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FRICTION

Def^n :→ Force acting b/w the Surface of two contact bodies in such a way so that it always opposes the tendency of relative motion or relative motion b/w the two bodies

Type of friction

1. Static friction
2. Kinetic friction

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Static friction

↳ It always b/w two contact surfaces when there is tendency of relative motion

↳ It is a self adjustable friction force. It's value vary from zero to its limiting value.

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

$(f_s)_{max}$ = [Maximum value of static friction] $\boxed{(f_s)_{max} = \mu_s \cdot N}$

[μ_s = coff^n^ of static friction

↳ When static friction acts, body is in equilibrium so apply Newton's Law.

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** Kinetic friction

⇒ It has fixed value.

$$\boxed{f_K = \mu_K \cdot N}$$

μ_K = Cofficient of Kinetic friction, depends on the nature of contact surface.

N = Normal reaction.

➡ It act's when relative motion started b/w the two bodies

⇒ At the time of kinetic friction, Apply Newton's 2nd Law

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LAW OF FRICTION

According to law of friction, friction force acting b/w two surface is directly proportional to Normal reaction b/w the contact surface.

$$f \propto N$$

$$\boxed{f = \mu N}$$

μ = proportionality Constant [depends on nature of the contact surface]

If friction is kinetic
$\mu \rightarrow \mu_k \rightarrow$ cofficient of kinetic friction

If friction is static then for maximum static friction
$(\mu \rightarrow \mu_s)$

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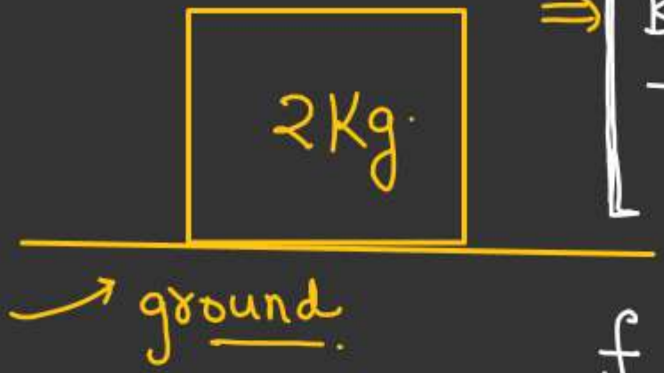
4. Deciding friction force :→

$\mu_s = 0.2$

$\mu_K = 0.1$

At t = 0



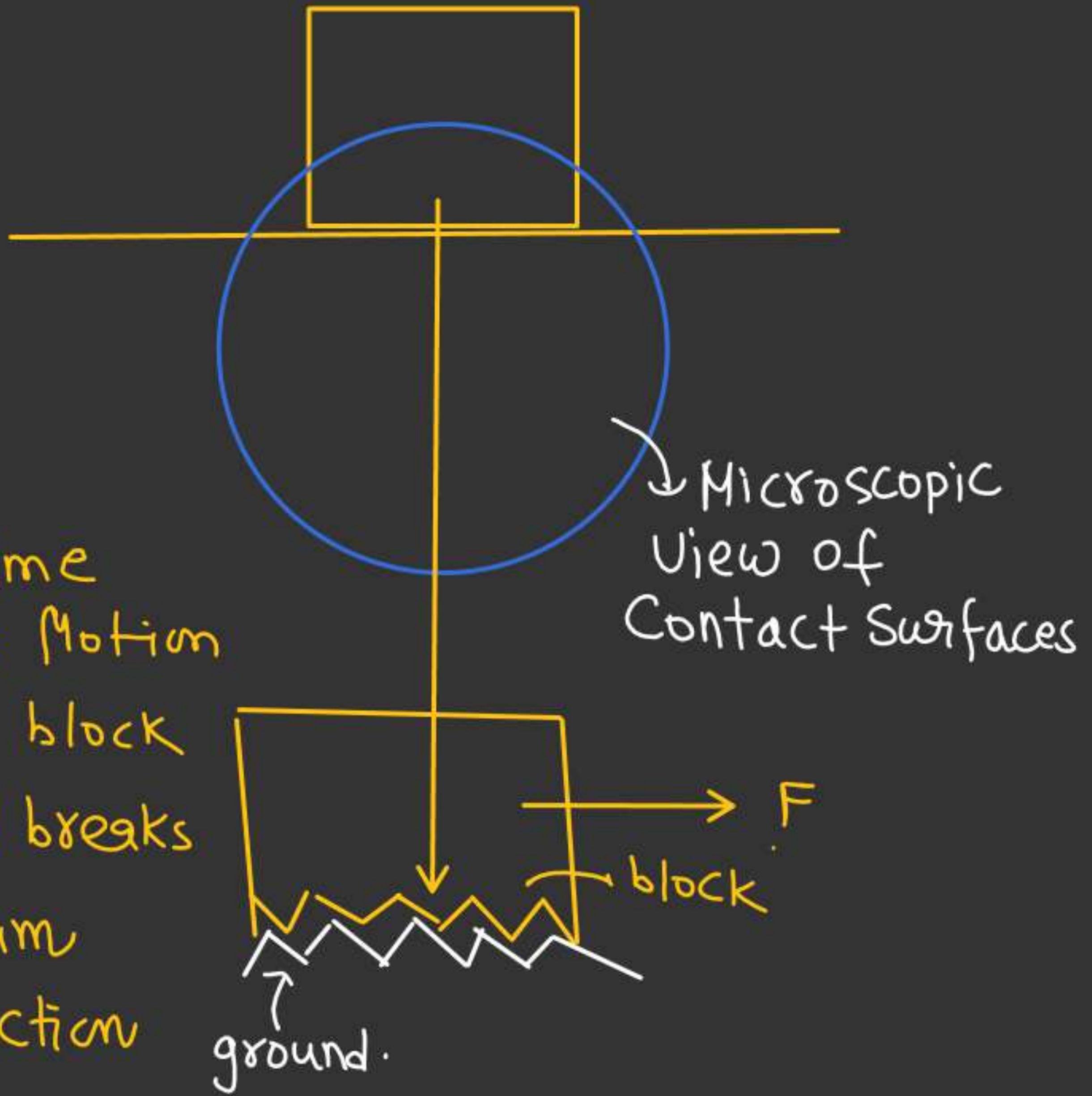
F = 0

⇒ [Block neither has a tendency of relative motion nor it has relative motion

$f = 0$

Note :-

At the time of relative Motion linkage b/w block and ground breaks and maximum static friction acts



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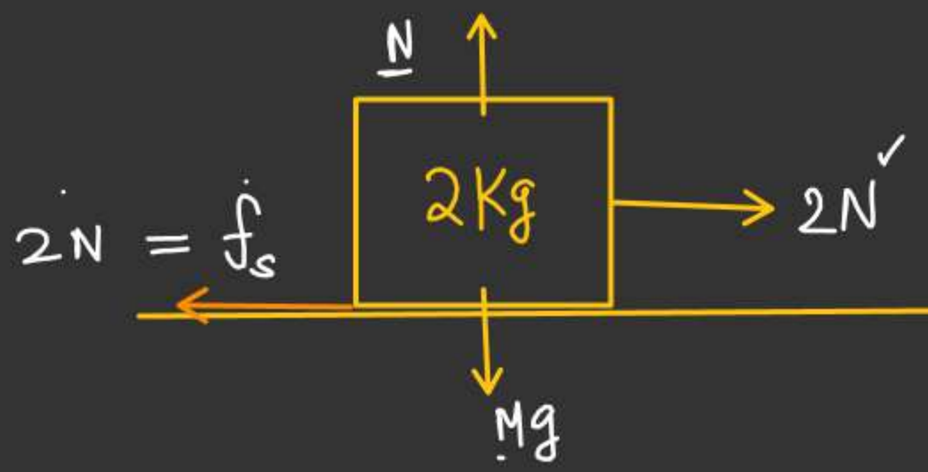
At $\underline{t = 1\,sec}$, $(F = 2N)$



$(f_s)_{max} = \underline{\mu_s N}$

$\boxed{0 \le f_s \le \underline{4N}}$

$= \mu_s [Mg]$

$= 0.2 \times 2 \times 10$

$= \underline{4N}$

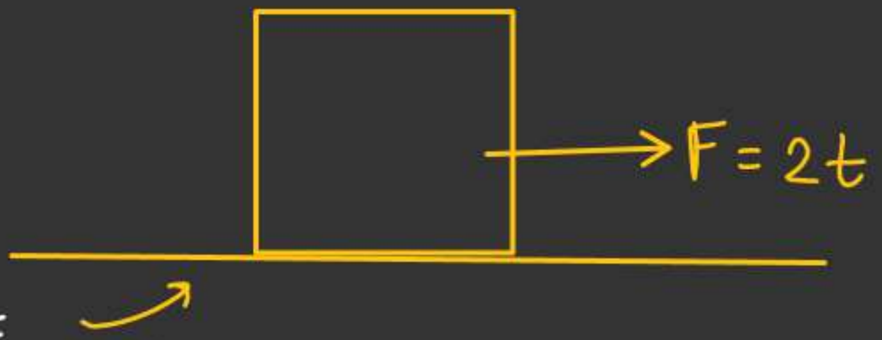
$$\boxed{\begin{array}{l} F < (f_s)_{max} \Rightarrow F = f_s \\ \qquad\qquad\quad \Rightarrow \text{Block stationary} \end{array}}$$

$\underline{\text{At } t = 2\,sec}$

$F = 4N$

$\mu_s = 0.2$

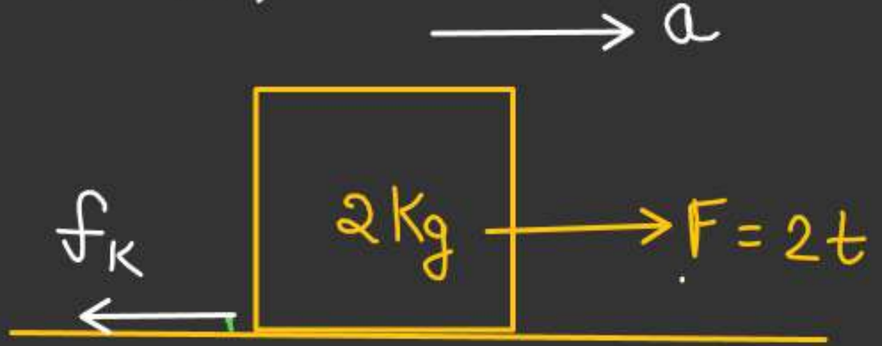
$\mu_K = \underline{0.1}$



Here $F = (f_s)_{max}$
the block has tendency
of relative motion

$\underline{\text{At } t > 2\,sec}$

$F > (\underline{4N})$



$f_K = \mu_K \cdot N$

$= 0.1 \times 2 \times 10$

$= 2N$

$a = \dfrac{2t - 2}{2}$

$a = (t - 1)$

$\Downarrow$

$a = \left(\dfrac{F - f_K}{m}\right)$

Relative
$\underline{\text{Motion}}$ Started

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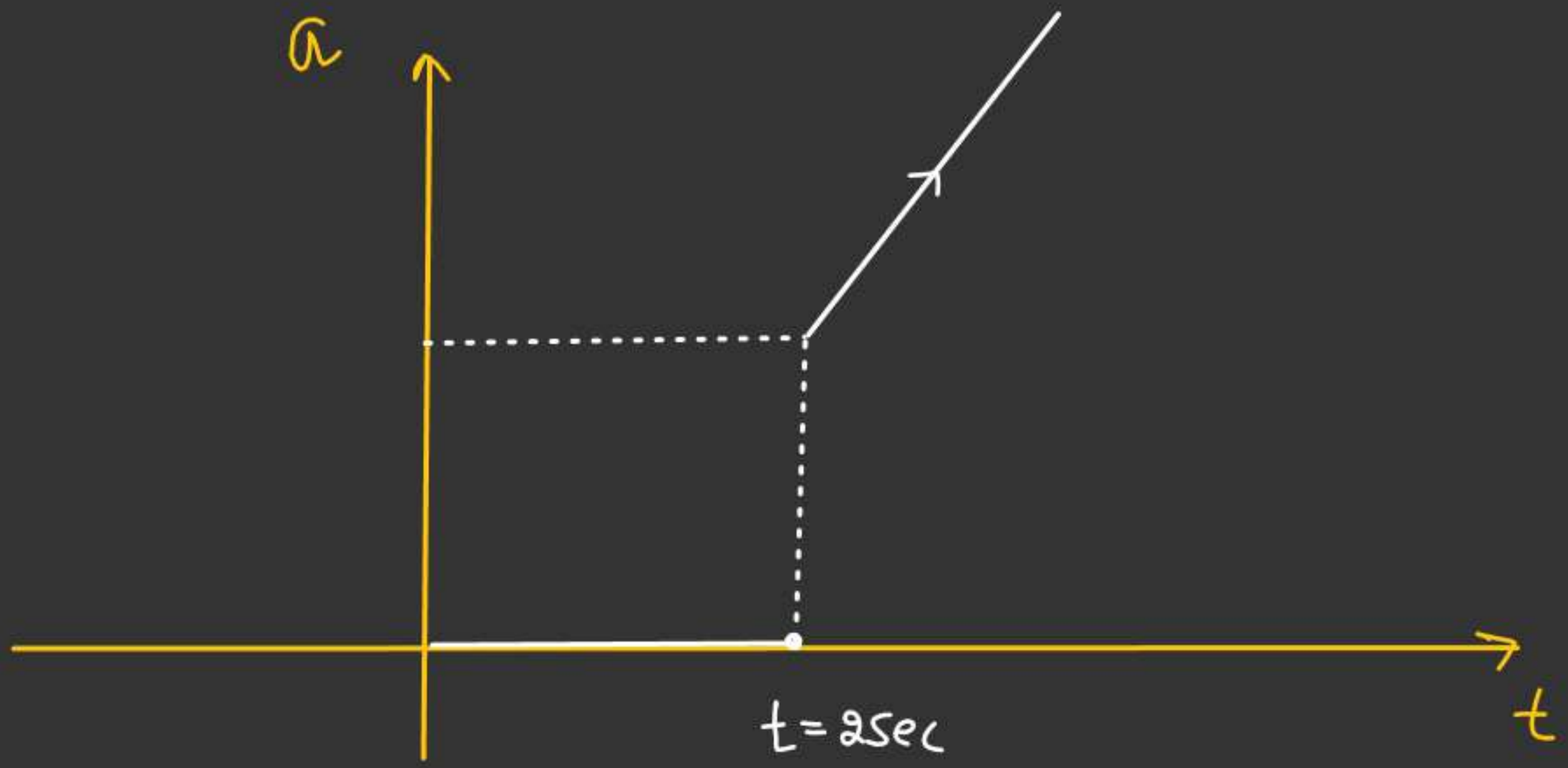

$0 \le t \le 2\,sec$ | $t > 2\,sec$

$a = 0$ | $a = (t-1)$

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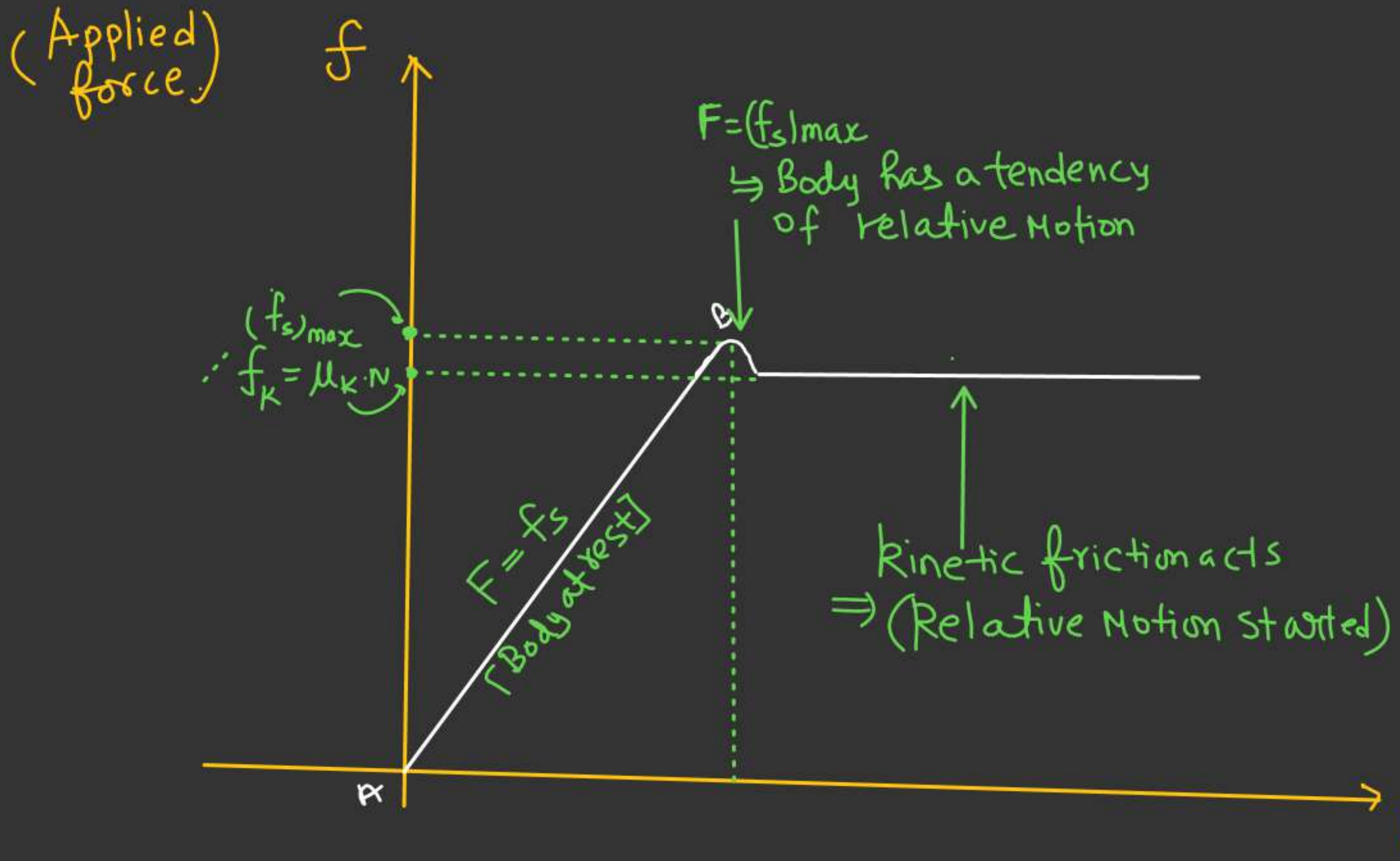

$F < (f_s)_{max}$

$F = f_s$

In general (Not always)

$\mu < 1$

μ_s is always grater than μ_k

$\boxed{\text{If in question only } \mu \text{ is given then take } \mu_s = \mu_k = \mu.}$

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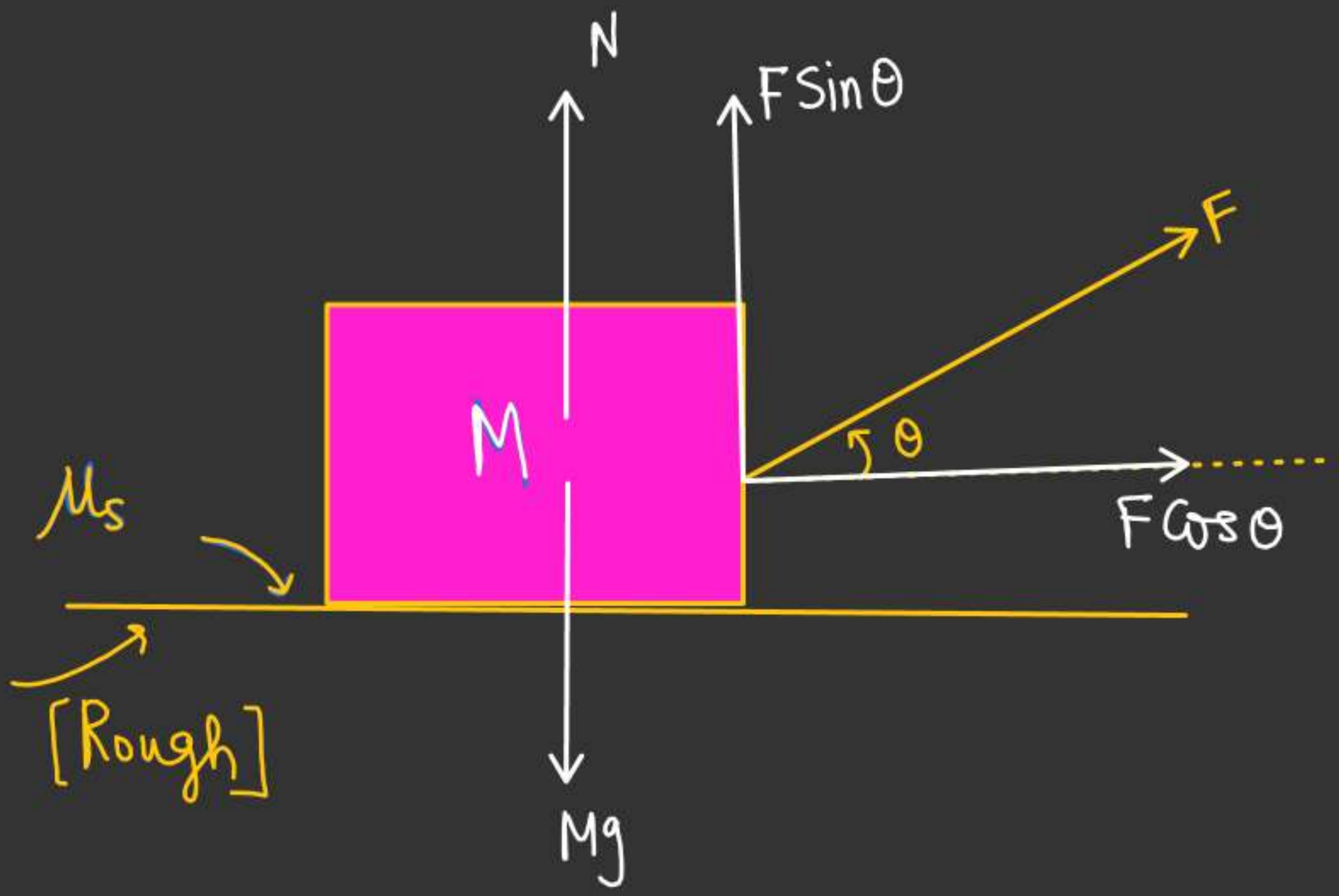
Case of push or pull :→

Case of pull :→ (Block always in contact with the ground)



In y-direction

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

$$N = [Mg - F\sin\theta]$$

For block to move

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

$$F\cos\theta \geq \mu_s N$$

$$F\cos\theta \geq \mu_s (Mg - F\sin\theta)$$

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

$$\boxed{F \geq \frac{\mu_s Mg}{\cos\theta + \mu_s \sin\theta}}$$

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For block just to move :→

$$F = \frac{\mu_s mg}{\cos\theta + \mu_s \sin\theta}$$

Minimum value of F for block just to move.

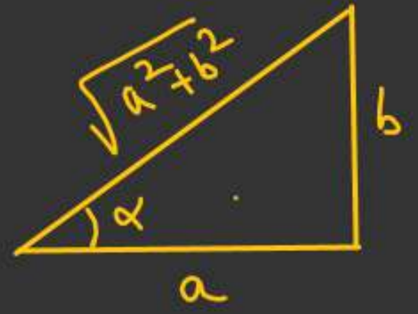
for F_{min}, $(\cos\theta + \mu_s \sin\theta)$ should be maximum

$$\text{Max}(\cos\theta + \mu_s \sin\theta) = \sqrt{(1)^2 + \mu_s^2}$$

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

$y = f(\theta)$.

$y = a \sin\theta + b\cos\theta$



M-1 For maxima or minima

$$\left[\frac{dy}{d\theta} = 0\right]$$

M-2

$$y = \sqrt{a^2+b^2}\left[\frac{a}{\sqrt{a^2+b^2}}\sin\theta + \frac{b}{\sqrt{a^2+b^2}}\cos\theta\right]$$

$$y = \sqrt{a^2+b^2}\left[\sin\theta\cos\alpha + \sin\alpha\cdot\cos\theta\right]$$

$$\boxed{y_{max} = \sqrt{a^2+b^2}} \leftarrow y = \sqrt{a^2+b^2}\,[\sin(\theta+\alpha)]$$