

# 10. Force and Motion

**Inertia:** The property of a body which tends to keep the body in its state of rest or of uniform motion is called inertia.

**Momentum:** Measure of motion is called momentum i.e. momentum = mass × velocity

$$p = mv$$

### Laws of motion

**First law:** whenever a body is at rest or uniform motion it will continue in rest or in uniform motion until or unless an external unbalanced force is applied on the body.

**Second Law:** The rate of change of momentum of a body is directly proportional to the force acting on it and takes place in the same direction as the force i.e.

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

$$F = k \frac{dp}{dt}$$

$$F = \frac{dmv}{dt} \quad (\because p = mv \text{ and } k = 1)$$

$$= m \frac{dv}{dt}$$

$$F = ma \quad \left( \because a = \frac{dv}{dt} \right)$$

The S.I. unit of force is Newton.

**Third Law:** To every action there is an equal and opposite reaction but they act on different objects.

**Law of Conservation of Momentum:** It states that the momentum of a system remains unchanged (conserved/constant) if no external force is acting on the system i.e.

$$F = \frac{p_2 - p_1}{t} \quad (\text{From Newton's second law})$$

When  $F = 0$  i.e. external force is not applied

Then 
$$0 = \frac{p_2 - p_1}{t}$$

i.e.  $p_1 = p_2$  i.e. no change in its momentum

**Friction:** Whenever a body slides over the surface of another body, an opposing force comes into play which resists the motion of the body and is called force of friction.

**Static friction:** The resistive force before the body starts moving over the surface of another body is called static friction

### Disadvantages of Friction

- (i) Force of friction causes lot of wear and tear in the moving parts of machine.
- (ii) Efficiency of machine decreases due to presence of force of friction
- (iii) Force of friction restricts the speed of moving vehicles.

### Advantages of Friction

- (i) The force of friction between chalk and blackboard helps to write on the board.
- (ii) Moving belt remain on the rim of a wheel because of friction.
- (iii) Force of friction helps us to move on the surface of the earth.

### Methods of reducing friction

- (i) Polishing of surfaces
- (ii) Lubrication
- (iii) Use of ball bearings and roller bearings.

**Thrust:** The force acting upon the surface of a body perpendicular to it is called thrust.

**Pressure:** Thrust per unit area is called pressure

i.e. pressure =  $\frac{\text{Thrust}}{\text{Area}} \Rightarrow \frac{F}{A}$ . The unit of pressure

is  $\frac{\text{N}}{\text{m}^2}$  or (pascal)

## Build Your Understanding

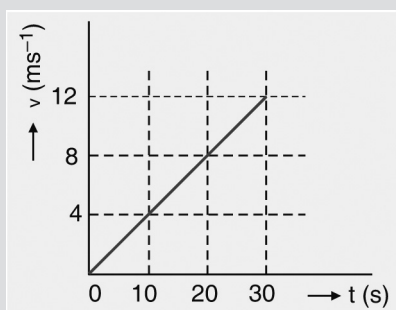
- Inertia is measure of mass.
- A person gets hurt when he falls on a cemented floor because the momentum of person becomes zero within very short time. As the rate of change of momentum is very high, so very large force is exerted on the person.
- The force of reaction appears so long as the force of action acts.
- Action and reaction act on two different bodies.
- Friction depends upon normal reaction i.e.  
$$f \propto R$$
- Friction does not depend on surface area of given bodies which are in contact with each other.

## ★ Stretch Yourself

1. Can unbalanced forces acting on the body change its state of rest or motion?
2. Can balanced forces change the state of rest or motion?
3. Why do massive objects resist more than lighter ones?
4. A bullet when fired from a gun can kill person. while same bullet thrown with hand hardly do any harm. Explain.
5. Why do porters carrying heavy load, wear turbans on their heads?

## ? Test Yourself

1. Velocity-time graph of a body of mass 2 kg is shown in figure. Find the rate of change in momentum of the body.



2. A block of mass 5 kg is resting on an inclined plane at angle of  $30^\circ$  with the horizontal. What are the forces acting on the body.
3. The velocity of a 2 kg object changes from  $4 \text{ ms}^{-1}$  to  $12 \text{ ms}^{-1}$  in 6s. Find the acceleration of the body and force acting on the body.
4. The body of mass 5 kg gets acceleration of  $2 \text{ ms}^{-2}$  under the influence of a certain force. If same force is applied on a body of mass 2 kg. What acceleration will it acquire?
5. A force of 5 N is required to keep a body in motion with constant velocity. What is the force of kinetic friction acting on it?
6. Can force of action and reaction act on the same body? Write its consequences with examples.