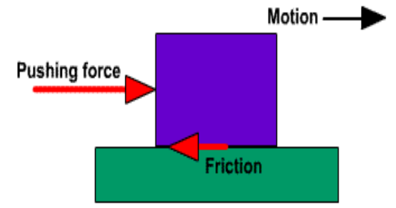
2. FRICTION

TERMINOLOGIES IN FRICTION:

1. NORMAL REACTION (N):
2. FORCE IN DIRECTION OF POSSIBLE MOTION (P):
3. COEFFICIENT OF FRICTION (μ):

Static Friction Coefficient (μ_s)	Kinetic or Dynamic Friction Coefficient (μ_k)

4. FRICTIONAL FORCE (f): $f = \mu N$

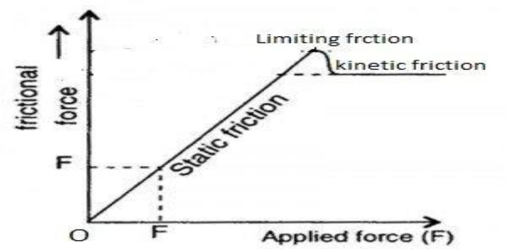


DYNAMICS ANALYSIS	
KINEMATICS: Without considering Force	**KINETICS:** With considering force

LAW OF DRY FRICTION:

1. The frictional force opposes the relative motion. (Coulomb's Law Statement-I)
2. The frictional force acts tangential to the contact surfaces. (Coulomb's Law Statement-II)
3. The total friction developed doesn't depend upon the contact area.
4. The maximum friction in static case, $f_{max} = \mu_s N = Limiting\ Friction$
5. Force required to sliding is frater than that is required to maintain sliding. $\mu_s > \mu_k$

GRAPHICAL REPRESENTATION OF FRICTIONAL FORCE:



UNDERSTANDING THE FRICTIONAL FORCE:

If $P \leq f_{max}, f = P.$	If $P > f_{max}, f = \mu_k N = Constant\ and\ opposite\ to\ P$

Impending Condition: Body is about to move but block hasn't started motion. $P = f_{max}$

Condition for Static Equilibrium: $\mu_s N \leq P\ or\ f \leq \mu_s N$

When to use the limiting frictional force (f_{max}):

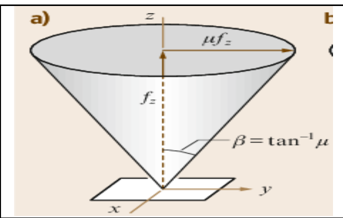
1. Limiting Friction	3. Maximum Force for equilibrium
2. Impending Condition	4. Minimum force to start motion (Force just to start motion)

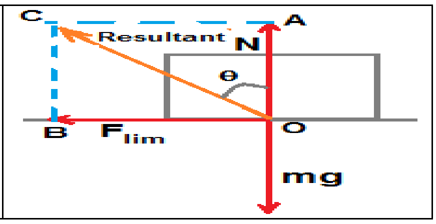
ANGLE OF FRICTION ($\emptyset$):

$R = \sqrt{N^2 + f^2}$	$\emptyset = \tan^{-1}\dfrac{f}{N}$

At Limiting Friction, $\emptyset = \tan^{-1}\mu_s$

CONE OF FRICTION: Cone generated with cone angle $2\emptyset$ is known as cone of friction.





- Minimum force required to cause the motion in the block, $F_{min} = W\ \sin\theta, Where\ \theta = \emptyset$

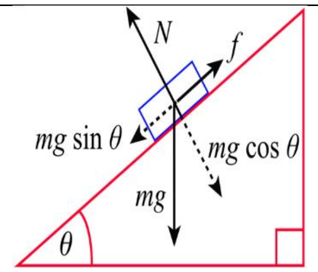
BELT FRICTION:		
$\dfrac{T_1}{T_2} = e^{\mu\theta}$	θ = Angle of contact, μ = Friction between belt and friction, T_1 & T_2 = Tight side and slack side tension.	The side of belt which will try to create the motion or higher force is applied is the tight side.

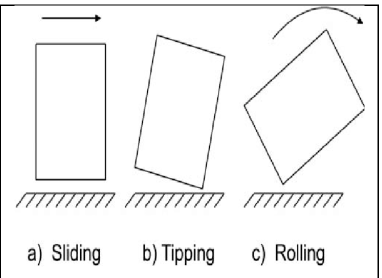
- After deciding tight side and slack side we can decide the Force/ Tension is either minimum or maximum.

Sliding: Consider Equilibrium of forces.
Tipping: Consider Moment Equilibrium about tipping point.
For Inclined Block at θ angle with self-weight,

$\theta < \emptyset$	$\theta = \emptyset$	$\theta > \emptyset$
Static Cond.	Impending Cond.	Motion
$f = P$	$f_{max} = \mu_s N$	$f_{max} = \mu_k N$

$\emptyset$ = Angle of friction.





ANGLE OF REPOSE: It's the angle at which block slides on any surface. E.g. For inclined surface AOR = $\emptyset$

Min. and Max. force required to **stop sliding** the bock on inclined surface found by changing the direction of friction.

Both are smooth (Unstable)	Wall is rough & floor is smooth (Unstable)	Floor is rough & Wall is smooth (stable)	Floor is rough & Wall is rough (stable)
Pythagoras Theorem	$\sum F = 0$	$\sum M_{@Rough\ Normal\ Reaction} = 0$	

Stability of inclined ladder increases including angle of inclination Because $Restoring\ Couple = Turning\ Couple.$