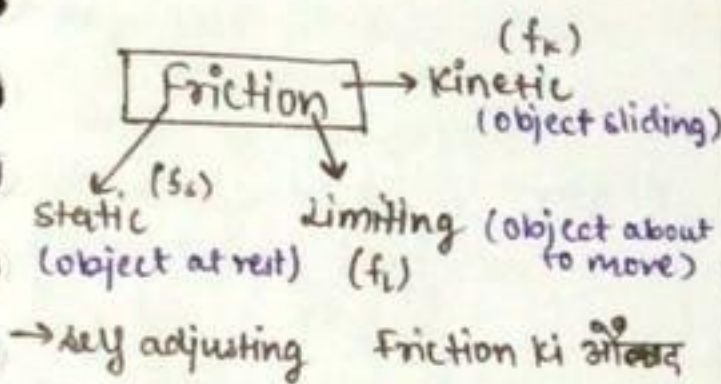


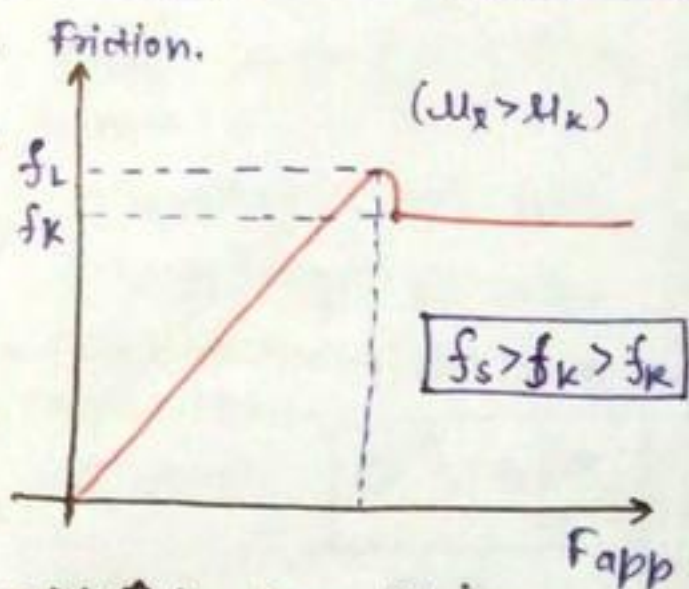
FRICTION

→ Oppose Relative motion or tendency of relative motion.



Self adjusting Friction ki baad

$$f_s = F_{app} \quad f_k = \mu_k N \quad f_r = \mu_r N$$



MR* for Ques Solving

- 1) Find Limiting friction force
- 2) Compare it with F_{app}

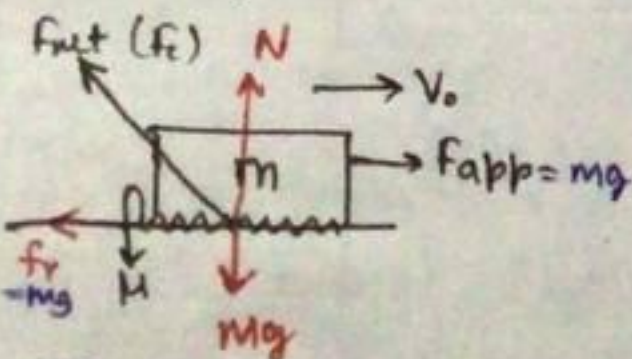
$$f_{lim} > F_{app} \text{ [Rest]} \quad [F_{app} = f_s]$$

$$f_{lim} < F_{app} \text{ [Move]} \quad [f_r = \mu_k N]$$

★ Object is thrown with velocity V_0 not on rough surface of coefficient of friction ' μ ', then stopping distance / time is :-

$$a = \mu g \quad s = \frac{V_0^2}{2\mu g} \quad t = \frac{V_0}{\mu g}$$

★ Object is moving with constant velocity as shown then find a contact force b/w ground and block.



$$|F_c| = \sqrt{N^2 + f_r^2}$$

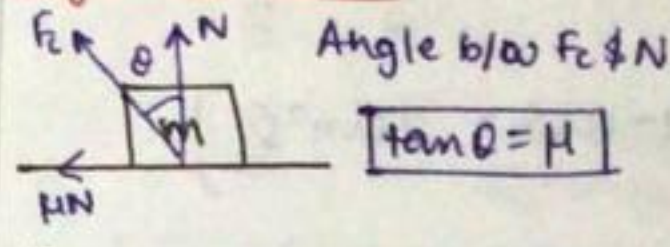
NOTE:- Friction kisi ka saga nahi hai, uska koi fix dir nahi. Motion nhi hone dega.

★ Max and Min value of Friction such that block won't move.

Given M_1 on M_2

$$(F_{min}) = F_a - F_{lim} \quad (F_{max}) = F_a + F_{lim} \quad F_{lim} = \mu N$$

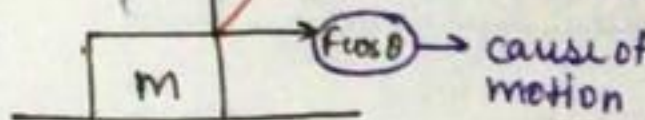
Angle of friction



Angle b/w F_c & N

$$\tan \theta = \mu$$

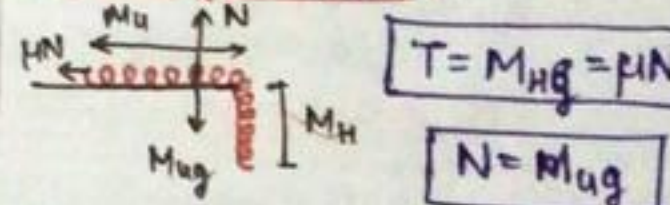
★ F_{min} req to move an object :- decrease interlocking



$$F \cos \theta = \mu N \quad N = mg - F \sin \theta$$

$$F = \frac{\mu mg}{\cos \theta + \mu \sin \theta} \quad F_{min} = \frac{\mu mg}{\sqrt{1 + \mu^2}}$$

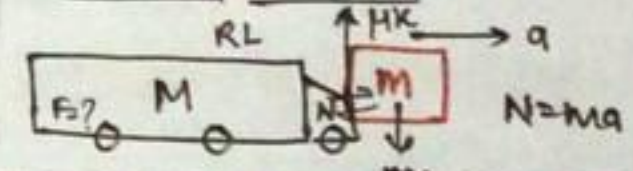
★ Table Chain Ques:-



$$T = M_H g = \mu N$$

$$N = M_H g$$

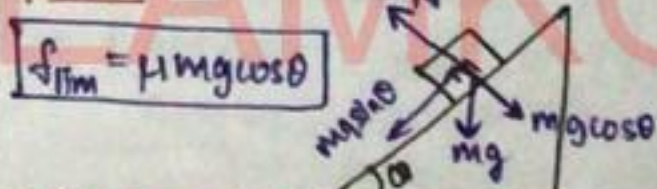
★ Car Block Ques:-



$$f_r = Mg \quad \mu N = mg \quad \mu = \frac{g}{a}$$

$$F = (M+m)a \quad F = \frac{(M+m)g}{\mu}$$

★ Friction Force on inclined plane:-



★ Angle of Repose

Max angle (θ) of a Rough IP with horizontal such that the block is at rest (Just about to slide)

$$\mu = \tan \theta$$

MR* (When object on Rough IP) Object chlega ya nhi?

$$\mu = \tan \theta \text{ [Just slide]}$$

$$\mu < \tan \theta \text{ [Motion]}$$

$$f_r = \text{up [Down]} \quad [a = g \sin \theta - \mu g \cos \theta]$$

$$f_r = \text{down [Up]} \quad [a = g \sin \theta + \mu g \cos \theta]$$

$$\mu > \tan \theta \text{ [Rest]}$$

$$F_c = \sqrt{N^2 + F_r^2}$$

$$F_c = mg$$

★ Max and Min force req to move an object on incline.

Block up:- $F_{max} = mg \sin \theta + \mu mg \cos \theta$

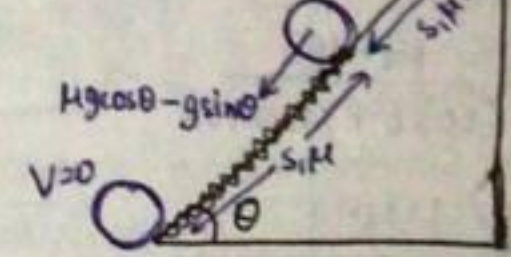
Block down:- $F_{min} = \mu mg \cos \theta - mg \sin \theta$

★ If ($\mu < \tan \theta$) then force required to keep object at rest

$$F = mg \sin \theta - \mu mg \cos \theta$$

Half Rough, Half smooth IP

Rest to Rest Motion $a_s = \text{const}$



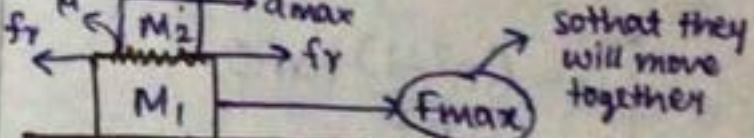
$$g \sin \theta \cdot s = s(-g \sin \theta + \mu g \cos \theta)$$

$$2 \sin \theta = \mu \cos \theta$$

$$\mu = 2 \tan \theta \quad V_{imp}$$

★ Block Over Block system:-

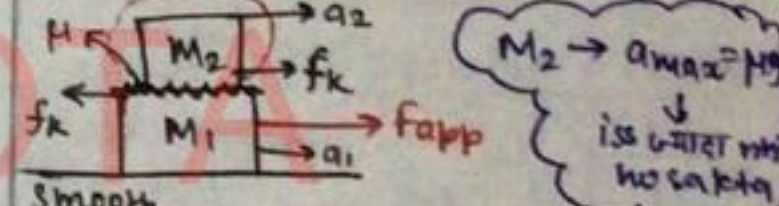
$$1) F = (M_1 + M_2) \mu g \quad (\text{साथ-साथ})$$



$$F_{max} = (M_1 + M_2) a_{max}$$

$$a_{max} = \mu g$$

$$2) F_{app} > (M_1 + M_2) \mu g$$



'a' ki value 'F' par depend karegi 'a', ka koi limit nhi hai

$$a_2 = \mu g$$

$a < a_{max}$	$a = a_{max}$	$a > a_{max}$
Move together	About to slip	Slip!!
$f_r = \text{static}$	$f_r = \text{limiting}$	$f_k = \text{kinetic}$ (diff accn)

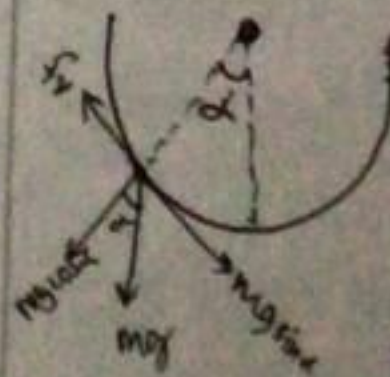
$$a = \frac{F_{app}}{M_{net}}$$

$$a_{max} = \mu g$$

Note: If F_{app} on upper block

$$(a = \frac{F}{M_1 + M_2}) \text{ move together} \quad a_{max} = \mu g \text{ (Upward) (downward)}$$

★ Insect Ques



$$f_r = mg \sin \alpha$$

$$\mu mg \cos \alpha = mg \sin \alpha$$

$$\mu = \tan \alpha$$

$$\cot \alpha = \frac{1}{\mu} = 3$$