



## INTERMEDIATE

# Friction

*Hand Notes For JEE Mains, Advance, NEET UG, Class 11 & 12 etc...*

## Hand Notes

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# FRICTION

Property of oppose b/w relative motion of + to surface.

## Type of friction

- \* Internal Friction → Friction b/w two surface of same mat. → viscosity.
- \* External Friction → B/w surface of two different solid.
- |a| → Static friction → \* When body is at rest, friction force b/w two layer of solid is self adjusting friction & its max value is called limiting friction.
- \*  $F_L = (F_s)_{max}$
- |b| → Dynamic/Kinetic friction → When body move fr. b/w two surface of solid.

# Limiting friction depend on → \* It is  $\propto$  Normal  $RKN$ .  
\* It depend on nature of surface.  
\* Independent from surface or contact area.

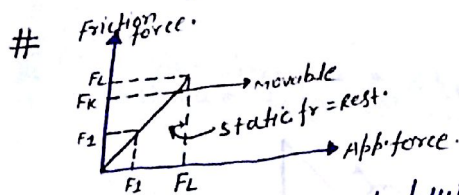
# Max value of static friction →  $F_L \propto N$   
 $F_L = (F_s)_{max} = \mu_s N$   
 $\mu_s$  = static friction coefficient.

# Kinematic friction →  $F_k \propto N$   $F_k = \mu_k N$   
 $F_L > F_k \Rightarrow \mu_s > \mu_k$

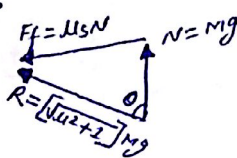
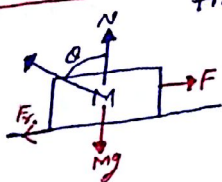
**NOTE**

- \*  $(F_x)_{app} < F_L = (F_s)_{max} \Rightarrow$  Body does not move  $\Rightarrow F \cdot F = (F_x)_{app}$ .
- \*  $(F_x)_{app} = F_L = (F_s)_{max} \Rightarrow F \cdot F = F_L = (F_s)_{max}$
- \*  $(F_x)_{app} > F_L \Rightarrow$  body moves on surface  $\Rightarrow F \cdot F = F_k$

\* order of friction →  $\mu_s > \mu_k > \mu_r$



# Friction Angle ( $\theta$ ) → Angle b/w Resultant of Normal  $RKN$  & friction force normal to the surface.



$$\tan \theta = \frac{F_f}{N} = \frac{\mu_s N}{N} = \mu_s$$

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

# Angle of Repose → Angle of plane surface from horizontal. (If body just slide on surface).

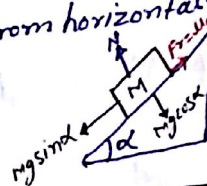
\* Just slide on surface.

$$Mg \sin \alpha = F_f = \mu_s N$$

$$Mg \sin \alpha = \mu_s (Mg \cos \alpha)$$

$$\tan \alpha = \mu_s$$

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



Angle of Repose = Angle of friction.

**NOTE**

- |a| →  $\alpha = 0 \Rightarrow$  Just slide on surface  $\Rightarrow F \cdot F \Rightarrow \mu_s Mg \cos \alpha$
- |b| →  $\alpha < 0 \Rightarrow$  Body present at rest  $\Rightarrow F \cdot F \Rightarrow Mg \sin \alpha$
- |c| →  $\alpha > 0 \Rightarrow$  Body moving downward  $\Rightarrow F \cdot F \Rightarrow F_f = \mu_k = \mu_k Mg \cos \alpha$

$$a = g \sin \alpha - \mu_k \cos \alpha$$

$$Mg \sin \alpha > \mu_s Mg \cos \alpha$$