Static friction :→

→ selfadjustable force

→ maximum static force

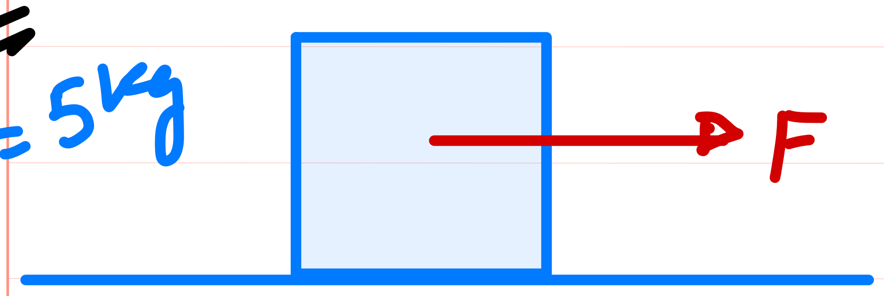
$$\boxed{(f_s)_{max} = f_{SL} = \mu_s N}$$

$$f_s \leq f_{SL}$$

$$\boxed{f_s \leq \mu_s N}$$

Ex

$m = 5 kg$



Rough surface $\left(\mu_k = 0.2,\ \mu_s = 0.3\right)$

$f_k = \mu_k N$

$= 0.2 \times Mg$

$= 0.2 \times 5 \times 10$

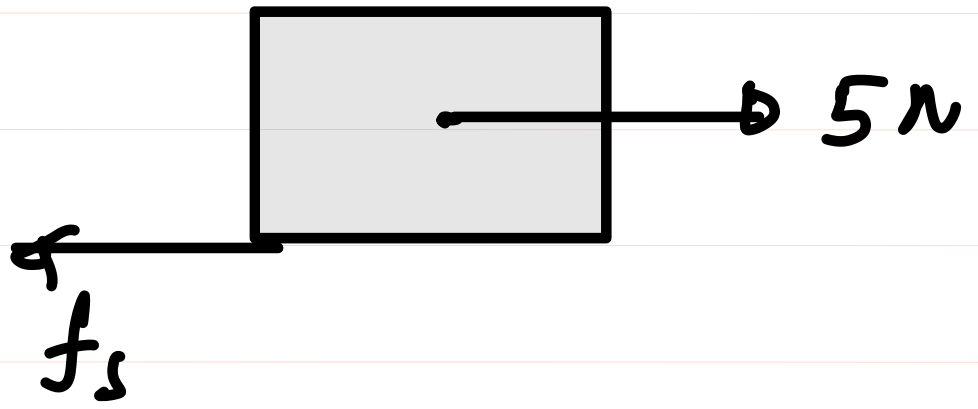
$$\boxed{f_k = 10 N}$$

$f_{SL} = \mu_s N$

$= 0.3 \times 5 \times 10$

$$\boxed{f_{SL} = 15 N}$$

Now $F = 5N$ acc. of body and value of friction force is



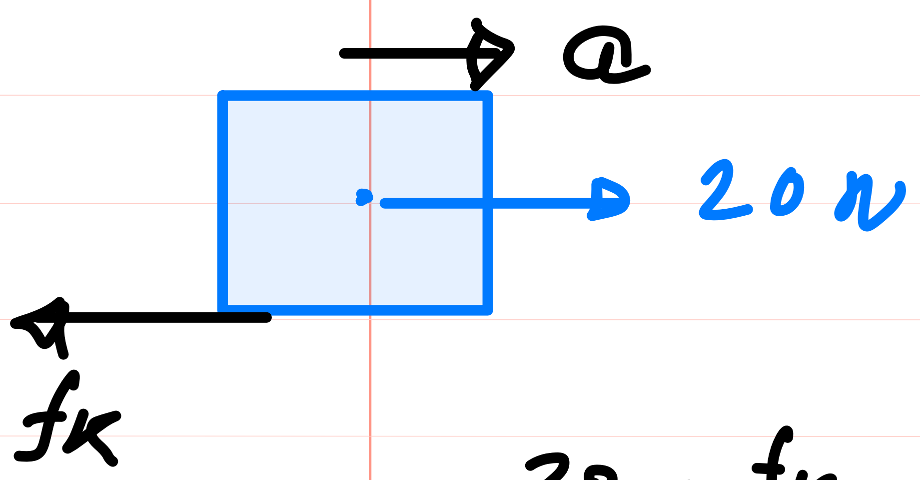
$a = 0$

$f_s = 5N$

If $F = 10 N$ $\quad a = 0$, $f_s = 10 N$

If $F = 15 N$ $\quad a = 0$ $\quad f_{SL} = 15 N$

If $F = 20 N > f_{SL}$ body is in motion

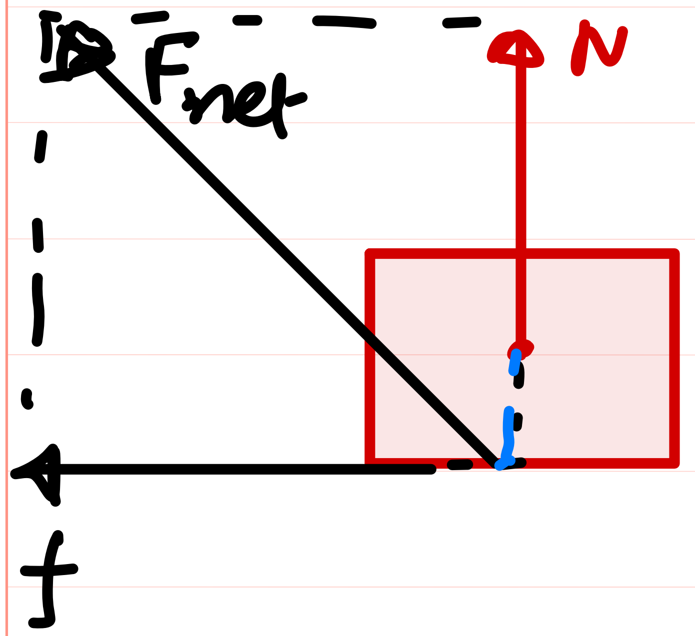


$a = \dfrac{20 - f_k}{m}$

$a = \dfrac{20 - 10}{5}$

$$\boxed{a = 2 m/s^2}$$

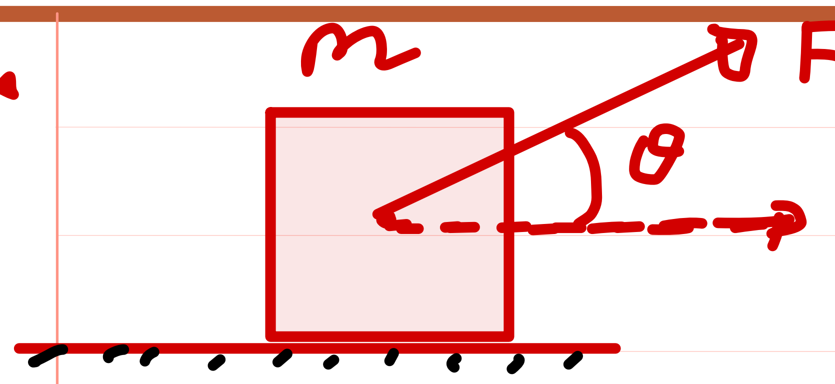
NET contact force (F_{net})



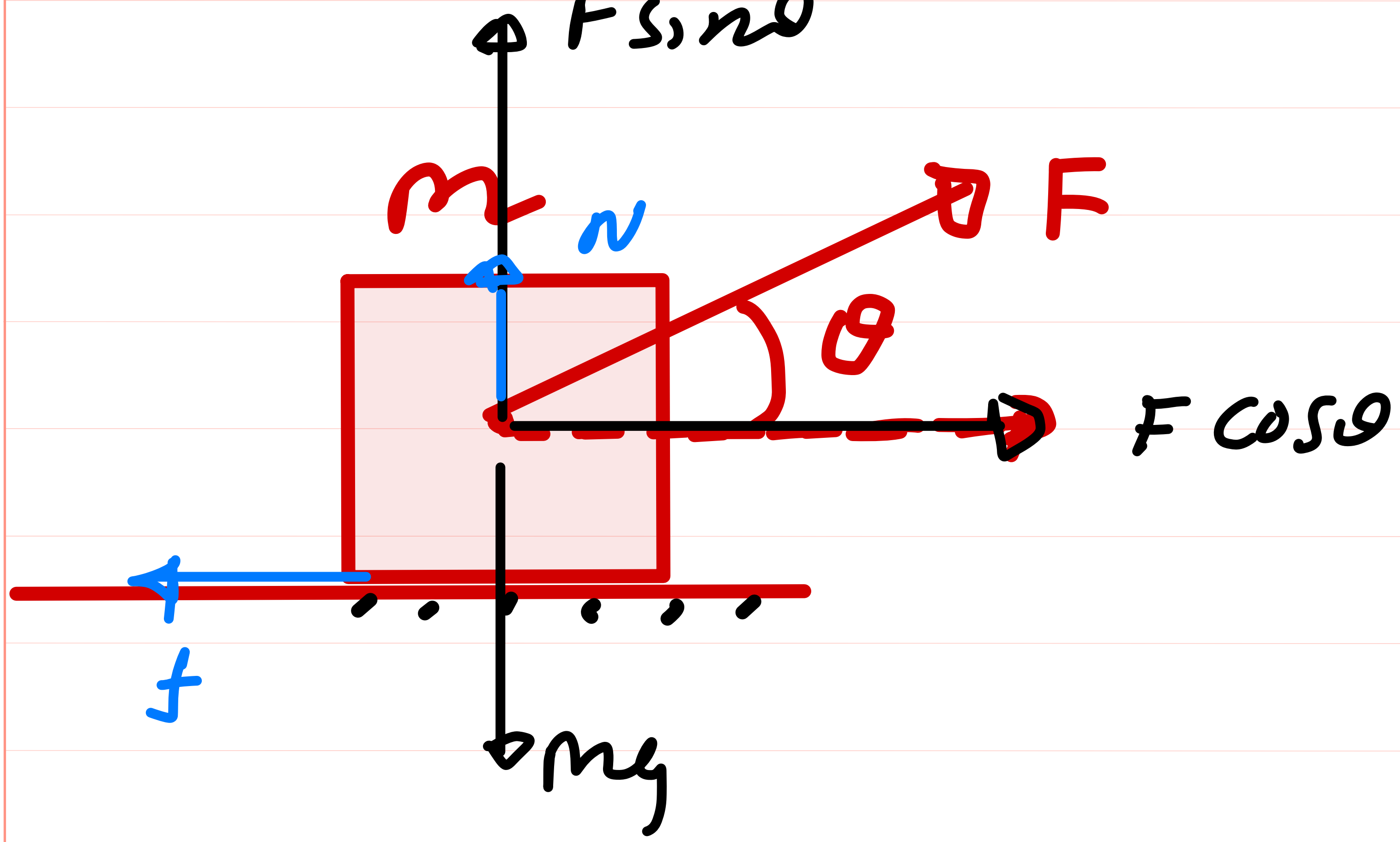
$$\boxed{F_{net} = \sqrt{N^2 + f^2}}$$

Condition of motion of object and Net contact force

Ex



μ_s, μ_k



Body will not move if.

$f \le f_{sL}$

$f_{sL} = \mu_s N$

$F\sin\theta + N = mg$

$N = mg - F\sin\theta$

$\boxed{f_{sL} = \mu_s(mg - F\sin\theta)}$

Body is not in motion

$f = F\cos\theta \le f_{sL}$

$F\cos\theta \le \mu_s(mg - F\sin\theta)$

$F\cos\theta + \mu_s F\sin\theta \le \mu_s mg$

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

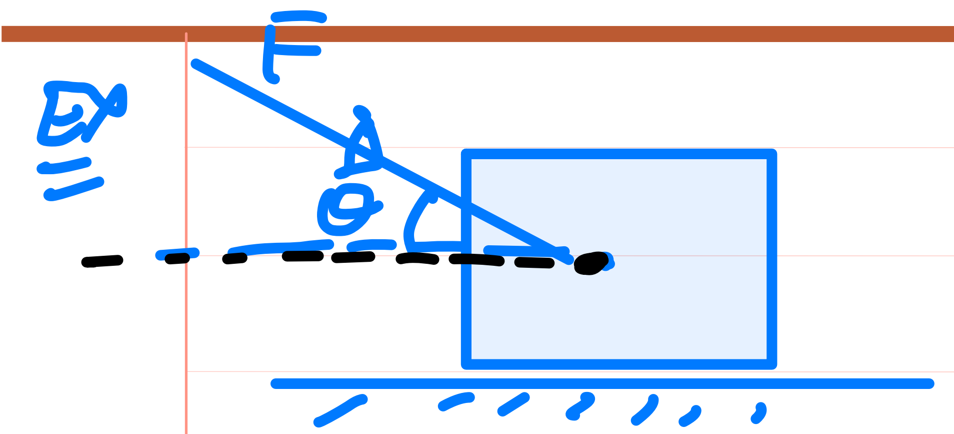
F_{max} for that object will not move

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

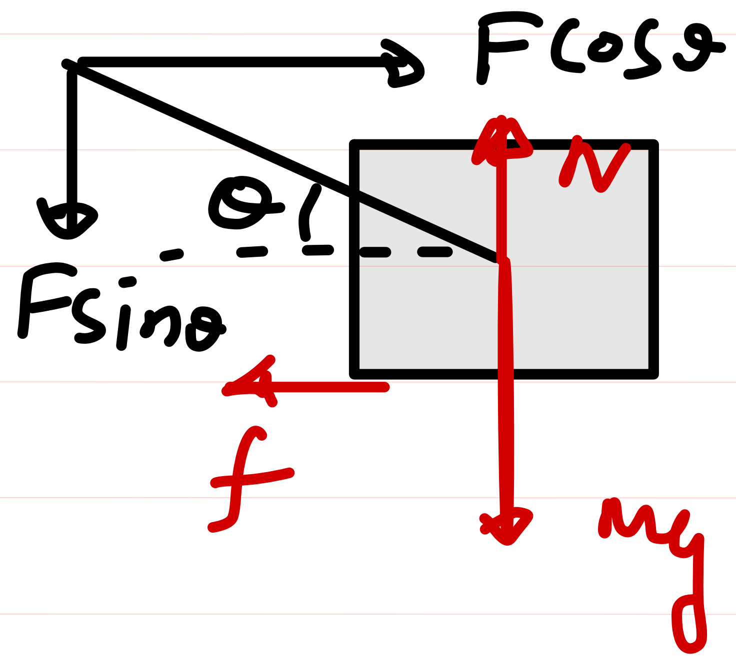
$F < F_{max}$ will not move

$F > F_{max}$ will move

Ex



Rough surface



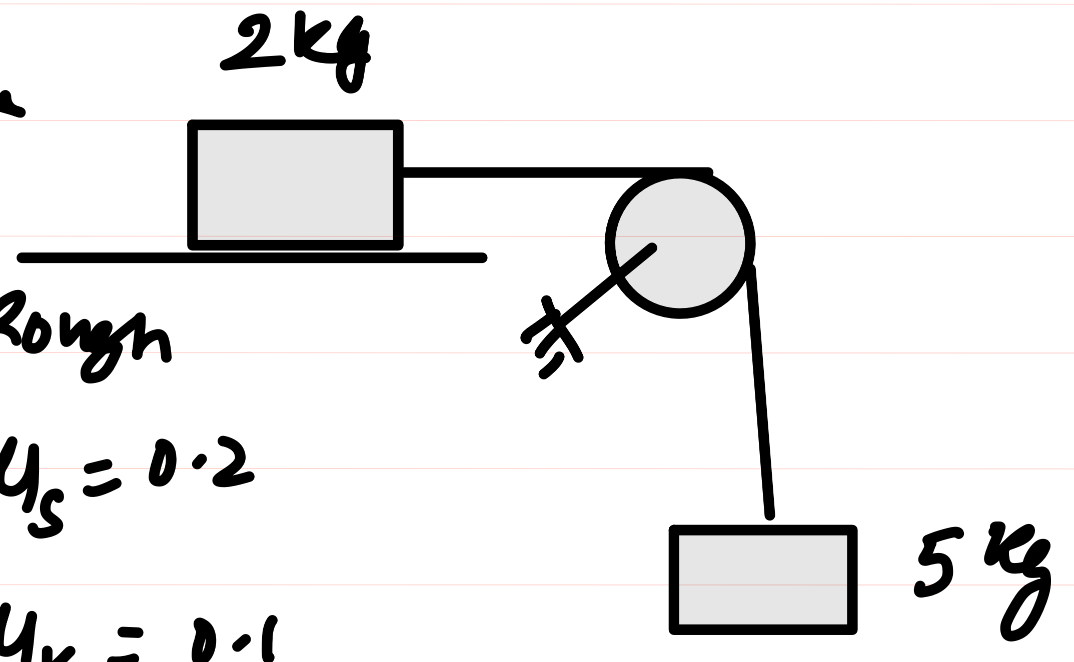
Body will not move if

$f > F\cos\theta$

$N = mg + F\sin\theta$

$\boxed{f_{sL} = \mu_s N}$

Ex

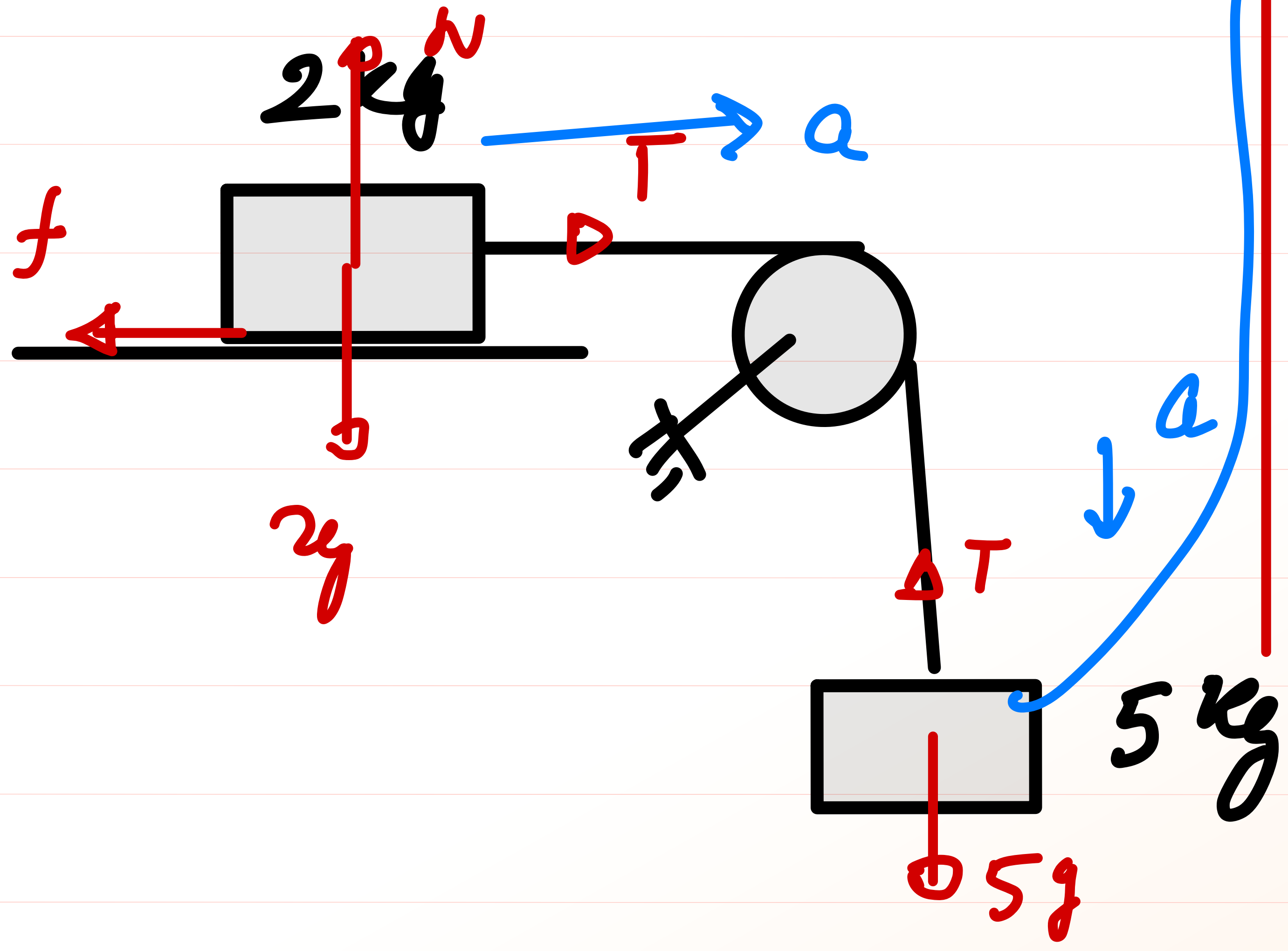


Rough

$\mu_s = 0.2$

$\mu_k = 0.1$

Find acc. of System and Tension in String



$f_{sL} = \mu_s N$

$= 0.2 \times 2 \times 10 = 4N$

$f_k = \mu_k \times N = 2N$

$a = \frac{5g - f_k}{2+5} = \frac{50-2}{7}$

$\boxed{a = \frac{48}{7}\ m/s^2}$ Ans

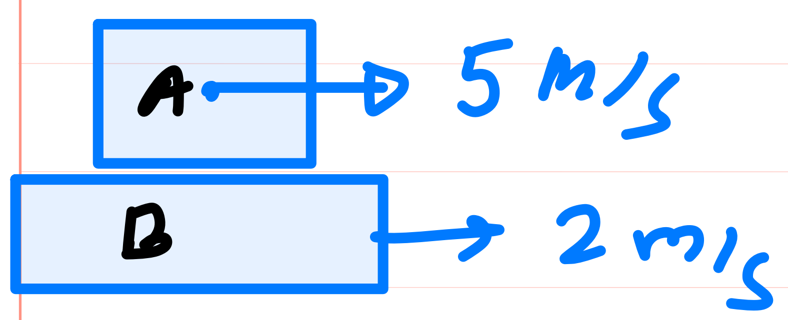
$50 - T = 5 \times \frac{48}{7}$

$T = 50 - \frac{5 \times 48}{7}$

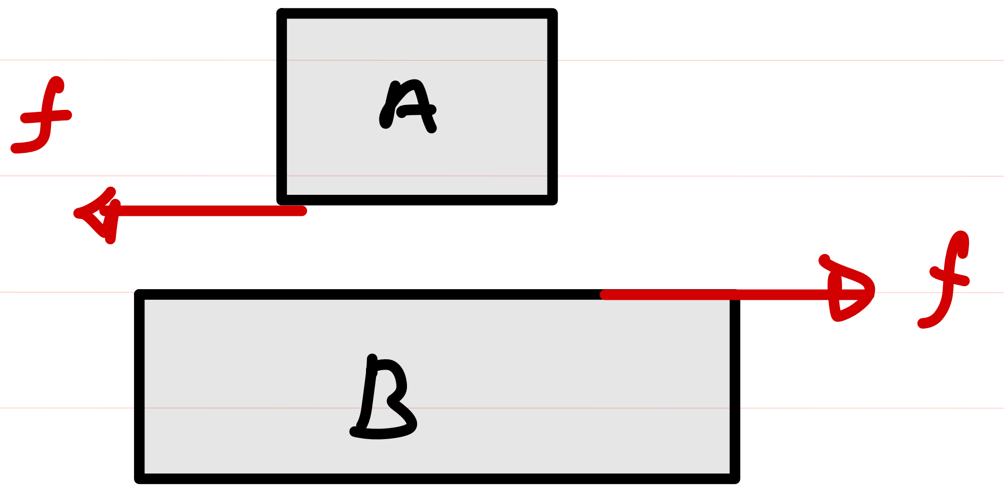
$= \frac{5}{7}(70-48)$

$\boxed{T = \frac{5}{7} \times 22\ N}$

Ex

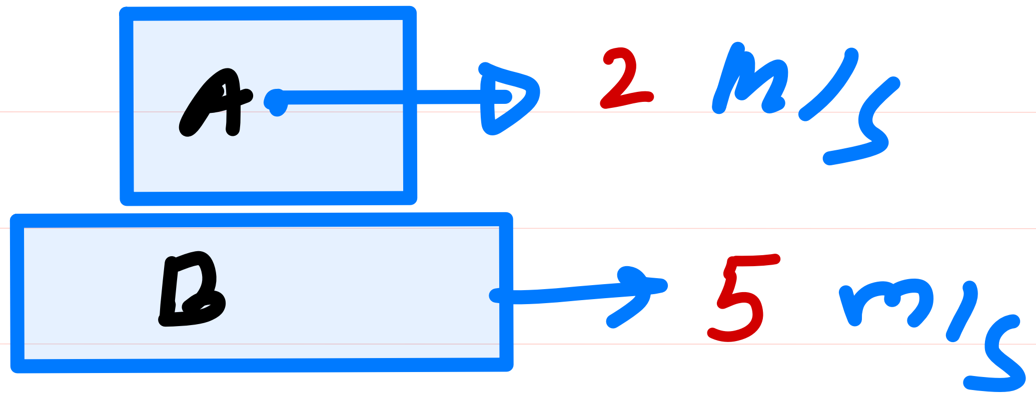


Draw dirn of friction on objects

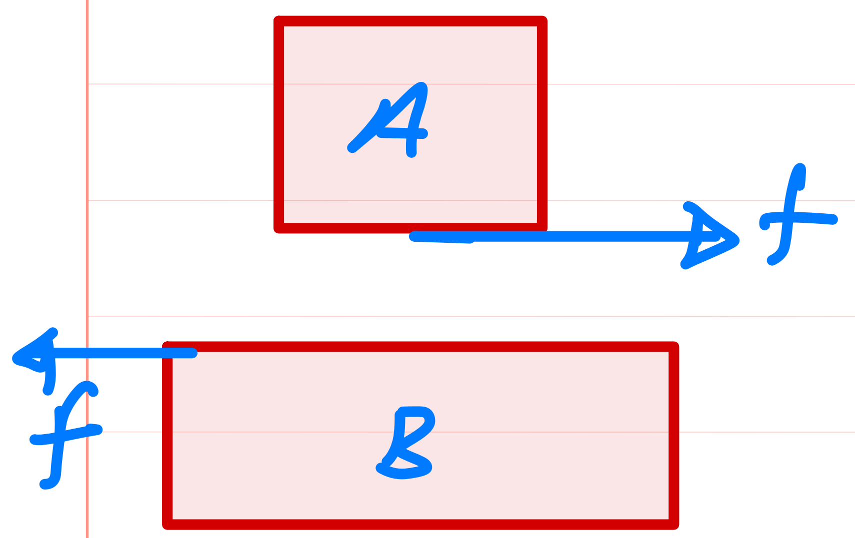


$V_A > V_B$

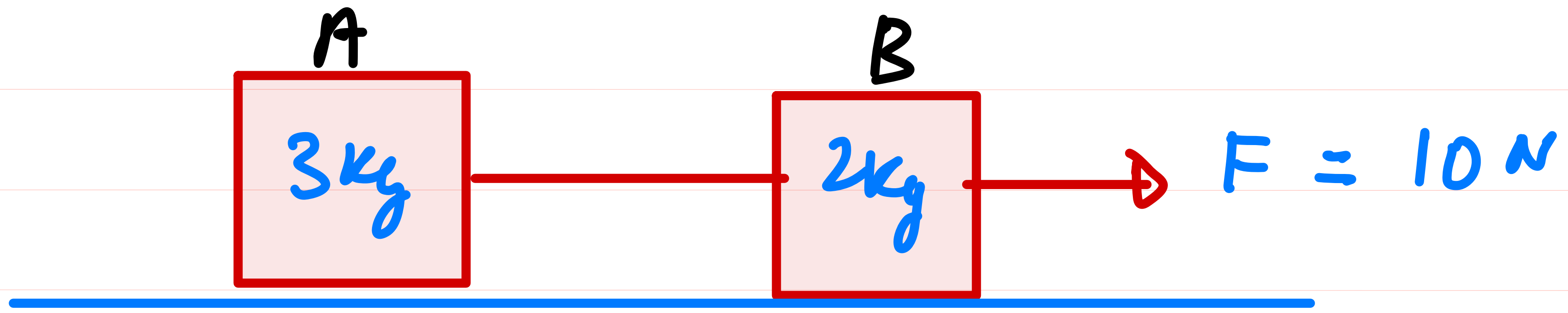
Ex



$V_B > V_A$



Ex



Find Acc. of objects and Tension in string

$\mu_s = 0.2$ $\qquad$ $\mu_s = 0.3$

$\mu_k = 0.1$ $\qquad$ $\mu_k = 0.2$

$f_{sL} = 0.2 \times 3 \times 10$

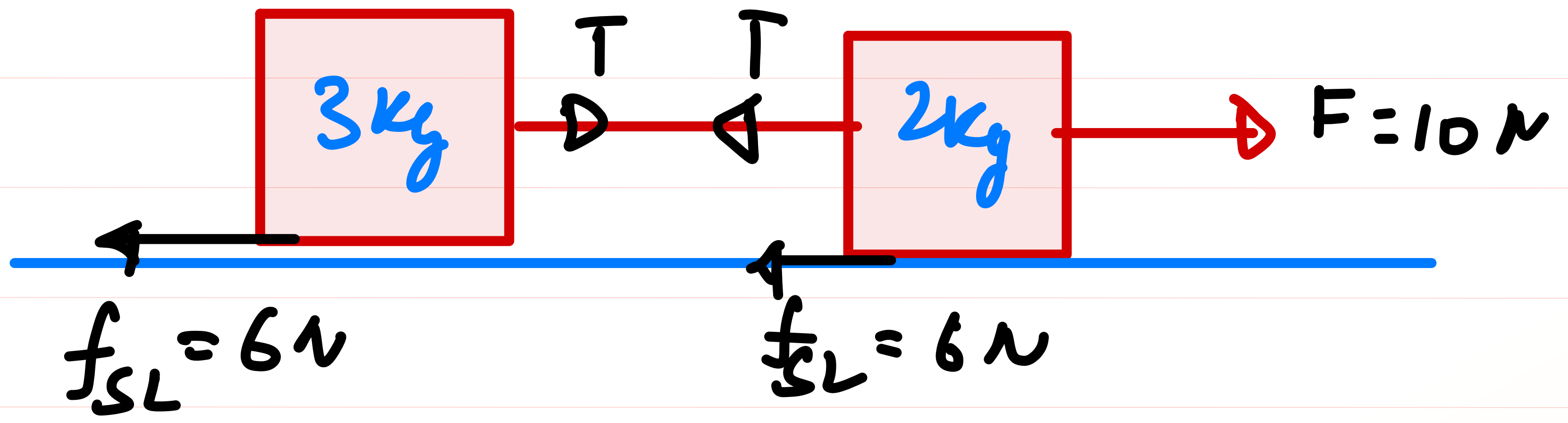
$= 6\ N$

$f_k = 3N$

$f_{sL} = 0.3 \times 20$

$= 6N$

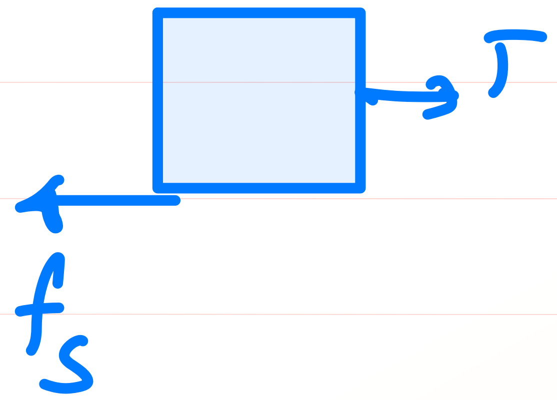
$f_k = 4N$



Blocks will not move

$\boxed{a = 0}$

For A

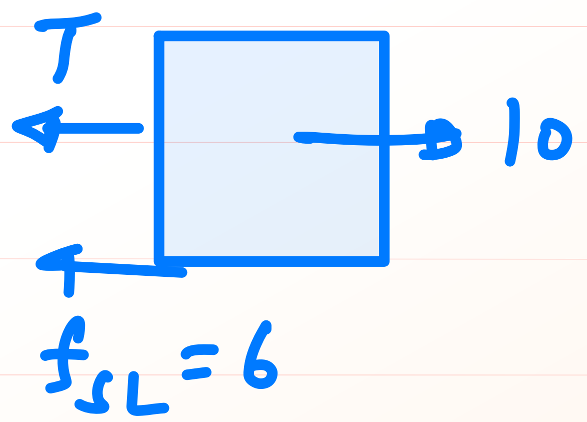


$f_s = T$

$\boxed{f_s = 4N}$

Ans

For B

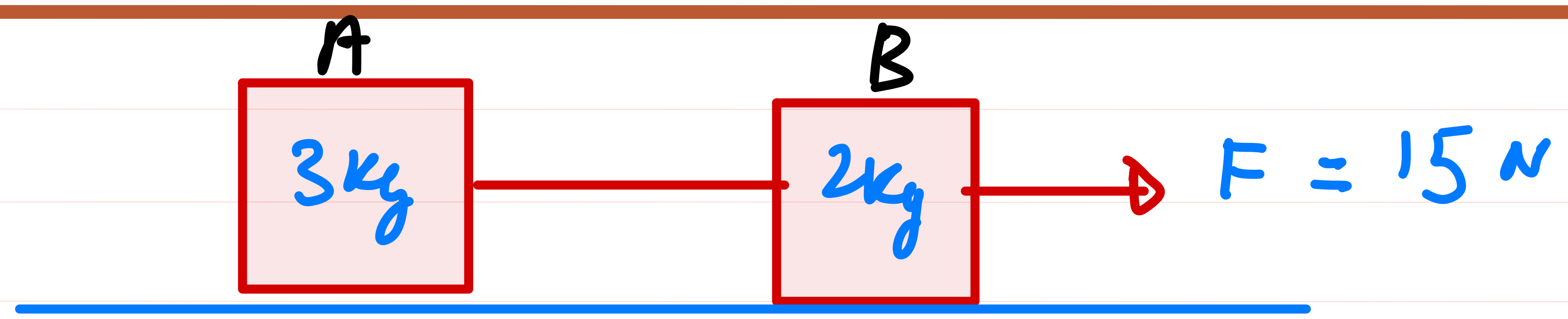


$T + 6 = 10$

$\boxed{T = 4N}$

Ans

Ex



$\mu_s = 0.2$ $\quad$ $\mu_s = 0.3$

$\mu_k = 0.1$ $\quad$ $\mu_k = 0.2$

Find ① Acc. of objects and Tension in string

② values of Friction on each object

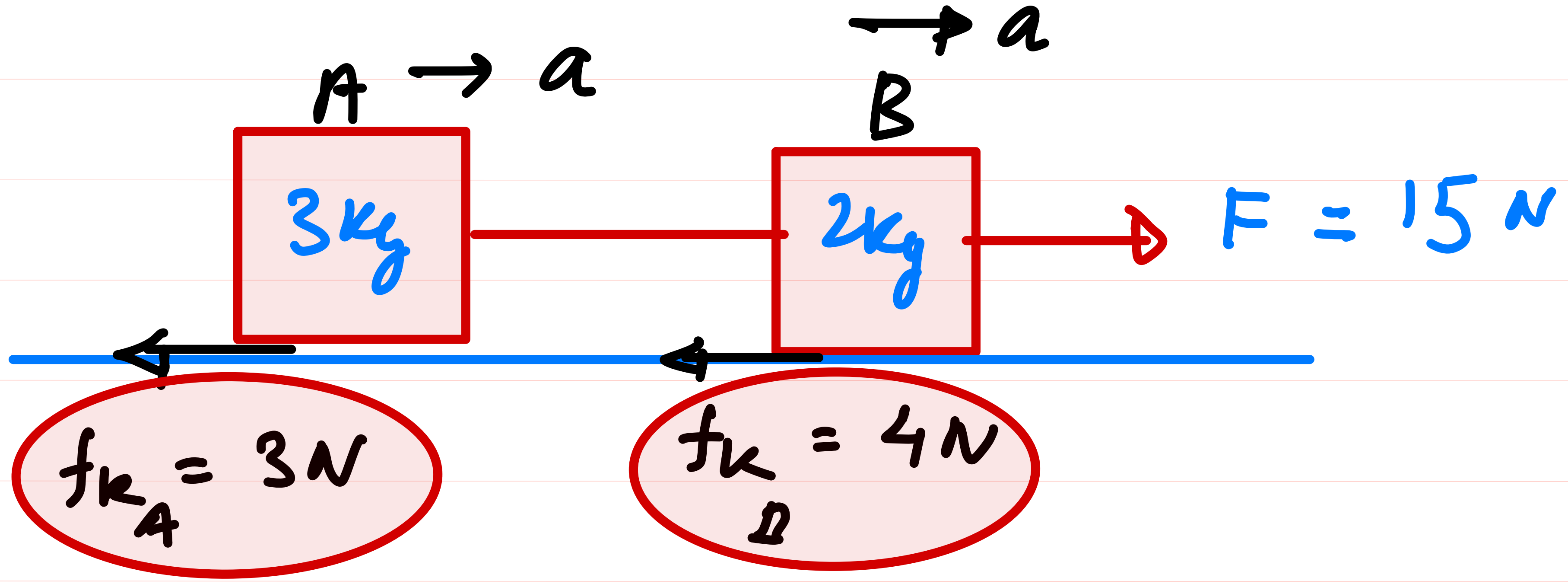
$f_{sL} = 0.2 \times 3 \times 10 = 6\,N$

$f_k = 3\,N$

$f_{sL} = 0.3 \times 20 = 6\,N$

$f_k = 4\,N$

Objects will move

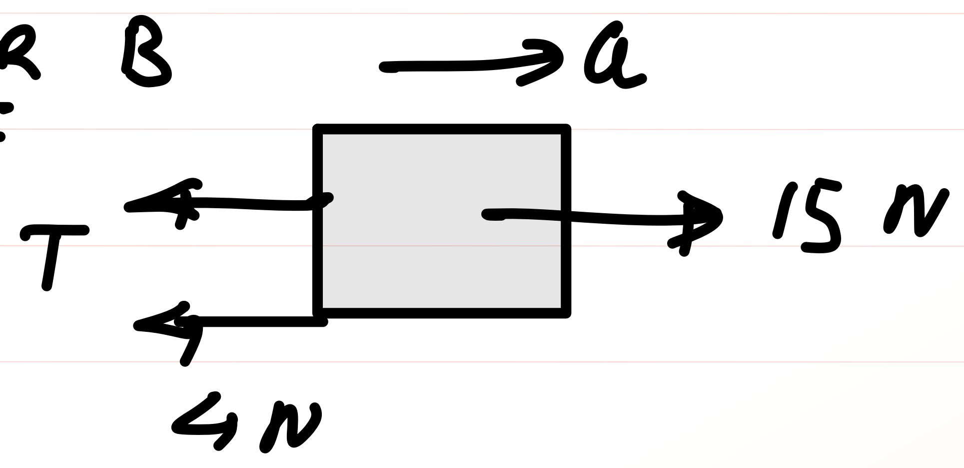


①

$$a = \frac{15 - (4+3)}{5}$$

$$\boxed{a = \frac{8}{5} = 1.6\ m/s^2}$$ Ans

② FOR B



$15 - T - 4 = 2 \times 1.6$

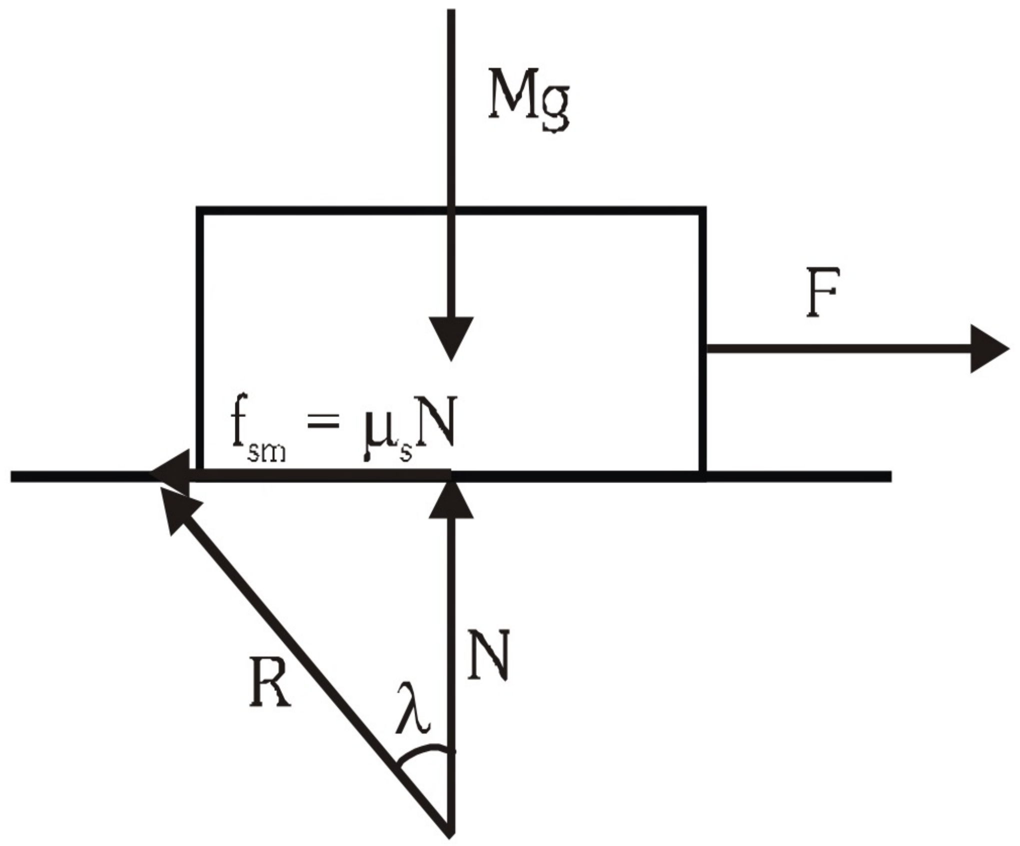
$11 - T = 3.2$

$T = 11 - 3.2 \Rightarrow$

$\boxed{T = 7.8\ N}$ Ans

ANGLE OF FRICTION :→ (λ)

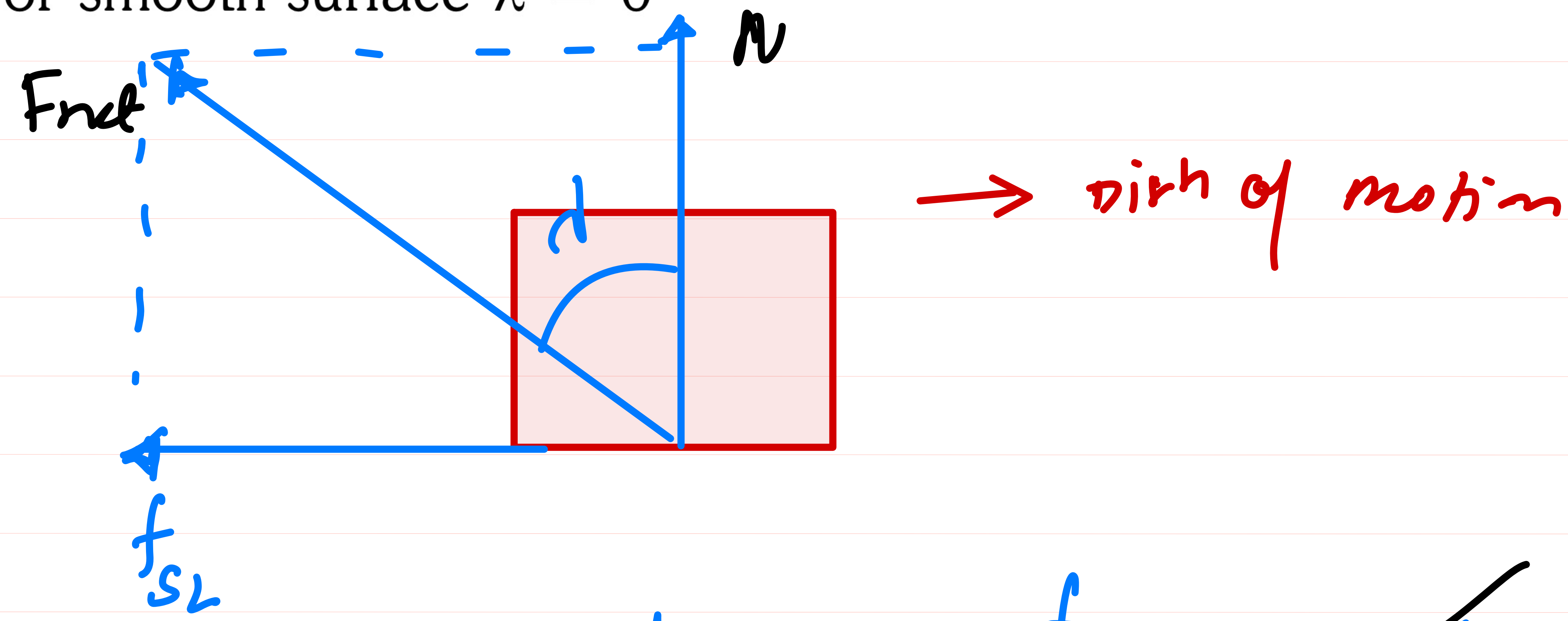
SL



The angle of friction is the angle between resultant contact force of and normal reaction N, when sliding is initiating. It is denoted by λ

$$\tan\lambda = \frac{f_{sm}}{N} = \frac{\mu_s N}{N} = \mu_s$$

- For smooth surface $\lambda = 0$



$$\tan\lambda = \frac{f_{SL}}{N} = \frac{\mu_s \cancel{N}}{\cancel{N}}$$

$$\tan\lambda = \mu_s$$

$$\boxed{\lambda = \tan^{-1}(\mu_s)}$$

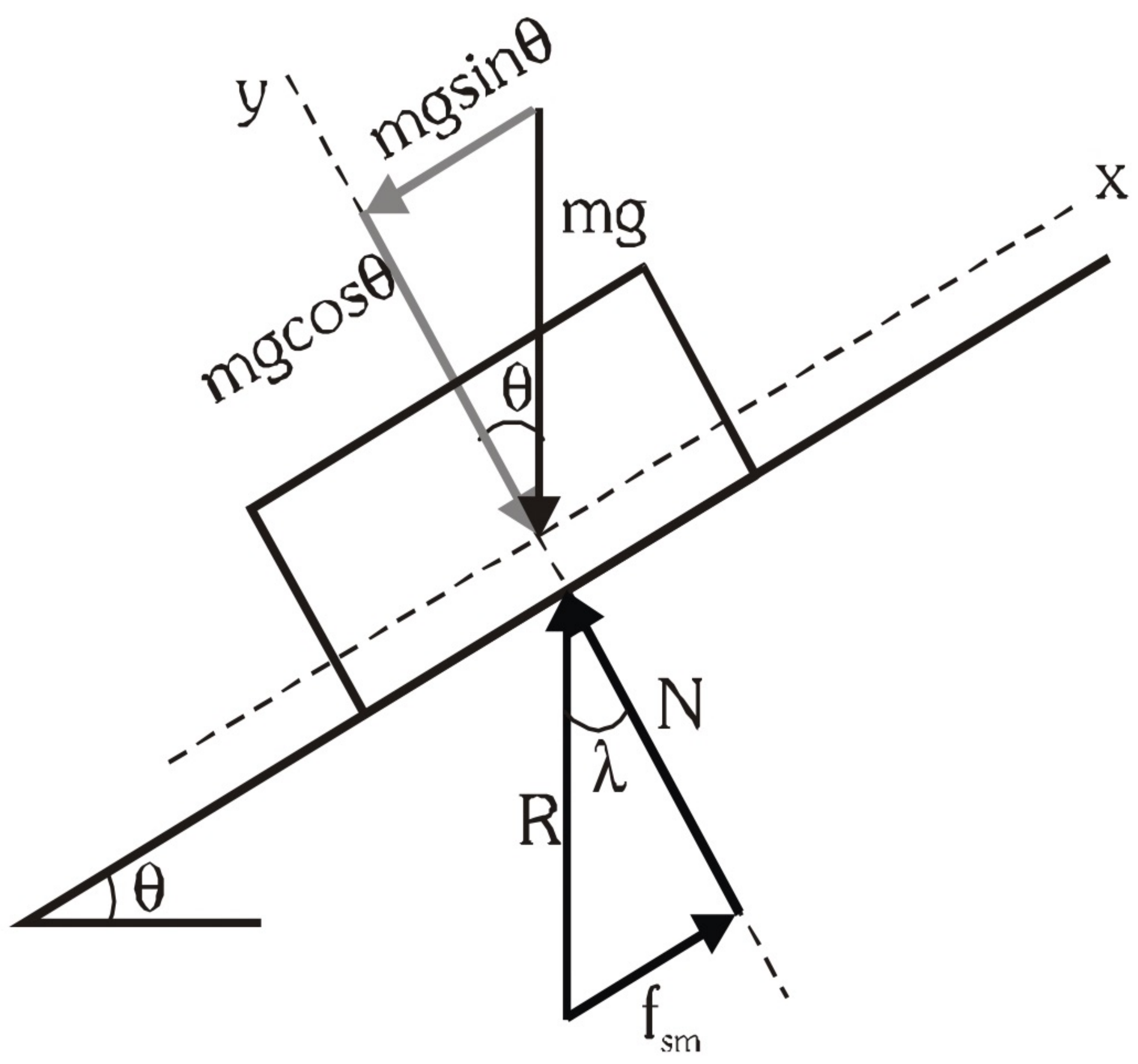
ANGLE OF REPOSE (θ)

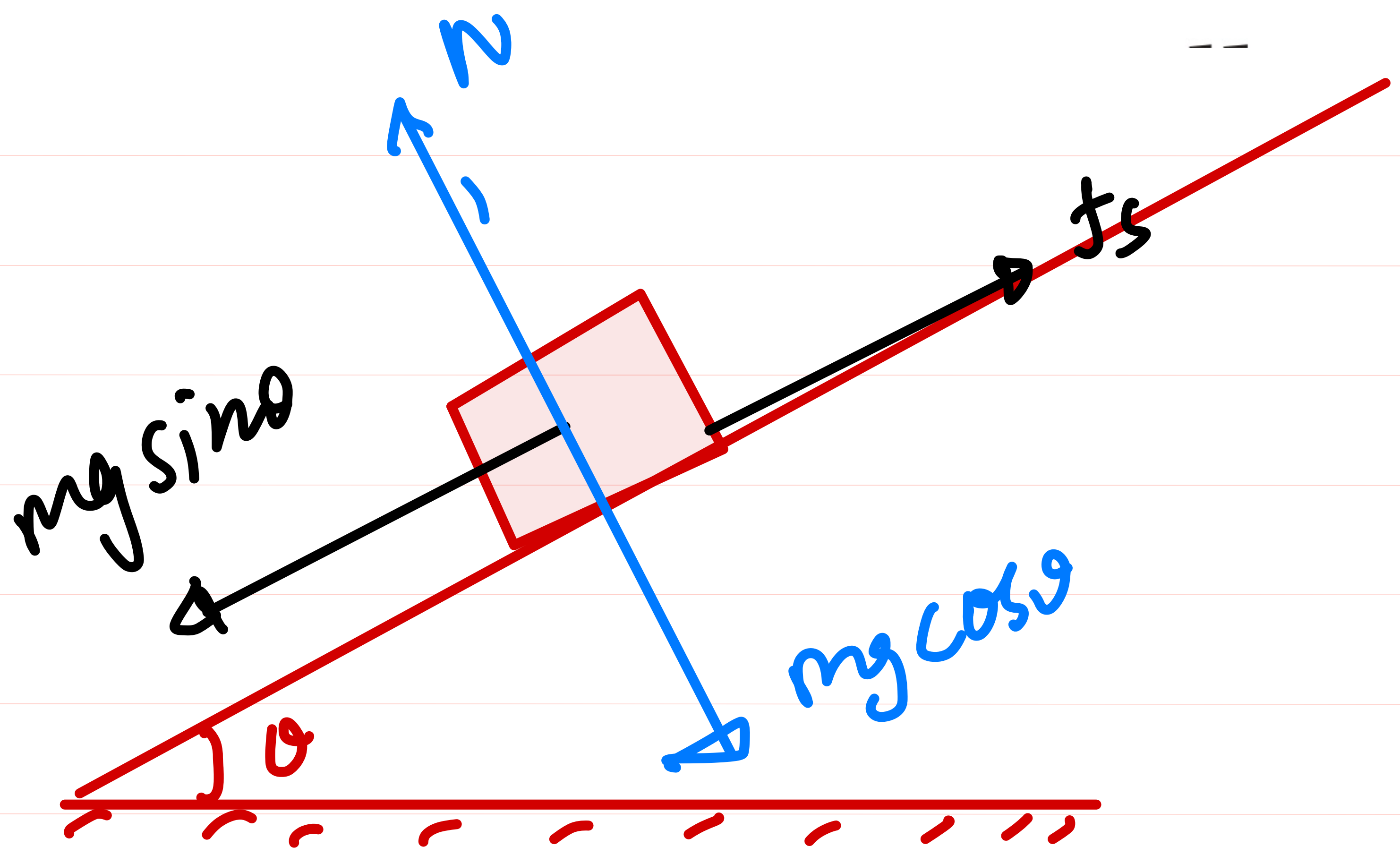
SL

A body is placed on an inclined plane and the angle of inclination is gradually increased. At some angle of inclination θ the body starts sliding down the plane due to gravity. This angle of inclination is called angle of repose (θ).

Angle of repose is that minimum angle of inclination at which a body placed on the inclined starts sliding down due to its own weight.

Thus, $\boxed{\text{angle of repose = angle of friction.}}$





$mg\sin\theta = f_{sL}$

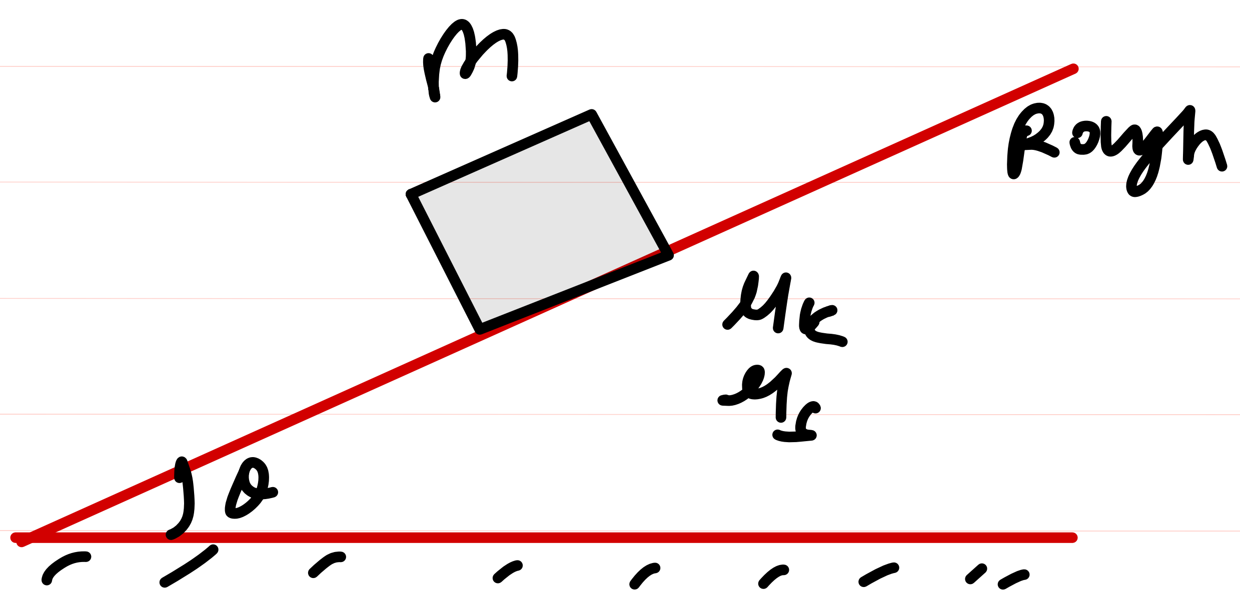
$mg\sin\theta = \mu_s N$

$\cancel{mg}\sin\theta = \mu_s \cancel{mg}\cos\theta$

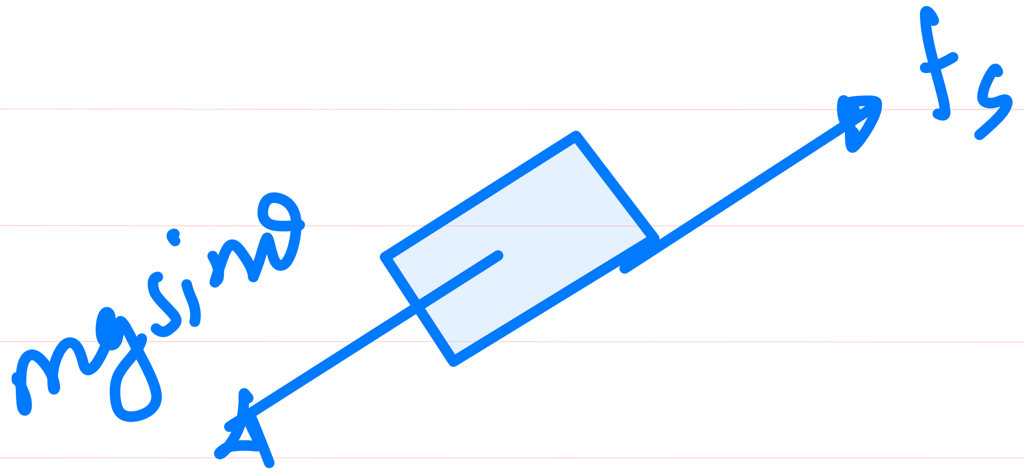
$\tan\theta = \mu_s$

$$\boxed{\theta = \tan^{-1}(\mu_s)}$$

Ex



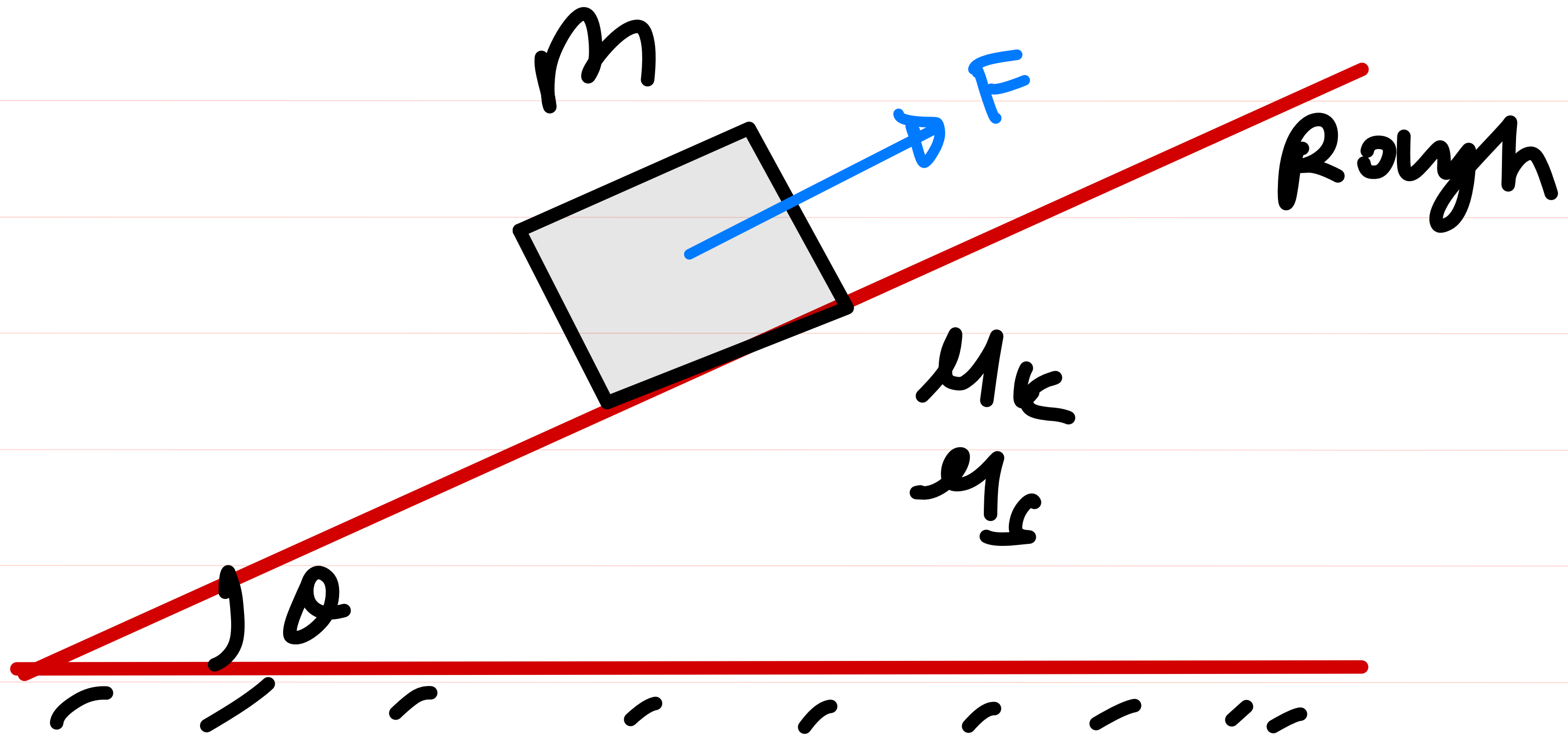
Value of Friction for that object at Rest:-



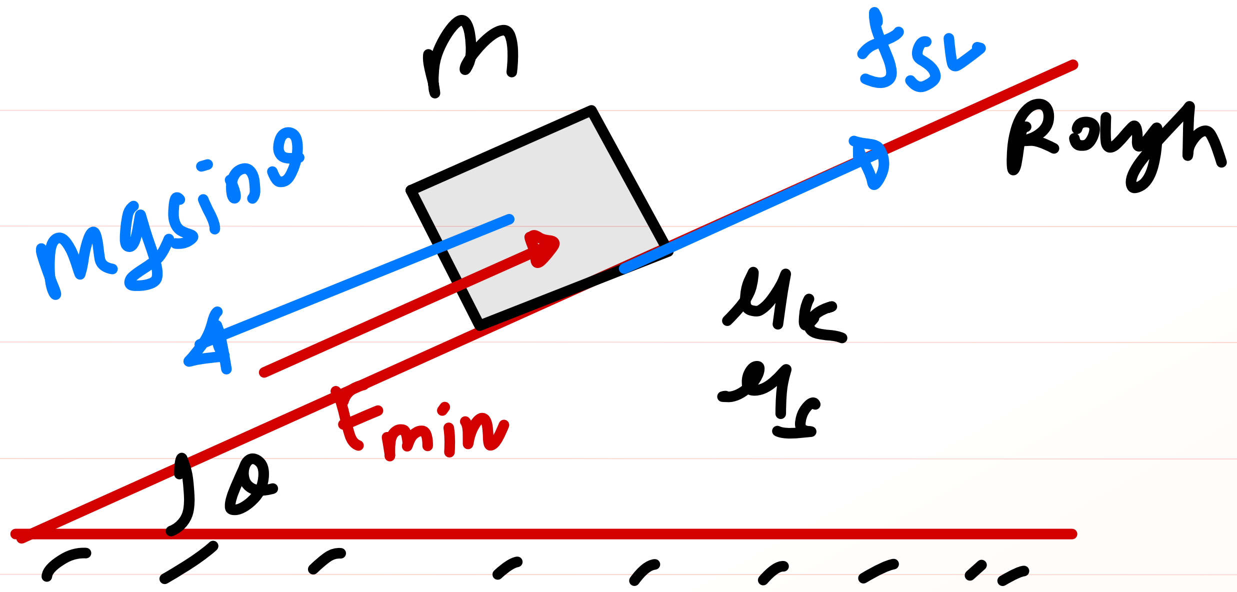
At Eq.

$\boxed{f_s = mg\sin\theta}$ Ans

Ex

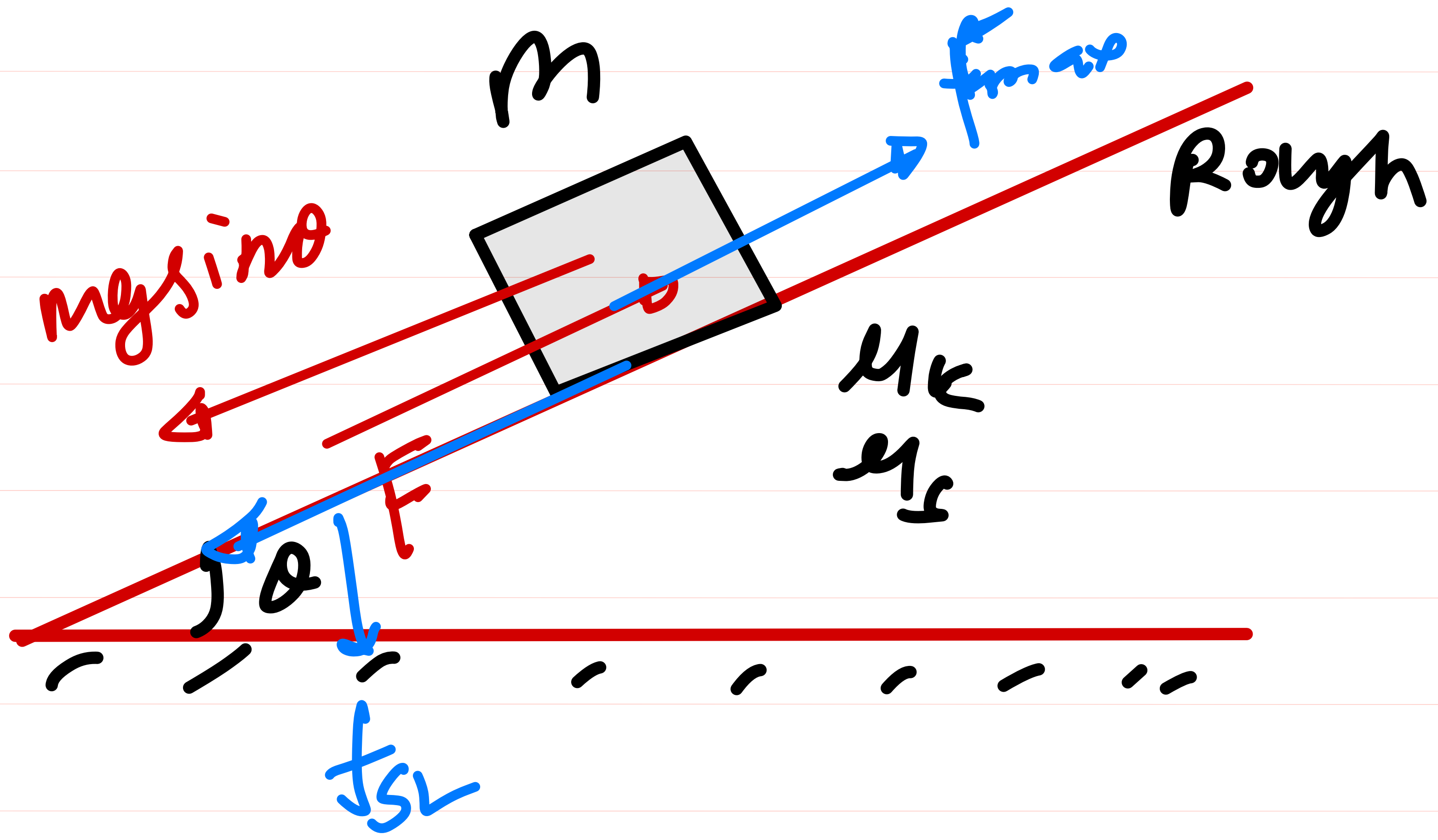


Range of F for that object will be at rest



$F_{min} = mg\sin\theta - f_{sL}$

$$\boxed{F_{min} = mg\sin\theta - \mu_s mg\cos\theta}$$



$$F_{max} = mg\sin\theta + f_{SL}$$

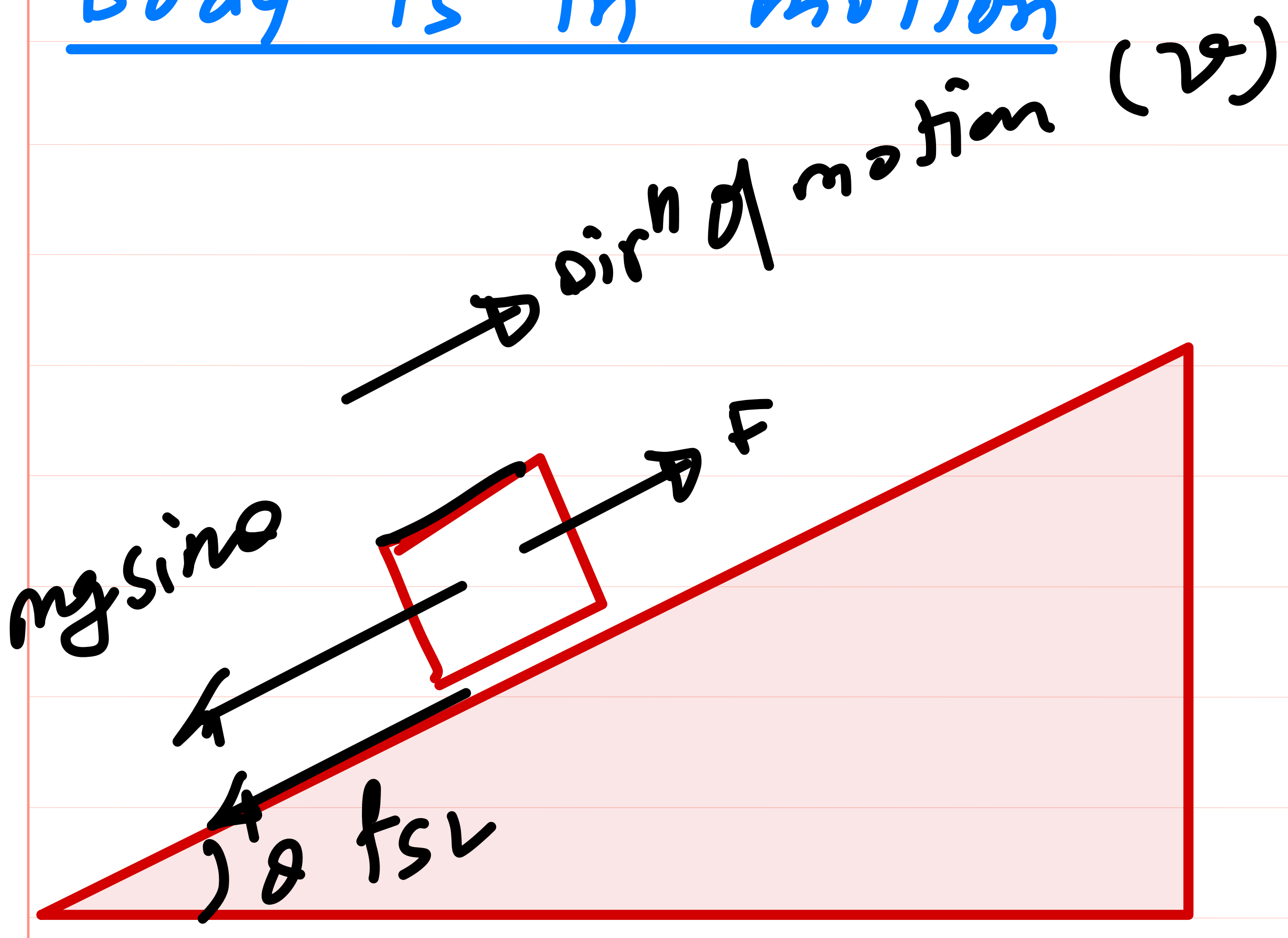
$$F_{max} = mg\sin\theta + \mu_s mg\cos\theta$$

Rang

$$\boxed{F_{min} \le F \le F_{max}}$$

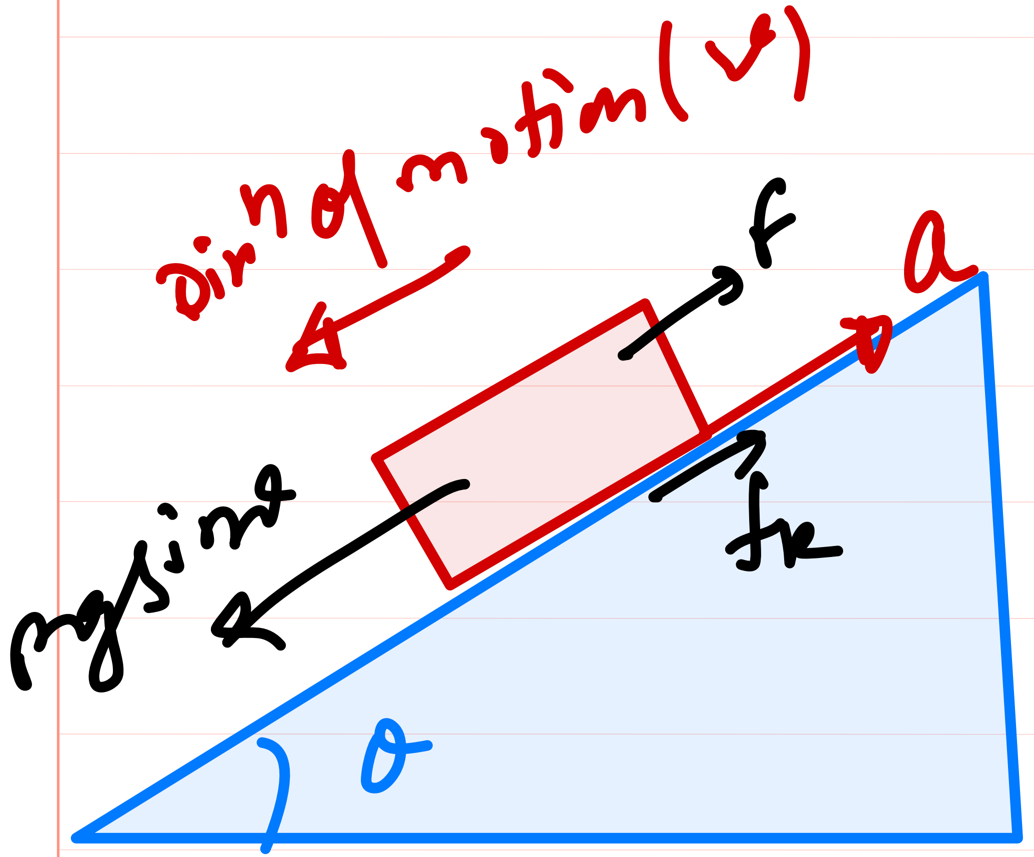
$$\boxed{(mg\sin\theta - \mu_s mg\cos\theta) \le F \le (mg\sin\theta + \mu_s mg\cos\theta)}$$

Body is in motion



$$F = mg\sin\theta + f_k$$

$$\boxed{a = g(\sin\theta + \mu_k\cos\theta)}$$



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

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

$$\cancel{m}a = \cancel{m}g\sin\theta - \mu_k \cancel{m}g\cos\theta$$

$$\boxed{a = g[\sin\theta - \mu_k\cos\theta]}$$