FORCE AND LAWS OF MOTION

Force

The cause of motion is the force. No one has seen force or tasted force. However, we see or feel the effects of a force. Hence, concept of force is explained by describing what happens when some force is applied on an object. Force is an external effort in the form of pushing, pulling, stretching, compressing etc.,

The forces are of two types: Balanced forces and unbalanced forces.

Balanced and Unbalanced Forces

If the resultant of all the forces acting on a body is zero, the forces are called **balanced forces.**The balanced forces cannot change the state of rest or state of uniform motion or the direction of motion of the body. They can however change the shape and size of the body.

If the resultant of all the forces acting on a body is not zero, the forces are called **unbalanced forces.**

Newton's First Law of Motion

According to Newton's first law of motion, a body continues to be in a state of rest or in a state of uniform motion along a straight line, unless an external force is applied on the body to change the state.

Newton's first law of motion gives us qualitative definition of force. Further, this law means that a body on its own, cannot change its state of rest or state of uniform motion along a straight line. This property is called **inertia.** Therefore, **Newton's first law of motion is also called the law of inertia.**

Inertia

Inertia of a body is of three types: (i) Inertia of rest (ii) Inertia of motion and (iii) Inertia of direction.

(i) Inertia of Rest

(a) When a bus suddenly starts moving forward, the passengers in the bus fall backward.

(b) The carpet is beaten with a stick to remove the dust particles.

(c) Place a fifty paisa coin on a piece of a card-board covering the glass. Coin falls into the glass when the card board is hit.

(d) When a tree is vigorously shaken, some of the fruits fall from the tree.

(ii) Inertia of motion

(a) The passengers fall forward when a fast moving bus stops suddenly.

(b) A person falls forward while getting down from a moving bus or train.

(c) A luggage is usually tied with a rope on the roof of buses.

(iii) Inertia of Direction

(a) When a fast moving bus negotiates a curve on the road, passengers fall towards the centre of the curved road.

(b) The sparks produced during sharpening of a knife against a grinding wheel leave the rim of the wheel tangentially. This is because of the inertia of direction.

(c) A stone tied to a string is whirling in a horizontal circle. If the string breaks, the stone flies away tangentially.

(d) An umbrella protects us from rain.

Momentum and Newton's Second Law of Motion

Linear momentum (*p*) of a body is the product of mass of the body (*m*) and velocity of the body (*v*), i.e. $\vec{p} = m\vec{v}$

According to Newton's second law of motion, **the rate of change of linear momentum of a body is directly proportional to the external force applied on the body, and this change takes place always in the direction of the applied force.**
The SI unit of force is newton (N). One newton is that much force which produces an acceleration of 1 m/s^2 in a body of mass one kilogram.

i.e., $1\ \text{N} = 1\ \text{kg} \times 1\ \text{m/s}^2$
$= 1\ \text{kg m/s}^2$

Newton's Third Law of Motion

According to Newton's third law of motion, **"To every action, there is always an equal and opposite reaction".**

Law of Conservation of Momentum

According to the law of conservation of momentum, when two or more bodies interact with one another, the vector sum of their linear momenta remains constant (i.e., conserved), and is not affected due to their mutual action and reaction. The only condition is that no external unbalanced forces should be acting on the system of bodies. This law is deduced from Newton's third law of motion.