

1 SAQ = 4 MARKS

4. LAWS OF MOTION

• Inertia • Newton's laws of motion • Momentum • Force • Impulse
• Friction - Types - uses - disadvantages

SMART SYNOPSIS

1. **Inertia** is an **inherent property** of a body which opposes **any change** in its state.
It is the resistance to change the state of uniform motion or rest or direction.
3 types of Inertia: [SAQ]
 - 1.1 **Inertia of Rest** is the resistance of a body to change its 'state of rest' by itself.
Ex: When a stationary bus starts suddenly, passengers experience a backward jerk due to inertia of rest.
 - 1.2 **Inertia of Motion** is the resistance of a body to change its 'state of motion' by itself.
Ex: When a moving bus stops suddenly, passengers fall forward due to inertia of motion.
 - 1.3 **Inertia of direction** is the resistance of a body to change its 'direction' by itself.
Ex : When a bus travelling in a straight path suddenly turns towards left, the passengers get themselves pressed towards the right due to inertia of direction.
2. **Newton's Laws of motion:** [SAQ]
 - 2.1 **Newton's First law (Law of inertia)** states that an object at rest, stays at rest, and an object in motion stays in motion unless acted upon by an external force.
Significance: It introduces the concept of inertia.
Ex: When a stationary bus starts suddenly, passengers experience a backward jerk.
 - 2.2 **Newton's Second law (Law of momentum)** states that the 'rate of change of momentum' of a body is directly proportional to the force applied on it and it occurs in the direction of force.
Significance: It gives a measure of momentum, acceleration, force ($F=ma$).
Ex: A cricketer draws his hands backward while catching a fast-moving ball.
 - 2.3 **Newton's Third law (Law of action & reaction)** states that 'to every action, there is always an equal and opposite reaction'.
Significance: It establishes the law of conservation of momentum.
Ex: When a bullet is fired from a gun, the gun recoils backward.
3. **Momentum (p)** is the product of mass (m) and velocity (v) of a moving body. [VSAQ]
Formula: $p = mv$ **SI unit:** kg ms^{-1} . **CGS units :** g cm s^{-1} .
4. **Law of conservation of Momentum :** [VSAQ]
Total momentum before collision = Total momentum after collision
Mathematically, $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

5. **Force** is the product of mass (m) and acceleration (a) of a moving body.

Force changes the state of rest or motion of a body.

Formula: Force $F = m a$

[VSAQ]

Units of force : SI unit: **newton (N)** (or) kg ms^{-2} ; CGS unit : **dyne (or) gm cm s⁻²**

Conversions: $1\text{N} = 10^5 \text{ dyne}$; $1 \text{ kg weight} = 9.8\text{N}$; $1\text{g wt} = 980 \text{ dyne}$.

Ex : Gravitational force, Frictional force, Electromagnetic force, Nuclear force

6. **Impulse and Impulsive Force:**

- 6.1 **Impulse (J)** is the product of **force** and **time** for which the force acts .

[VSAQ]

It is the **change** produced in the **linear momentum** due to the force acting on a body.

Formula: Impulse $J = \text{Force} \times \text{time}$ (or) $J = m(v-u)$

S.I unit: N.s (or) kg.ms^{-1}

Ex: Applying brakes in a moving car causes impulse.

- 6.2 **Impulsive force** is a **very large force** acting on a body for a very **small interval of time**.

Formula: Impulsive force $= \frac{\Delta p}{\Delta t}$

S.I unit: N

Ex: Bat hitting a cricket ball , Hammer hitting a nail.

Note: When impulsive force acts on a body it creates impulse.

Thus, impulsive force is the action and impulse is the result.

7. **Friction** is the force which opposes the relative motion between two surfaces in contact.

The direction of frictional force is parallel / tangential to the surfaces in contact.

- 7.1 **Advantages of friction:** i) Walking on a road ii) Brakes to stop iii) Picking an object

- 7.2 **Disadvantages of friction:** i) Wear and tear in machines ii) Energy losses in engine

- 7.3 **Methods used to decrease friction:**

i) Polishing ii) Using Lubricants iii) Using ball bearings iv) Stream lining

- 7.4 **Types of friction:**

i) **Limiting friction (f_L):** **Ex:** A heavy cupboard just about to move when pushed.

ii) **Sliding friction (f_k):** **Ex:** A book sliding on a table.

iii) **Rolling friction (f_r):** **Ex:** A trolley wheel rolling on the road

