

Name: Chandra Shekhar
College: IIT Gandhinagar
Subject: Physics
Weightage: Regular
Title: Laws of Motion

LAWS OF MOTION

Newton's Laws of Motion

First Law (Law of Inertia)

A body remains at rest or continues to move with constant velocity unless acted upon by a net external force.

Second Law

The net external force on an object equals the rate of change of its momentum:

$$\sum \vec{F} = m\vec{a}$$

Component-wise:

$$\begin{aligned}\sum F_x &= ma_x \\ \sum F_y &= ma_y \\ \sum F_z &= ma_z\end{aligned}$$

Third Law

For every action, there is an equal and opposite reaction:

- $\vec{F}_{AB} = -\vec{F}_{BA}$
- Example: Earth and Sun pull each other with equal and opposite forces.

Linear Momentum

Defined as:

$$\begin{aligned}\vec{p} &= m\vec{v} \\ \sum \vec{F} &= \frac{d\vec{p}}{dt}\end{aligned}$$

Impulse

Impulse equals the change in momentum:

$$\vec{J} = \Delta\vec{p} = \vec{F}_{avg}\Delta t$$

Law of Conservation of Momentum

Total momentum of a system remains conserved in absence of external forces:

$$\sum \vec{p}_{initial} = \sum \vec{p}_{final}$$

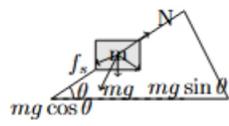
Frictional Force

- Static Friction: $f_s \leq \mu_s N$
- Kinetic Friction: $f_k = \mu_k N$
- Note: $\mu_s > \mu_k$

Angle of Repose

When a body just begins to slide on an inclined plane:

$$\tan \phi = \mu_s$$



Centripetal Force

Force required to keep a body in circular motion:

$$F_c = \frac{mv^2}{r} = m\omega^2 r$$

Centrifugal Force

Apparent outward force observed in rotating frame, equal in magnitude but opposite to centripetal force.