ATOMIC ENERGY CENTRAL SCHOOL INDORE

CHAPTER : LAWS OF MOTION
CLASS : XI
SUBJECT : PHYSICS
Module : 2/3

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Law of conservation of linear momentum

Thus in an isolated system (i.e. a system with no external force), mutual forces between pairs of particles in the system can cause momentum change in individual particles, but since the mutual forces for each pair are equal and opposite, the momentum changes cancel in pairs and the total momentum remains unchanged. This fact is known as the **law of conservation of linear momentum.**

- **The total linear momentum of an isolated system of interacting particles is conserved.**

Conservation of Linear Momentum

- An important example of the application of the law of conservation of momentum is the collision of two bodies. Consider two bodies A and B, with initial momenta **p*A and pB. The bodies collide,*** get apart, with final momenta **p′** ***A and p′ B*** respectively.

  By the Second Law

- $\mathbf{F}_{AB}\Delta t = p'_A - p_A$ and

- $\mathbf{F}_{BA}\Delta t = p'_B - p_B$

  (where we have taken a common interval of time for both forces i.e. the time for which the two bodies are in contact.)

- Since $\mathbf{F}_{AB} = -F_{BA}$ ***by the third law,***

  $$\mathbf{p}'_A - p_A = -(p'_B - p_B)$$

  i.e. $\mathbf{p}'_A + p'_B = p_A + p_B$

  which shows that the total final momentum of the isolated system equals its initial momentum.

  Notice that this is true whether the collision is elastic or inelastic. In elastic collisions, there is a second condition that the total initial kinetic energy of the system equals the total final kinetic energy .

EQUILIBRIUM OF A PARTICLE

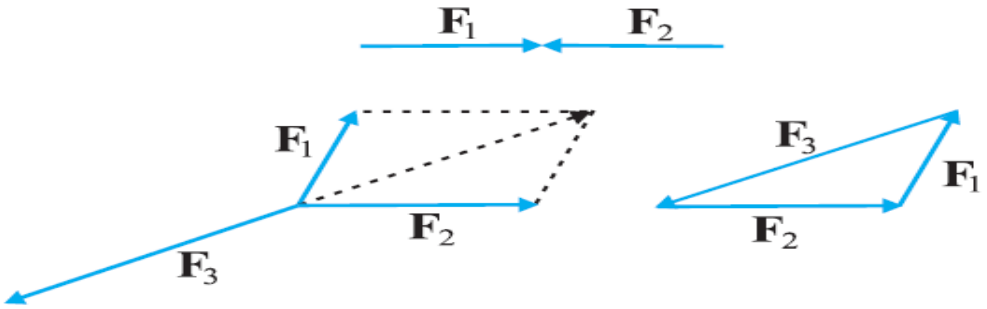
- Equilibrium of a particle in mechanics refers to the situation when the net external force on the particle is zero. **According to the first law, this** means that, the particle is either at rest or in uniform motion.
- If two forces **F1 and F2, act on a particle,** equilibrium requires

$$F1 = -F2$$

i.e. the two forces on the particle must be equal and opposite. Equilibrium under three concurrent forces **F1, F2 and F3 requires that** the vector sum of the three forces is zero

$$F1 + F2 + F3 = 0$$

EQUILIBRIUM OF A PARTICLE



The resultant of any two forces say **F1 and F2, obtained by the parallelogram** law of forces must be equal and opposite to the third force, **F3. The three** forces in equilibrium can be represented by the sides of a triangle with the vector arrows taken in the same sense. The result can be generalised to any number of forces. A particle is in equilibrium under the action of forces F**1,F2,... Fn if they can be represented by the sides** of a closed n-sided polygon with arrows directed in the same sense.

Friction

Suppose body of mass m at rest on a horizontal table. The force of gravity (*mg) is cancelled by the normal reaction force* (N) of the table. Now suppose a force *F is applied* horizontally to the body. We know from experience that a small applied force may not be enough to move the body. But if the applied force *F were the only external force on the body,* it must move with acceleration *F/m, however* small. Clearly, the body remains at rest because some other force comes into play in the horizontal direction and opposes the applied force *F, resulting in zero net force on the body.*

This force *fs parallel to the surface of the body in* contact with the table is known as frictional force, or simply friction.

Types of Friction

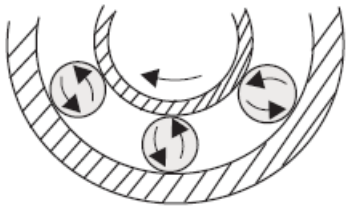
1) As the applied force *F increases, fs also increases, remaining* equal and opposite to the applied force (up to a certain limit), keeping the body at rest. Hence, it is called **static friction(*fs*).**

2) Frictional force that opposes relative motion between surfaces in contact is called **kinetic or sliding friction(*fk*).**

3) Force of friction that comes into play when one body just slides over the surface of other body is called force of ***limiting friction****. It is the maximum value of the friction between two surfaces in contact.*

Rolling Friction

- Rolling friction – It is a type of friction that comes in to play when one body rolls over the surface of other body.
- During rolling, the surfaces in contact get momentarily deformed a little, and this results in a finite area (not a point) of the body being in contact with the surface. The net effect is that the component of the contact force parallel to the surface opposes motion.



Laws of friction

- The limiting friction depends upon nature of surfaces in contact.
- The limiting friction acts tangential to the surfaces in contact.
- The value of limiting friction is independent of area of surfaces in contact.
- Limiting friction(F) is directly proportional to normal reaction (R) between the surfaces in contact.

$$F \alpha R$$

$$F = \mu R$$

μ is called the coefficient of static friction.

Methods of changing friction

- By polishing- it makes the surfaces in contact highly polished and smooth and minimised the friction.
- Lubrication- Lubricant is a substance which forms a thin layer between two surfaces in contact.
- Streamlining-friction due to air can be minimised by streamlining the shape of body.
- Using ball bearings – Ball Bearings converts sliding friction to rolling friction and reduce the friction considerably.

- THANKYOU