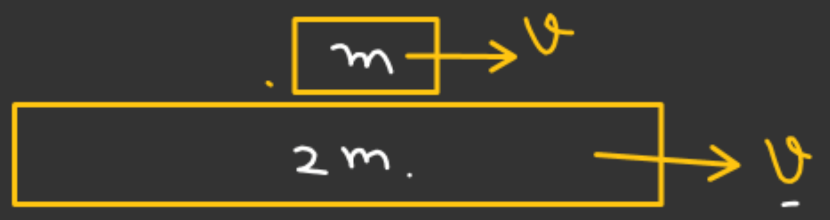
Nishant Jindal

i) Find the common velocity of block & plank.

ii) Distance covered by block. [μ = cofficient of friction b/w block & plank)

f_K retard the motion of block and acclerate the motion of plank

At $t=t$ both attained common velocity



$$a_1 = \frac{f_K}{m} = (\mu g)$$

$$a_2 = \frac{f_K}{2m} = \frac{\mu m g}{2m} = \left(\frac{\mu g}{2}\right)$$

Equation for block.

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

Equation for plank.

$$v = 0 + \frac{\mu g}{2} t$$

$$v_0 - \mu g t = \frac{\mu g}{2} t$$

$$v_0 = \frac{3}{2} \mu g t$$

$$t = \left(\frac{2v_0}{3\mu g}\right)$$

$$v = \frac{\mu g}{2} \times \frac{2v_0}{3\mu g}$$

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

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$$S_{block/E} = v_0 t - \frac{1}{2}a_1 t^2$$

$$= v_0\left(\frac{2v_0}{3\mu g}\right) - \frac{1}{2}(\mu g)\left(\frac{2v_0}{3\mu g}\right)^2$$

$$= \frac{2v_0^2}{3\mu g} - \frac{2v_0^2}{9\mu g}$$

$$= \left(\frac{4v_0^2}{9\mu g}\right) \checkmark$$

$$S_{plank/E} = \frac{1}{2}a_2 t^2$$

$$= \frac{1}{2}\left(\frac{\mu g}{2}\right)\left(\frac{2v_0}{3\mu g}\right)^2$$

$$= \left(\frac{v_0^2}{9\mu g}\right) \checkmark$$

M-1 $\vec{S}_{block/Plank} = \vec{S}_{block/E} - \vec{S}_{plank/E} = \left(\frac{4v_0^2}{9\mu g}\hat{i} - \frac{v_0^2}{9\mu g}\hat{i}\right) = \frac{3v_0^2}{9\mu g}\hat{i}$

$$= \left(\frac{v_0^2}{3\mu g}\right)\hat{i} \checkmark$$

or

M-2 $\left[S_{block/plank} = \left(u_{rel}t + \frac{1}{2}a_{rel}t^2\right)\right.$

$u_{rel} = v_0$

$a_{rel} = (a_1 + a_2)$

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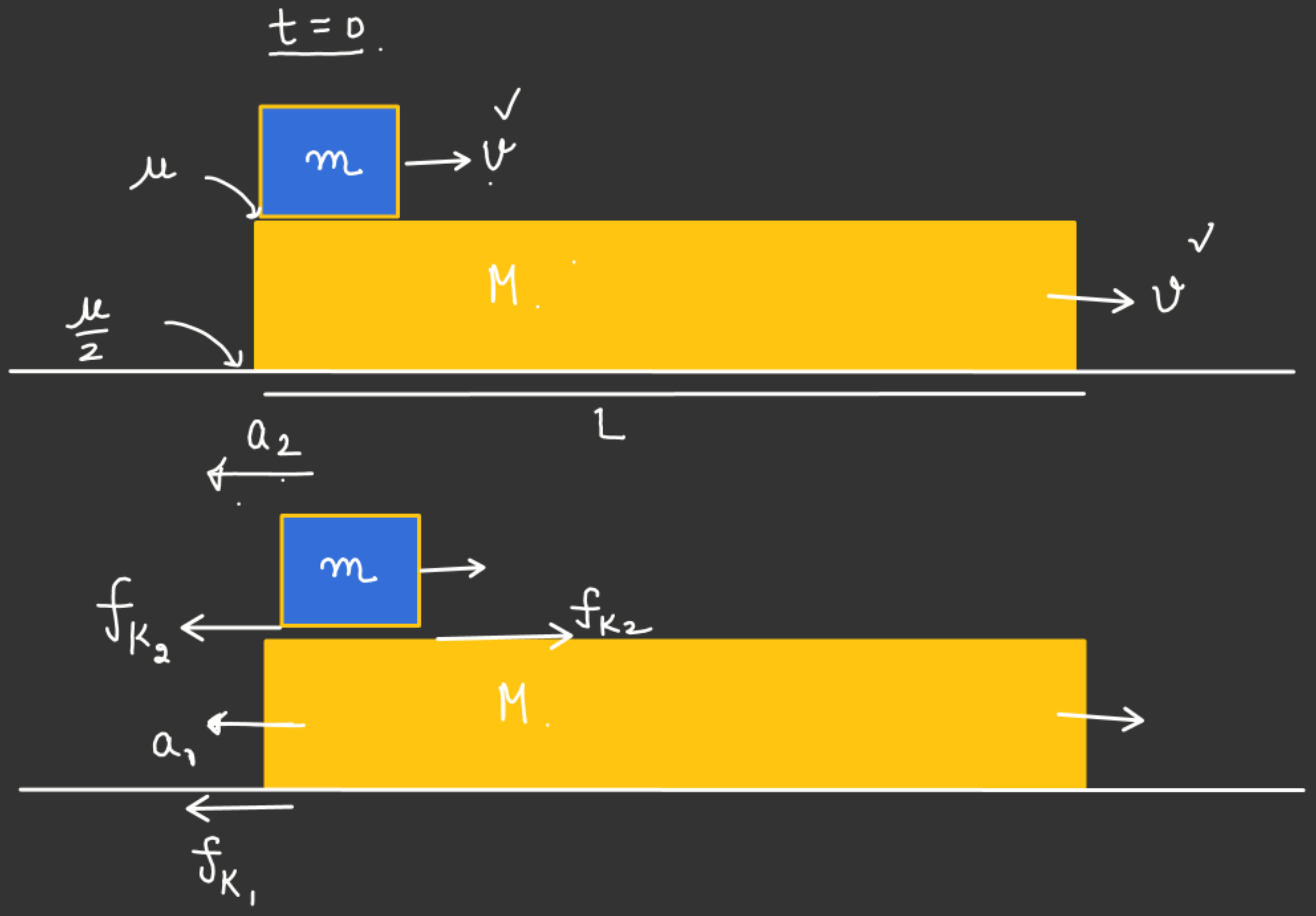
Both plank & block projected horizontally with velocity v at $t = 0$.

Find the time when block seperate with plank



$$f_{K_2} = \mu m g$$

$$a_2 = \frac{\mu m g}{m} = \mu g$$

$$f_{K_1} = \frac{\mu}{2}(M+m)g$$

For plank

$$f_{K_1} - f_{K_2} = Ma_1$$

$$\frac{\mu}{2}(M+m)g - \mu m g = Ma_1$$

$$\mu g\left[\frac{M}{2} + \frac{m}{2} - m\right] = Ma_1$$

$$Ma_1 = \mu g\left(\frac{M-m}{2}\right)$$

$$a_1 = \mu g\left(\frac{M-m}{2M}\right) = \frac{\mu g}{2}\left(1 - \frac{m}{M}\right)$$

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$$S_{rel} = (\underline{u_{rel}})t + \frac{1}{2}a_{rel} \cdot t^2$$

$$\Downarrow$$

$$L = 0 + \frac{1}{2}a_{rel} \cdot t^2$$

$$t = \sqrt{\frac{2L}{a_{rel}}}$$

$$\vec{a}_{rel} = \vec{a}_{block/plank} = \vec{a}_{block/\varepsilon} - \vec{a}_{plank/\varepsilon}$$

$$= -a_1\hat{i} - (-a_2)\hat{i}$$

$$= (a_2 - a_1)\hat{i}$$

$$= \left[\mu g - \frac{\mu g}{2}\left(1 - \frac{m}{M}\right)\right]\hat{i}$$

$$= \mu g - \frac{\mu g}{2} + \frac{\mu g}{2}\frac{m}{M}$$

$$= \frac{\mu g}{2}\left(\frac{m+M}{M}\right) \checkmark$$

$$\checkmark \quad t = \sqrt{\frac{4ML}{\mu g(M+m)}}$$

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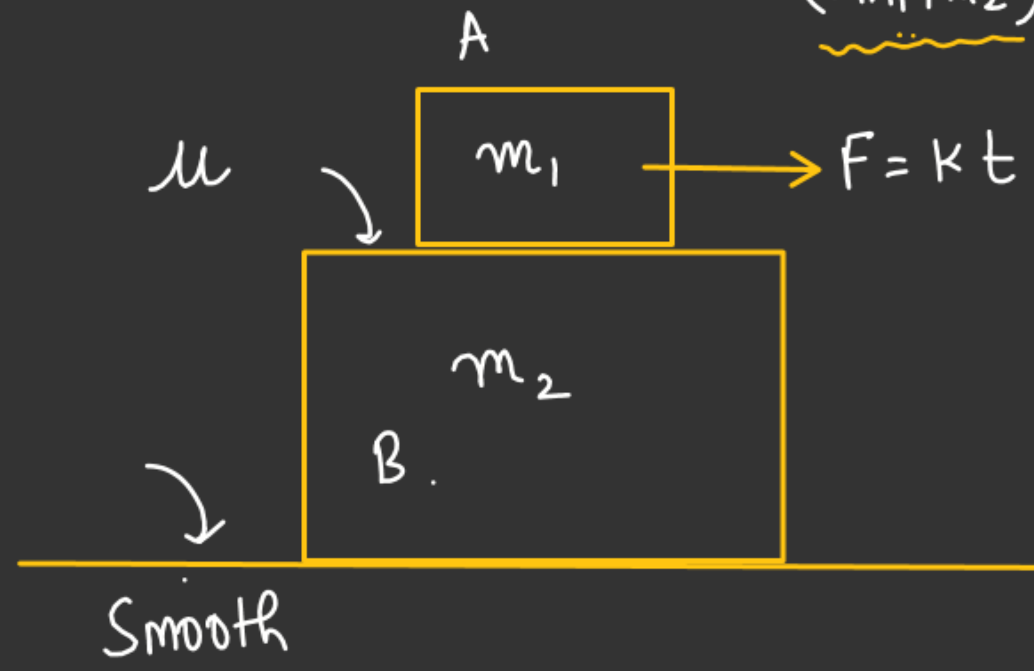
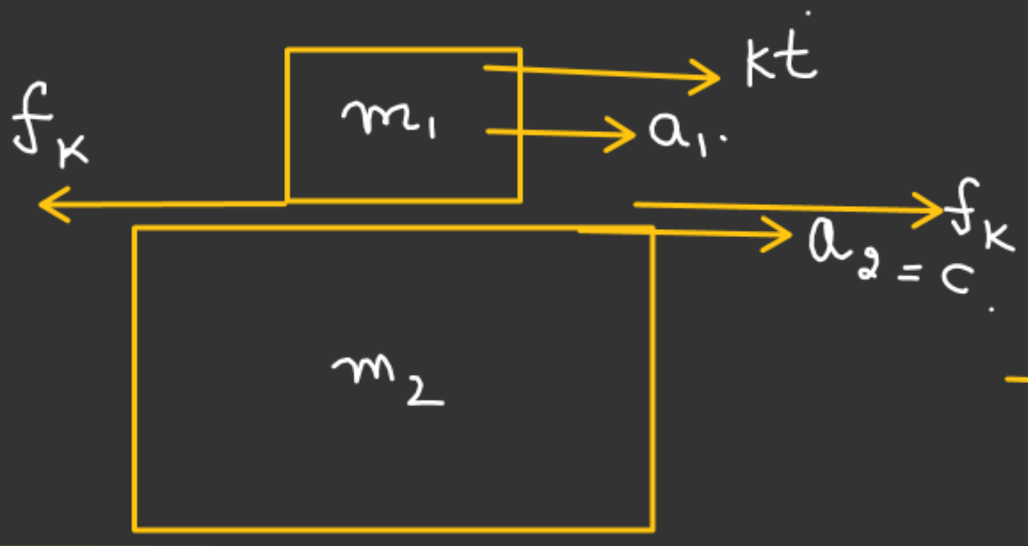
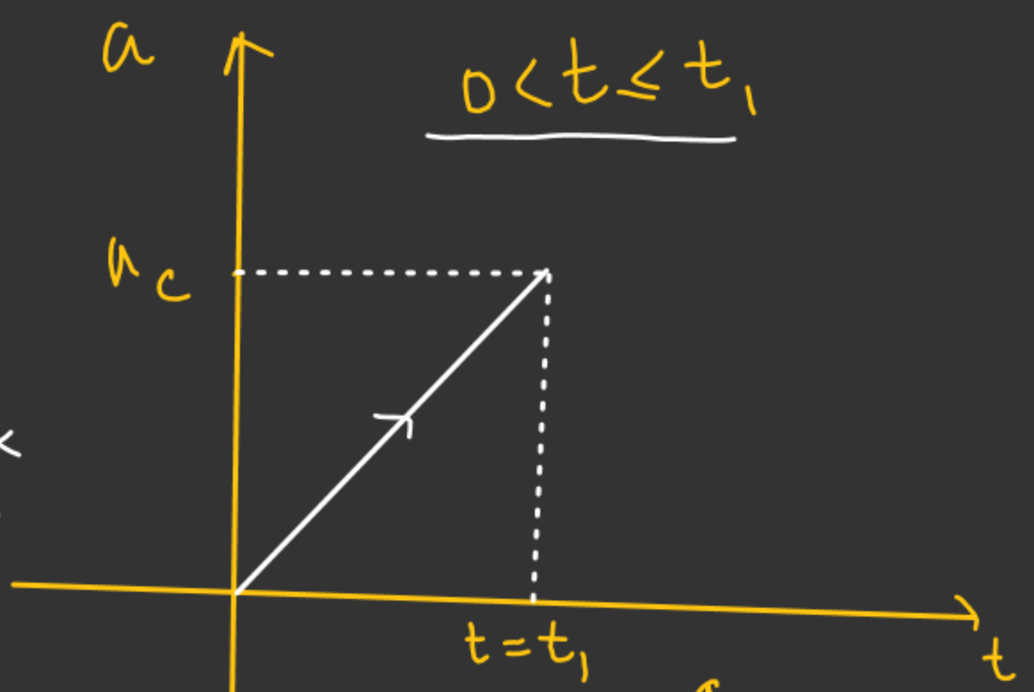
$$a_c = \frac{F}{m_1+m_2} = \left(\frac{kt}{m_1+m_2}\right)$$

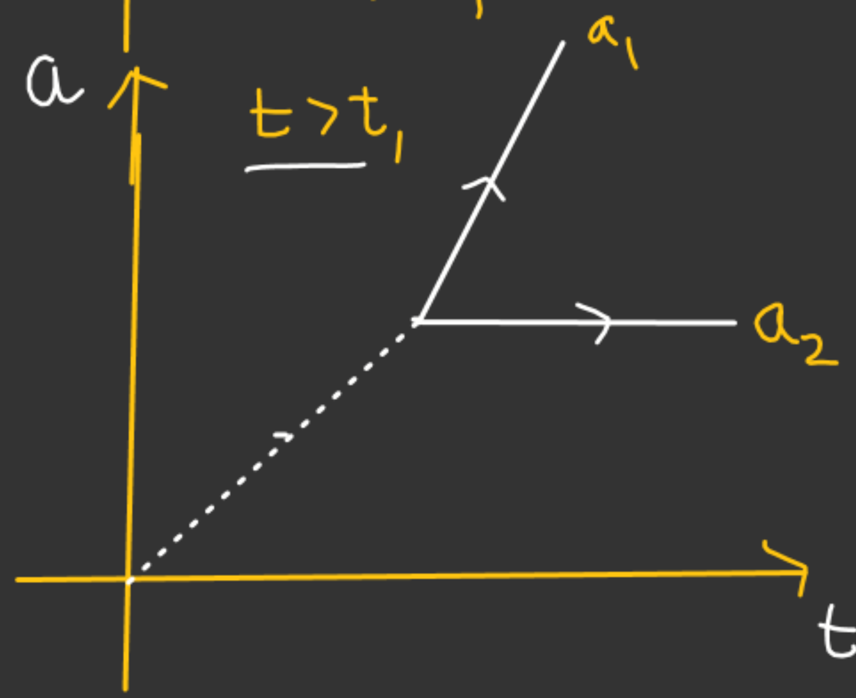
$$a_c = \left(\frac{K}{m_1+m_2}\right)t$$



After $t > t_1$ relative slipping starts.







Solⁿ Block A & B move with common accleration untill & unless $F \geq (f_s)_{max}$

$$a_2 = \frac{f_K}{m_2} = \left(\frac{\mu m_1 g}{m_2}\right)$$

$$a_1 = \frac{kt - \mu m_1 g}{m_1}$$

$$a_1 = \left(\frac{K}{m_1}t - \mu g\right)$$

$$Kt_1 = \mu m_1 g$$

$$t_1 = \left(\frac{\mu m_1 g}{K}\right)$$

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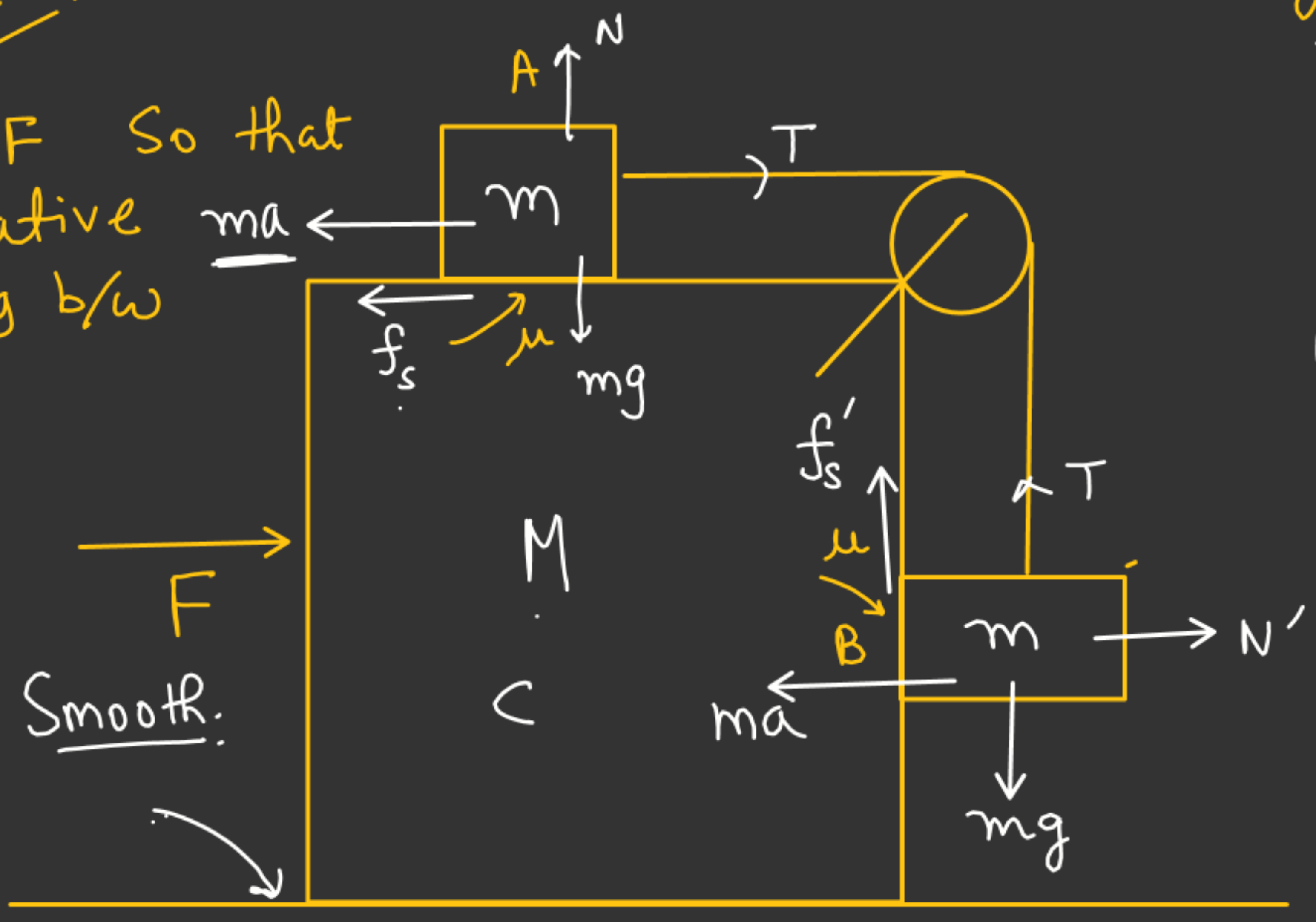
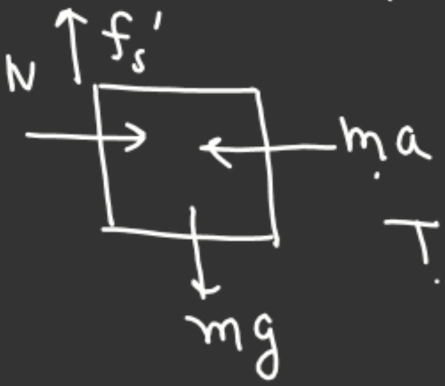
Find F So that No relative slipping b/w A & B



W.r.t Wedge C → For block A

$$T = (f_s)_{max} + ma \quad — ①$$

For Block B



$$T + (f_s')_{max} = mg \quad — ②$$

$$a_c = \left(\frac{F}{M+2m}\right)$$

From ① & ②

$$(f_s)_{max} + ma + (f_s')_{max} = mg$$

$$\mu mg + ma + \mu ma = mg.$$

$$\cancel{m}a(1+\mu) = (1-\mu)\cancel{m}g$$

$$a = \frac{(1-\mu)g}{(1+\mu)}.$$

$$F_{min} = (M+2m)\frac{(1-\mu)g}{(1+\mu)}.$$

$$F_{max} = (M+2m)\left(\frac{1+\mu}{1-\mu}\right)g.$$

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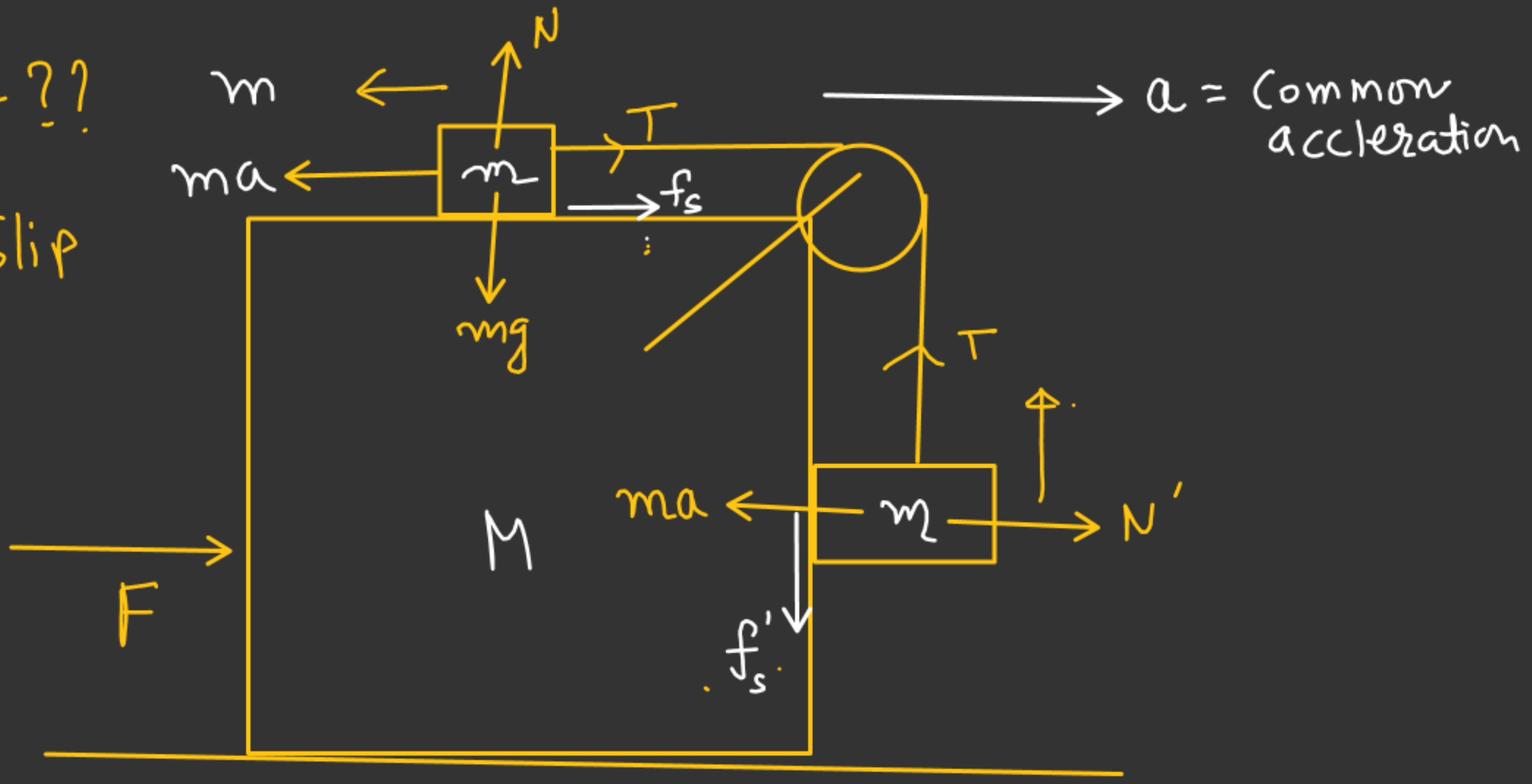
For $(F_{max}) = ??$

For Not to Slip

$$\left[F_{min} \leq F \leq F_{max} \right]$$



FRICTION