpha}{\sin\beta}\right) \rightarrow \text{put in (1)}$$

$$M = \rho A(h\,\mathrm{Cosec}\alpha + \mathrm{Cosec}\beta)$$

$$M = \rho A h(\mathrm{Cosec}\alpha + \mathrm{Cosec}\beta)$$

$$a = -\frac{\cancel{\rho A} g\sin\beta \left(x + \frac{x\sin\alpha}{\sin\beta}\right)}{\cancel{\rho A} h(\mathrm{Cosec}\alpha + \mathrm{Cosec}\beta)}$$

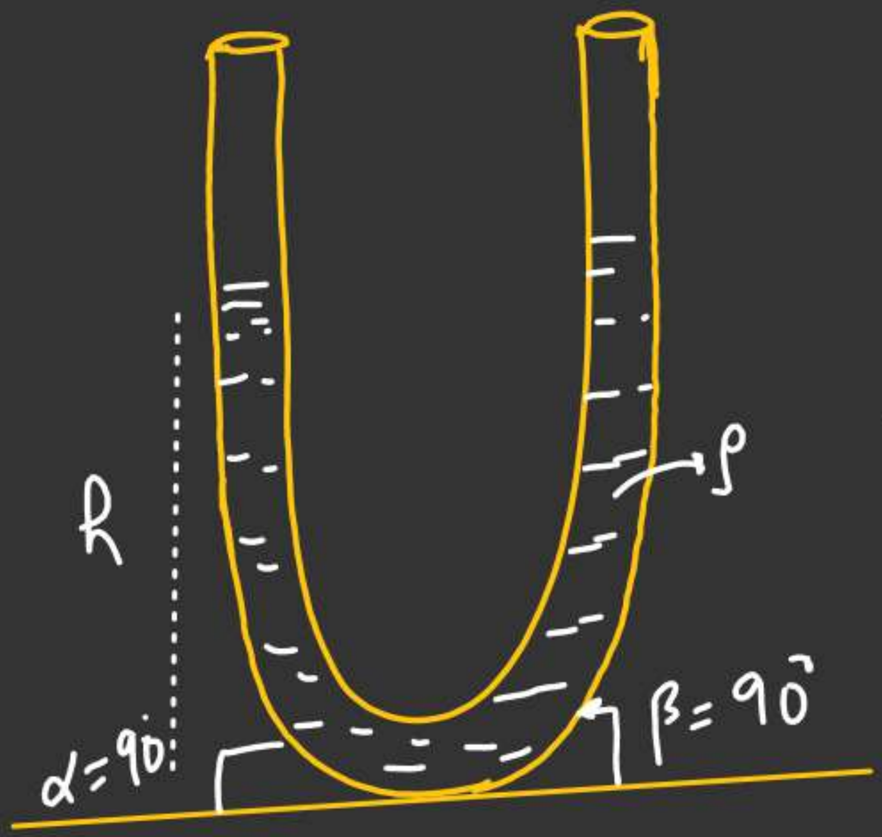
$$a = -\frac{g\sin\beta}{h}\,\frac{\left(\frac{\sin\alpha + \sin\beta}{\sin\beta}\right)}{\frac{1}{\sin\alpha} + \frac{1}{\sin\beta}}\, x$$

$$a = -\left(\frac{g \sin\alpha \cdot \sin\beta}{h}\right) x$$

$$a = -\omega^2 x$$

$$\omega = \sqrt{\frac{g\sin\alpha \cdot \sin\beta}{h}} \Rightarrow \boxed{T = 2\pi\sqrt{\frac{h}{g\sin\alpha \cdot \sin\beta}}}$$

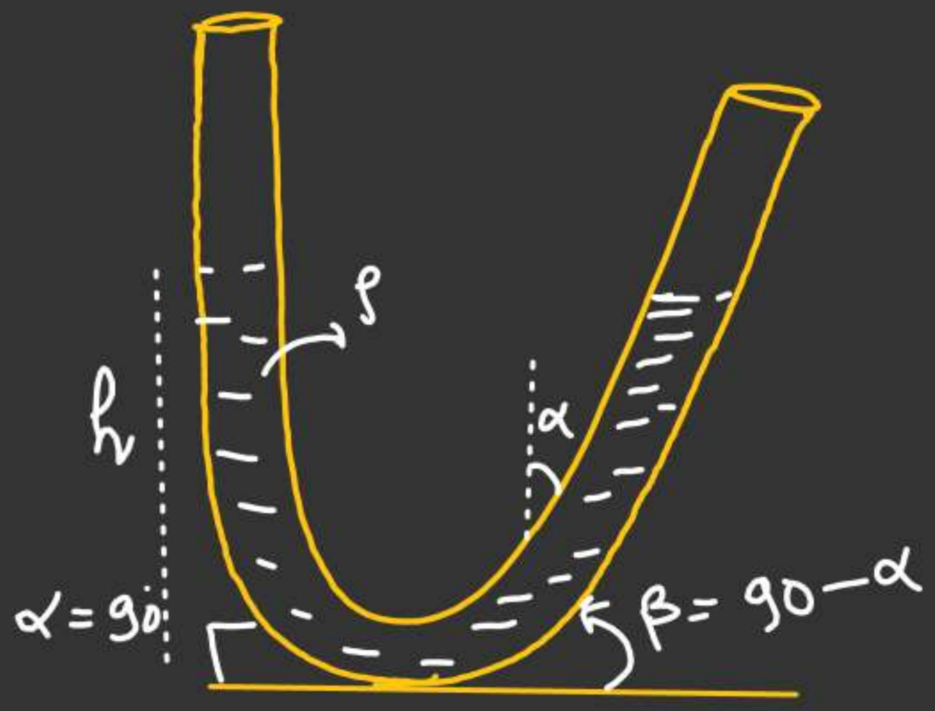
#



$$T = ??$$

$$T = 2\pi\sqrt{\frac{h}{g\sin 90^\circ \cdot \sin 90^\circ}}$$

$$T = 2\pi\sqrt{\frac{h}{g}}$$



$$T = 2\pi\sqrt{\frac{h}{g\sin 90^\circ \sin(90-\alpha)}}$$

$$T = 2\pi\sqrt{\frac{h}{g\cos\alpha}}$$

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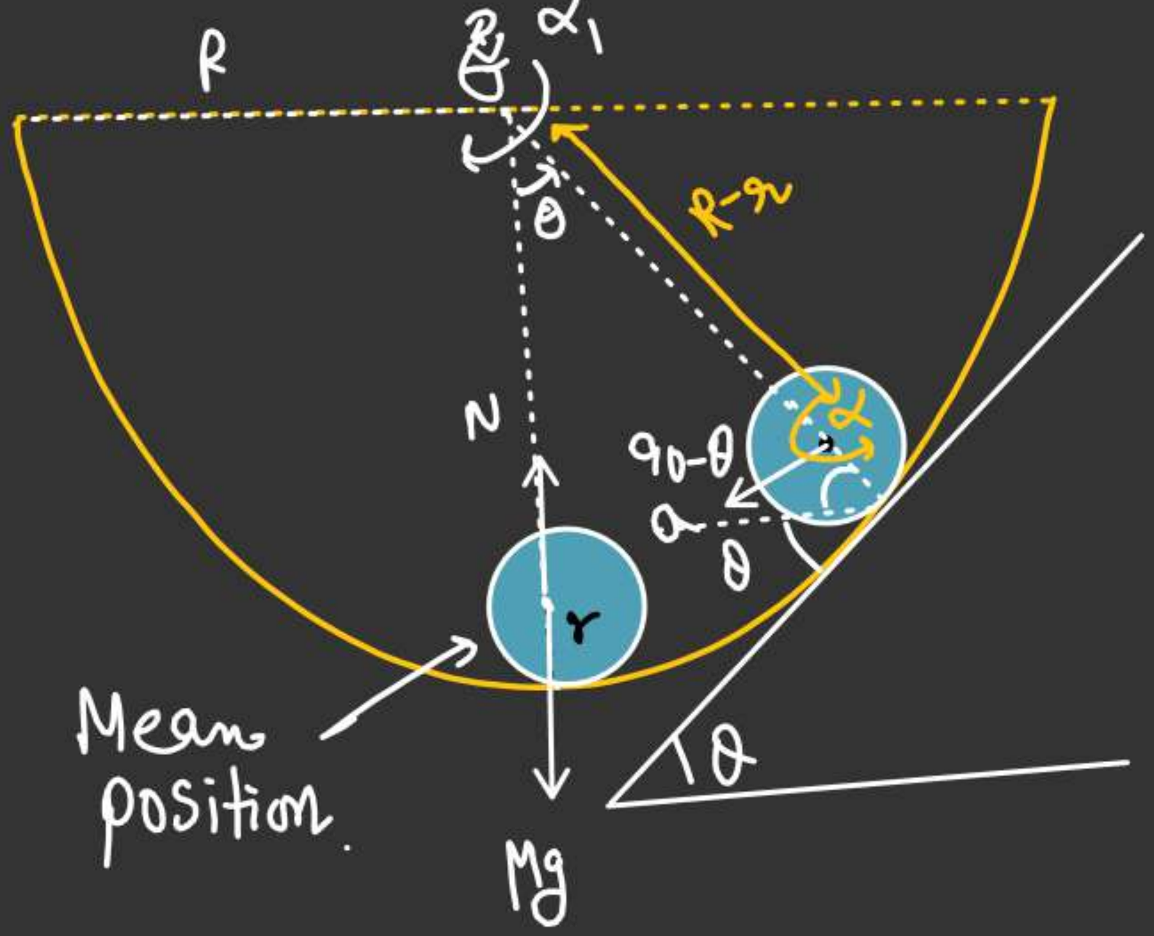
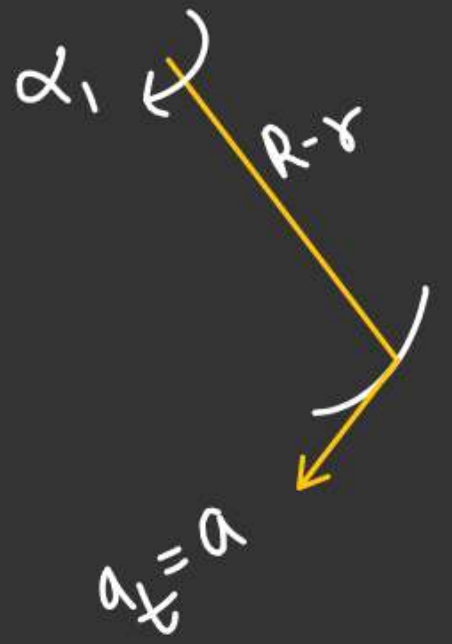
Sphere of radius r have pure rolling Motion.
Prove that Sphere perform S.H.M & find its time period.

$\alpha_1 \propto \theta \rightarrow$ for S.H.M



$$a' = \left(\frac{g\sin\theta}{1+\frac{I}{MR^2}}\right) \qquad I = \frac{2}{5}MR^2$$
$$\Downarrow \qquad \sin\theta \simeq \theta$$

$a = r\alpha \Rightarrow$ pure rolling -①



$a = (R-r)\alpha_1$ -②

$r\alpha = (R-r)\alpha_1$

$\alpha = \left(\frac{R-r}{r}\right)\alpha_1$

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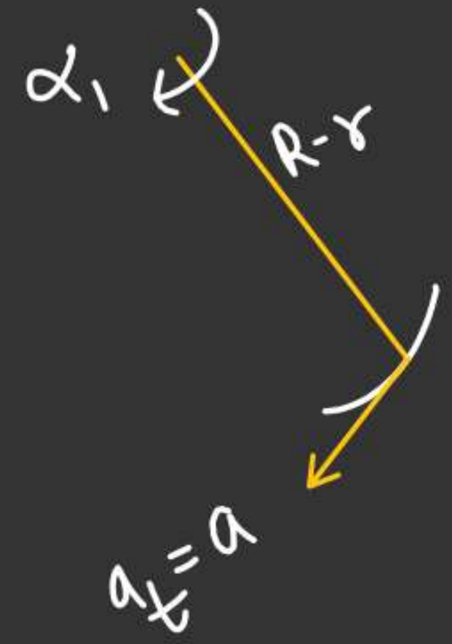
$$a = \left(\frac{g\sin\theta}{1+I/MR^2}\right) \quad (1)$$

$\Downarrow$

$I = \frac{2}{5}MR^2$

$\sin\theta \simeq \theta$

$a = r\alpha \Rightarrow$ pure rolling - (2)



$a = (R-r)\alpha_1$ - (3)

$$\left.\begin{aligned} r\alpha &= (R-r)\alpha_1 \\ \alpha &= \left(\frac{R-r}{r}\right)\alpha_1 \end{aligned}\right] \text{ from (2) \& (3)}$$

From (1)

$$r\alpha = \frac{g}{\left(1+\frac{\frac{2}{5}MR^2}{MR^2}\right)}\theta$$

$$\cancel{r}\frac{(R-r)}{\cancel{r}}\alpha_1 = \left(\frac{5g}{7}\right)\theta$$

$$\alpha_1 = \frac{5g}{7(R-r)}\theta$$

$$\alpha_1 = \omega^2\theta$$

$$\omega = \sqrt{\frac{5g}{7(R-r)}} \Rightarrow \boxed{T = 2\pi\sqrt{\frac{7(R-r)}{5g}}}$$

Angular frequency

Nishant Jindal

M-2

H.W

Try by Energy Method