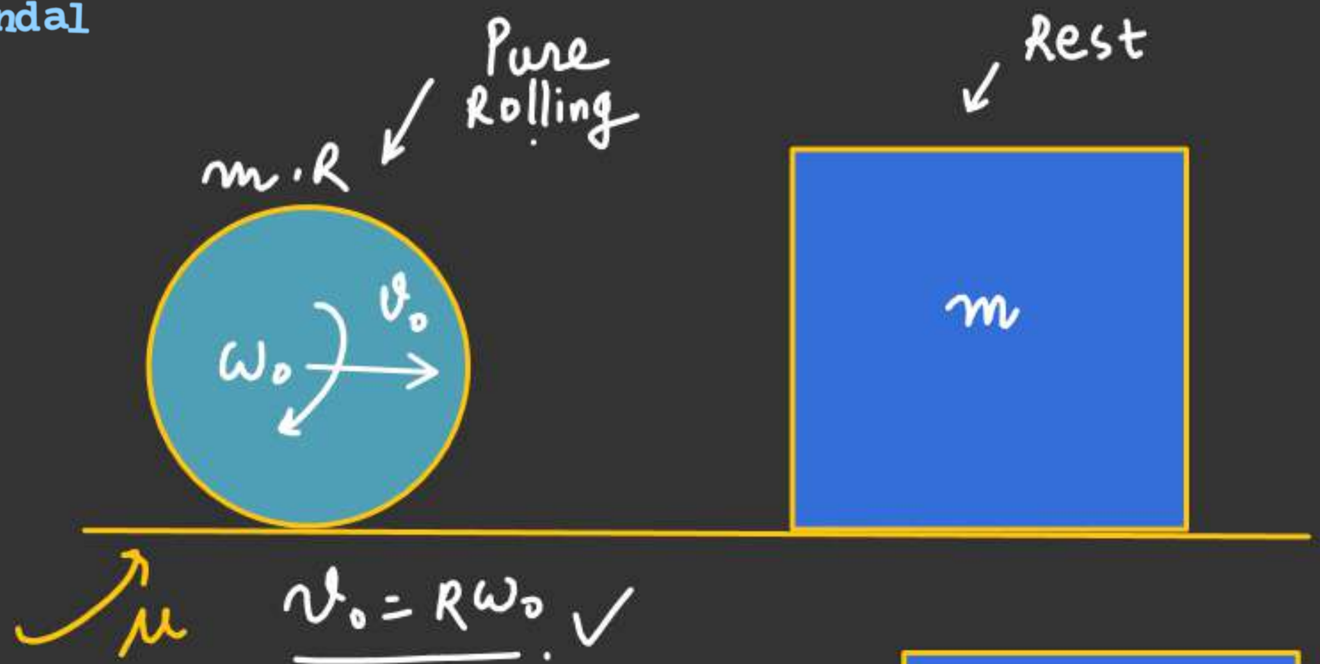
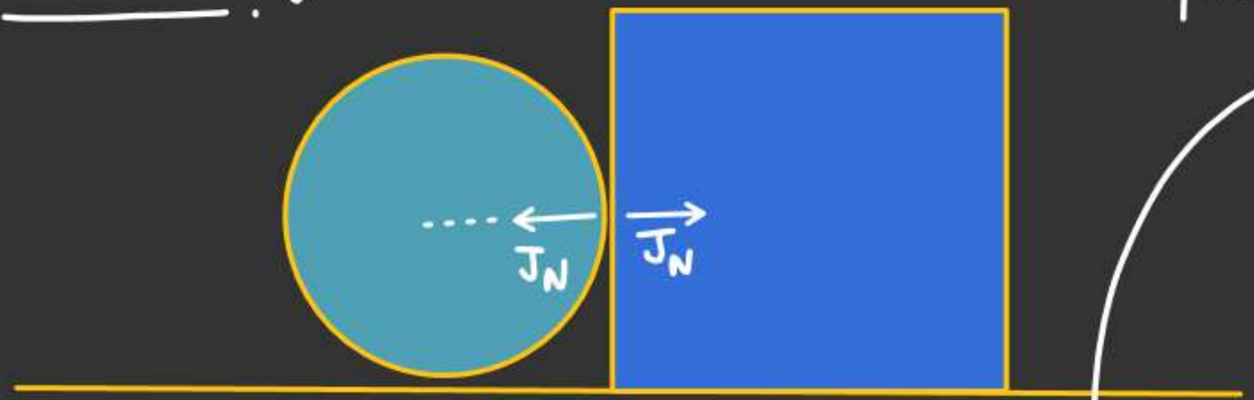
Nishant Jindal

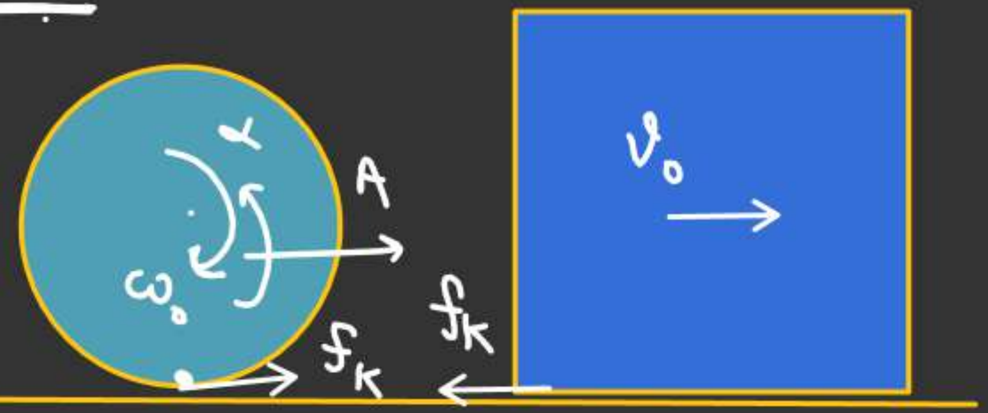
Collision b/w Cylinder and Cube is perfectly elastic. Find velocity of Cube when Cylinder again starts pure rolling after collision.



$v_0 = R\omega_0$ ✓

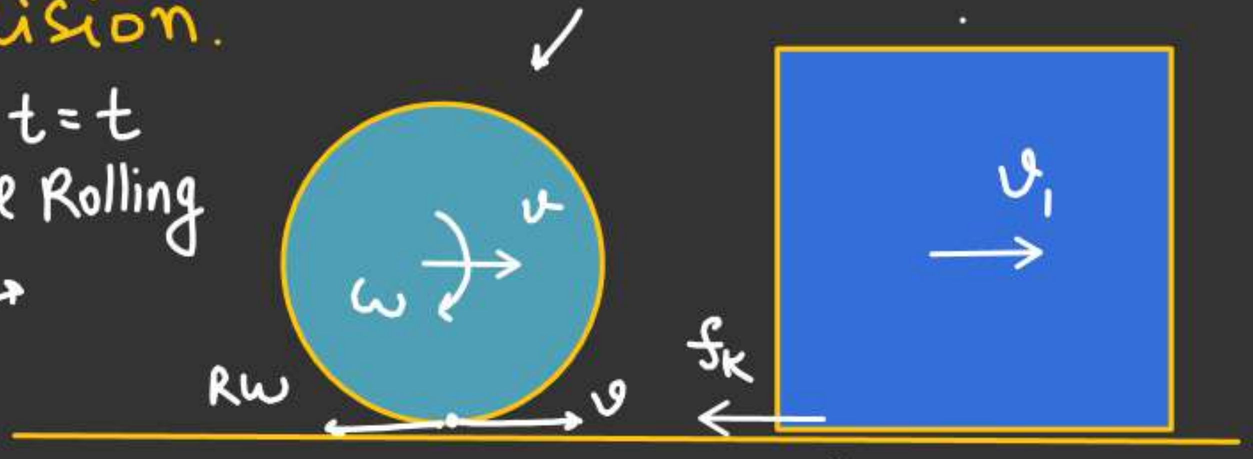


Just after collision. $t = 0$ ✓



$$\alpha = \frac{f_K R}{I} = \frac{\mu m g R}{\frac{mR^2}{2}} = \left(\frac{2\mu g}{R}\right)$$

At $t = t$
Pure Rolling



$v = R\omega$

$$\cancel{u} + \mu g t = R\left(\omega_0 - \frac{2\mu g}{R} t\right)$$

$$+\mu g t = R\omega_0 - 2\mu g t$$

$$3\mu g t = v_0$$

$$t = \left(\frac{v_0}{3\mu g}\right)$$

for Block

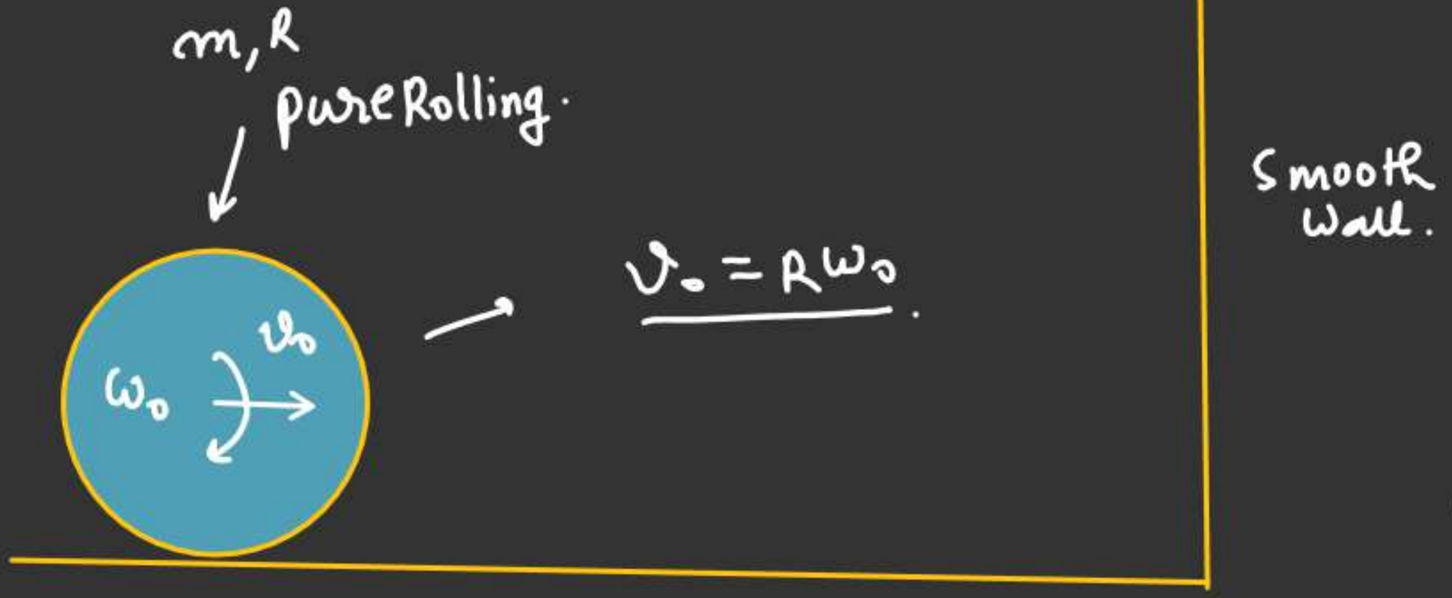
$a = \mu g$

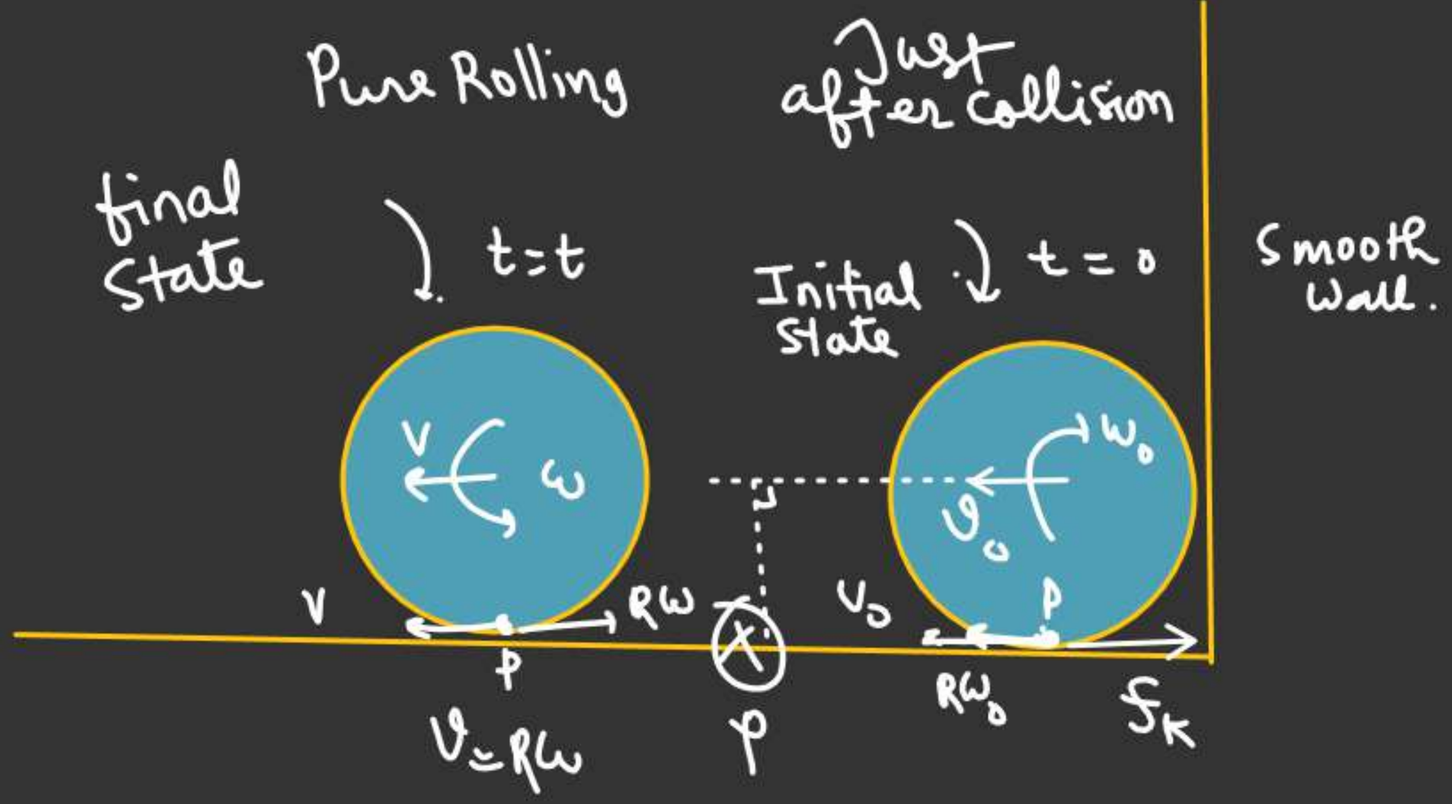
$$v_1 = v_0 - \mu g t$$

$$v_1 = v_0 - \mu g\left(\frac{v_0}{3\mu g}\right)$$

$$v_1 = \frac{2v_0}{3}$$

Nishant Jindal





Find velocity of cylinder when it starts pure rolling after collision with wall.
Collision is perfectly elastic.

A·M·C about point P.

$$\underbrace{+mv_0R - \frac{MR^2}{2}\omega_0}_{L_i} = mvR + \left(\frac{MR^2}{2}\omega\right)$$

$$mv_0R - \frac{MR^2}{2}\times\left(\frac{v_0}{R}\right) = \left(MvR + \frac{MR^2}{2}\times\frac{v}{R}\right)$$

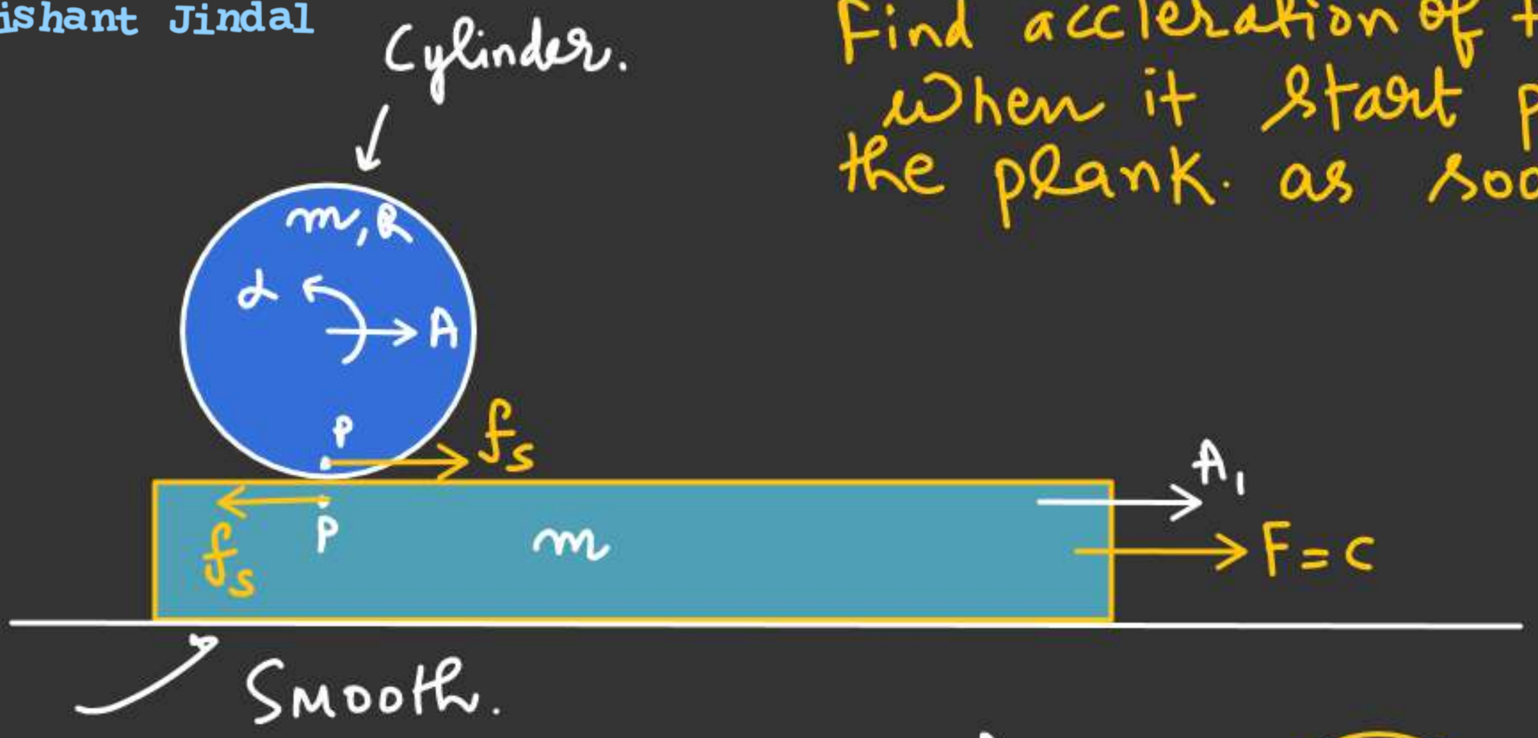
$$\frac{mv_0R}{2} = \frac{3}{2}MvR$$

$$v = \left(\frac{v_0}{3}\right)$$

$$\omega = \left(\frac{v_0}{3R}\right)$$

Nishant Jindal

Find accleration of the Cylinder when it start pure rolling on the plank. as soon as F applied.



For Cylinder.

$$\begin{cases} f_s = MA & -(1) \\ f_s \cdot R = \dfrac{MR^2}{2}\alpha & -(2) \quad (\tau = I\alpha) \end{cases}$$

For plank

$$F - f_s = mA_1 - (3)$$

$$MA = \frac{M}{2}R\alpha$$

$$2A = R\alpha$$

$$A + R\alpha = A_1 - (4)$$

(Condition of pure Rolling)

From (3)

$$F - MA = m(A + \underbrace{R\alpha}_{2A})$$

$$F - MA = 3mA$$

$$F = 4MA$$

$$A = \left(\frac{F}{4m}\right)$$

$$f_s = \left(\frac{F}{4}\right)$$

$$R\alpha = 2A$$

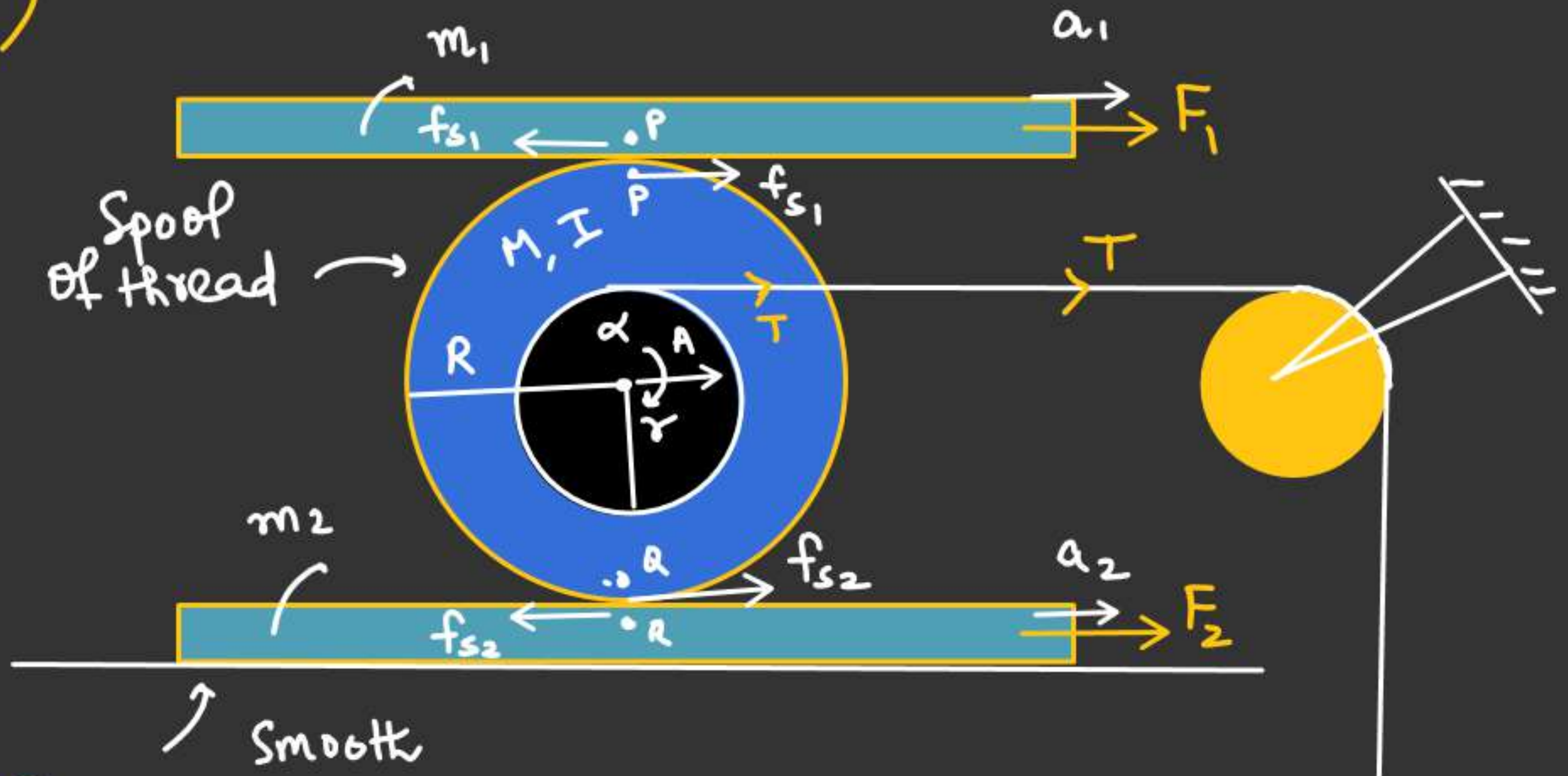
$$\alpha = \frac{2A}{R} = \frac{2F}{4mR}$$

$$A_1 = 3A = \left(\frac{3F}{4}\right) \checkmark$$

Nishant Jindal

Spool of thread have a pure rolling motion

$$\left(\begin{array}{l} F_1 = F \\ F_2 = 2F \end{array} \right)$$



Condition for pure rolling.

$$A + R\alpha = a_1 \rightarrow (1)$$

$$A - R\alpha = a_2 \rightarrow (2)$$

Equation of Constrain Motion

$$x + r\theta = y$$

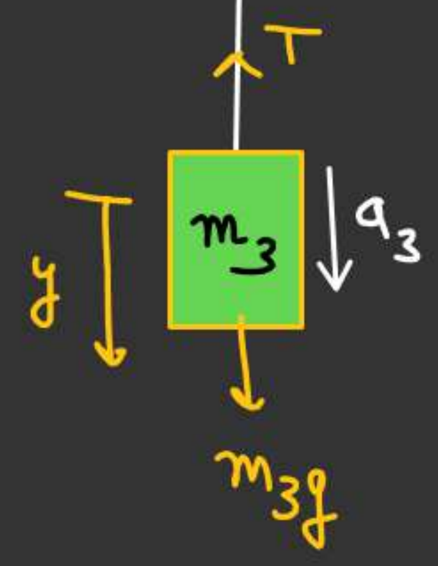
$$\frac{d^2x}{dt^2} + r\frac{d^2\theta}{dt^2} = \frac{d^2y}{dt^2}$$

$$\Downarrow$$

$$\boxed{A + r\alpha = a_3 - (3)}$$

Equation for Rotational Motion

$$f_{s_1}R + Tr - f_{s_2}R = I\alpha - (8)$$



Equation of translational motion

$$F_1 - f_{s_1} = m_1 a_1 - (4)$$

$$T + f_{s_1} + f_{s_2} = mA - (5)$$

$$F_2 - f_{s_2} = m_2 a_2 - (6)$$

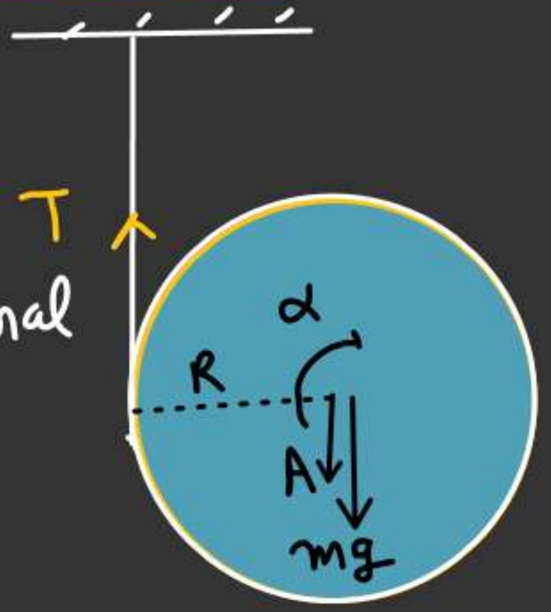
$$m_3g - T = m_3 a_3 - (7)$$

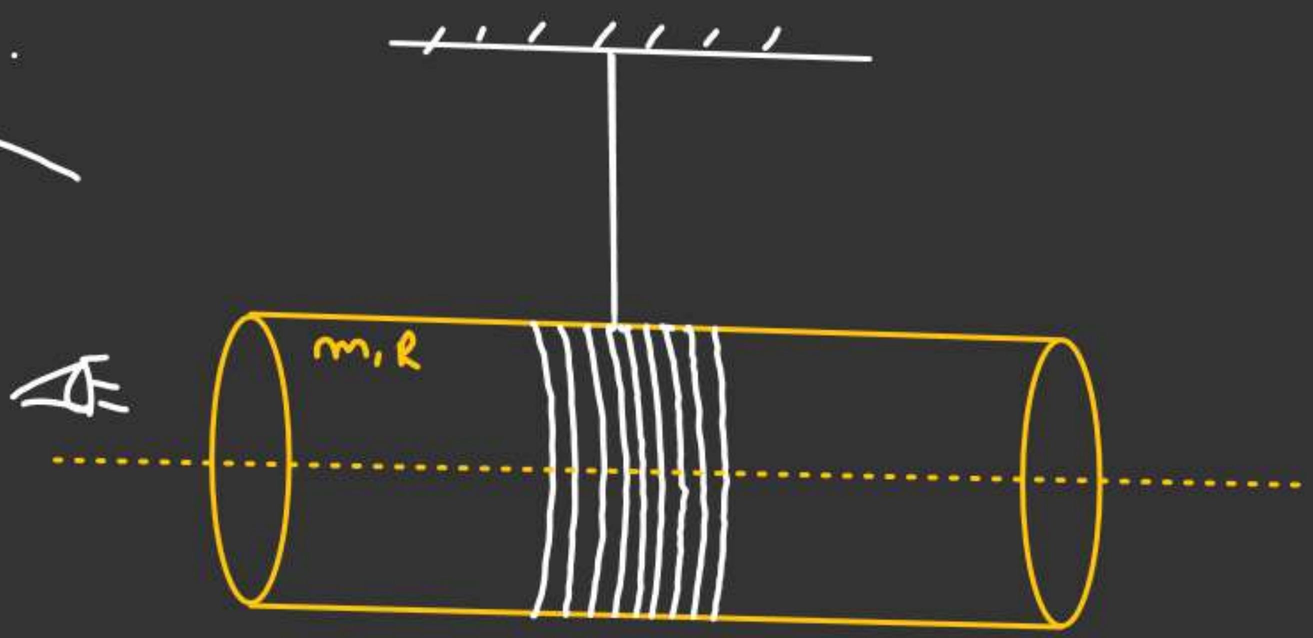
Nishant Jindal

Case of Unwinding of thread.

$T = ?$

$a = ?$





Equation for translational Motion.

$$Mg - T = MA \quad -(1)$$

Equation for Rotational Motion

$$T \cdot R = \frac{MR^2}{2}\alpha \quad -(2)$$

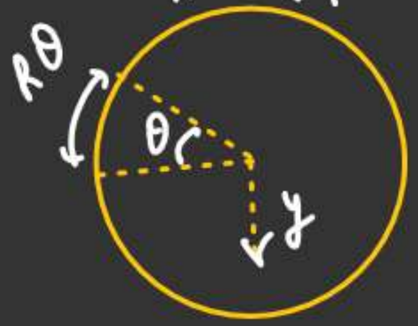
For No Slipping of Cylinder on the thread

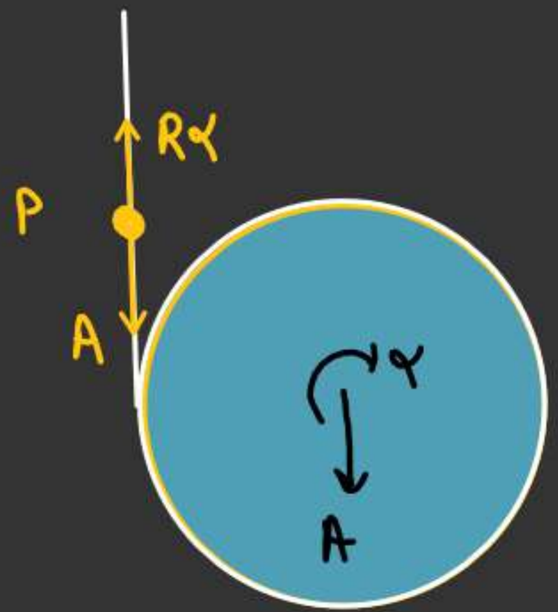
$$A = R\alpha \quad -(3)$$

$y = R\theta$

$v = R\omega$

$A = R\alpha$





From (2)

$$T = \frac{M}{2}(R\alpha) = \frac{MA}{2} \quad -(4)$$

put in (1)

$$Mg = MA + \frac{MA}{2}$$

$$Mg = \frac{3}{2}MA$$

$$A = \left(\frac{2g}{3}\right) ✓$$

$$\alpha = \left(\frac{2g}{3R}\right) ✓$$

$$T = \frac{M}{2} \times \frac{2g}{3} = \frac{Mg}{3} ✓$$