DATE: __/__/____
PAGE: _____

# Chapter-8
## (Force & Laws of Motion)

* Question:
1. Define force.
2. Illustrate the effects of force.
3. Diff. b/w balanced & unbalanced force.
4. List the characteristics of force
5. Explain: friction.

## # Force
- Force is an agent that tries, successfully or unsuccessfully
- To move a body which is at rest or
- To stop a moving body.

## # Effects of force:

→ force can change:
- The state of rest or of motion.
- The direction of motion or
- The shape

## # Characteristics of force:

1. Magnitude ⇒ It is the measure or quantity of force.

Unit:

| | |
|---|---|
| SI system | N |
| CGS system | dyn |

Magnitude of force is indicated by:
- Numerical value depicting the quantity of force applied.

Good Write

- Unit of force.

2. → Line of action is a line along with the force acts.

3. Nature: • A force can be a push/pull by nature.

4. Point of Application: • The effect of force on a body depends on the point at which the force is applied.

- Force is a vector quantity. $\vec{F}$ (magnitude & direction)

⇒ Net force

- Case I: If two forces are acting in the same direction, the net force will be the sum of the forces.

[object] $F_a \rightarrow$ $F_b \rightarrow$ = [object]

Net force = $F_a + F_b$

- Case II: If two forces are acting in the opposite direction.

$F_a \rightarrow \leftarrow F_b$ ⇒ Net force = $N_a - N_b$

# Balanced force

→ When forces are balanced:
- A stationary obj. remains at rest.
- A moving obj. continues to move at the same speed and in the same direction.

# Unbalanced force

→ When forces are unbalanced:
- Change its state.
- Change its speed or direction of motion in the direction of the net force.

# Friction

- Friction is the force resisting the relative motion of two bodies that acts along the surfaces in contacts.
- Friction is a hidden force that arises between two surfaces in contact.
- This force acts in a direction opposite to the directions of the force trying move on an object.
- Examples / Applications:
  → objects lying on a slightly inclined plane
  → pens, pencils or chalk in use. (writing).
  → automotive brakes.
  → force b/w vechile tyres & road when in motion

# Relation b/w Force & Motion: (1st Law of Motion)

"An object in a state of motion possess an 'inertia' that causes it to remain in that state of motion unless an external force acts on it."

~Galileo

"A body at rest will remain at rest, a body at motion will tend to remain in motion until and unless it is compelled by an external force." } INERTIA

→ What is Inertia?

⇒ It is the property of a body to resist the change in its state of rest or motion.

⇒ It is directly proportional to mass of a body.

# Newton's Laws of Motion (To be written before)

Isaac Newton further studied the theories & statements given by Galileo regarding the force & motion and later on, presented the three fundamental laws of motion.

## 1st Law of Motion (Done)

# II Law of Motion ⇒ The rate of change of momentum of an object is proportional to the applied force and takes place in the same direction of the applied force.

Mathematical formula : $F = ma$

Where, 'F' is the force applied on a body.
- 'm' is the mass of the body.
- 'a' is the acceleration produced in the body.

Force ∝ Rate of change of momentum

∝ $\frac{\text{Change in Momentum}}{\text{Time}}$

Let a body of mass 'm' Kg moving with
initial velocity = $\vec{u}$ m/s
final velocity = $\vec{v}$ m/s
Initial momentum = $\vec{P_1} = m\vec{u}$
Final momentum = $\vec{P_2} = m\vec{v}$

Good Write

$\vec{F} \propto \frac{\text{Change in Momentum}}{\text{Time taken}}$

$= \vec{F} \propto \frac{m(\vec{v}-\vec{u})}{t}$ $= \vec{F} \propto m\vec{a}$

$F = kma$ [K = 1 (constant) of proportionality]

$\boxed{F = ma}$

— What is Momentum?

- Momentum of an obj. is the product of its mass and velocity. $\boxed{P = mv}$

| | |
|---|---|
| SI Unit | Kg ms$^{-1}$ or Ns |
| CGS Unit | g cms$^{-1}$ or dyn s |

$f = \frac{m\Delta v}{t}$

$p = \frac{\Delta p}{t} = f \times t$ = Ns

— Relation b/w Newton and Dyn

Let F = 1N
m = 1Kg
a = 1 ms$^{-2}$
F = ma
1N = 1Kg × 1ms$^{-2}$
∵ 1Kg = (1000g) & 1m = 100cm
1N = 1000 g × 100 cms$^{-2}$
1N = $10^5$ g cms$^{-2}$
$\boxed{1N = 10^5 \text{ dyn}}$

⇒ A large amount of force acting on an object for a short duration is called an impulse.

$\boxed{\text{Impulse } (J) = Ft = \text{change in momentum } (\Delta p)}$

$J = Ft$

Good Write

Impact of any object on the other depends on two factors-

- Mass of the object causing the impact.
- Velocity of the object causing the impact.

## III Law of Motion

- When one obj exerts a force on another, the second obj. instantaneously exerts a force back on the first.
- These two forces are always equal in magnitude but opposite in direction.
- These forces act on diff. objects but never on the same object.
- The rate of change of momentum of an obj. is related to that of the other, since the force exerted by both the objects is equal.
- The sum of momentum of both, before and after the collisions remains constant.

| Object | A | B |
|---|---|---|
| Mass | $M_A$ | $M_B$ |

# Before collision:

| Velocity | $U_A$ | $U_B$ |
|---|---|---|
| Momentum | $m_A U_A$ | $m_B U_B$ |

Total momentum = $m_A U_A + m_B U_B$

# After collision:

| Velocity | $V_A$ | $V_B$ |
|---|---|---|
| Momentum | $m_A V_A$ | $m_B V_B$ |

Total momentum = $m_A V_A + m_B V_B$

Good Write

By second law of motion:

$$* \quad F_{AB} = \frac{m_B - V_B - m_B U_B}{t}$$

$$F_{AB} = \frac{m_B (V_B - U_B)}{t}$$

$$F_{BA} = m_A V_A - m_A U_A$$

$$F_{BA} = \frac{m_A (V_A - U_A)}{t}$$

According to Newton's third law of Motion:

$$F_{AB} = -F_{BA}$$

$$\frac{m_B (V_B - U_B)}{t} = \frac{m_A (V_A - U_A)}{t}$$

$$m_B V_B - m_B U_B = m_A V_A + m_A U_A$$

Total initial momentum = Total final momentum

OR

Total momentum before = Total momentum after collision

OR

collision

Good Write