Applications of law of conservation of momentum

1. Recoiling of a gun.

When a bullet is fired from the gun, the gun recoils. The recoil vel. of the gun can be calculated using law of conservation of momentum.

Total momentum of the bullet and the gun before firing $= 0$

Total momentum of the bullet and the gun after firing $= m_g v_g + m_b v_b$

According to law of conservation of momentum,

Total momentum before firing = Total momentum after firing.

$$0 = m_g v_g + m_b v_b$$

$$v_g \text{ (Recoil vel)} = -\frac{m_b v_b}{m_g}$$

Equilibrium of concurrent forces

Many forces acting at a point is called concurrent forces.

Translational (linear) equilibrium of a particle refers to a situation when the external force on the particle is zero. ie, the body will not be accelerated. ie, either the body is at rest or moving with const. vel along a straight line.

If there are three forces acting on the body,

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0.$$

ie, the resultant of F_1 and F_2 should be equal and opposite to F_3.

$$\vec{F}_1 + \vec{F}_2 = -\vec{F}_3$$

If there are 'n' forces, $\vec{F}_1 + \vec{F}_2 + \cdots + \vec{F}_n = 0$.

Friction

Friction is the tangential force that comes into play when an object starts to slide over the other. It always opposes the relative motion between two objects in contact because the surface irregularities are the cause of friction.

Static friction.

The force of friction which exactly counter balance the applied force when the body is at rest is called static friction. When the body is at rest, $f = F$

static friction = applied force.

Limiting friction.

The force of static friction increases with increase in the applied force. ie, static friction is a self adjusting force. The max. value of static frictional force when the body just slides over the horizontal surface is called force of limiting friction.

Laws of friction.

1. The force of limiting friction always acts tangential to the surfaces of contact and opposes the relative motion of one object over the other.
2. The force of limiting friction is directly proportional to the normal reaction.
   $f \propto N$. $f = \mu N$, where μ is a constant called coefficient of friction.
3. The force of limiting friction is independent of the area of contact and depends only on the normal reaction N and the nature of the surfaces.

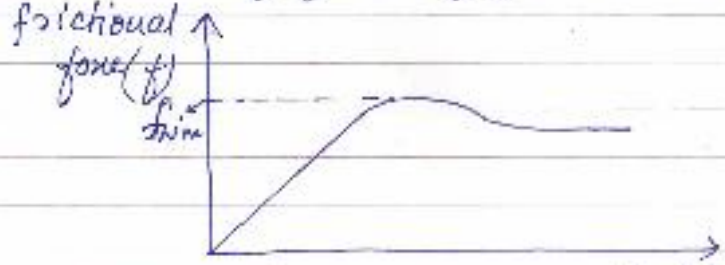
KINETIC FRICTION -

The force of friction that comes into play when one body slides over the other is called kinetic friction.

a. sliding friction - The force of friction that comes into play when one body slides over the other is called sliding friction. It is less than static friction.

b. Rolling friction - The frictional force that comes into play when the body rolls over the other. It is less than sliding friction.

Variation of force of friction with applied force.



Coefficient of friction

$$f = \mu N.$$

coeff. of friction $\mu = \frac{f}{N}$

At rest, $N = mg$.

$$\mu = \frac{f}{mg}$$

Two types are coefficient of static friction and coeff. of kinetic friction.

$\mu_s > \mu_k$.

Angle of friction:

The angle between the resultant of frictional force and normal reaction to the normal reaction is called angle of friction.