- Inertia depends upon mass. So, lighter objects require less force to change their state of rest or motion in comparison with heavier ones. The lighter object has small inertia and the heavier has large inertia. So inertia in linear motion is equal to mass. Hence mass is the measurement of inertia.

Types of Inertia:

1. ***Inertia of rest***: The inability of a body at rest to change its state of rest to a state of motion by itself is called inertia of rest. For e.g.
   - When a bus suddenly starts moving, the passengers fall backwards.
   - On the shaking branch of a tree, the fruits fall down.
   - A coin places on a cardboard over a glass falls into the glass if the cardboard is suddenly removed.
   - Dust particles are removed from a carpet by hitting it.

2. ***Inertia of motion:*** The inability of a moving body to change its state of motion to a state of rest by itself is called inertia of motion. For e.g.
   - When the moving bus suddenly stops, the passengers fall forward.
   - An athlete runs before a long jump.
   - The rotating fan takes some time to come to rest after the switch is off.
   - A ball thrown upwards in a train moving with uniform velocity returns to the thrower.

3. ***Inertia of direction***: The inability of a moving body to change its direction of motion by itself is called inertia of direction. For e.g.
   - When the vehicle takes a sharp turn, the passengers are thrown away.
   - The mud sticking to the wheel of the vehicle flies off tangentially.
   - A stone tied to a string is whirling in a horizontal circle, if the string breaks, the stone flies off tangentially.

Newton's second Law of motion:

Statement: The net external force acting on a body is directly proportional to time rate of change of its momentum.

If $'F'$ is the force applied on a body whose momentum at time $'t'$ is $'p'$, then from Newton's 2nd law,

$$Force\ (F) \propto Rate\ of\ change\ of\ momentum\ \left(\frac{dp}{dt}\right)$$

$$or, F \propto \frac{dp}{dt}$$

$$or, F = k\frac{dp}{dt}; \qquad \text{k is proportionality constant and its value is one}$$

$$\therefore F = \frac{dp}{dt} - - - - - (1)$$

We have, $p = mv$, then eq. (1) becomes,

$$F = \frac{d(mv)}{dt}$$

$$or, F = m\frac{dv}{dt} + v\frac{dm}{dt} \qquad [\text{differential form of Newton's } 2^{\text{nd}} \text{ law}]$$

Since, mass is constant, $\frac{dm}{dt} = 0$, then

$$or, F = m\frac{dv}{dt}$$

$$or, F = ma, \qquad a = \frac{dv}{dt}\ is\ acceleration\ of\ a\ body$$

$$\therefore \boldsymbol{F_{net} = ma}$$

If we know the mass (m) and acceleration (a) of a body, we can calculate the net force acting on the body.

Simplified Note