

FRICITIONCase of push

$$N = (Mg + F \sin \theta)$$

For block to move

$$F \cos \theta \geq (f_s)_{\max}$$

$$F \cos \theta \geq \mu N$$

$$F \cos \theta \geq \mu (Mg + F \sin \theta)$$

$$F (\cos \theta - \mu \sin \theta) \geq \mu mg$$

$$F \geq \left(\frac{\mu mg}{\cos \theta - \mu \sin \theta} \right)$$

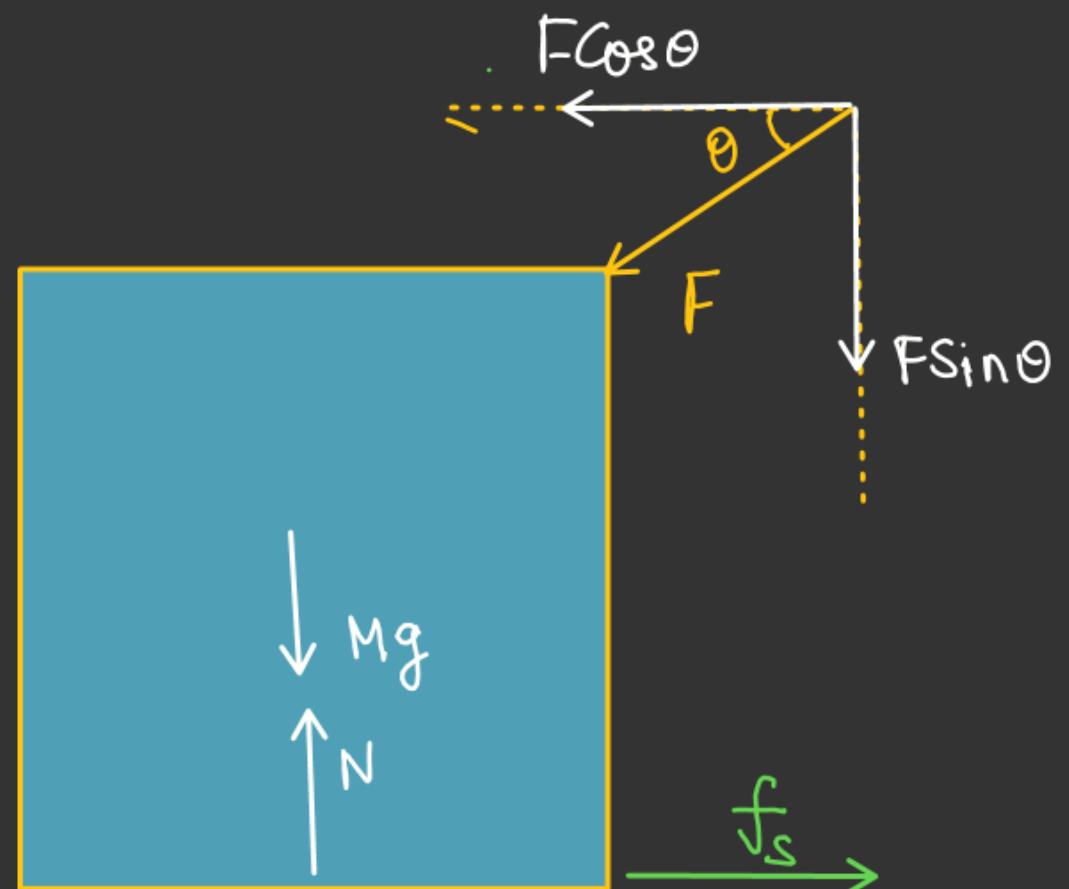
For block just to move

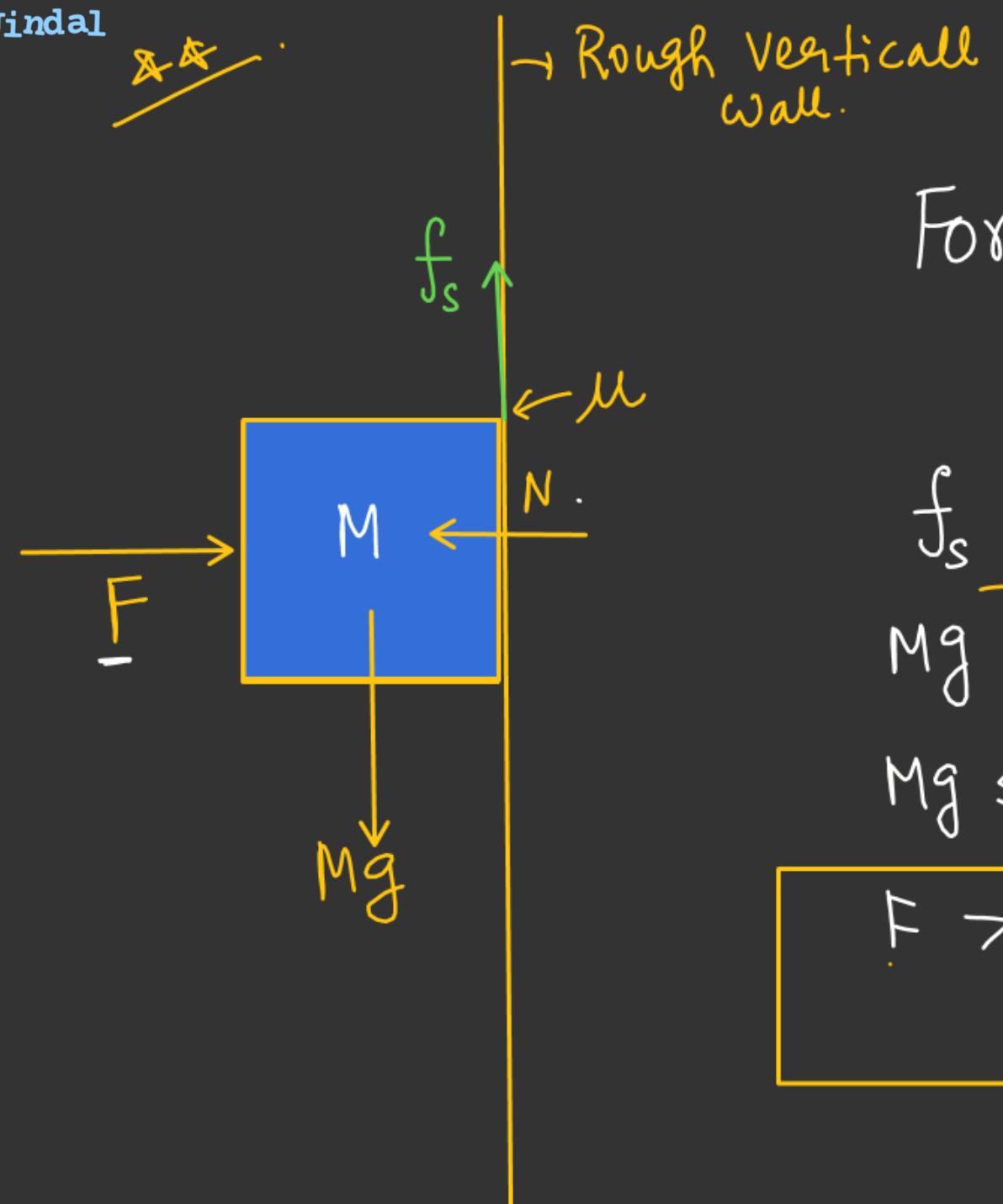
$$F = \left[\frac{\mu mg}{\cos \theta - \mu \sin \theta} \right]$$

\downarrow

$$F_{\min} = \frac{\mu mg}{\sqrt{1 + \mu^2}}$$

$\uparrow \mu_s$





F_{\min} for block not to slide

For block not to Slip.

$$f_s = Mg$$

$$\frac{f_s \leq (f_s)_{\max}}{Mg \leq \mu N}$$

$$Mg \leq \mu F$$

$$F \geq \frac{Mg}{\mu}$$

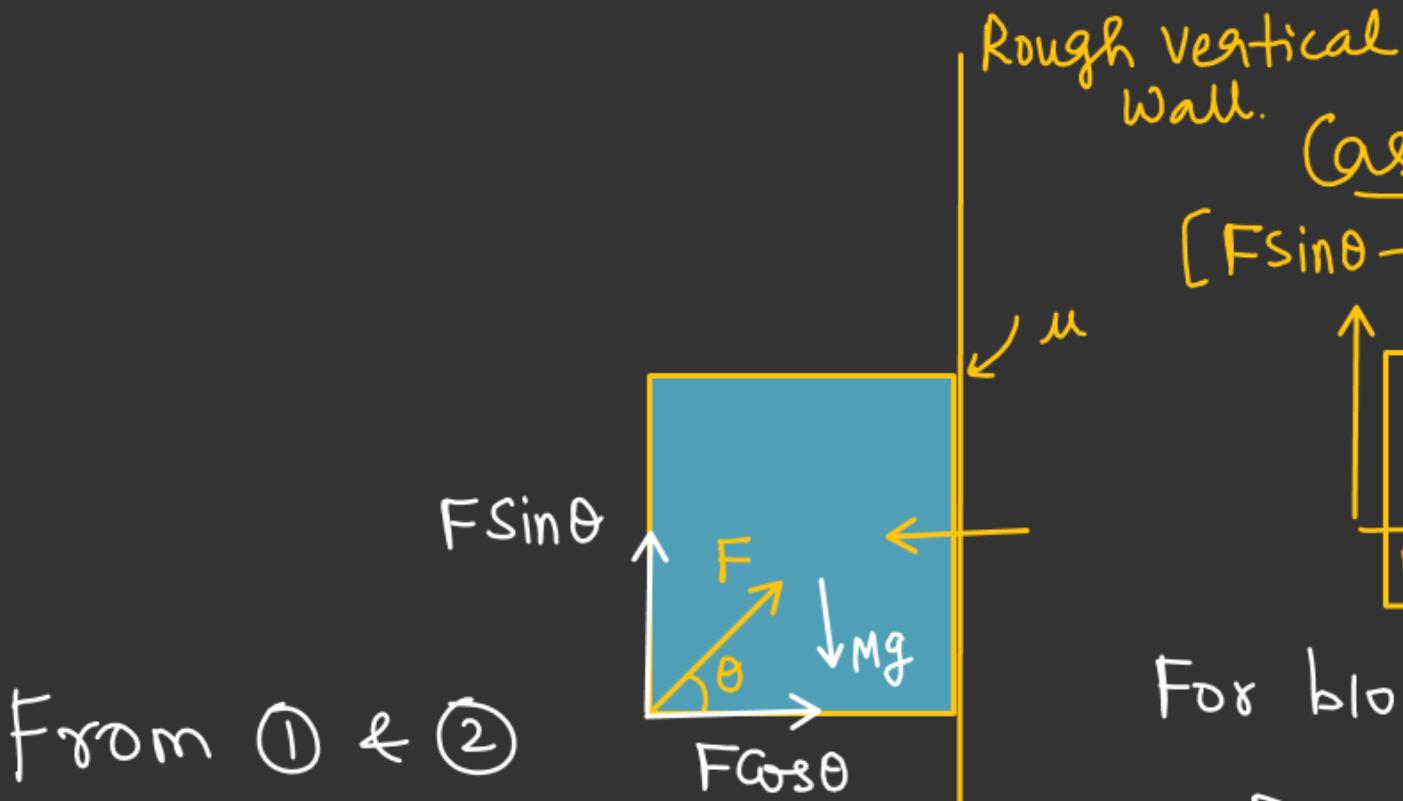
For horizontal
Equilibrium
 $[N = F]$

$$0 \leq f_s \leq (f_s)_{\max}$$

For F_{\min}

$$F_{\min} = \frac{Mg}{\mu} \text{ Ans.}$$

(1). Range of F for block not to slip: →

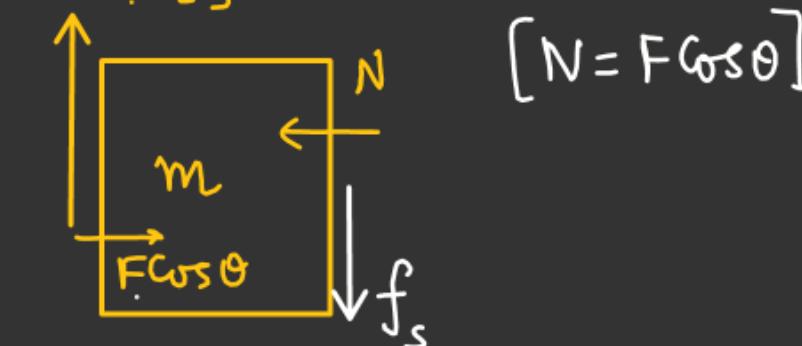


From ① & ②

$$\left(\frac{Mg}{\sin\theta + \mu\cos\theta} \right) \leq F \leq \left(\frac{Mg}{\sin\theta - \mu\cos\theta} \right)$$

$$\begin{cases} F_{\max} = \left(\frac{Mg}{\sin\theta - \mu\cos\theta} \right) \\ F_{\min} = \left(\frac{Mg}{\sin\theta + \mu\cos\theta} \right) \end{cases}$$

Case-1: $\rightarrow FSin\theta > Mg$
[$FSin\theta - Mg$]



For block not to slip

$$FSin\theta - Mg = f_s$$

$$f_s \leq \mu N$$

$$FSin\theta - Mg \leq \mu(F\cos\theta)$$

$$F(\sin\theta - \mu\cos\theta) \leq Mg$$

$$F \leq \left[\frac{Mg}{\sin\theta - \mu\cos\theta} \right] - ①$$

Case-2: $FSin\theta < Mg$

For block not to slip.



$$Mg - FSin\theta = f_s$$

$$f_s \leq (f_s)_{\max}$$

$$f_s \leq \mu F\cos\theta$$

$$Mg - FSin\theta \leq \mu F\cos\theta$$

$$Mg \leq F(\sin\theta + \mu\cos\theta)$$

$$F \geq \left[\frac{Mg}{\sin\theta + \mu\cos\theta} \right] - ②$$

Find F So that there is no relative slipping b/w bigger block and smaller block

Solⁿ $F = (M+m)a$

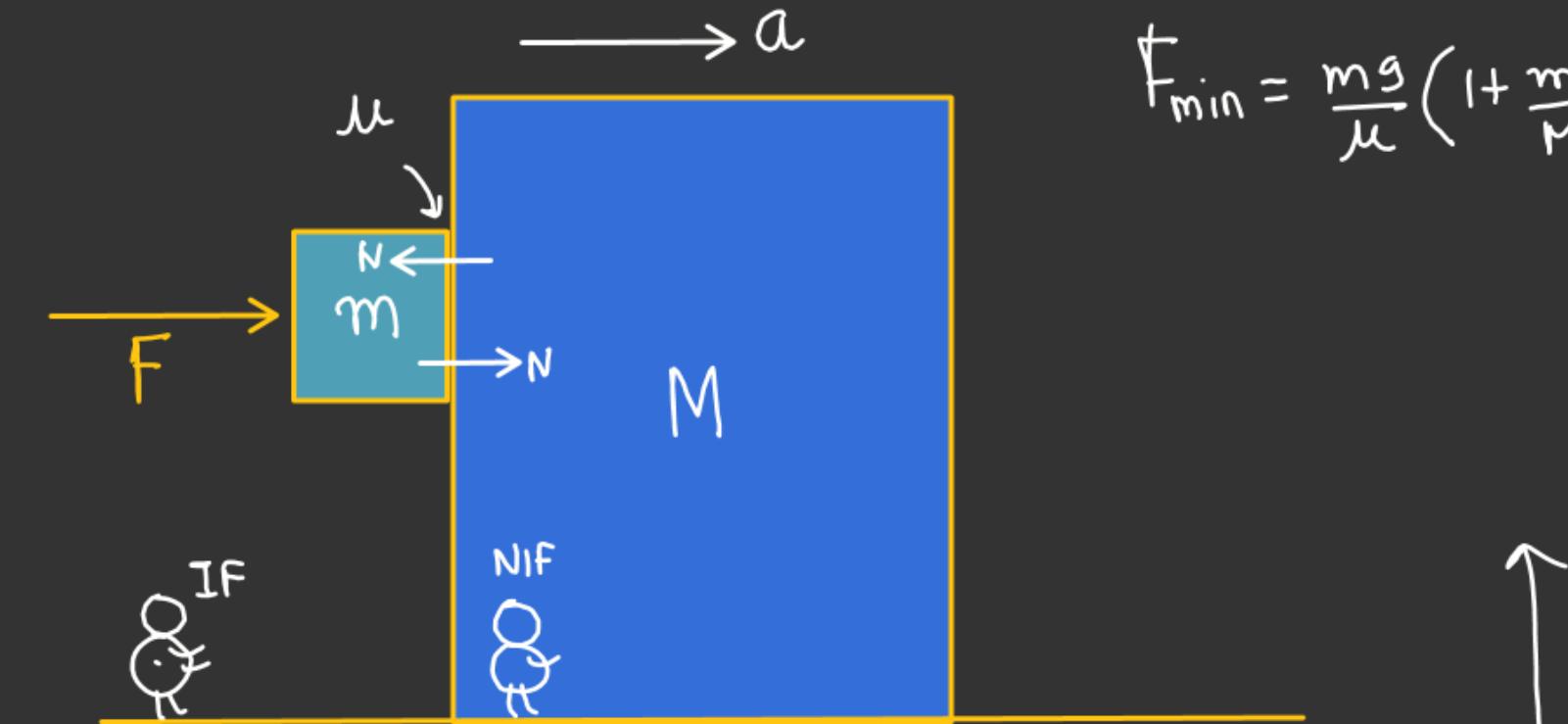
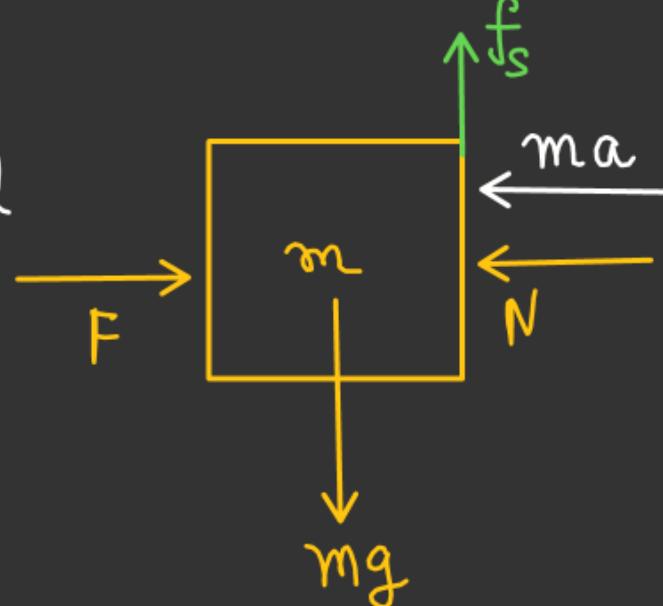
$$a = \left(\frac{F}{M+m}\right) \checkmark$$

F.B.D of smaller block w.r.t bigger block

In horizontal direction

$$F = N + ma$$

$$N = (F - ma)$$



$$f_s = mg \quad \begin{array}{l} \text{Block not} \\ \text{to Slip} \end{array}$$

$$f_s \leq (f_s)_{\max}$$

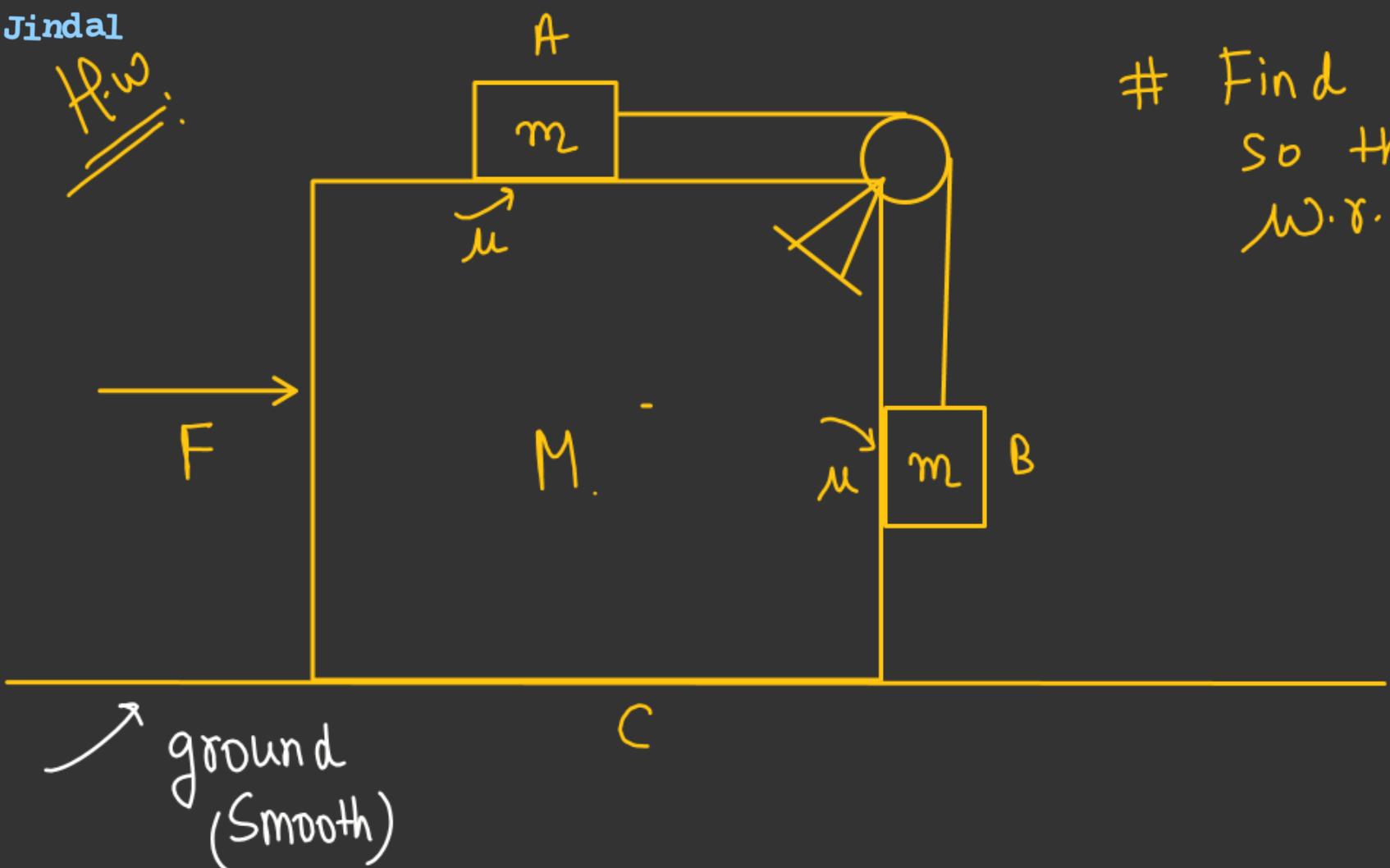
$$mg \leq \mu N$$

$$mg \leq \mu (F - ma)$$

$$mg \leq \mu \left[F - \frac{mF}{M+m} \right]$$

$$mg \leq \frac{M M F}{(M+m)} \Rightarrow F > \frac{(M+m)g}{\frac{\mu}{M}}$$

$$F \geq \frac{mg}{\mu} \left(1 + \frac{m}{M} \right)$$



Find min & max. Value of F
so that block A and B doesn't slip
w.r.t block C



FRICTION ON AN INCLINED PLANE

$$[0 < \theta < \pi/2]$$

For block not to slip.

$$N = mg \cos \theta$$

Angle of Repose: →
Min. angle of inclination at which block is about to slip.

$$mg \sin \theta = f_s$$

$$f_s \leq (f_s)_{\max}$$

$$mg \sin \theta \leq \mu N$$

$$mg \sin \theta \leq \mu mg \cos \theta$$

$$\tan \theta \leq \mu$$

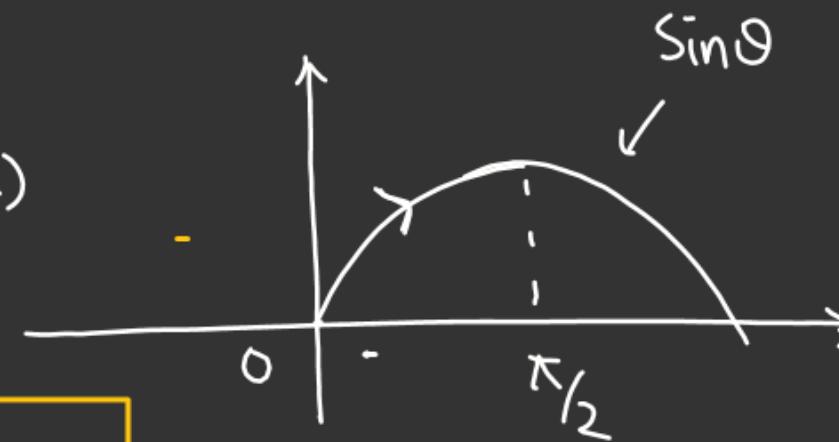
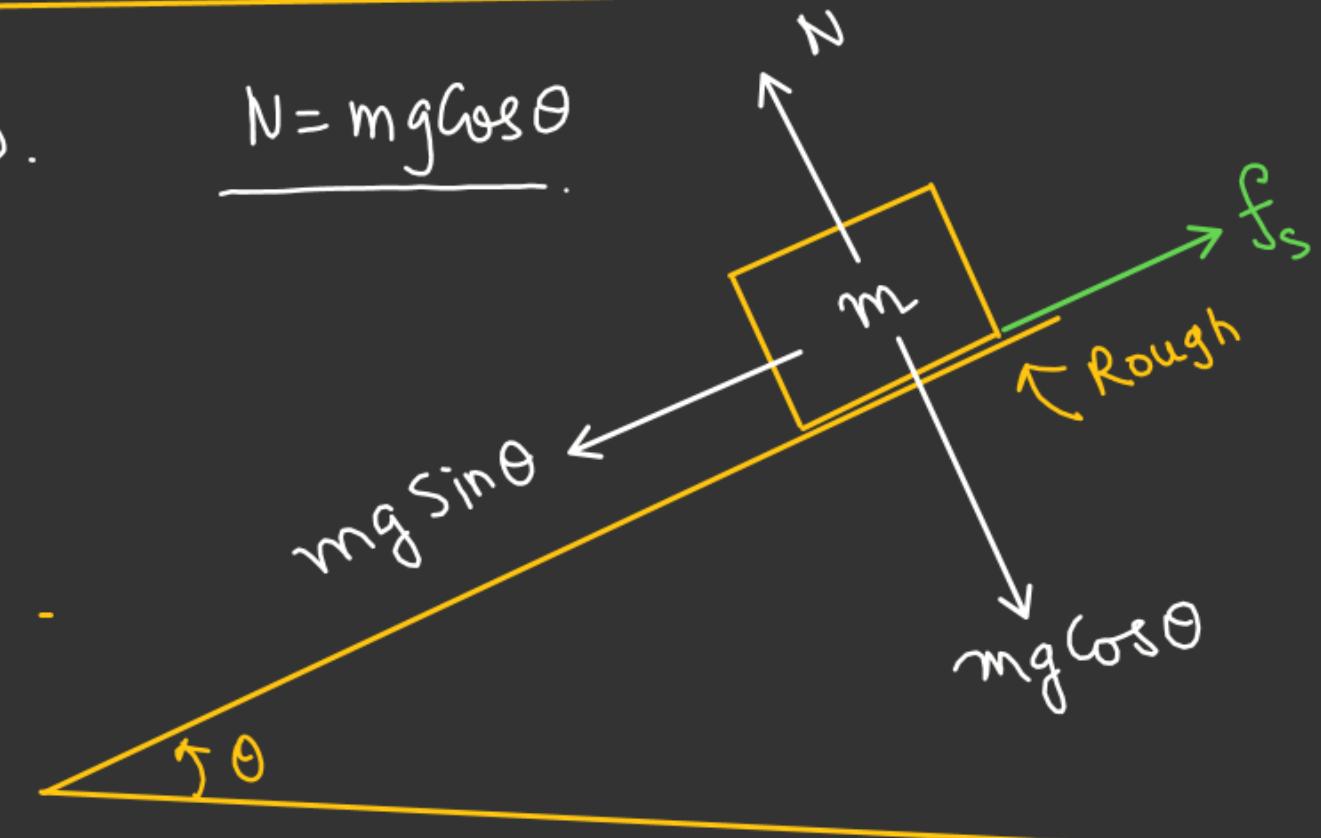
$$\theta \leq \tan^{-1}(\mu)$$

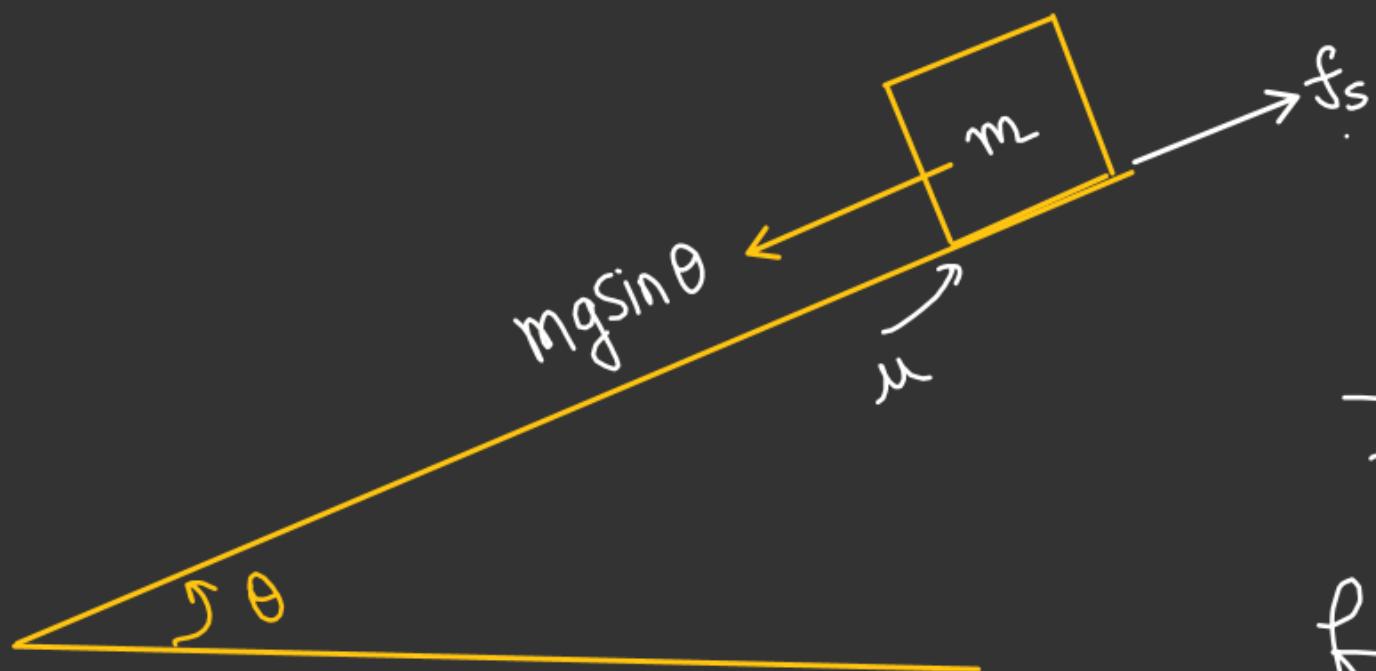
Angle of Repose

Not to slip
 $\theta_{\max} = \tan^{-1}(\mu)$

For block just to slip

$$\theta_{\min} = \tan^{-1}(\mu)$$





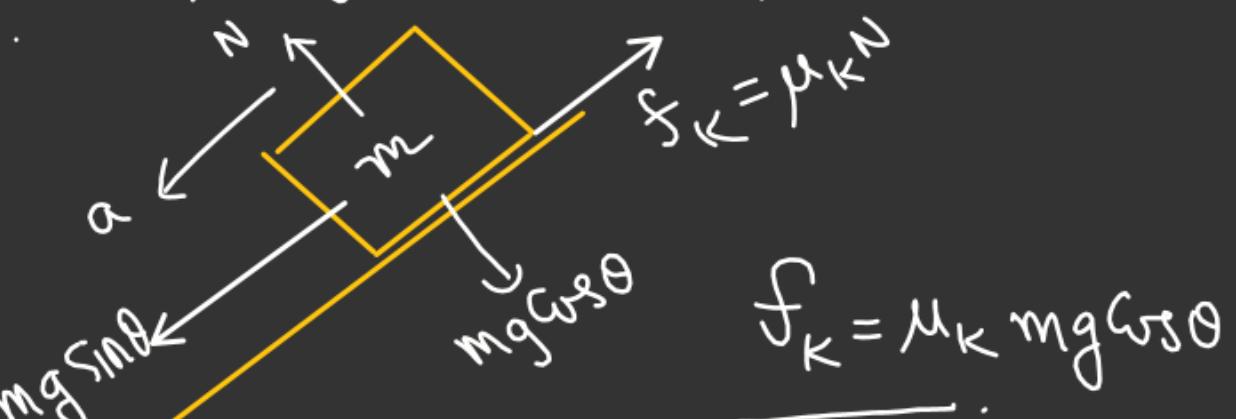
If $mg \sin \theta < (f_s)_{\max}$
 $\Rightarrow [f_s = mg \sin \theta]$

If $mg \sin \theta > (f_s)_{\max}$
Relative Slipping started & kinetic
friction.

$$mg \sin \theta - f_k = ma$$

$$mg \sin \theta - \mu_k mg \cos \theta = ma$$

$$a = g (\sin \theta - \mu_k \cos \theta)$$



$$f_k = \mu_k mg \cos \theta$$

