Force and Momentum :

Force and Momentum,

Causes of Motion,

- Newton's Law of Motion
- Applications of Newton's Laws.
- Equilibrium of forces.

Linear Momentum,

- Conservation of Linear momentum
- Impulse
- Motion with Variable Mass.

Newton's Laws of Motion,

Every body continues in its state of rest or of uniform motion in a straight line unless it is compelled to change that state by force impressed upon it."

* Newton's Law is also known Law of inertia and.

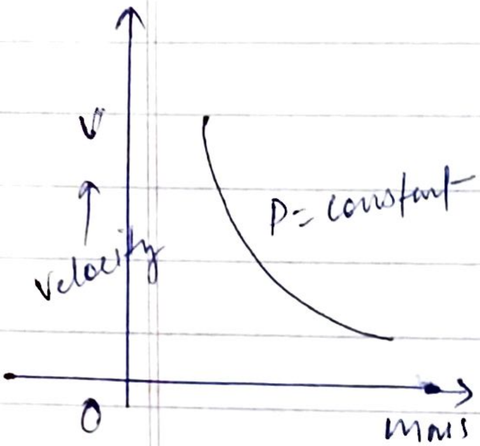
*

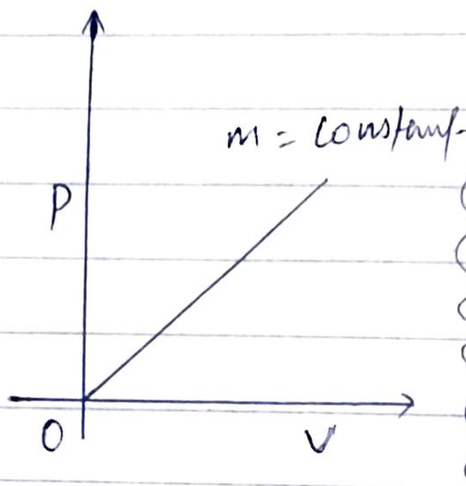
Linear Momentum :- it is also measured as the product of the mass of the body and its velocity

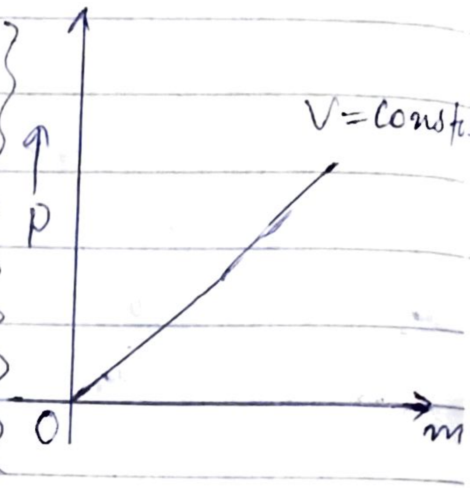
* Momentum = mass × velocity

* $\boxed{\vec{P} = m\vec{v}}$

* it is vector quantity







$P = m_1 v_1 = m_2 v_2 = \text{constant}$

$\frac{V_1}{V_2} = \frac{m_2}{m_1}$

that $\boxed{v \propto \frac{1}{m}}$

$p = \text{constant}$

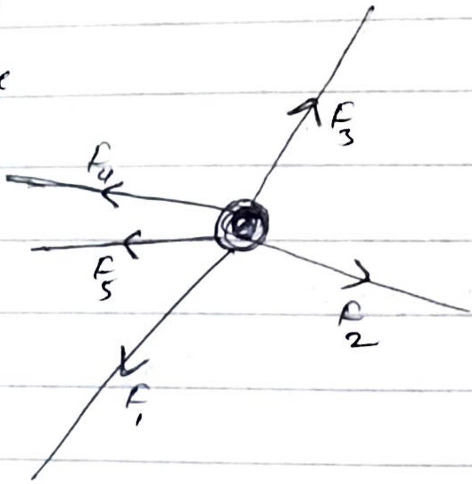
$P \propto V$

$\boxed{p \propto m}$

Equilibrium of Forces

We say that a particle is in equilibrium, when the resultant of all the ~~particle~~ forces acting on it is zero.

Let F_1, F_2, F_3 .. force acting on the body and Net force is zero, and the accel^n in the block is zero. Then F_1, F_2, F_3 --- are called Equilibrium forces.



$$\vec{F_1} + \vec{F_2} + \vec{F_3} + \vec{F_4} + \vec{F_5} = 0$$

So F_1, F_2, F_3, F_4, F_5 all are Force of equilibrium.

Mass

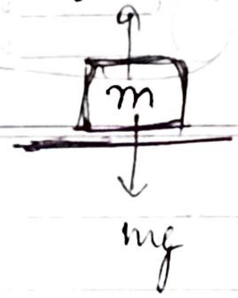
Mass is the amount of matter contained in a body. It is a constant.

- It is a Scalar.
- It obeys of rules of arithmetic.
- Mass is measured using a common balance.

SI unit of Mass is Kg. (kilogram)

Weight — It is the force with which a body is attracted toward the centre of earth.

- It is not an inherent property of body.
- It is change with the position.



- $W = mg$

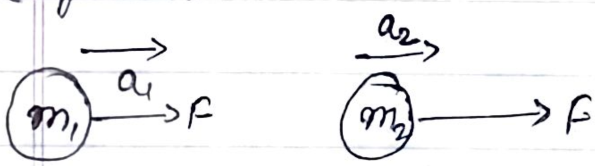
Values of g varies from places to places.

- it is vector quantity.
- It is measured using a spring balance SI unit is N.

Inertial Mass

Inertial is a property of the body and is a measure of the response of the body to an external force. Mass of the body is a measure of its inertia.

If the same force is exerted on a body of mass m_1 and a light body of mass m_2 the accelⁿ of the heavy body a_1 is less than the accelⁿ of the light body a_2.



Force acting on the body if m_1 is heavy and m_2 is light body, and a_1 is ~~force~~

Let.

$F = m_1 a_1$ $\qquad$ $F = m_2 a_2$

if $m_1 < m_2$

$m_1 a_1 = m_2 a_2$

$$\frac{m_1}{m_2} = \frac{a_2}{a_1}$$

$$a_1 \propto \frac{1}{m_1} \quad \text{or,} \quad a_2 \propto \frac{1}{m_2}$$

- This mass of body which measures its inertia is called the inertial Mass.

Impulse

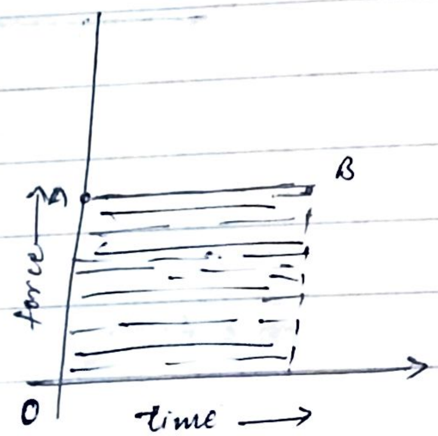
The product of a large force and small interval of time for which the force act on the body is called impulse.

it also,

it is also measured of the degree to which an external force produces a "change in momentum of a body."

& it is not a property of the body alone.

Let a external force acting on the body for small time interval t second and change the velocity from u to v from Newton's Law



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

$$F \times t = mv - mu$$

mu ↳ initial momentum

mv ↑ final momentum

final

$$F \times t = \Delta mv$$

↳ Change in momentum.

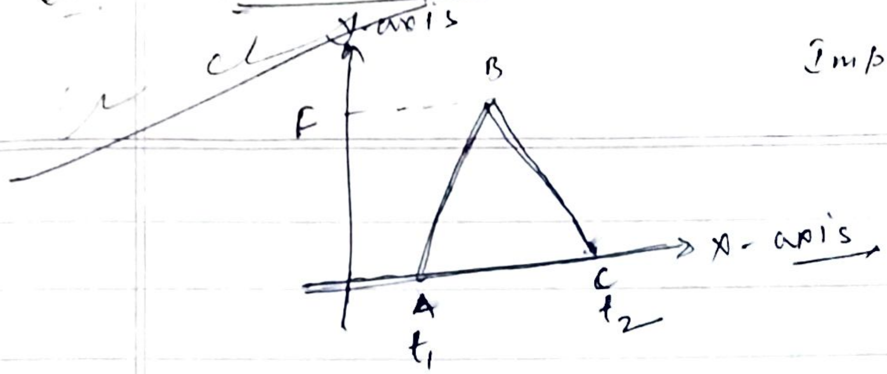
Note The area enclosed of curve of F-t graph given the impulse of body.

Impulse = Change of momentum.

SI unit of impulse is N s

Dimensional formula is $[MLT^{-1}]$

Condition for calling a force as an impulsive force, ex: — force-time graph:



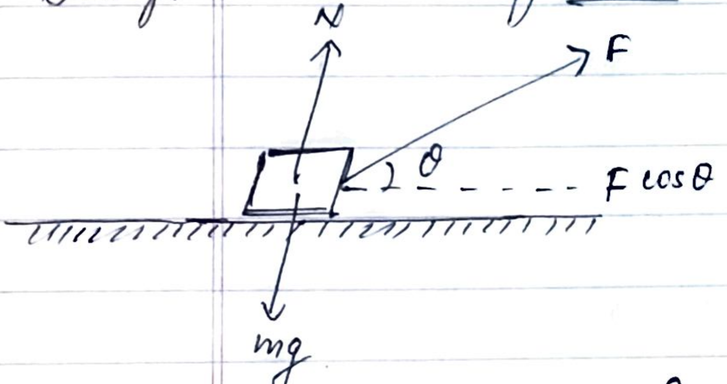
Impulse delivered to the ball

$= F \times t$,

= Area enclosed by the force-time graph with the X-axis,

$$I = F \times (t_2 - t_1)$$

ex: — A block of mass m is placed on a horizontal frictionless table. Under the action of a force of constant magnitude $F = \frac{mg}{4}$ the starts moving. During the motion θ change with. $\theta = bs$. b is constant and s is distance travelled by the block from its initial position



$F_x = a_x m$,

$F_x = F\cos\theta = F\cos(bs)$

$a_x = \frac{dv}{ds} \cdot \frac{ds}{dt} = v\frac{dv}{ds}$

accel^m of block in X-direction

$F\cos(bs) = m v\frac{dv}{ds}$

$F\cos(bs)\, ds = m v\, dv$

Force is change with distance and it intigreate the force

$$\int_0^s F\cos(bs)\, ds = \int_0^v m v\, dv$$

$$F\left[\frac{\sin bs}{b}\right]_0^s = m\left[\frac{v^2}{2}\right]_0^v$$

putting the value of $F = \frac{mg}{4}$,

$$F\frac{\sin bs}{b} = m\frac{v^2}{2}$$