# LAW OF MECHANICS

## Newton's First law:

It states that "A body continues in its states of rest or of uniform motion in a straight line, unless acted upon by some external force". This is known as First law of inertia.

## Newton's second Law of motion:

It states "The rate of change of momentum is directly propositional to the impressed force and tasks places in same direction in which the force acts".

$$F = \text{Mass} \times \text{Acceleration} = ma$$

## Newton's third Law of motion:

It states "To every action there is always an equal and opposite reaction".

- A particle remains in its position (rest or motion) if the resultant force acting on the particle is zero.
- Acceleration of a particle will be proportional to the resultant force and in the same direction if the resultant force is not zero.
- Action and reaction b/w interacting bodies are in the same line of action equal in magnitude but act in the opposite direction.
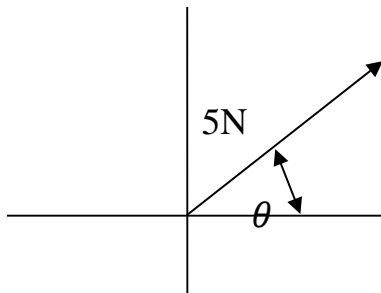
## FORCE

Force is an agent which changes or tends to change the states (or) uniform motion of a body upon which it acts. Force is a vector quantity.

## Characteristics of a Force:

1. Magnitude

2. Line of action

3. Direction

**Graphical Representation of force:**



Newton's second law of motion

$$\text{Momentum} = \text{Mass} \times \text{velocity}$$

M= mass of the body

u = Initial velocity of body

v = final velocity of body

a = Constant acceleration

t = time required to change velocity from u to v

∴ change of momentum $= mv - mu$

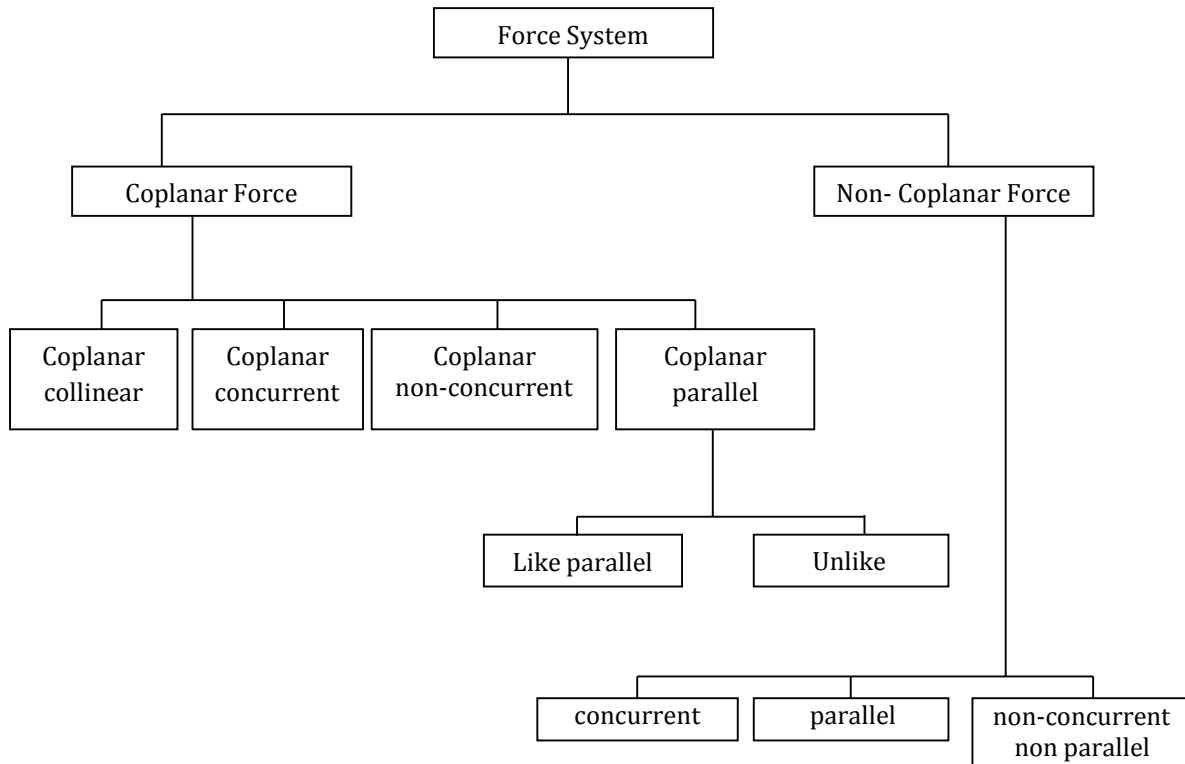Rate of change of momentum $= \dfrac{mv-mu}{t} = \dfrac{(v-u)}{t} = ma$

By Newton's second Law

Force = Rate of change of momentum

$$F = ma$$

**Unit of Force:**

In SI system unit of force is (N) Newton. One Newton may be defined as the force while acting upon a mass of one kg. Produces an acceleration of 1 m/s² in the direction in which it acts.

$$1 \text{ N} = 1 \text{ kg} \times 1 \text{m/s}^2 = 1 \text{kgm/s}^2$$

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                        ┌──────────────┐
                        │ Force System │
                        └──────┬───────┘
              ┌────────────────┴──────────────────┐
      ┌───────────────┐                    ┌────────────────────┐
      │ Coplanar Force│                    │ Non- Coplanar Force│
      └───────┬───────┘                    └─────────┬──────────┘
   ┌──────┬───────┬──────────┐                       │
┌────────┐┌────────┐┌──────────────┐┌──────────┐
│Coplanar││Coplanar││  Coplanar    ││ Coplanar │
│collinear││concurrent││non-concurrent││ parallel │
└────────┘└────────┘└──────────────┘└────┬─────┘
                                  ┌───────┴────────┐
                           ┌──────────────┐┌──────────┐
                           │ Like parallel ││  Unlike  │
                           └──────────────┘└──────────┘
                        ┌──────────┬──────────┬──────────────┐
                   ┌────────────┐┌──────────┐┌───────────────┐
                   │ concurrent ││ parallel ││ non-concurrent│
                   │            ││          ││ non parallel  │
                   └────────────┘└──────────┘└───────────────┘
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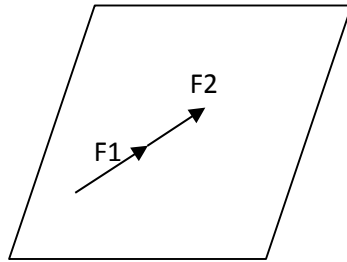
## Parallel

The forces do not line on same plane but their line of action is parallel to each other.

## Non concurrent,Non parallel

The forces neither lie on same plane not their line of action meet at common point.
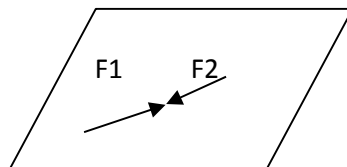
## Like collinear coplanar forces

Forces acting in the same direction, lies on a common on line of action and acts in a single plane
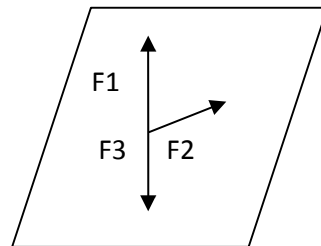
## Unlike collinear coplanar forces:

Forces acting in the different lies on a common line of a action and act is a single plane.
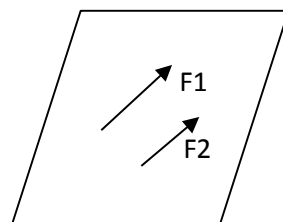
## Coplanar concurrent forces:

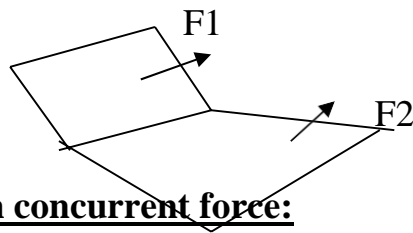Force intersects at a common point and lies in a single plane.

## Coplanar Non concurrent flow:

Forces which do not intersects at a common point but acts in one plane. They may be parallel or non parallel
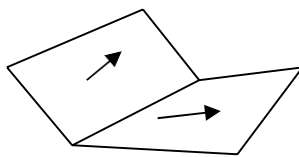
## Non coplanar concurrent forces

Forces intersect at a common point but either line of action do not lie on same plane.
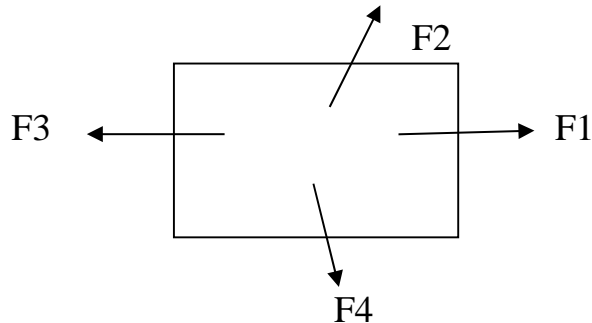
F1

F2

## Non Coplanar Non concurrent force:

Forces do not intersect at one point and also their lines of action do not lie on same plane.
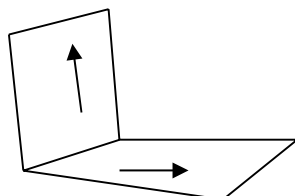
## Coplanar forces:

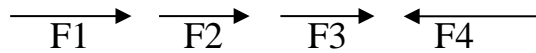The line of action of the forces lies on same plane.

F2

F3

F1

F4

## Non coplanar forces:

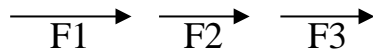The lines of action of the forces not lie on same plane.

## Collinear:

The Line of action of the forces lie on same plane.

$$\xrightarrow{\text{F1}} \xrightarrow{\text{F2}} \xrightarrow{\text{F3}} \xleftarrow{\text{F4}}$$

## Like collinear:

The line of action of forces lies on a same line and in same direction.

$$\xrightarrow{\text{F1}} \xrightarrow{\text{F2}} \xrightarrow{\text{F3}}$$

## Unlike collinear

The lines of action of forces lie on same line but are in opposite direction.

$$\xrightarrow{\text{F1}} \qquad \xleftarrow{\text{F2}} \qquad \xleftarrow{\text{F1}} \quad \text{F2} \xrightarrow{}$$
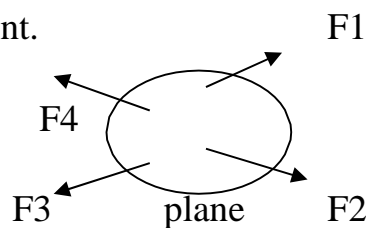
## Concurrent forces:

The lines of action of all forces meet at a common point and lie in the same plane.
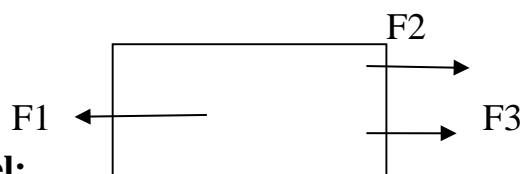
F2   F1

F3   F4   F5
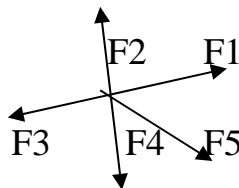
## Non concurrent force system:

The forces will lie on same plane but their line of action will not intersect at a common point.                                    F1

F4

F3        plane        F2

## Parallel forces:

The forces lying on same plane whole line of action are parallel to each other.

F2

F1        F3

## Like parallel:

If the force acts in the same direction they are coplanar like parallel force

system.

**Unlike parallel:** If the force acts in opposite direction, they are coplanar unlike parallel force system.