Date: 18/7/19 Page: _____

Force & Laws of Motion

* **Force**

A force is that external push on an object to change the state of an object **OR** to change direction of an object.

Example To stretch a spring, pulling a door

* **Balanced Force**

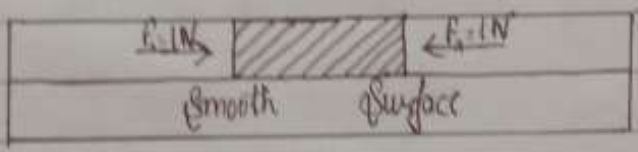

Fig 1.

Net force = $F_1 - F_2$
= 1 - 1
= 0

When a number of forces acting simultaneously on an object, do not produce any change in it's state of rest **OR** of uniform linear motion, the forces are said to be balanced force.

In the fig 1, force of equal magnitude acting in mutually opposite direction at simultaneously on an object. The object placed at rest

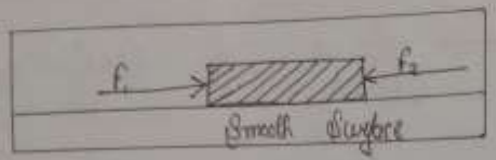

Fig. 2

$f_1 > f_2$

Net force $= f_1 - f_2$

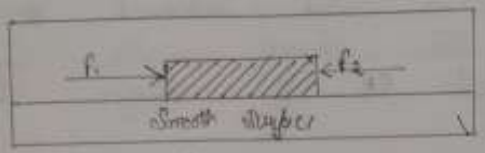

Fig. 3

$f_2 > f_1$

Net force $= f_2 - f_1$

* Unbalanced force

⇒ When two or more forces acting simultaneously on an object have a non-0 resultant force and change the state of rest or of uniform linear motion, the forces are said to be unbalanced force.

- In fig 2 & 3 dot the two forces of unequal magnitude f_1 & f_2 is acting mutually opposite direction on an object then the net force $(f_1 - f_2)$ $(f_2 - f_1)$ acting on the object is non-0 and then the force is said to be unbalance force

▶ Effect of balanced force

- It can not change a state of rest or uniform motion.
- It may change the shape and size of an object.

▶ Effect of unbalanced force

- An object at rest may start motion
- A moving object may come to rest
- Speed & direction of a moving object may change.

Newton's law of Motion

Newton presented three fundamental laws. These are known as Newton's law of motion

* First law of Motion

⇒ An object remains in state of rest or motion in a straight line uniform unless compelled to change that state by an external unbalanced force applied on it.

- Example - A moving car, A moving football
- This law is also called law of Inertia.

* Second law of Motion

⇒ The rate of change of momentum of an object is directly proportional to the applied unbalanced force on it and takes place in the direction of force applied.

$$F \propto \text{rate of change of momentum}$$

- Example of fast moving cricket ball coming towards the fielder

* Third law of Motion

⇒ To every action, there is a equal and opposite reaction the action-reaction force act simultaneously for same time it different object interacting with one another

- Example of forward force on the bullet & recoil of the gun

Momentum

- It is an effect of force
- It is the product of mass & velocity
- It depends on the mass & velocity of an object
- The momentum of an object is defined as the product of it's mass & velocity. If an object of mass 'm' in motion with velocity 'v' then
- SI unit - Kg m/s

Momentum = Mass × Velocity

[p = mv]

- Momentum is a vector quantity & it's direction is same as direction of it's velocity
- An object at rest has 0 momentum because it's velocity is 0

Num ① Calculate the momentum of cricket ball of mass 0.15 Kg travelling at a velocity of 144 Km/h

$$\text{Velocity} = 144 \text{ Km} = \frac{\cancel{144}^{8}}{\cancel{1}} \times \frac{5}{\cancel{18}} \text{ m/s}$$

$$= 40 \text{ m/s}$$

$$\text{Momentum} = mv$$
$$= (0.15 \times 40) \text{ Kg m/s}$$
$$= 60 \text{ Kg m/s}$$

Num ② Find momentum (maximum & minimum) in the following :

ⓐ Ball of mass 200g with velocity 30 m/s

$$\text{Momentum} = mv$$
$$= (200 \times 30) \text{ Kg m/s}$$
$$= 6000 \text{ Kg m/s}$$

ⓑ Tennis ball

© A bullet of mass 10 g with velocity 250 m/s

Inertia

The tendency of an disturbed object to stay at rest or to keep moving with same velocity is called inertia.

Types of inertia

Inertia of rest

The property or tendency of an object to opposed any change in state of rest by itself is known as inertia of rest

Example- When a bus suddenly stard moving forward the passenger fall backward

Inertia of motion

The property or tendency of an object to opposed any change in state of motion by itself is known as Inertia of motion.

Example: When a bus suddenly stops, the passengers experience a forward push

Inertia of direction
The property or tendency of an object to oppose any change in it's direction

Example: When a moving bus negotiates a turn on the road, passenger of bus experience a outward push

Mathematical Formulation of 2nd Law of Motion

Let an object of mass 'm' moving with initial v 'u' a constant force applied on the object so that it is uniformly accelerated to a final velocity in time 't'

Initial momentum - $P_1 = ma$
Final momentum - $P_2 = mv$
Change of momentum $= P_1 - P_2$
$= mu - mv$
Rate of change of momentum $= \frac{mv - mu}{t}$

$F \propto$ rate of change of moment
$F \propto \frac{mv - mu}{t}$

Date: _____ Page: _____

$$f \propto m\left(\frac{v-u}{t}\right)$$

$$f \propto ma$$

$$f = Kma$$

here, K is constant of proportionality.