NEWTONS LAWS OF MOTION

LAWS OF MOTION

SUBJECT PHYSICS

CLASS LEVEL 11th.

AUTHOR'S NAME N.GOKUL

ABSTRACT

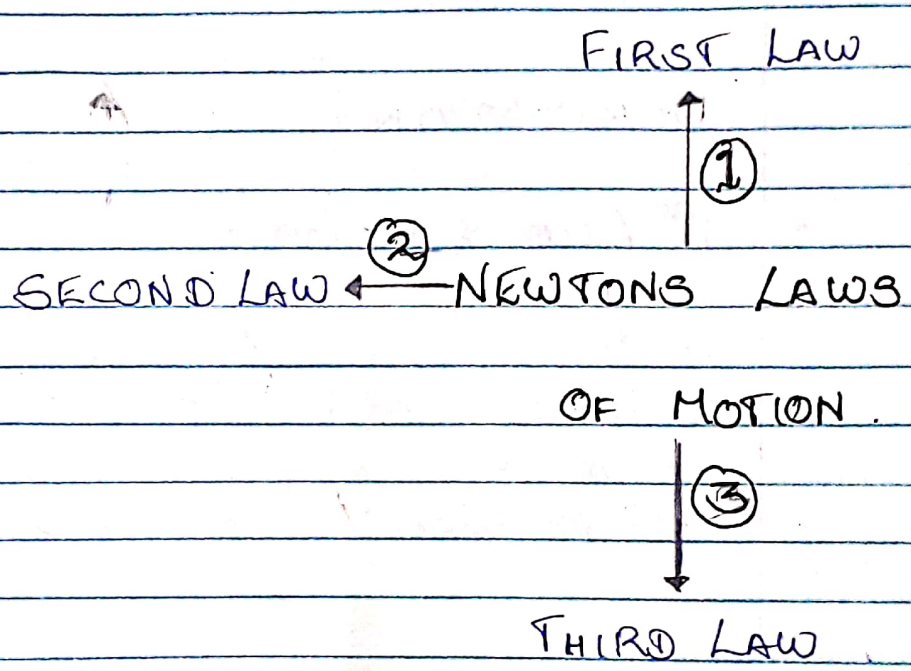
In this concept we are going discuss about three laws of motion.

MNEMONIC: FLISLTL

REFERENCE

E.RAMANATHAN, SAITECH Lecture Notes.

CONCEPT MAP.



TERMS AND DEFINITION.

1) FIRST LAW OF MOTION	Every body continues to be in its state of rest or of uniform motion in a straight line unless compelled by some external forces to act otherwise
2) SECOND LAW OF MOTION	The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in

which the force acts

3) THIRD LAW OF MOTION — To every action, there is always an equal and opposite reaction

DERIVATIONS.

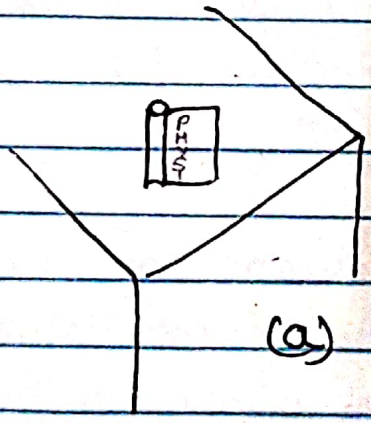
→ 1st Law of Motion.

If the external force on a body is zero, its acceleration is zero, Acceleration can be non-zero only if there is a net external force on the body.

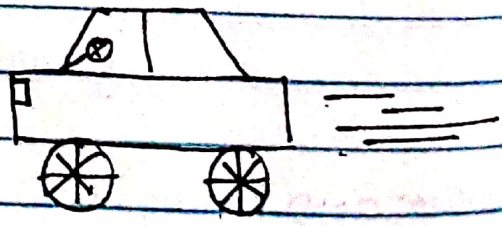
$$a = 0$$

$$a = \frac{v-u}{t} = \frac{0}{t}$$

$$v - u = 0 \Rightarrow v = u$$ uniform velocity.



(a)



(b)

(a) A book is at rest on the table.
(b) A car is moving with acceleration uniform velocity. The net force is zero in each case.

→ 2nd Law of Motion

It relates the net external force to the acceleration of the body

$P_2 = mv$ = final momentum.
$P_1 = mu$ = initial momentum.

$\Delta P = P_2 - P_1$ = change of momentum.

$\vec{p}$ → a vector.
$\vec{p} = m\vec{v}$
$\Delta\vec{p} = m\Delta\vec{v}$ m = mass = constant

→ $\vec{F} \propto \frac{\Delta\vec{p}}{\Delta t}$ rate of change of momentum

$\vec{F} = k\frac{\Delta\vec{p}}{\Delta t}$ k = constant of proportionality

In the shortest interval of time,

$$\vec{F} = k \frac{d\vec{p}}{dt}$$

$$= k \frac{d}{dt}(m\vec{v})$$

$$= k \cdot m \cdot \frac{d\vec{v}}{dt}$$

$$= k \cdot m \cdot \vec{a}$$

$$\boxed{\vec{F} = k \cdot m \cdot \vec{a}} \qquad k = \text{unity}$$

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

Unit of force

$$F = ma \qquad [F = MLT^{-2}]$$

$$= kg\ ms^{-2}$$

$$= N$$

$$\boxed{1N = 1kg\ ms^{-2}}$$

Impulse

Force acting on a body for a moment of time is the product of Force and time

$$F = \frac{m(v-u)}{t}$$

$$F.t = mv - mu = \Delta P$$

Importance of 2nd law:

1. When $\vec{F} = 0$, it implies $\vec{a} = 0$.

$\vec{F} = m\vec{a}$ — m cannot be 0.

$\therefore \vec{a} = 0$.

2. The 2nd law of motion is called as vector law.

$$F_x = \frac{dp_x}{dt} = ma_x$$

$$F_y = \frac{dp_y}{dt} = ma_y$$

$$F_z = \frac{dp_z}{dt} = ma_z$$

3. The second law of motion is applicable to a single point particle.
Any internal forces to the system are not to be included in F.

→ 3rd Law of Motion.

Features →

* Force always occur in pairs
* Force on a body A by B is equal and opposite to the force on the body B by A.
* $F_{AB} = -F_{BA}$

[force on A by B] = − [Force on B by A]

KEY

529) $a = \frac{-u^2}{2s} = \frac{-90 \times 90}{2 \times 0.6}$

$= -6750\ ms^{-2}$

Retarding force, by 2nd law

$= 0.04\ kg \times 6750\ ms^{-2}$

$= 270N.$

530) We know

$$y = ut + \frac{1}{2}gt^2.$$

$$v = \frac{dy}{dt} = u + gt.$$

$$a = \frac{dv}{dt} = g.$$

$\therefore$ Force $= ma = mg$

531) Change in momentum

$= 0.15 \times 12 - (-0.15 \times 12)$

$= 0.15 \times 12 - (0.15 \times 12)$

$= 3.6\ Ns.$

532) Acc. to 1st law, a body at rest remains at rest, to set it in motion a force is required

till an external force is not applied on it. Galileo's law of Inertia is base of Newton's 1st law.

544) Frictional force by road accelerates the car only. External agency can exert force on body so that body accelerate.