

- Newton's 2<sup>nd</sup> law of motion gives the quantitative (measurement) of force. (significance of 2<sup>nd</sup> law)
- The force is a vector quantity. Its SI unit is  $kgm/s^2$  or *Newton (N)*. Its dimension is  $[M^1L^1T^{-2}]$
- If  $m = 1kg$  and  $a = 1m/s^2$  then  $F = 1N$ . Hence,  $1N$  force is defined as the that force which produces an acceleration of  $1m/s^2$  when applied on a body of mass  $1kg$ .
- $1N = 10^5 dyne$

### Questions:

1. A body of mass  $5kg$  at rest is acted by a force. After  $5 sec$ , the body covers  $50m$  displacement. Calculate the force acting on the body.
2. A force of  $10N$  is applied at  $60^\circ$  to above the horizontal. Find the acceleration of  $5kg$  body which moves in horizontal direction.

### Newton's 3<sup>rd</sup> law:

Statement: "To every action, there is an equal and opposite reaction". i.e. **Action = -Reaction**

- The action and reaction always act on **two different bodies**. Hence, they never cancel each other.
- The forces always exist in pairs. (Significance of Newton's 3<sup>rd</sup> law)
- Action-reaction pairs are of the same nature.
- This law cannot be applied to a single body. There should be an interaction between two bodies. In an interaction between two bodies in contact, the force applied by one body on the other creates a reaction force which is equal and opposite to the action.

Some Applications of Newton's 3<sup>rd</sup> law:

- While walking, a person pushes the ground in the backward direction, and the ground in return pushes the person in the forward direction, thus making him walk.
- When a bullet is fired from a gun, the gun recoils. In rocket propulsion, the burnt fuel moves downward and the rocket moves upward.
- When a man jumps from a boat, the boat moves backwards away from him. While it is difficult to walk in sand or ice. This is because we cannot push the ground sufficiently hard. As a result, the reaction force is not sufficient to help us move forward.
- A person pushes water backwards during swimming. While swimming we push the water in a backward direction whereas the reaction of water pushes the swimmer in a forward direction.

### Newton's 2<sup>nd</sup> law of motion is the fundamental law of motion (Real law of motion)

Newton's 2<sup>nd</sup> law is the fundamental (basic) law of motion while the first law and third law are the special cases of the second law.

#### 1. Newton's 1<sup>st</sup> law from 2<sup>nd</sup> law:

According to Newton's 2<sup>nd</sup> law of motion,

$$F_{net} = ma$$

If,  $F_{net} = 0$ , [No net external force]

Then,  $ma = 0$

$$\Rightarrow a = 0 \quad [m \neq 0]$$

This implies that if no net external force act on the body then,

- a. Either the body is at rest
- b. Or the body is in uniform motion in a straight path.

These two cases explain the first law.