

NCERT Force and laws of motion

Force - A push or pull on a body.

Force is an external force that can set an object in motion or rest or change its state.

- Force is a vector quantity.
- SI unit of force = Newton (N).
- Its CGS is dyne.
[1N = 1,00,000 dyne.]

Effects of Force:-

- Force can make a stationary body move.
- Force can stop a moving body.
- Force can change the direction of moving obj.
- Force can change the speed of a moving body.
- Force can change shape & size of an object.

Balanced Force	Unbalanced Force
1. When two or more force act on a body and produce a net force equal to zero.	1. When two or more force act on a body and produce a net force $\neq 0$.
2. A balanced force doesn't produce any change in the state of uniform motion or rest.	2. Unbalanced force produce change in state of motion.
3. Balanced force cannot produce acceleration.	3. Unbalanced force can produce acceleration.

⇒ Resultant Force = Net Force.

Galileo's analysis on Motion:-

- Aristotle's Belief:- The natural state of body is rest.

Galileo's observation:-

⇒ Ball rolling down an inclined plane: speed increases.

⇒ Ball rolling up an inclined plane: speed decreases.

Experiment on Horizontal Plane:-

- On smooth surface, ball continues to move.
- Speed remains constant with no external force or friction acting on it.

Conclusion:- Bodies naturally oppose change in state of rest or motion.

~~Iner~~ Inertia: is defined as a property of matter by which it tries to maintain its state of rest or state of motion.

- Inertia of an object is measured by its mass.
Inertia is directly proportional to mass of object.

± Newton's First Law of motion [Law of Inertia]

→ A body remain in state of rest or uniform motion in a straight line unless and untill an external force acts on it.

Momentum - Momentum is the quantity of motion an object has.

$$[P = mv], \text{ Unit of momentum} = \text{kgms}^{-1} / \text{kgm/s}$$

Impulse = Force x Time

⇒ Example: - Even a small bullet can kill a person when it is fired from a gun because it has a lot of momentum ~~due to~~ velocity.

Q. Find momentum of body with: - mass = 5kg, vel = 0.2 m/s

Sol: $P = mv$

$$P = 5 \times 0.2$$

$$P = 1 \text{ kgms}^{-1}$$

Q. mass of goods lorry is 4000 kg with mass of goods loaded on it is 20000 kg. If vel. of lorry is 2 m/s, find its momentum.

Sol: Combined mass of lorry = 24000 kg

$$\text{Velocity} = 2 \text{ m/s}$$

$$\text{Momentum} = mv$$

$$P = 24000 \times 2$$

$$[P = 48000 \text{ kgm/s}]$$

Newton's First Law of Motion:-

⇒ An object stays in rest or uniform motion until and unless an external unbalanced force acts on it. It is also known as Law of Inertia.

Momentum

⇒ The quantity of motion in an object.

⇒ Momentum = mass $\times$ velocity
 $p = mv$

[Note: Momentum is a vector quantity and its direction is same as velocity.]

⇒ SI unit = kgms^{-1} or kgm/s .

Newton's Second Law of Motion:-

⇒ Rate of Change of momentum of a body is directly proportional to the external unbalanced force acting on the body.

Mathematical Formulation of IInd Law:-

⇒ Let us suppose, an unbalanced force F is acting on a body of mass ' m ' such that its velocity changes from ' u ' to ' v ' in time ' t '.

[O-N-P]

$$\therefore \text{Initial momentum } (P_i) = mu$$

$$\therefore \text{Final momentum } (P_f) = mv$$

$$\therefore \text{Rate of change of momentum} = mv - mu = P_f - P_i$$

Then according to Newton's IInd Law of Motion:-

Force applied $\propto$ Rate of change of momentum

$$F \propto \frac{mv - mu}{t}$$

$$F \propto \frac{m(v - u)}{t} \quad [\because \text{Taking 'm' common}]$$

$$F \propto ma \quad [\because \frac{v - u}{t} = a]$$

$$\therefore F = kma \quad [\because k = \text{constant} = 1]$$

$$\therefore F = 1 \times m \times a$$

$$\therefore \boxed{F = ma}$$

SI unit = Newton (N)

Newton's Third Law of Motion:-

$\Rightarrow$ For every action, there is equal and opposite reaction

OR

$\Rightarrow$ When two objects interact with each other, the force exerted by first object (called action) on the second object, is always equal and opposite to the force exerted by the second object on the first object (called reaction).

Law of conservation of momentum:-

⇒ If a group of objects are interacting with each other, then their total momentum remains conserved (same) before and after the interaction or collision provided that no external force acts on them.

Revision of SI units:-

- ⇒ Force = N (Newton)
- ⇒ Momentum = kg m s^{-1} (kilogram-metre-per-second)
- ⇒ Acceleration = m s^{-2} (metre-per-second-square)
- ⇒ Velocity = m s^{-1} = speed (metre-per-second)
- ⇒ Mass = kg (kilogram)
- ⇒ Time = s (Second)