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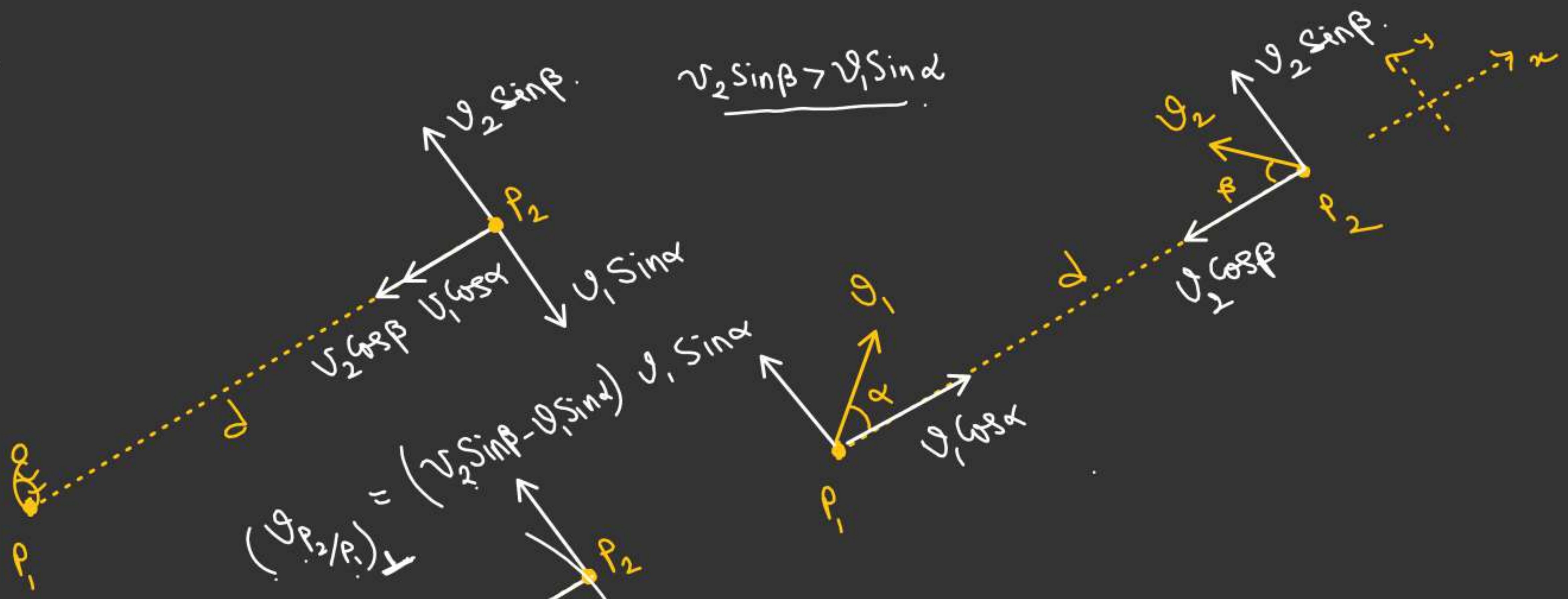
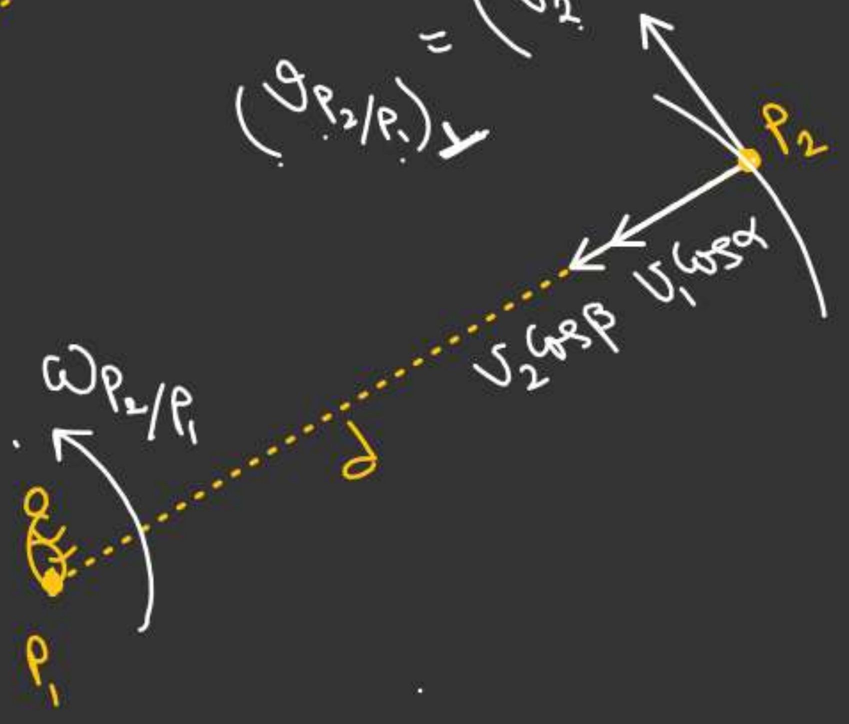
Relative angular velocity

Relative angular velocity b/w two points moving in a plane

$v_2 \sin\beta > v_1 \sin\alpha$



$(v_{P_2/P_1})_\perp = (v_2 \sin\beta - v_1 \sin\alpha)$



$$\boxed{\omega_{P_2/P_1} = \frac{(v_{P_2/P_1})_\perp \text{ to line joining}}{d}}$$

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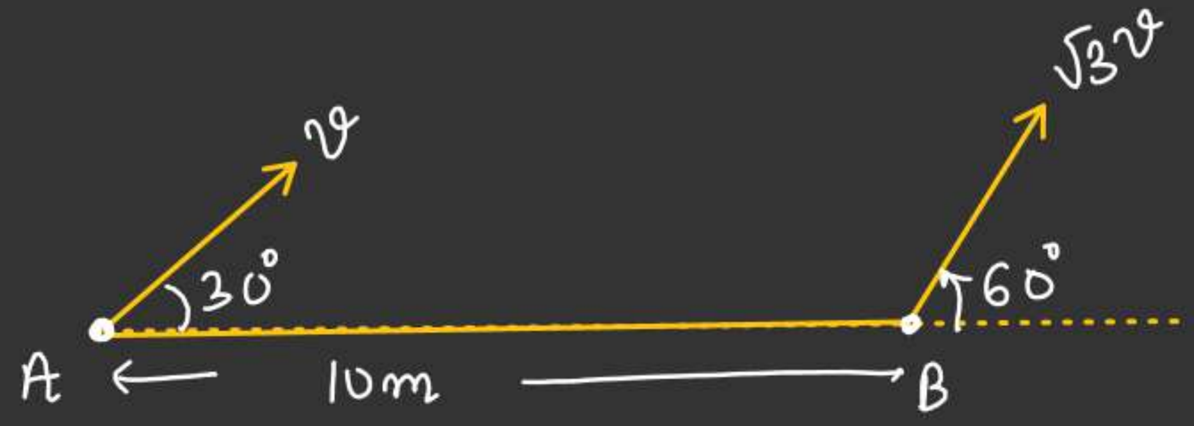
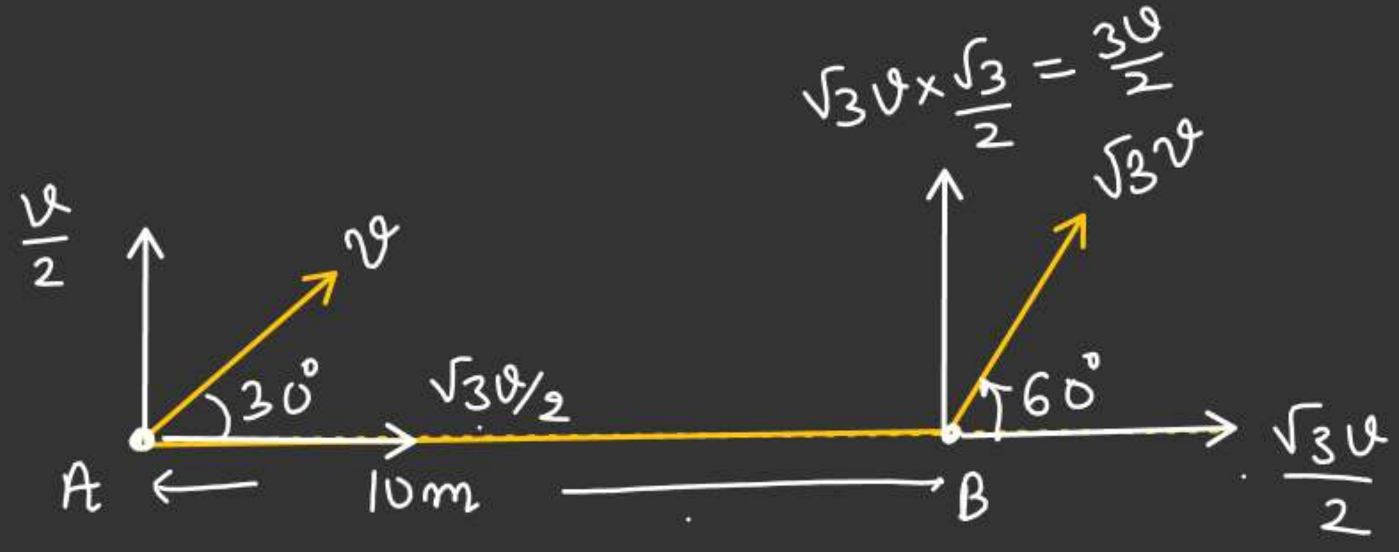
$\omega_{B/A} = ??$

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

$= \left(\frac{\sqrt{3}v}{2}\hat{i} + \frac{3v}{2}\hat{j}\right) - \left(\frac{\sqrt{3}v}{2}\hat{i} + \frac{v}{2}\right)\hat{j}$

$= v\hat{j}$





$\omega_{B/A} = \frac{v}{10}$ Ans.

$\left(\begin{matrix} v = R\omega \\ \omega = v/R \end{matrix}\right)$

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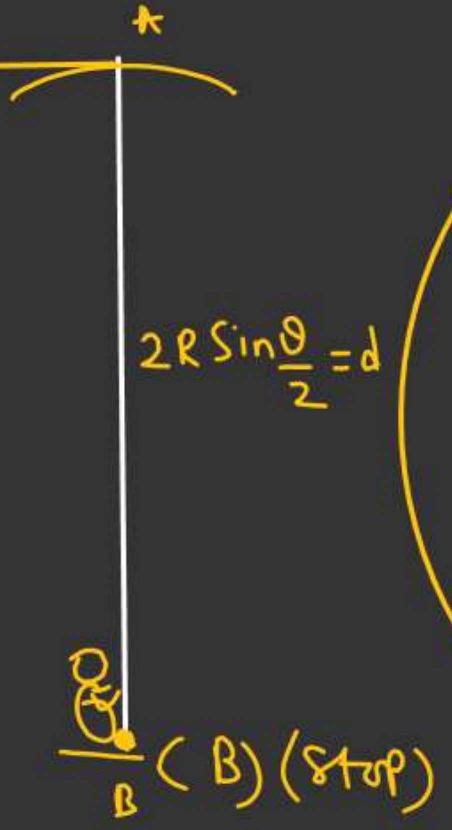
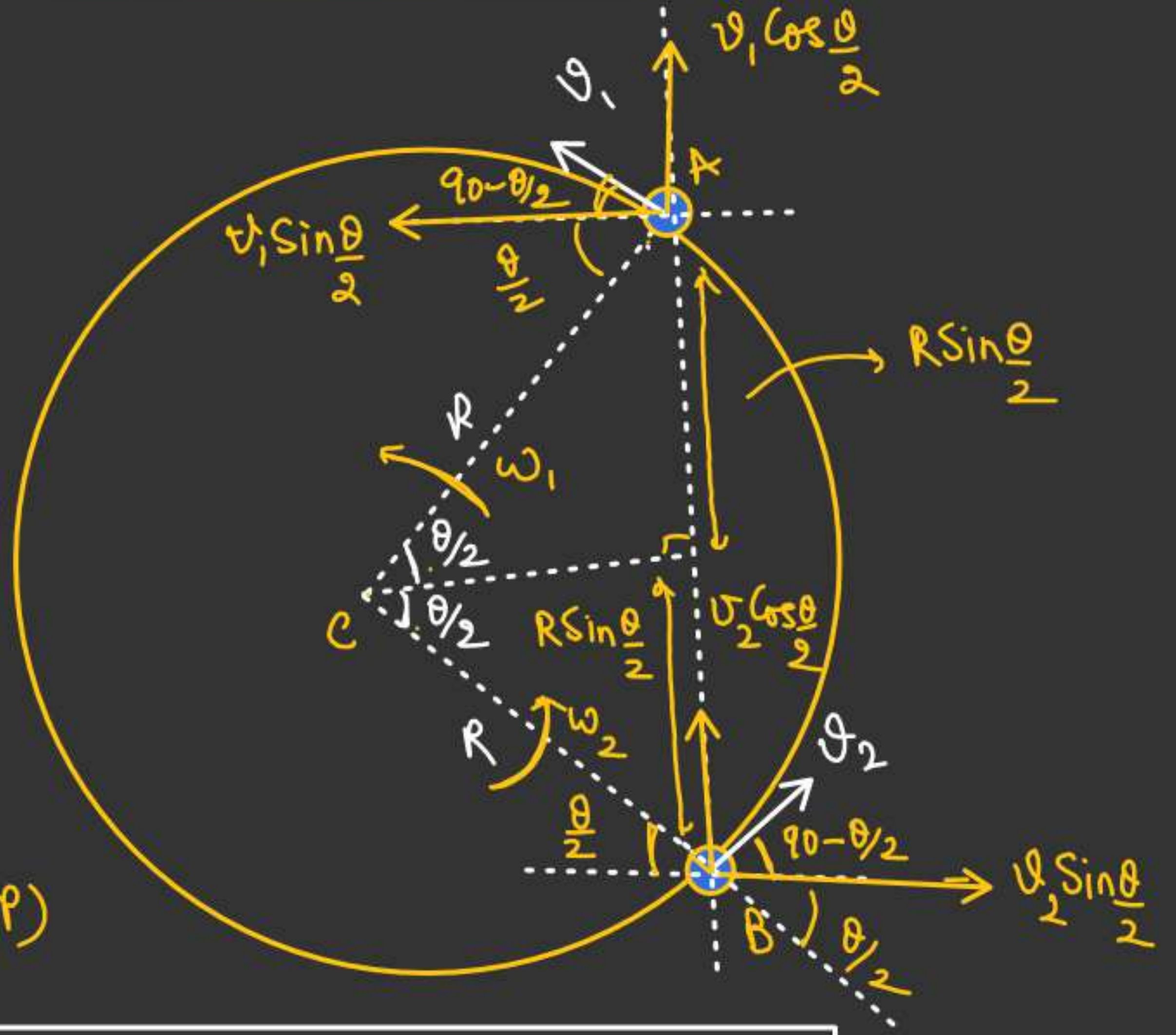
Relative Angular velocity b/w two points Moving in a Circle of radius R with velocity v_1 & v_2

v_1 & v_2 Constant

$$\omega_{A/B} = \frac{(v_{A/B})_\perp}{d_{AB}}$$

$$(v_1+v_2)\sin\frac{\theta}{2}$$
$$\Downarrow$$
$$(v_{A/B})_\perp$$





$$\omega_{A/B} = \frac{(v_1+v_2)\sin(\theta/2)}{2R\sin(\theta/2)}$$

$$\omega_{A/B} = \left(\frac{v_1+v_2}{2R}\right)$$

$$\omega_{A/B} = \frac{(v_1/R)+(v_2/R)}{2} = \frac{\omega_1+\omega_2}{2}$$

$$\boxed{\omega_{A/B} = \frac{\omega_1+\omega_2}{2} \Rightarrow \text{Rotating in Same sense}}$$

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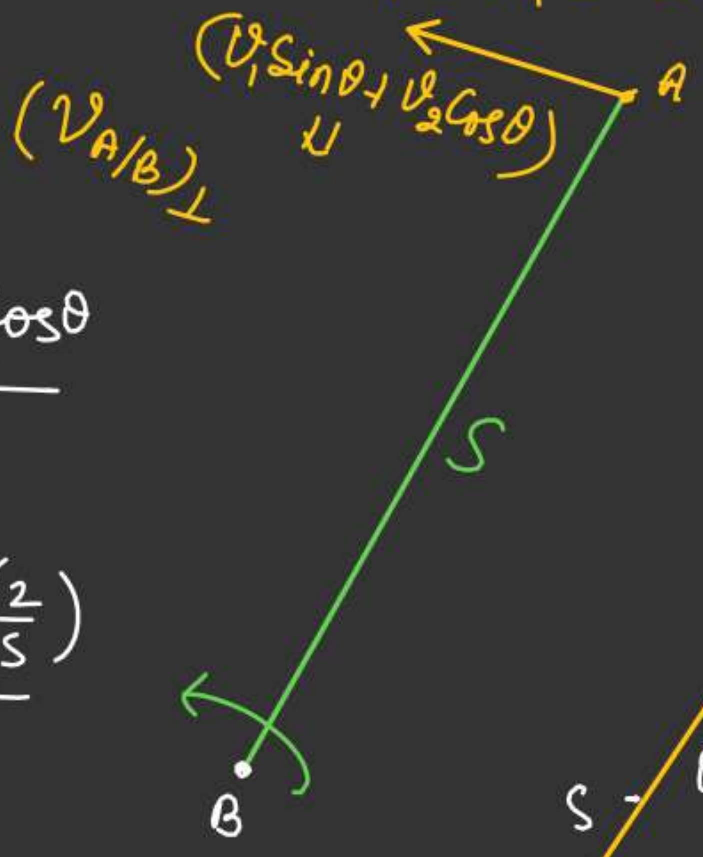
Q: Relative Angular velocity b/w two points moving in a Concentric circle when their radius vector are perpendicular to each other.

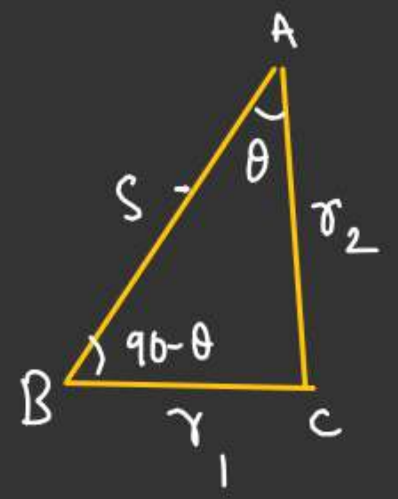


$$\omega_{A/B} = \frac{v_1\sin\theta + v_2\cos\theta}{S}$$

$$\omega_{A/B} = \frac{v_1\left(\frac{r_1}{S}\right) + v_2\left(\frac{r_2}{S}\right)}{S}$$

$$= \frac{v_1 r_1 + v_2 r_2}{S^2}$$

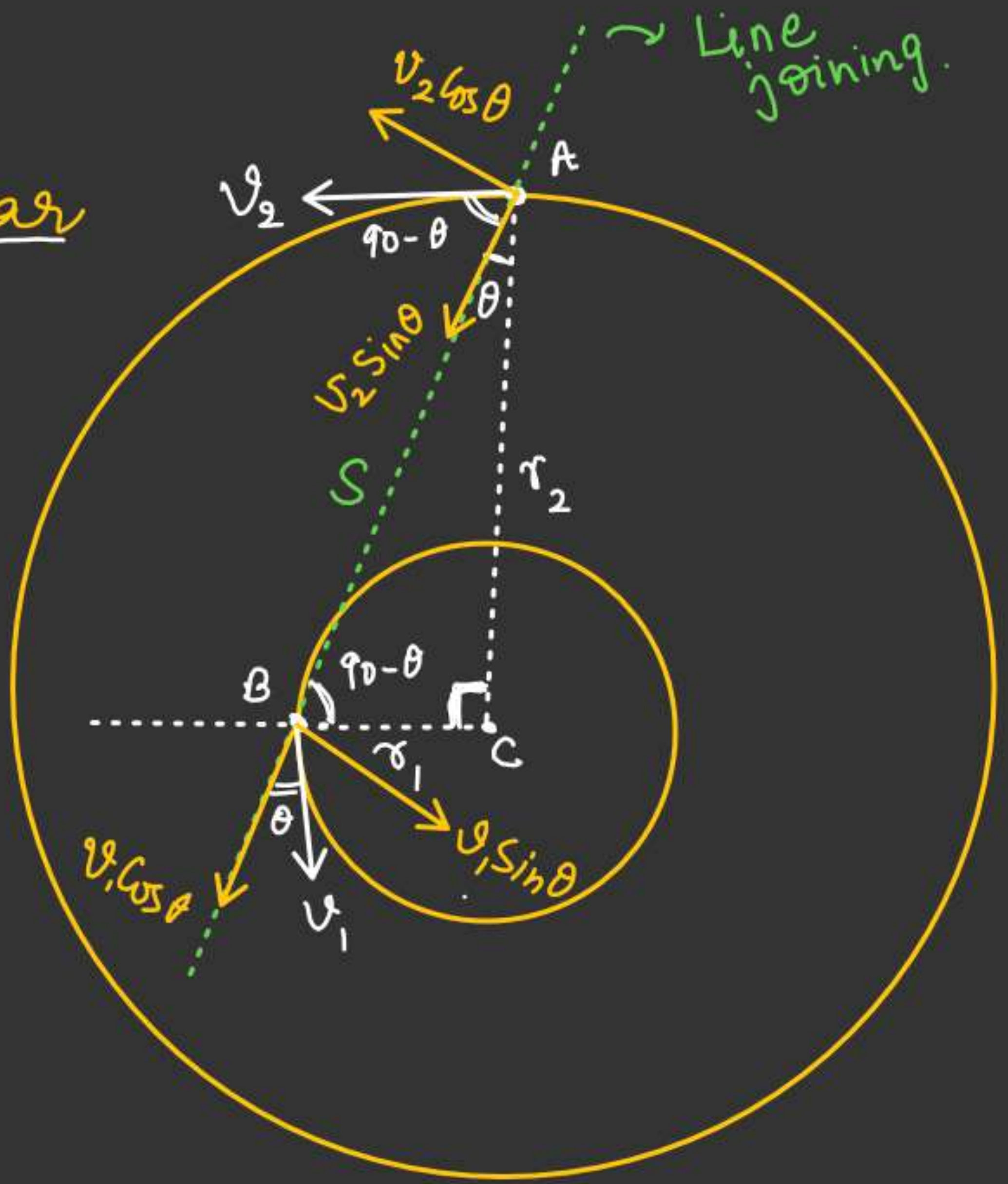
$$\boxed{\omega_{A/B} = \left(\frac{v_1 r_1 + v_2 r_2}{r_1^2 + r_2^2}\right)}$$



$$S = \sqrt{(r_1^2 + r_2^2)}$$

$$\sin\theta = \frac{r_1}{S}$$

$$\cos\theta = \frac{r_2}{S}$$



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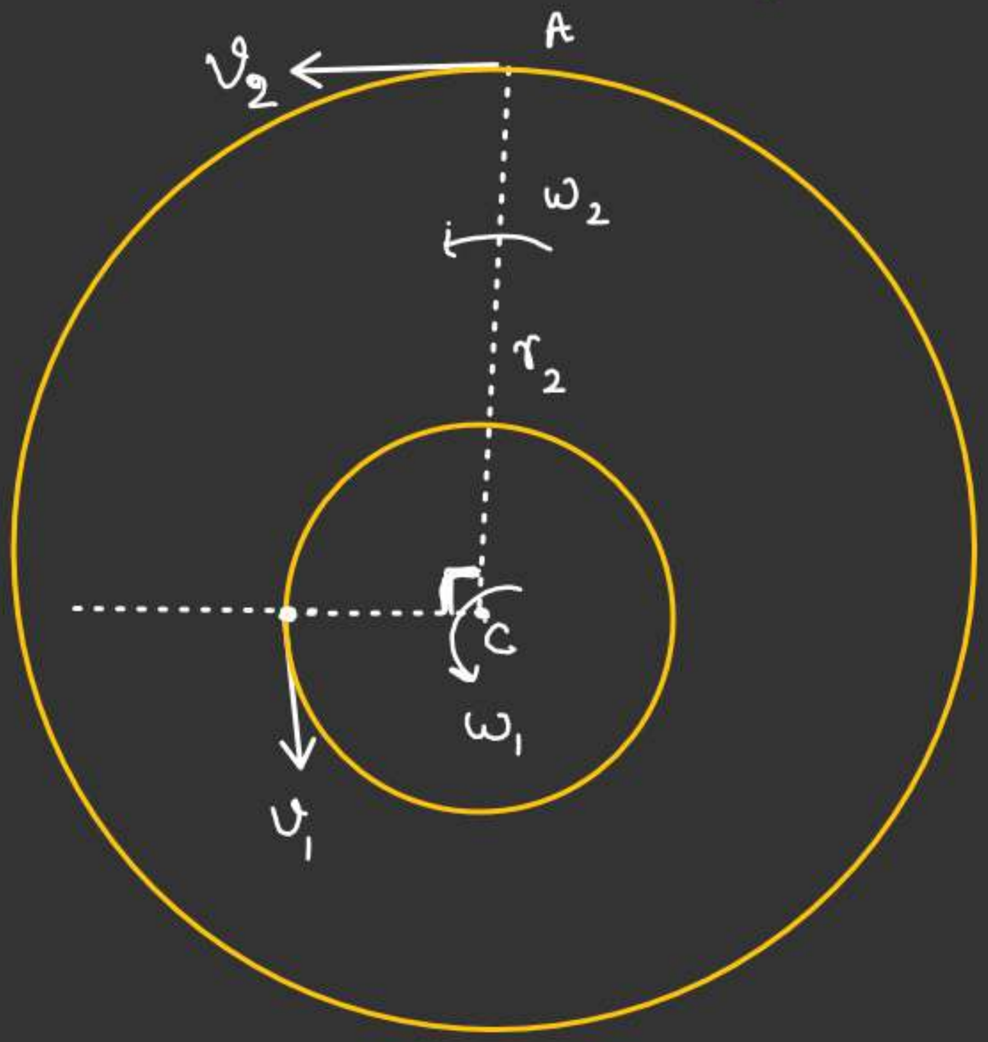
$$\boxed{\omega_{A/B} = \left(\frac{v_1 r_1 + v_2 r_2}{r_1^2 + r_2^2}\right)}$$

$$\left(\begin{aligned} \omega_2 &= \frac{v_2}{r_2} \\ \omega_1 &= \frac{v_1}{r_1} \end{aligned}\right)$$

$$\boxed{\omega_{A/B} = \frac{\omega_1 r_1^2 + \omega_2 r_2^2}{r_1^2 + r_2^2}}$$

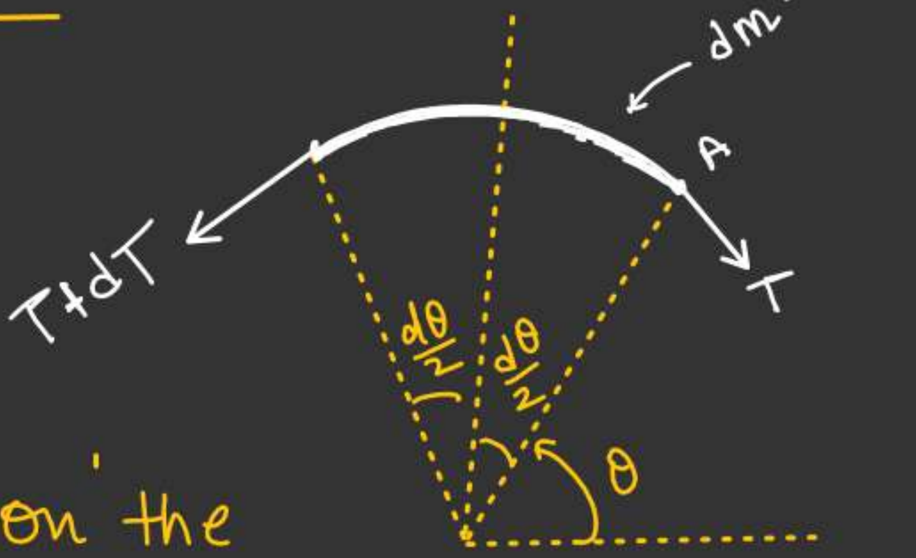
→ Line joining.

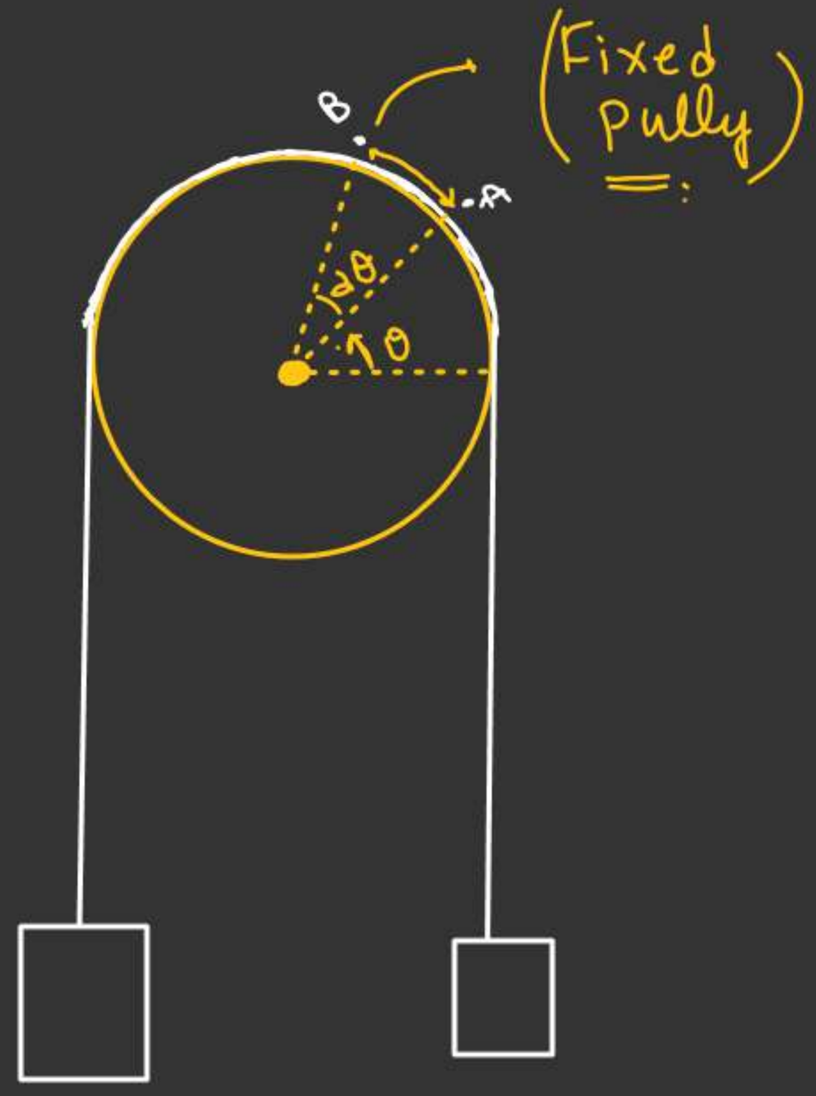


String Massless and pully is frictionless

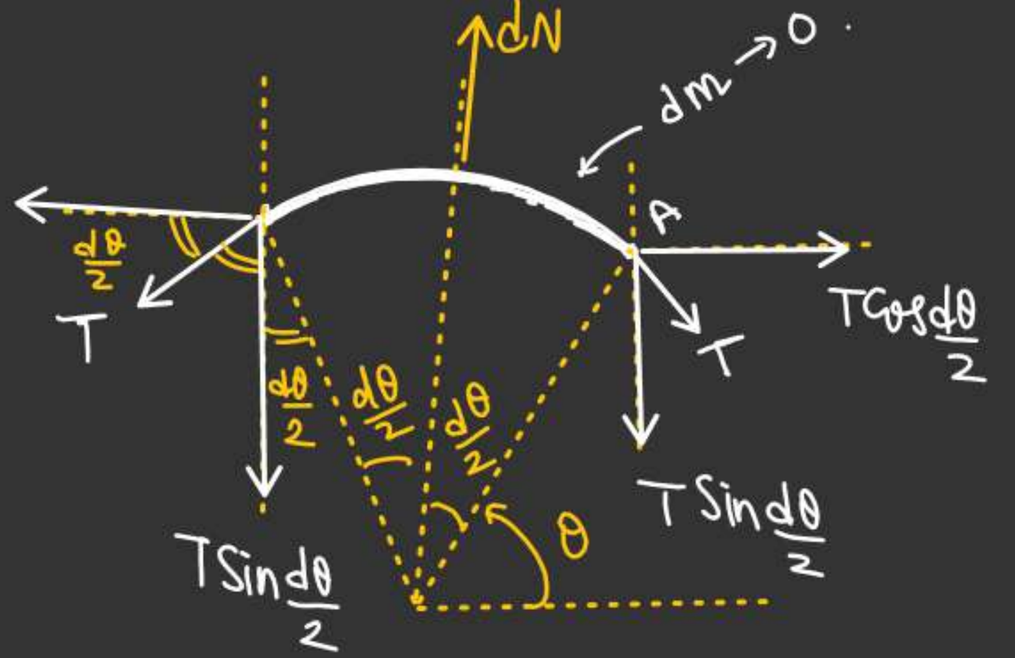
$$T - (T + dT) = \underset{\substack{\Downarrow \\ 0}}{dm}\, a$$

$$dT = 0$$





Normal reaction on the pully.



$$dN = 2T \sin\left(\frac{d\theta}{2}\right)$$

$$dN = 2T\left(\frac{d\theta}{2}\right)$$

$$\boxed{dN = T\,d\theta}$$

If θ is very small

$$\sin\theta \simeq \theta$$

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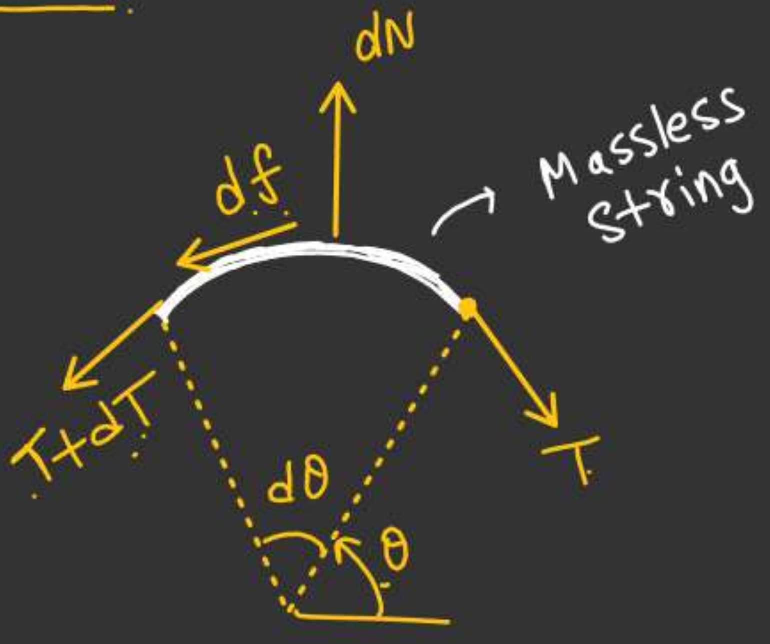
When pully is Rough

String massless



$$T = T + dT + df$$

$$dT = -df$$

For string just about to slip.

$$df = \mu \, dN$$

$$dN = (T \, d\theta)$$

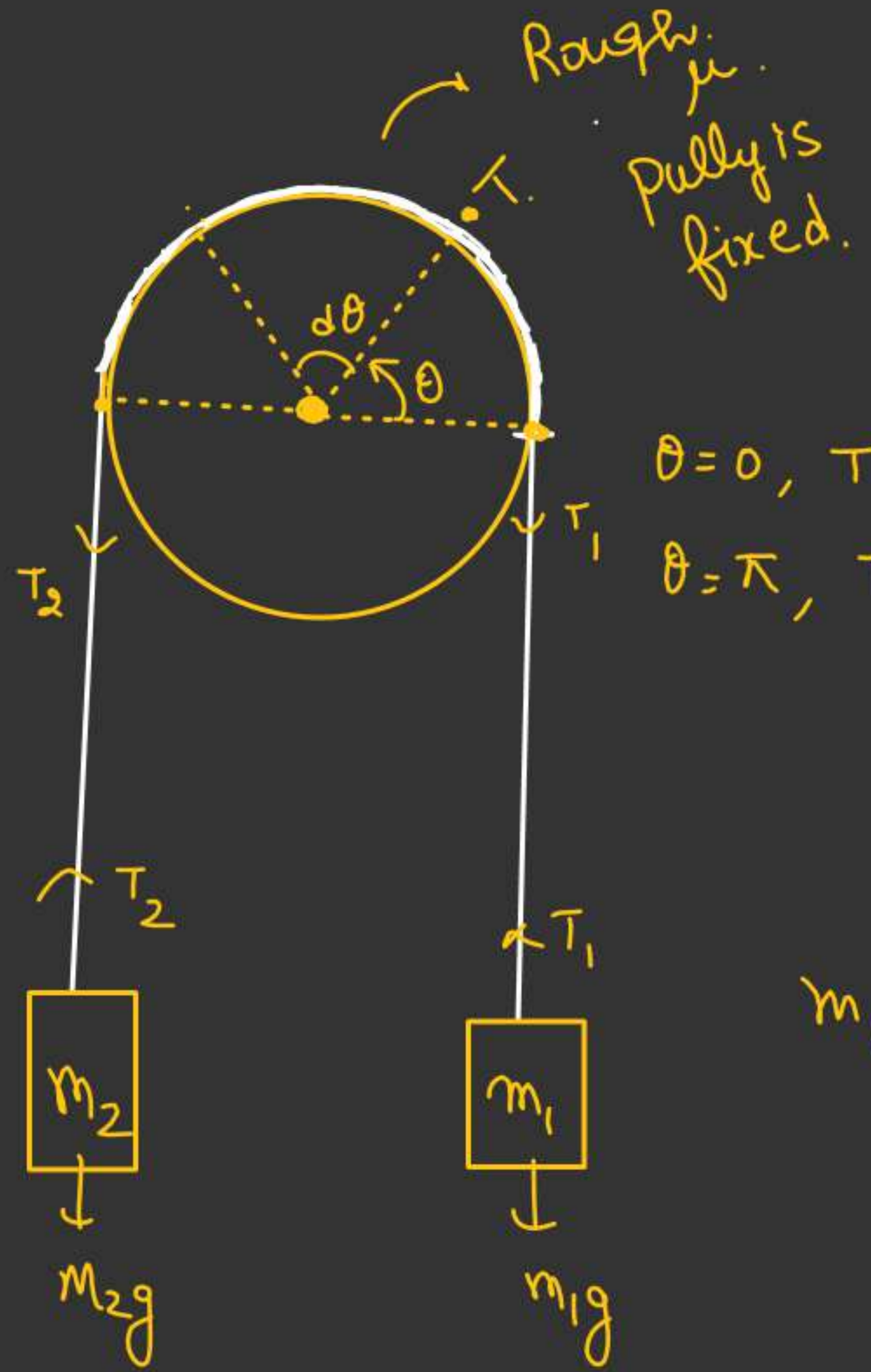
$$dT = -\mu \, dN$$

$$dT = -\mu T \, d\theta$$

$$\int_{T_1}^{T} \frac{dT}{T} = -\mu \int_0^{\theta} d\theta$$

$$\ln\left(\frac{T}{T_1}\right) = -\mu\theta$$

$$\boxed{T = T_1 e^{-\mu\theta}}$$



$\theta = 0, \; T = T_1 = m_1 g$

$\theta = \pi, \; T = T_2 = m_2 g$

$m_1 > m_2$

$$\boxed{T = T_1 e^{-\mu\theta}}$$

When $\theta = \pi$, $T = T_2$

$$T_2 = T_1 e^{-\mu\pi}$$

$$T_1 = T_2 e^{\mu\pi}$$

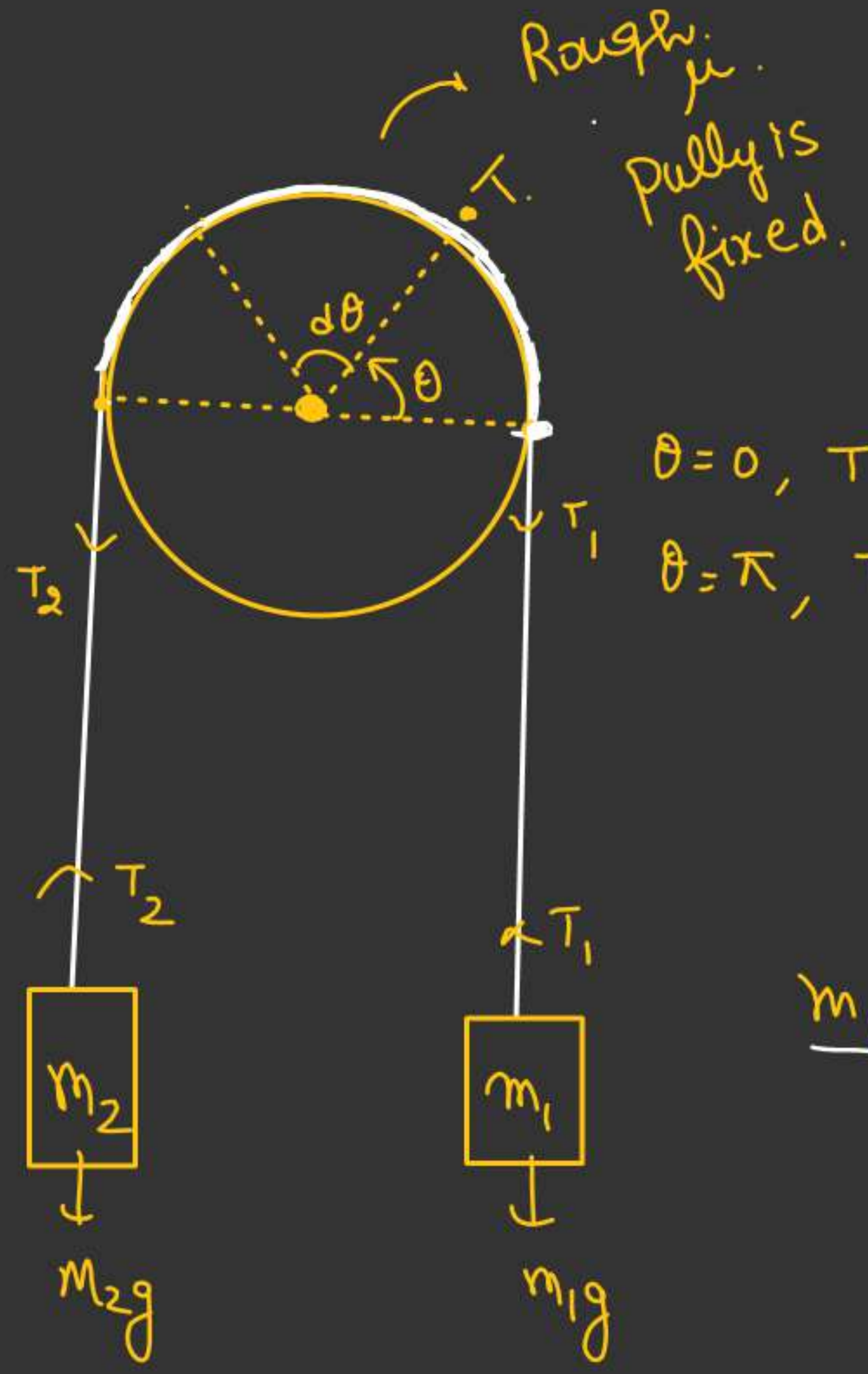
$$\Downarrow$$

$$T_{max} = T_{min} e^{\mu\pi}$$

$$\left(\frac{m_1}{m_2}\right) = \frac{T_{max}}{T_{min}} = e^{\mu\pi}$$

$$\left(\begin{array}{l} T_2 = m_2 g \\ T_1 = m_1 g \end{array}\right)$$

$$\mu\pi = \ln\left(\frac{m_1}{m_2}\right) \Rightarrow \boxed{\mu = \frac{1}{\pi}\ln\left(\frac{m_1}{m_2}\right)}$$



$\theta = 0$, $T = T_1 = m_1 g$

$\theta = \pi$, $T = T_2 = m_2 g$.

$m_1 > m_2$

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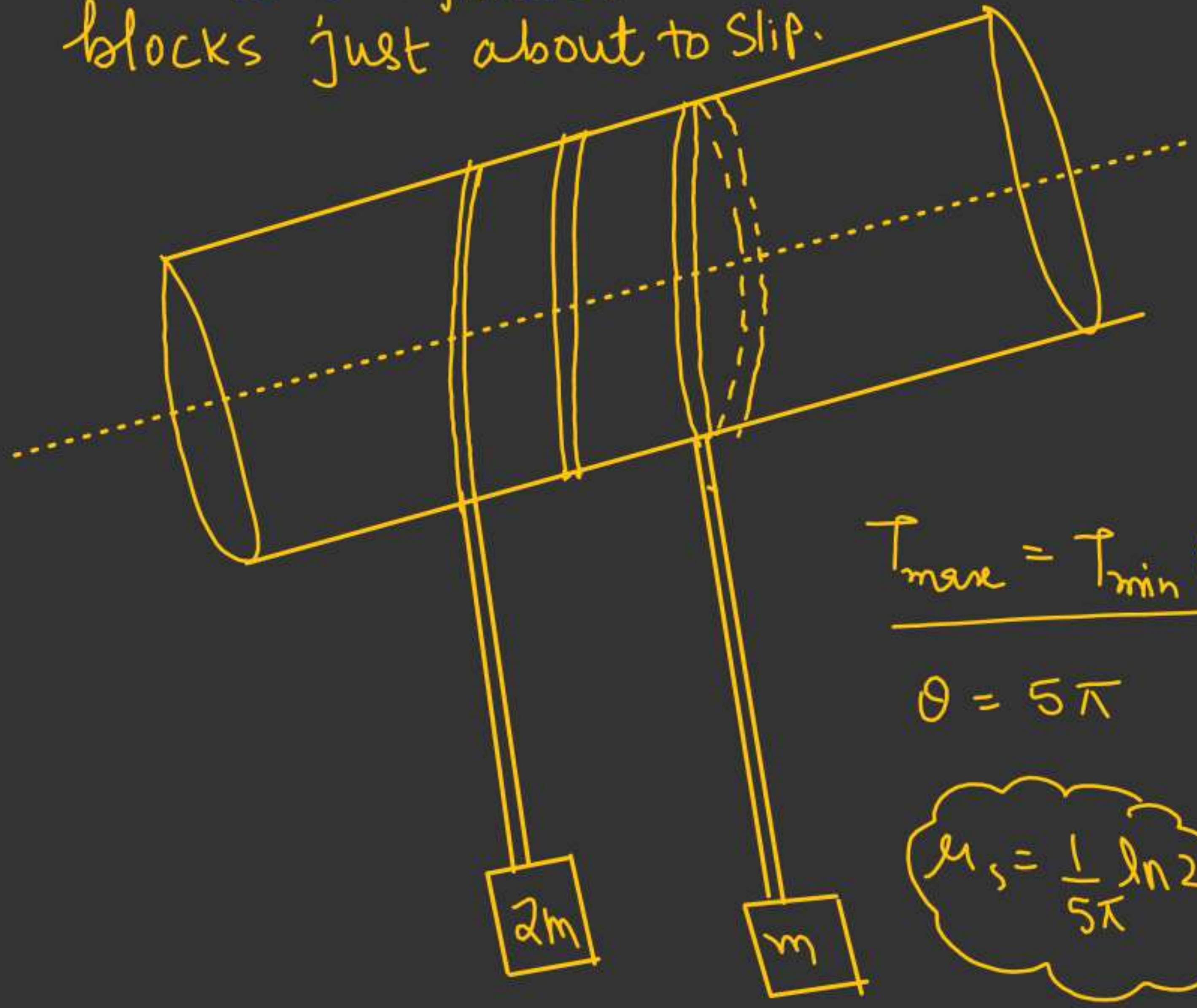
Fin 'μ' b/w String and Cylinder so that blocks just about to Slip.



$$T_{max} = T_{min}\, e^{\mu\theta}$$

$$\theta = 5\pi$$

$$\mu_s = \frac{1}{5\pi} \ln 2$$ Ans