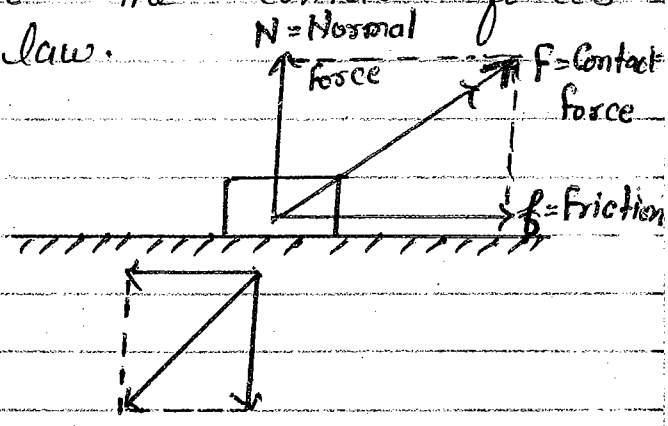
Friction force

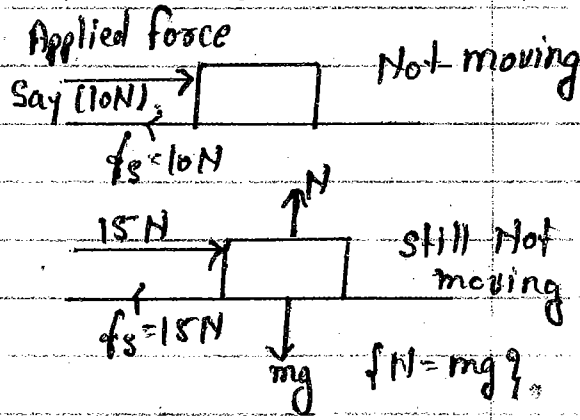
When two bodies are kept in contact, electro-magnetic forces act between the charged particles at the surfaces of the bodies. As a result each body exerts a contact force on the other.

The magnitude of the contact forces on the two bodies are equal but their direct are opposite and hence the contact forces obey Newton's III rel law.



Static Friction (f_s) :-

When two bodies do not slip on each other the force of friction is called static friction.



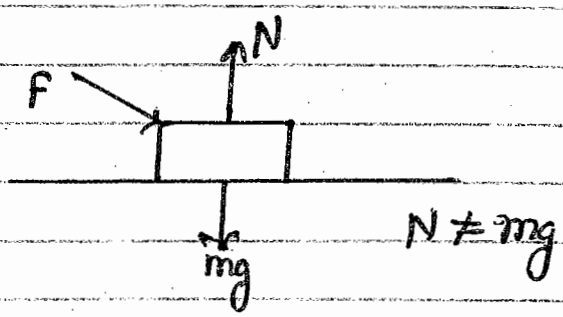
$$\therefore \boxed{f_s \leq \mu_s N}$$

N → Normal Reaction

μ_s → Coefficient of static friction.

The limiting value of static friction is -

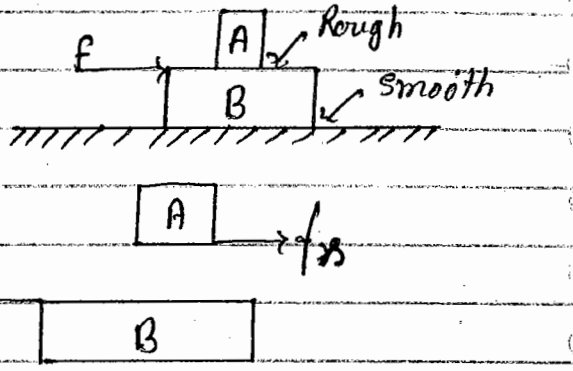
$$\boxed{(f_s)_{max} = \mu_s N}$$



N may or may not be equal to mg.

⇒ friction may not be opposite to direction of motion always.

Ex. Here A will move with B since B is applying friction on A.

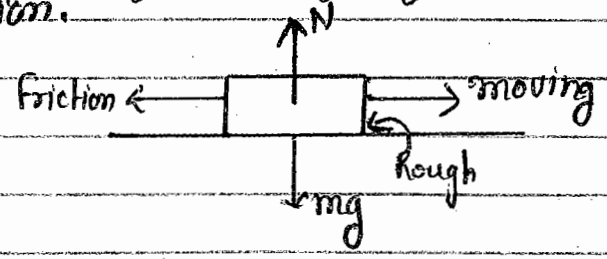


Kinetic Friction :- (f_k) :-

When two solid bodies slip over each other, the force of friction is called kinetic friction.

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

$\mu_k < \mu_s$ (slightly)



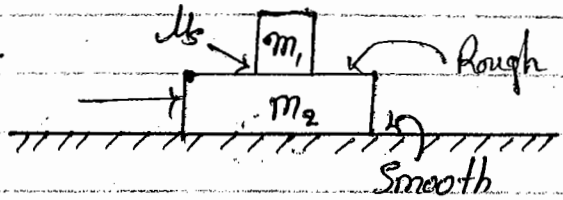
- Maximum force that can be applied without moving an object is $\mu_s N$.
- Minimum force required to move an object is almost equal to $\mu_k N$.

* Two Object Cases :-

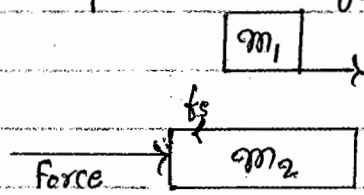
Q. What maximum force can be applied on lower block so that the two blocks move together (no relative motion between them).

Sol^n

The acceleration of upper block has a limit because it is moving due to static friction.



{ Upper block will move due to static friction



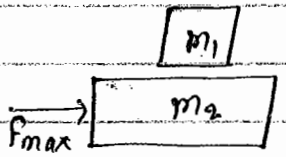
Maximum acceleration of upper block $= \frac{(f_s)_{max}}{m_1}$

$= \frac{\mu_s N}{m_1}$

$= \frac{\mu_s m_1 g}{m_1} = \mu_s g.$

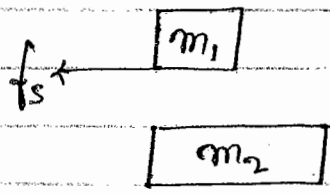
The two blocks will move together without any relative motion if their acceleration is less or equal to $\mu_s g$.

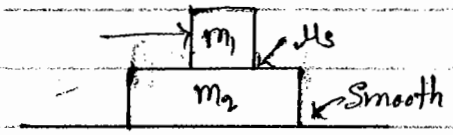
$$\boxed{f_{max} = (m_1 + m_2)\mu_s g}$$



$a_{max} = \mu_s g$

Q. What is maximum acc^n so that the two blocks move together.





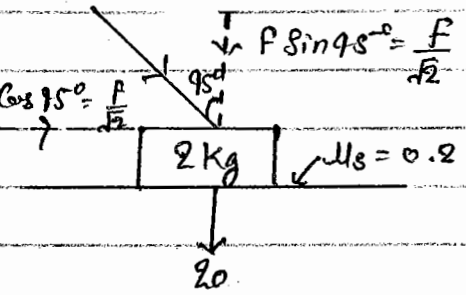
Maximum acc^n of m_2 = $\frac{(f_s)_{max}}{m_2} = \frac{\mu_s N}{m_2}$

$$\boxed{\text{Maximum acc}^n \text{ of } m_2 = \frac{\mu_s m_1 g}{m_2}}$$

Basic.

Q.15 A 2kg block is lying on a rough surface. If coefficient of static friction between the block & ground is 0.2. What maxm force can be applied on the block without moving it.

Sol^n



The block will not move if -

$$\frac{f}{\sqrt{2}} = (f_s)_{max} = \mu_s N$$

$$\frac{f}{\sqrt{2}} = 0.2N \quad \text{——} (1)$$

Vertical Equilibrium :-

$$20 + \frac{F}{\sqrt{2}} = N$$

Put N from (1)

$$20 + \frac{F}{\sqrt{2}} = \frac{f}{0.2\sqrt{2}}$$

$$\frac{f}{\sqrt{2}}\left[1 - \frac{1}{0.2}\right] = -20 \Rightarrow -\frac{F}{\sqrt{2}}\left[\frac{0.8}{0.2}\right] = -20$$

$$\Rightarrow F = \frac{20\sqrt{2}}{4} \Rightarrow F = 5\sqrt{2}$$

$$\Rightarrow \boxed{F \approx 7N} \quad \underline{\underline{\text{Ans}}}$$

To match the option