Grade 09
Science Chapter Notes

BYJU'S Classes
Chapter Notes

Philosophiae Naturalis Principia Mathematica

Force and Laws of Motion
Class IX

Topics to Be Covered

MIND MAP

Inertia of rest   Inertia of motion   Inertia of direction

Resistance to state of rest or uniform motion

Inertia

State of rest or motion remains unaltered until an external force acts on it

Contact forces

Non-contact forces

Types of Forces

Effects of Force

Net force

$F_{net} = 0$ $F_{net} \neq 0$

Balanced Force   Un-balanced Force

1st law

Force

Force and Laws of Motion

2nd law

3rd law

Net unbalanced force acting on a body:

$$F_{net} = \frac{\Delta p}{\Delta t}$$

For constant mass:

$$F = ma$$
$$= m(v-u)/t$$

$$F_1 = -F_2$$

Every action has equal and opposite reaction
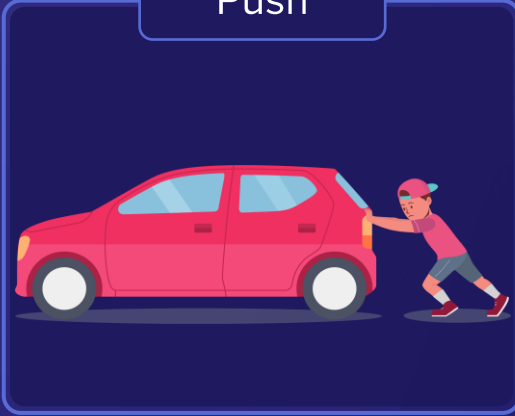
Conservation of momentum

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

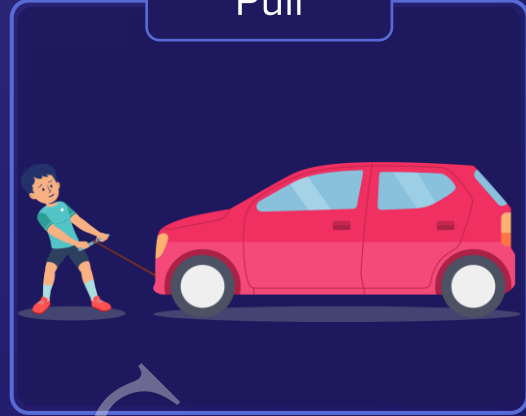Momentum before collision = Momentum after collision

1. Force

1.1 Definition of Force

Push

Pull

- A Push or a Pull acting on an object is called a Force.
- SI unit of force is newton(N).

1.2 Effects of Force

Change in state of motion

Change in speed

Change in direction

Change in shape

▶▶▶ Contact Force

Frictional force

- Resists motion when the two or more surfaces come in contact.

Normal force

- The force that a surface employs on any other body.

Muscular force

- When any force applied by using of muscles like arms or legs.

▶▶▶ Non-Contact Force

Gravitational force

- The force of attraction between all masses in the universe.

Electrostatic force

- An attractive and repulsive force between particles are caused due to their electric charges.
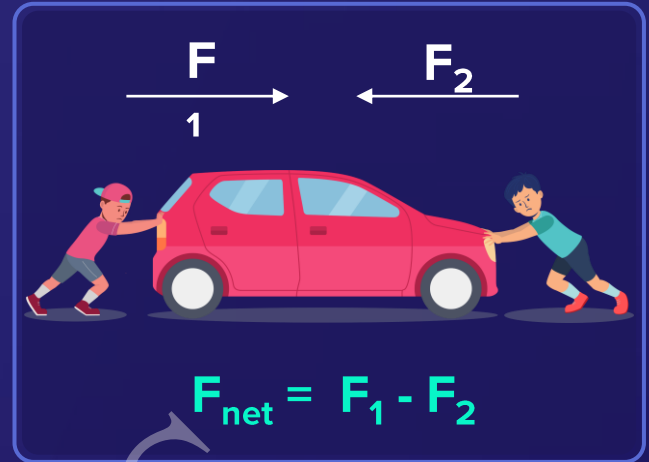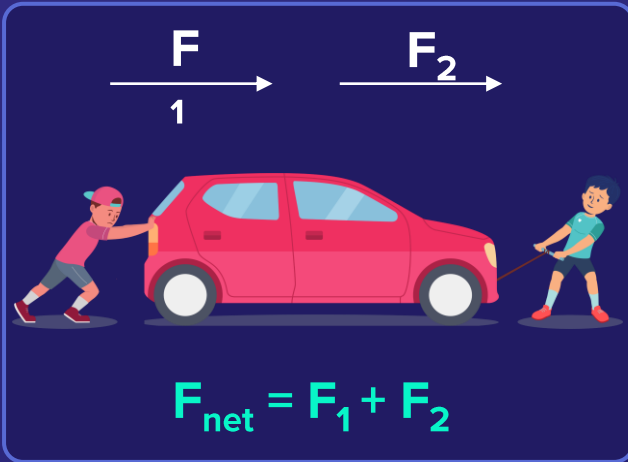
Magnetic force

- An attractive or repulsive force that is exerted between the poles of a magnet.
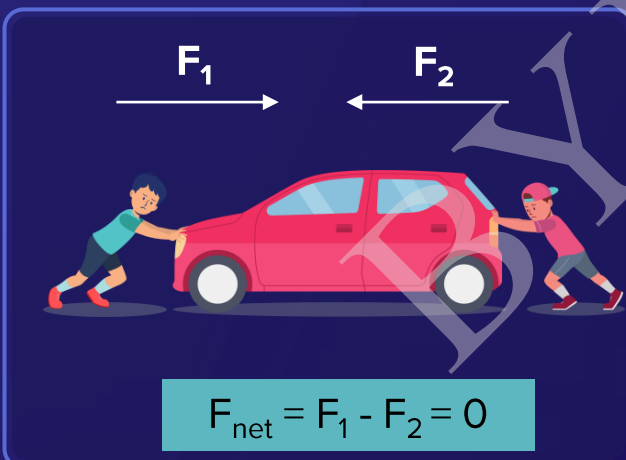
1.4 Balanced and Unbalanced Force

Net force is the **equivalent** force acting on the object.

$$F_{net} = F_1 + F_2$$
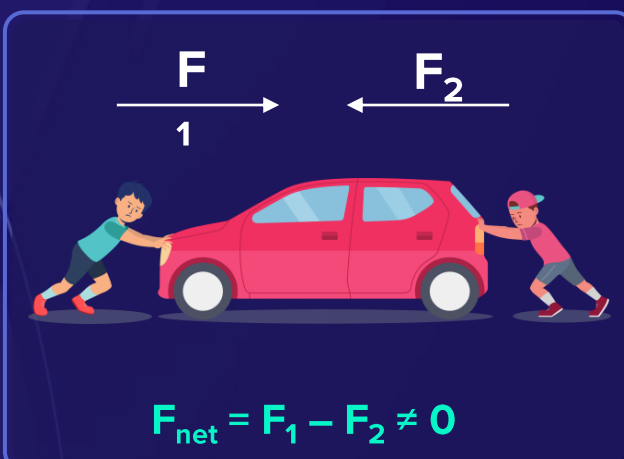
$$F_{net} = F_1 - F_2$$

▶▶▶ **Balanced force** $F_{net} = 0$

$$F_{net} = F_1 - F_2 = 0$$

- All forces cancel out each other.
- Net force is zero.

▶▶▶ **Unbalanced force** $F_{net} \neq 0$

- Forces do not cancel out.
- Net force is not equal to zero.

$$F_{net} = F_1 - F_2 \neq 0$$

2. Newton's Laws of Motion

2.1 First Law of Motion

- An object remains in a state of **rest** or in a state of **uniform motion**, until and unless an **external force** acts on it

Rest : No change in **position.**
Uniform motion : No change in **velocity.**

2.2 Inertia

- **Resistance** to the change in **state of rest** or **uniform motion**.

- The **mass** of an object is a measure of its inertia.

▶▶▶ Inertia of rest

- **Resistance** offered by the body to continue in the state of **rest.**
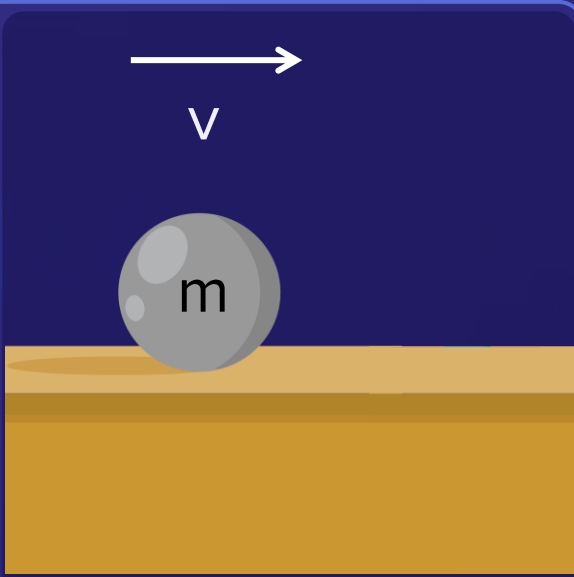
▶▶▶ Inertia of motion

- **Resistance** offered by the body to continue in the state of **motion.**
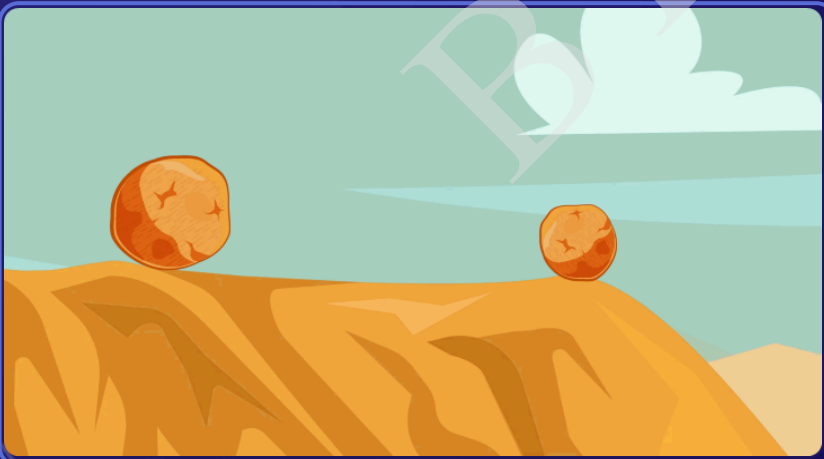
▶▶▶ Inertia of direction

- **Resistance** offered by the body to continue moving in **same direction.**

v

m

- Product of **Mass** and **Velocity**

- Momentum (p) = Mass (m) x Velocity (v)

- S.I. unit = **kg m/s** or **N s**

- Vector quantity

2.5 Second Law of Motion

- Net force acting on a body equals the rate of change of momentum.

$$F_{net} = \frac{\Delta p}{\Delta t}$$

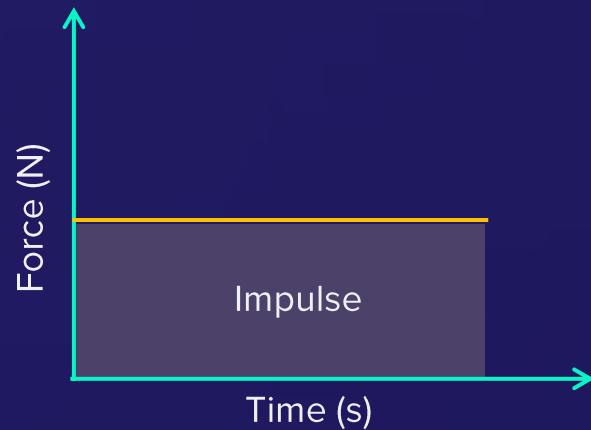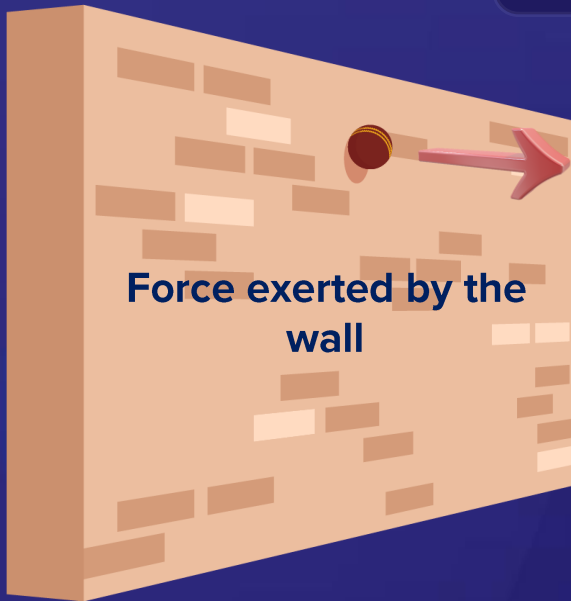▶▶▶ **For constant mass** $F_{net} = \dfrac{m \, \Delta v}{\Delta t}$

$$F_{net} = ma$$

Force exerted by the wall
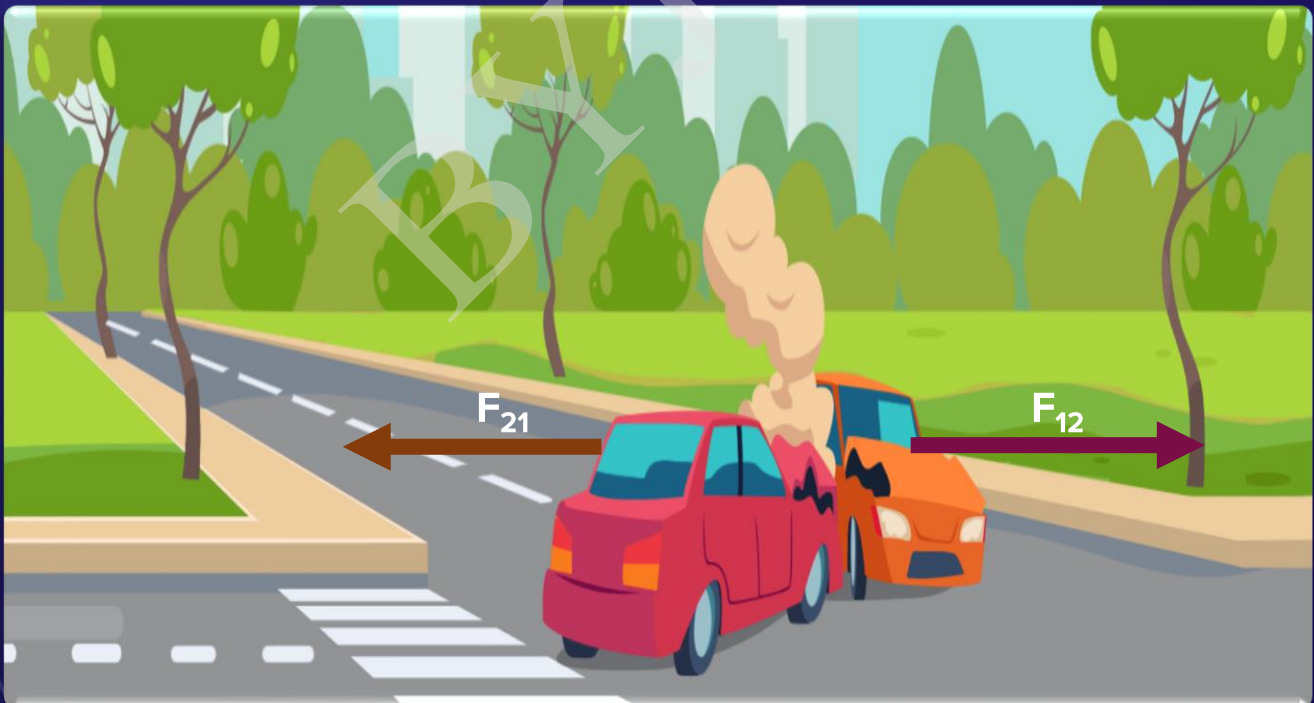
Force (N)

Impulse

Time (s)

Impulse = Change in momentum

$J = mv - mu = m\,\Delta v$

$J = F \times t$

2.7 Third Law of Motion

F_{21} F_{12}

- For every action there is an equal and opposite reaction.
- The action and reaction force always act on different bodies.
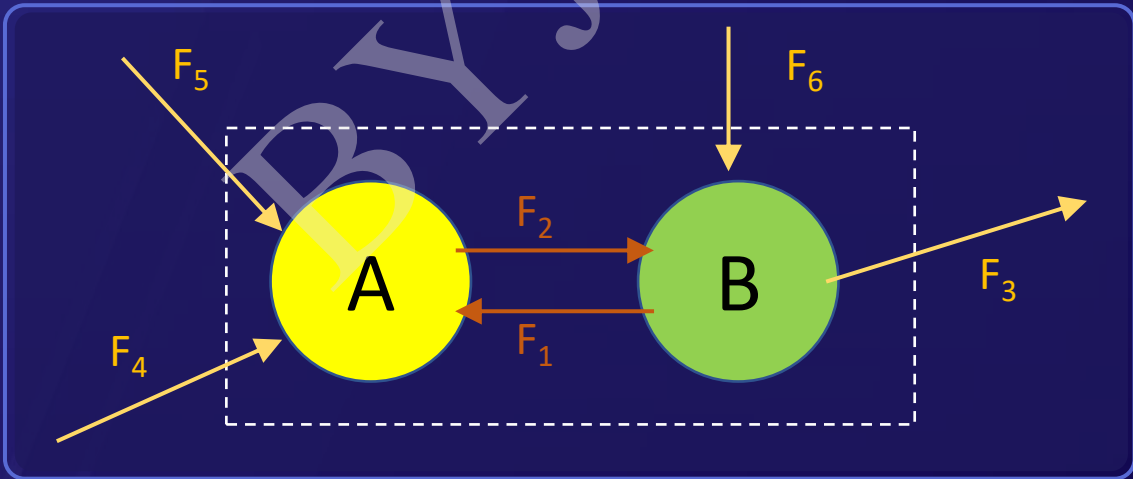
$$F_{12} = -F_{21}$$

Applications of 3ʳᵈ Law

Recoil of a gun

Propulsion of a rocket

2.8 Internal and External Forces

F_5

F_6

F_2

A

B

F_3

F_4

F_1

Internal forces: F_1, F_2
External forces: F_3, F_4, F_5, F_6

- Only external forces are capable of producing motion in a body.

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Formula Sheet

1 MOMENTUM
$$p = mv$$

2 SECOND LAW OF MOTION
$$F_{net} = \frac{\Delta p}{\Delta t}$$

$$F_{net} = ma$$

3 IMPULSE
$$J = mv - mu = m\,\Delta v$$

$$J = F \times t$$

4 THIRD LAW OF MOTION
$$F_1 = -F_2$$

5 CONSERVATION OF MOMENTUM
$$m_1\,u_1 + m_2\,u_2 = m_1\,v_1 + m_2\,v_2$$