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* Gauss' divergence theorm :-

The theorm states that the surface intigral of vector over the area of a closed surface is equal to the volume integral of divergence of a vector over the volume enclosed by the closed surface.

Let v be the vector

then. $$\iint_S \vec{v}.\vec{ds} = \iiint (\nabla.\vec{v})\, dv$$

lux of a vector $= \vec{V}.\vec{ds}$

Let us a closed surface of surface area s and volume v. Let this closed surface be _______ elementry Parts it being eachs a Parallopipe of sides dx, dy, dz.

Let $\vec{v}$ be a vector At the center of Parallelopipe than v_x, v_y, v_z are the components along x-axis, y-axis and z-axis respectively.

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Let $\vec{V}$ be a vector At the center of Parallelopipe than V_x, V_y, V_z are the components along x-axis, y-axis and z-axis respectively.

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A Parallelopipe is so small that v_x at a middle point P_1 of a left face becomes equal to the same over the entier face.

Let v_x at P_1 be $v_x(P_1)$ similary v_x at P_2 on the right face in $v_x(P_2)$

Then the flux through the left face $= -v_x(P_2)\,dydz$

The flux through the right face $= v_x(P_2)\,dydz$

Let v_x be changing at the rate $\frac{\partial v_x}{\partial x}$, then

Total value at P_2
i.e. $v_x(P_2) = v_x(P_1) + \frac{\partial v_x}{\partial x} dx$

The flux throught the right face $= \left[v_x(P_1)\, \frac{\partial v_x}{\partial x}\right] dydz$

Therefore the flux through the left and right faces.

i.e along x-direction $= \left(v_x(P_1)\, \frac{\partial v_x}{\partial v} dx\right) dydz = v_x(P_1)\,dydz$

$\Rightarrow v_x(P_1)\,dydz + \partial v_x\, dx\, dydz - v_x(P_1)\,dy\,dz$

$= \frac{\partial v_x}{\partial x}\, dx\,dy\,dz$

Similarly flux along y-direction.

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$$\frac{\partial V_y}{\partial y} \, dx \, dy \, dz$$

flux along z- direction

$$\frac{\partial V_z}{\partial z} \, dx \, dy \, dz.$$

Then the total flux through the parallelopipe

$= \frac{\partial V_x}{\partial x} dx dy dz + \frac{\partial V_y}{\partial y} dx dy dz + \frac{\partial V_z}{\partial z} dx dy dz$

$= \nabla \cdot \vec{v} \, dx \, dy \, dz$

$= \nabla \cdot \vec{v} \, dv$ —— ① where $dv = dx \, dy \, dz$

But the total flux over the parallopipes

$= \iint \vec{v} \cdot \vec{ds}$ —— ②

surface area of the Parallopipes

from equation ① and ⑪

$$\iint \vec{v} \cdot \vec{ds} = \nabla \cdot \vec{v} \, dv$$

surface area at the Parallelopipes

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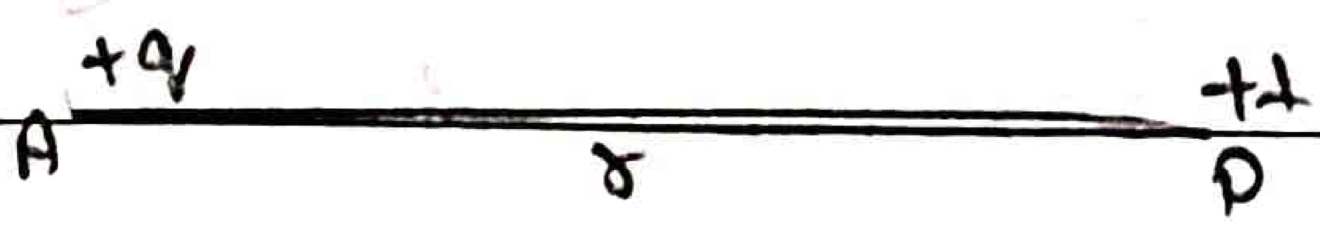
Then the total flux area over the Hole closed Surface is given by

$$\boxed{\iint_S \vec{V}\,\vec{ds} = \iiint_V \nabla\cdot\vec{V}\, dv}$$

This is Gauss' Theorm

Electricity and magnetion.

Electric field intensity :- The electric field intensity of Point in the electric field defined as the force experienced by a unit Positive charge.



Let us take a charge +q at A.
Let P be any Point in the electric field at a distance r from A at which the electric field intensity to be determind.

According to Coulomb's laws

$$f = \frac{1}{4\pi \varepsilon_0} \cdot \frac{q \cdot 1}{r^2}$$

According to the defination of electric field intensity.

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E = F

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$ Unit = N/C

Electric field lines or electric lines of force.

The Paths along with a unit Positive charge travels is called the electric lines of force. It may be a straight lines or a curved line and the tangent at any Point of which gives the direction of the electric field at that Point.

Characteristics :-

(i) The electric lines of force and Paths straight or curved tangent at any Point of which gives the direction of magnetic field at that Point.

(ii) The electric lines of force are Producessed from Positive charge and terminated at negative charge.

(iii) The electric lines of force are dis contin-ous in nature.

(iv) The electric lines of force never interset each other.

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(v) The electric lines of force can not longitudinally on account of force of attraction between two opposite charge.

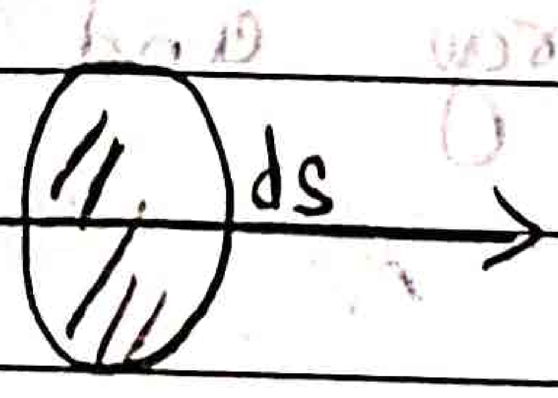
(vi) Electric lines of force exert lateral Pressure on account of force repulsion between two similar charges.

(vii) The electric lines of force ~~are~~ do not Pass through a conductor.

Electric flux :- The number of electric lines of force Passing Per second Per unit area normal to the surface is called the Electric flux.

It is equal to the Product of the electricity intensity at a Point and the surface area. Let E be the electric intensity at any Point of the surface and normal to it and ds the area of the surface.

Then electric flux. Eds



or $\phi = Eds$

If the electric intensity is not Perpendicular to the surface then it is reserved into two components $E\cos\theta$ and $E\sin\theta$. Here $E\cos\theta$ is normal to the surface.

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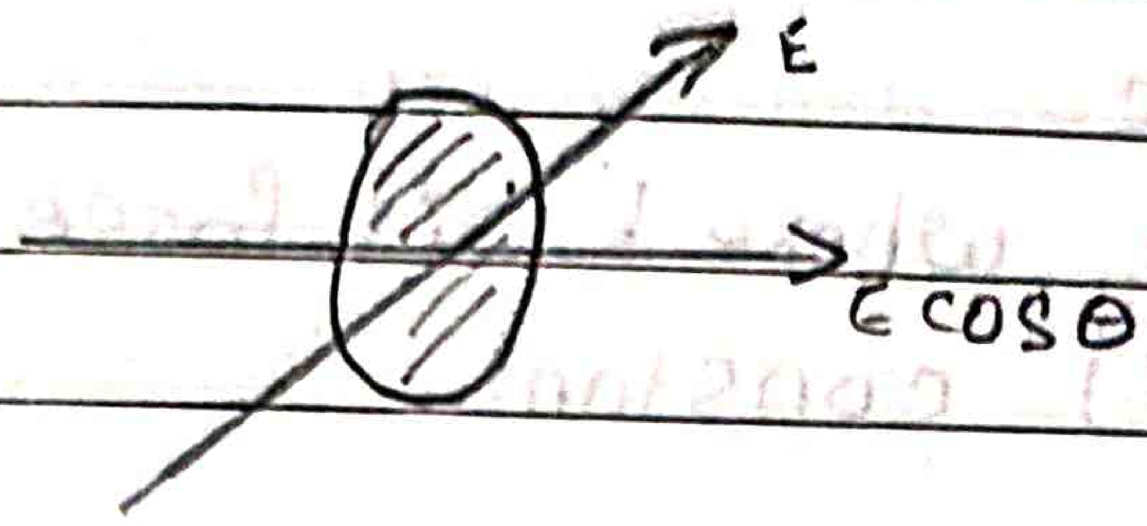
$\therefore$ flux = $E \cos\theta \, ds$ or

$\phi = E \, ds \cos\theta$



or $\phi = \vec{E} \cdot \vec{ds}$

Gauss Law :- The law states that total electric flux over a closed surface is equal to $1/\varepsilon_0$ time the total charge enclosed by it.

i.e to = $\frac{1}{\varepsilon_0}$ = Total charge

Oscillations :-

Simple harmonic motion :- A simple harmonic motion is a Periodic motion in which accelaration or the restoring force is directly Proportional to displacement. And is always directly towards the means Position.

i.e accel = or restering force $\propto$ displacement

Differential from of SHM :-

Let a body be exicuting SHM. Let x be the displacement in the body at any instant 't'

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The restoring force $\propto$ displacement

or $f \propto -x$

or $f = -kx$ where k is force constant — (i)

This force Produces an accelaration

Let m be the mass of the body. Then according to Newton's 2nd Law of motion

$$\text{force} = m\frac{d^2x}{dt^2} \quad — (2)$$

from eq. (1) and (2)

$$m\frac{d^2x}{dt^2} = -kx$$

or $$\frac{md^2x}{dt^2} + kx = 0$$

or $$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0 \quad — (3)$$

Let $\frac{k}{m} = (\omega)^2$

Then eq^n (3) reduces to

$$\boxed{\frac{d^2x}{dt^2} + (\omega)^2 x = 0}$$

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This is the differential from of SHM

This may also be written as.

$(D^2 + \omega^2) x = 0$ $\quad \left(\frac{d}{dt} = D\right)$

Then the auxiliary quadratic eq^n

$$m^2 + (\omega)^2 = 0$$
$$\text{or } m^2 = -\omega^2$$

$$\text{or } m = \pm i\omega$$

Then its sol^n is given by

$$x = Ae^{i\omega t} + Be^{+i\omega t}$$

Let $\frac{k}{m} = \omega^2$

$x = A(\cos\omega t + i\sin\omega t) + B(\cos\omega t + - i\sin\omega t)$

$= (A+B)\cos\omega t + i(A-b)\sin\omega t$

Let $A + B = R\sin\phi$
and $i(A-B) = R\cos\phi$

$\therefore x = R\sin\phi\cos\omega t + R\cos\phi\sin\omega t$

or $x = R[\sin\omega t\cos\phi + \cos\omega t \cdot \sin\phi]$

or $\boxed{x - R\sin(\omega t + \phi)}$

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velocity of a body executing SHM :-

∵ velocity is defined as

$$vel = \frac{dx}{dt}$$

$$\text{or } v = \frac{d}{dt}\left[R \sin(\omega t + \theta)\right]$$

$$= R \cos\left[\omega t + \theta\right]\omega$$

$$= R\omega \cos(\omega t + \theta)$$

$$\text{Also } v = R\omega \cos(\omega t + \theta)$$

$$= R\omega\sqrt{1 - \sin^2(\omega t + \theta)}$$

$$= R\omega\sqrt{1 - \left(\frac{x}{R}\right)^2}$$

$$= R\omega\sqrt{\frac{R^2 x^2}{R^2}}$$

$$= \frac{\cancel{R}\omega}{\cancel{R}}\sqrt{R^2 - x^2}$$

$$\boxed{v = \omega\sqrt{R^2 - x^2}}$$

Accelaration of a body executing SHM

∴ Accel $\approx$ is defined as

$$acc\ \approx = \frac{dv}{dt}$$

$$= \frac{d}{dt}\left[R\omega \cos(\omega t + \theta)\right]$$

$$= -R\omega\ \omega \sin(\omega t + \theta)$$

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$= -\omega^2 k \sin(\omega t + \alpha)$

$\boxed{acc^l = -\omega^2 x}$

$\Rightarrow \boxed{acc^l \propto -2}$

Case - I Cretical damping

Damped asciliation :- when the amplitude of the body asecillation body decreases then this types of ascillation is called Damped ascillation.

The Damping is due to the frictional force, extral and internal acting on the body. In this case the oscillating body is acted upon by two types of force.

(i) Restoring force
(ii) Damping force

The restoring force which is directly Propo-rtional to the displacement.

i.e restoring force $\propto$ - displacement

$f = -ax$ where x is the displacement

The Damping force which is directly Propor-tional to the velocity.

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i.e Damping force $\propto$ - velocity

$$F = -b \frac{dx}{dt}$$

This forces Produce an accelaration due to $\frac{d^2x}{dt^2}$ in the ascillating body.

If m be the mass of the ascillating body then

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + ax = 0$$

divided by m

$$\frac{d^2x}{dt^2} + \frac{b}{m}\frac{dx}{dt} + \frac{a}{m}x = 0$$

Hemoginious Differentation

Let $\frac{b}{m} = 2k$ and $\frac{a}{m} = \mu^2$

k = Damping constant

$$\therefore \frac{d^2x}{dt^2} + 2k\frac{dx}{dt} + \mu^2 x = 0$$

or $(D^2 + 2kD + \mu^2)x = 0 \quad (\frac{d}{dt} = D)$

$\therefore$ Auxeliary eqn is

$$m^2 + 2km + \mu^2 = 0$$

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$$m = \frac{-2k \pm \sqrt{4k^2 - 4\mu^2}}{2}$$

$$m = \frac{-2k \pm 2\sqrt{k^2 - \mu^2}}{2}$$

$$m = -k \pm \sqrt{k^2 - \mu^2}$$

Hence the solution is given by

$$x = Ae^{m_1 t} + Be^{m_2 t}$$

$$= Ae^{(-k + \sqrt{k^2 - \mu^2})t} + Be^{(-k - \sqrt{k^2 - \mu^2})t}$$

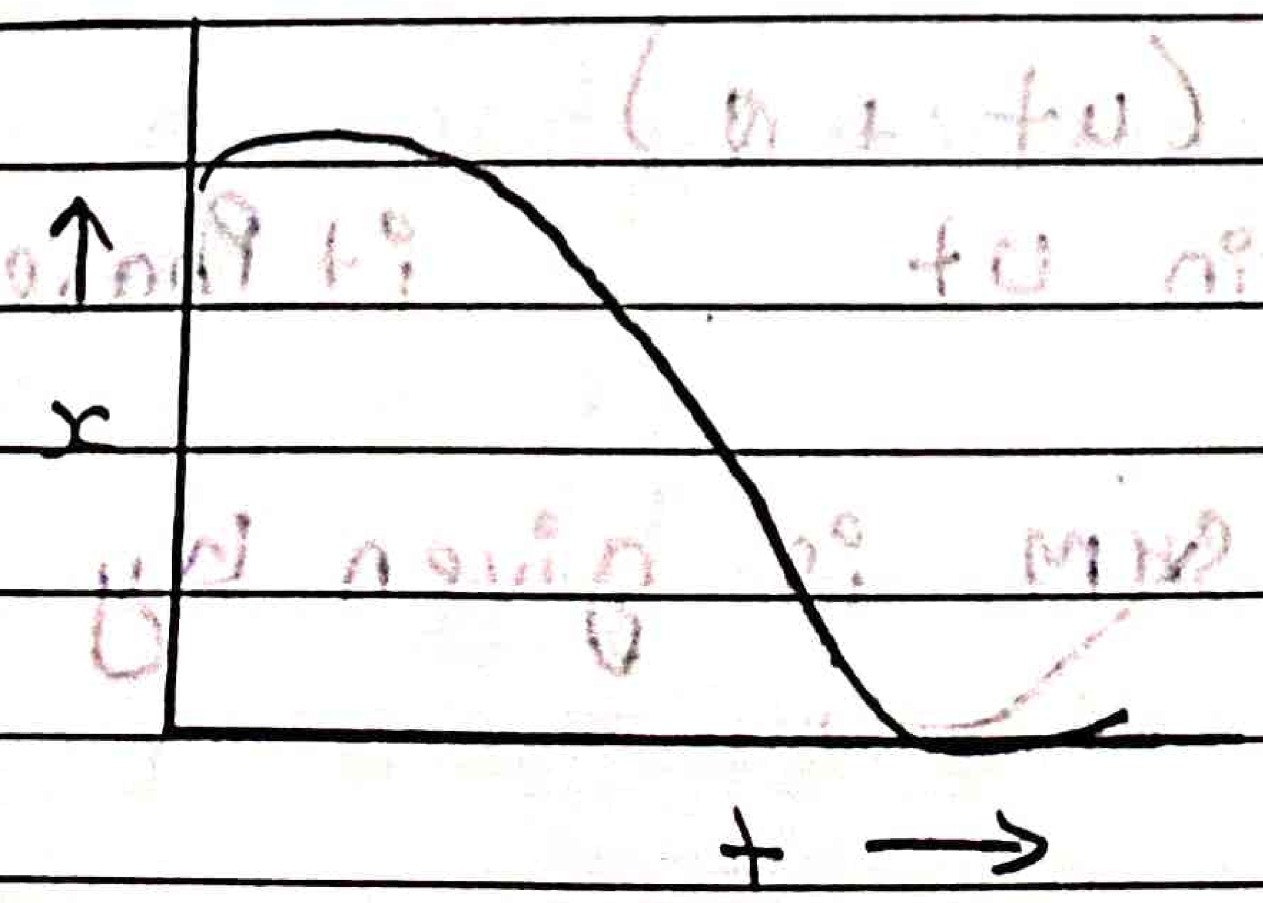
$$= A^{-kt} e^{(\sqrt{k^2 - \mu^2})t} + B^{-kt} e^{(\sqrt{k^2 - \mu^2})t}$$

$$x = e^{-kt}\left[Ae^{mt} + Be^{-mt}\right]$$

where $m = \sqrt{k^2 - \mu^2}$

case I Heavy Damping

Where $k > \mu$ then the Damping is heavy in this case $m = (\sqrt{k^2 - \mu^2})$ is real and is always less then k so the exponent is always negative so the oscillating body comes to rest without performing oscillation i.e. the oscillation heavielly damped.



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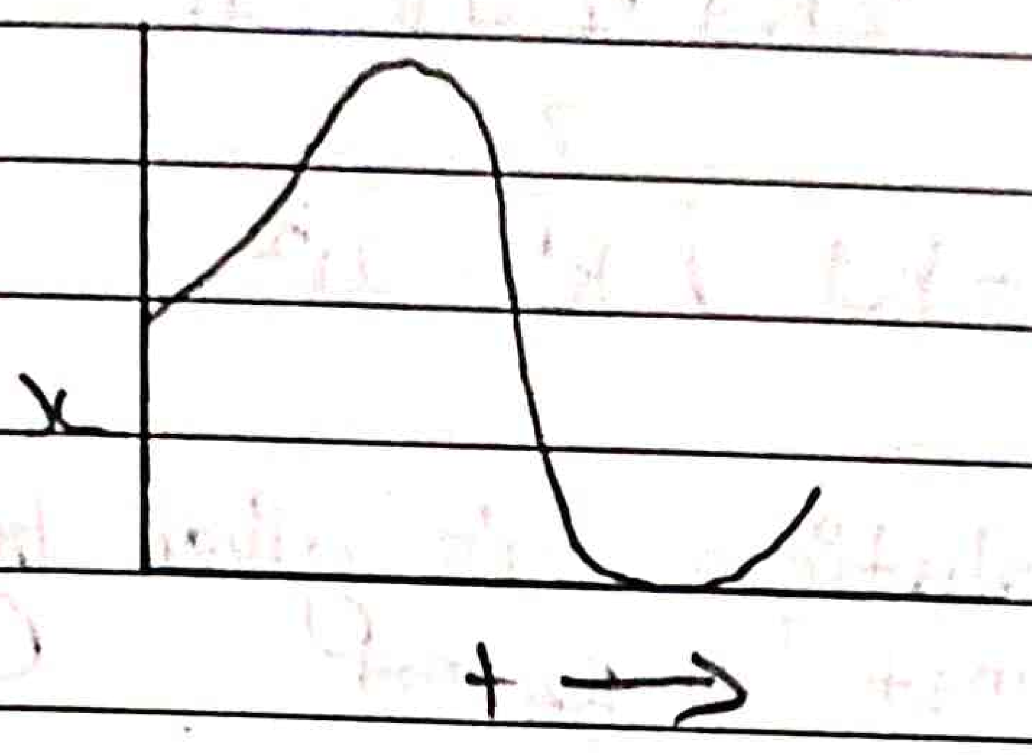
when the body is released from the external Point



when the body is relased term the Position.

Case II   Small Damping :

When $\omega > k$ then the damping is small. In the case $m = \sqrt{k^2 - \omega^2}$

$$m = \sqrt{k^2 - \omega^2}$$
$$= \sqrt{-1}\ \sqrt{\omega^2 - k^2}$$
$$= i\ \omega \quad \text{where } \sqrt{\omega^2 - k^2} = \omega$$

Then we have,

$$x = e^{-k}\left[A e^{i\omega t} + B e^{-i\omega t}\right]$$

$x = R \sin(\omega t + \alpha)$
or $x = R \sin \omega t$ if Phase diff. $\alpha = 0$

eq^n of SHM is given by

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$y = a \sin \omega t$

$\frac{y}{a} = \sin \omega t$

$\therefore$ velocity of a body executing SHM

$$v = \frac{dy}{dt}$$

$$= \frac{d\, a \sin \omega t}{dt}$$

$$= a \cos \omega t \cdot \omega$$

$$= a \omega \cos \omega t$$

$$\therefore v = a\omega \sqrt{1 - \sin^2 \omega t}$$

$\cos^2 \omega t = 1 - \sin^2 \omega t$

$$= a\omega \sqrt{1 - \frac{y^2}{a^2}}$$

$$= a\omega \sqrt{\frac{a^2 - y^2}{a^2}}$$

$$= \frac{\cancel{a}\, \omega \sqrt{a^2 - y^2}}{\cancel{a}}$$

$$\boxed{v = \omega \sqrt{a^2 - y^2}}$$

accl^n of a body executing SHM

$$\text{accl}^n = \frac{dv}{dt}$$

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$$= \frac{d(a\omega \cos \omega t)}{dt}$$

$$= a\omega(-\sin \omega t).\omega$$

$$accl^n = -\omega^2 a \sin \omega t$$

$$= -\omega^2 y$$

* Energy of a body execting SHM :-

Kinetic Energy of a body :- The veloeity of a body executing SHM at any Point at it y from the mean Position is given by.

$$v = \omega\sqrt{a^2 - y^2} \qquad a = \text{Amplitude}$$

$\therefore$ KE at any Point $= \frac{1}{2} mv^2$

$$= \frac{1}{2} m (\omega\sqrt{a^2 - y^2})^2$$

$$= \frac{1}{2} m \omega^2 (a^2 - y^2)$$

At the mean Position :- here $y = 0$

$$K.E = \frac{1}{2} m\omega^2(\cancel{a^2} - \cancel{a^2})$$

$$= 0$$

Potential Energy at any Point :-

Sence the given body execute SHM whose mass is m and accelaration

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is $\omega^2 y$ Then the force acting on body is $-m\omega^2 y$.

work done is displacing the body through small distance by against the restoring force $= -F dy$

$$= (-m\omega^2 y) dy$$

$$= m\omega^2 y \, dy$$

Then the work done is displacing through a distance.

$$y = \int_0^y m\omega^2 y \, dy$$

$$= m\omega^2 \int_0^y y \, dy$$

$$= m\omega^2 \left[\frac{y^2}{2}\right]_0^y$$

$$= \frac{m\omega^2 y^2}{2}$$

Potential Energy any Point $= \frac{1}{2} m\omega^2 y^2$

At the mean Position :- Here $y = 0$

$P.E = 0$

At extreme Point :- Here $y = a$

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$$P.E = \frac{1}{2} m\omega^2 a^2$$

Total Energy at the mean Position.

$$= K.E + P.E$$

$$= \frac{1}{2} m\omega^2 (a^2 + 0)$$

$$= \frac{1}{2} m\omega^2 a^2$$

Total energy at any Point

$$= K.E + P.E$$

$$= \frac{1}{2} m\omega^2 (a^2 - y^2) + \frac{1}{2} m\omega^2 y^2$$

$$= \frac{1}{2} m\omega^2 a^2 - \cancel{\frac{1}{2} m\omega^2 y^2} + \cancel{\frac{1}{2} m\omega^2 y^2}$$

$$= \frac{1}{2} m\omega^2 a^2$$

Total energy at the extreme Point

$$= K.E + P.E$$

$$= 0 + \frac{1}{2} m\omega^2 a^2$$

$$= \frac{1}{2} m\omega^2 a^2$$

Thus we find that the total energy at any Point in the Path of the nation is always constand. So a body executing Simple Harmonic Motion (SHM) satisfied the Principle of Conservation of Energy.

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★ Theory of relativity

Patulates

Special theory of is is the Physical theory of measurment. In

Inertial from of Propose by Eastean
It has two fundamental Potulates.

(i) Principle of relativity

The Laws of nature are the same in all inertial frame of refrenc moving uniformally relative to one another.

(ii) Principle of constrancy of velocity of Light

The velocity of light in free space has the same value in all inertial from of refrence and doesnt depend on the motion of the mitting body i.e the velocity of light is an invarial.

Relativistics addition of vectors:-

we have as Lorentz transformation

$$x' = \frac{x + vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$

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$$y' = y, \quad z' = z$$

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Then we have

$$u = \frac{dx'}{dt'}$$

$$= \frac{d(x - vt)}{d\left(t - \frac{vx}{c^2}\right)}$$

$$= \frac{dx - vdt}{dt - \frac{vdx}{c^2}}$$

divided by dt

or $$u' = \frac{u - v}{1 - \frac{vu}{c^2}} \quad \text{——— (1)}$$

On replacing u by u', u' by u, v by $-v$ we have

$$u = \frac{u' + v}{1 + \frac{u'v}{c^2}} \quad \text{——— (2)}$$

relation (1) and (2) give velocity transformation rules and a code the relavistic law of addition of velocity.

Time delation : Light space interval between two event is also different for two observe moving relative to feature

Let the instants of occurence of events in inertial S and t_1 and t_2 and inertial from S_1 moving with velocity t_1 & t_2 the lorentz transformation.

$$t_1 = \frac{t_1 + \frac{vx'}{c^2}}{\sqrt{c - \frac{v^2}{c^2}}}$$

$$t_2 = \frac{t_2' + \frac{vx_1}{c^2}}{\sqrt{1 - \frac{v}{c^2}}}$$

$$\therefore t_2 - t_1 = \frac{t_2' + \frac{vx'}{c^2} - t_1' - \frac{v \cdot x'}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{2 - \frac{v^2}{c^2}}}$$

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$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{2 - \frac{v^2}{c^2}}}$$

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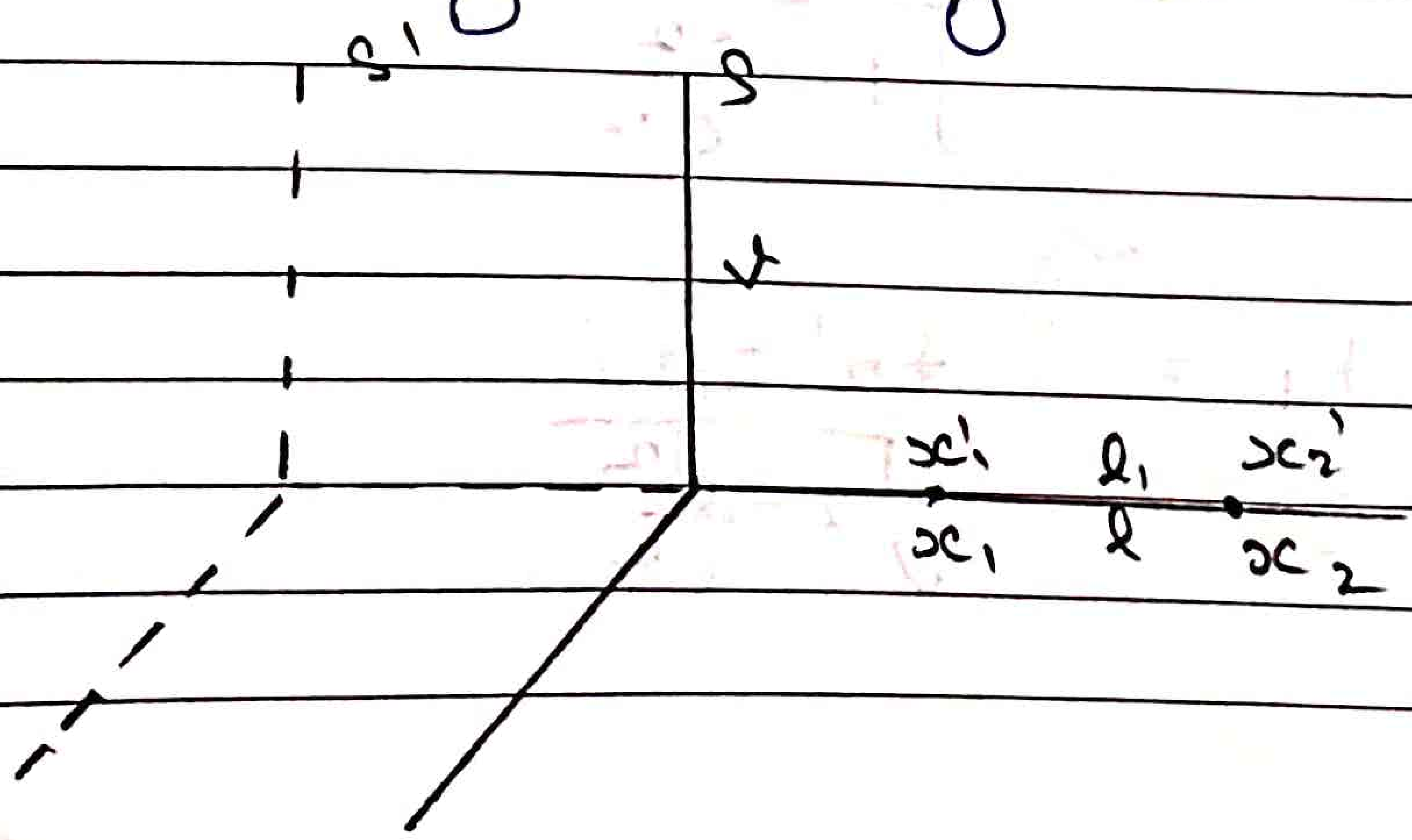
or $t_2 - t_2 > t_2' - t_1'$

Thus the time interval measured by an observed in the frame of reference S is longer then the time interval measure in the frame of refrense S. In other words, a moving clock appear to run slowly.

Length contraction:- The special theory of relativity rejects the absoluteness of . Hence length of the body measured at rest and the state of uniform motion with the different in the direction of motion when it speed approaches to speed of light.

Let a rode fixed in frame S'. l_0 of length and measured by the observe in space and l and measured by observer S length of the rode in frame S' as its natural length because in the frame it is stastionary and the length observed by the observer moving with velocity v away from it.



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We have $l_0 = x_2' - x_1'$
and $l = x_2 - x_1$

$$x_2' = \frac{x_2 - vt}{\sqrt{1 - \frac{v^2}{c^2}}} , \quad x_1' = \frac{x_1 - vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$l_0 = x_2' - x_1'$$

$$= \frac{x_2 - \cancel{vt} - x_1 + \cancel{vt}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$= \frac{x_2 - x_1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$l_0 = \frac{l}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\text{or } l = l_0 \sqrt{1 - \frac{v^2}{c^2}}$$

Thus the length of rode is shorter where it is moving velocity v. This is also called Lorenz contraction.

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force : force is an Pushing and Polling of an object. It is also defined as external agency which changes and tends to change the state of rest or uniform motion of a body.
eg: opening door, kicking ball, shifting, interaction between two object.

SI Unit : Newton (N)

Advantages:
(i) Force can change the shape
(ii) Force can change the direction of object.
(iii) Force can change the speed of object slower or faster.

There are two types of forces:
(i) contact force
(ii) Non - contact force

(i) Contact Force: when a body comes on contact with another body ie the force applied by making a Physical called as contact force.
eg: slaping, Pringing, water with Glass

(ii) Frictional Force: when body slides over a another surface a force acts which equal and applied as frictional force.
eg: walk, sliding

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* Newton's Law's of motion

Newton's 1st Law of motion

Every continus in it rest or motion unless and external force applied to change that state also known as law of Inertia of Motion.

(i) Inertia of rest

(ii) Inertia of motion

(iii) Inertia of Direction

(i) Inertia of rest

It is defined as tendency of a body to remain in its Position of rest.

eg:- falling down backword when a vehicle starts imidiatly Detachment of leave due to sheaking.

(ii) Inertia of Motion

It is defined as the tendency of a body to remain in its ~~Postion~~ State of motion

eg:- Rolling boll, stiearing of milk or coffie, wdden apply break in a vechical.

(iii) Inertia of Direction.

It as defined as inabelity of a body to change by itself, it direction of

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motion.

Eg ÷ A body moving in a certain direction cannot change its direction without any force. Therefore when we sharp turn to get one side.

Newton's 2nd Law ÷

It stats that the rate of change of momentes is directly proportional to the force applied in the direction.

$$F \propto \frac{dP}{dt}$$

$$\therefore F = k\frac{dP}{dt} \Rightarrow F = k\frac{dmv}{dt}$$

$$F = k\frac{mdv}{dt} + \frac{vdm}{dt}$$ $\left[\because \frac{dv}{dt} = a \text{ (accelation)}\right]$

Let $k = 1$

$\therefore F = ma + v \times a$

$\therefore F = ma$

SI unit of force - $kg\ ms^{-2}$ Newton

In CGS unit is - gcm/s^2 = dyne

$\therefore$ 1 dyne = $gcms^{-2}$

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Relation between Newton and Dyne

$1 N = 1 kg \times 1 m/s^2$
$= 1000 gm \times 100 cm/s^2$
$= 10^5 g cm/s^2$

$\therefore \boxed{1 N = 10^5 dyne}$

Newton's 3rd Law of Motion.

It State that to every action there is always in equal and opposite reaction.
Eg:- firing a bullet from a gun

Rockets motion while moving on the ground we exert a force by our fee to push ground backword and the ground also exert a force on our feet which makes us moves forword swiming. Motion of a Boat away from the share white staling dowing from it.

Momentum (p) :- Momentum of a body is a queintity of motion of a moving body.

SI unit - $kg\,ms^{-1}$
CGS unit - $g\,cm\,s^{-1}$

It is a vector quanlity

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Relation between Newton and Dyne

$$1N = 1kg \times 1m/s^2$$
$$= 1000\,gm \times 100cm/s^2$$
$$= 10^5\,g\,cm/s^2$$

$$\therefore \boxed{1N = 10^5\,dyne}$$

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Eg:- Firing a bollet from a gun

Rocikels motion while moving on the ground we ~~exst~~ exert a force by our fee to Push ground backword and the ground also exert a force on our feet which makes us moves forword. Swiming. Motion of a Boot away from the share white staling dowing from it.

Momentum (p) :- Momentum of a body is a queintity of motion of a moving body.

SI unit - $kg\,ms^{-1}$
CGS unit - $g\,cm\,s^{-1}$

It is a vector quanlity

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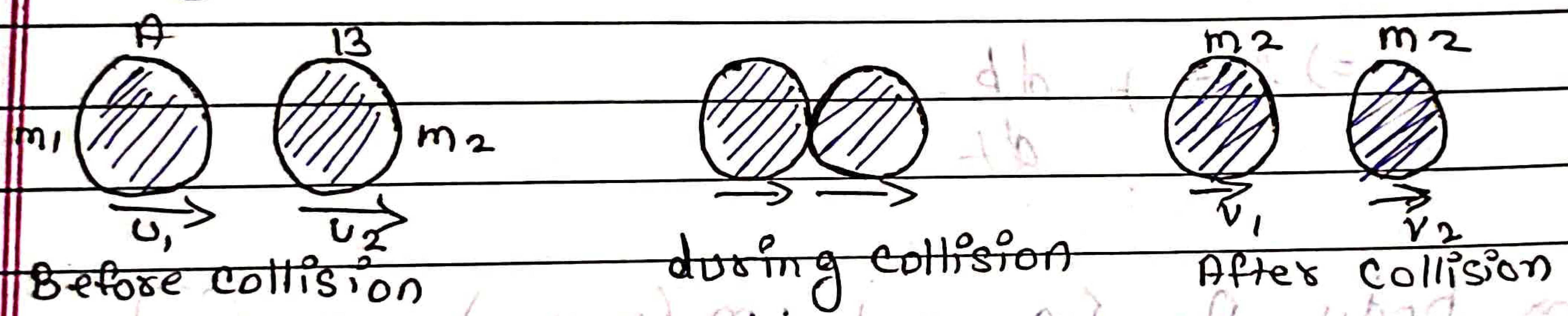
It a body at rest velocity i zero. Therefore momentum will be zero.

Eg: Bullet is very small in mass but it has large momentum because of its large velocity.

Law of conservation of Momentum.

It states that if no external force acts on a body the momentum of a body remains constant or zero.



Let a system of two bodies when no external force acts initially the body have masses m_1, m_2. The momentem of individual bodies may change but the net momentum of the system remain same

In case of body A

Initial momentum $(P_1) = m_1 u_1$
Final momentum $(P_2) = m_1 v_1$

Net momentum $= m_1 v_1 - m_1 u_1$
change in momentum $= m_1(v_1 - u_1)$ —— (1)

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In case of Body B

Initial momentum $(P_1') = m_2 u_2$
final momentum $(P_2') = m_2 v_2$

Net momentum $(P_1) = m_2 v_2 - m_2 u_2$
change in momentum $= m_2 (v_2 - u_2)$ —— (ii)

From Newton second law

$$F \propto \frac{dp}{dt}$$

$$\Rightarrow f = k \frac{dp}{dt}$$

for body A, $F_A = k \cdot \frac{m_1(v_1 - u_1)}{dt}$ —— (iii)

for body B, $F_B = k \frac{m_2(v_2 - u_2)}{dt}$ —— (iv)

Using Newton's third Law.

$$F_A = -F_B$$

$$k \frac{m_1(v_1 - u_1)}{dt} = -k \frac{m_2(v_2 - u_2)}{dt}$$

$$m_1(v_1 - u_1) = -m_2(v_2 - u_2)$$

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

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

$$p_1 + p_2 = p_1' + p_2' \quad \text{constant}$$

There force total momentum before collision = total momentum after collision of the system remain conserved

Eg :- Conservation of momentum is used to discribed collision between the object.

Impulse :- Impulse is an Impact for small time measured by the Product of force and the time act on the body.

$$\boxed{I = f \times t}$$

S.I unit - N.S
CGS unit - Dyne-s

Eg :- when the ball hits the wall and bouns back, the force of the ball act for the very short time

Eg :- when a cricket ball is hit by a bat

Eg :- car, buses, bogies of train Provided to avoid sebiear gerks during starting of train.

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Eg:- To avoid injery a cricket Player lower his hand while chaching a ball.

What is the relation between Impulse and Linear momentum.

It a force F act on a body for a small time dt

$$\int dI = \int_{t_1}^{t_2} F.dt \quad \text{——} \ (1)$$

The force act on a body for time interval from t_1 to t_2 ---

$$\int dI = \int_{t_1}^{t_2} F.dt$$

$$\Rightarrow I = F \int_{t_1}^{t} dt$$

$$\Rightarrow I = F [t_2 - t_1] \quad \text{——} \ (2)$$

According to Newton's 2nd Law

$$F = \frac{d\,p}{dt}$$

$$dp = Fdt \quad \text{——} \ (3)$$

integrating eq^n (3) Putting limits P_1 to P_2

$$F.dt = \int_{P_1}^{P_2} dp$$

$$F.dt = [P]_{P_1}^{P_2}$$

$$F.dt = [P_2 - P_1]$$

$$I = [P_2 - P_3] \quad \text{—— (4)}$$

Impulse = Change in momentum

Angular velocity :-

ω = Angular velocity

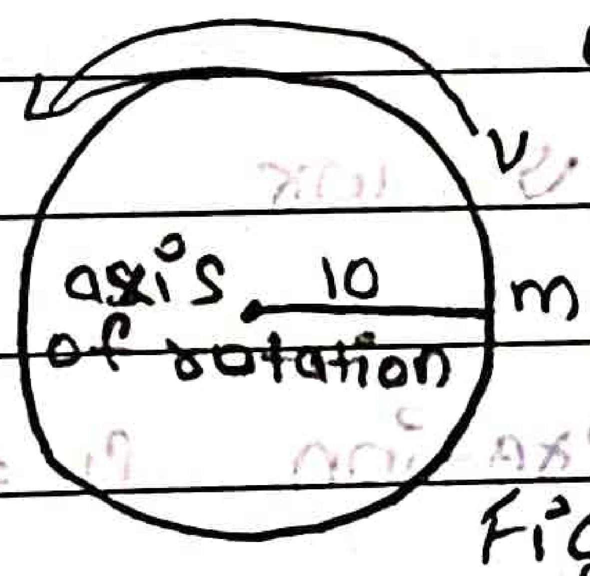

Fig. 1

The rate of change of angular displacement of Particle in a given time is called as angular velocity it is denoted by 'ω'.

$$\boxed{\omega = \frac{\theta}{t}}$$

We can also write angular velocity

$$\omega = \frac{\text{Linear velocity}}{\text{Position}}$$

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$\omega = \frac{v}{r} \Rightarrow \boxed{v = \omega r}$

Angular Accelaration (α) :- It is defined as the rate of change of Angular velocity of partical sence Angular velocity.

$$\omega = \frac{d\theta}{dt} \quad \text{—— (1)}$$

Therefore the angular accelration (α) is given by

$$\alpha = \frac{d\omega}{dt} \quad \text{—— (2)}$$

Again we know $v = \omega r$

Now, Linear acceleration $a = \frac{dv}{dt}$

$$a = \frac{d\omega r}{dt} \quad \text{—— (3)}$$

$$a = \omega \frac{dr}{dt} + r\frac{d\omega}{dt}$$

$$a = \frac{\omega dr}{dt}$$

$$\boxed{a = \omega . \alpha} \quad \text{—— (4)}$$

Thus R is the distance of Particle from axis of rotation.

when Particle rotates with uniform Angular velocity then.

$$\frac{d\omega}{dt} = 0$$

$$\text{or} \quad \alpha = 0 \quad \text{—— (5)}$$

It means Angular acceleration and linear acceleration is zero.

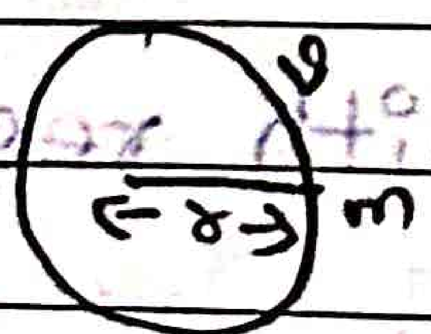
since we known linear momentum

$$P = mv$$

Angular Momentum :- A Partical moving in circular Path about a fixed Point

Angular momentum is also known as moment of momentum. It is denoted by (L).

It is the cross Product of Linear momentum of the Partical and the distance from reference Point (centre).



$$\boxed{P = mv}$$

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$$\because \vec{L} = \vec{r} \times \vec{p}$$
$$L = \vec{r} \times m\vec{v}$$

$$\boxed{L = m(\vec{r} \times \vec{v})}$$

SI unit - $kg\, m^2\, s^{-1}$

Torque (τ) :- Torque is a Product of Position vector of the point where the force acts. That is Torque is the measure of the force that can cause an object to rotate about an axis.

Eg:- A opening of a door.
It we try to open a door by Pushing on the door near its hings it most likely doesn't open because it is not enough torque to do this.

Relation between torque and angular momentum

Since we known angular momentum (L)

$$L = r \times p \quad \text{--- (1)}$$
$$= r \times (m \times v)$$

Also $\boxed{\tau = F \times r}$ --- (ii)

Now deff. eq. = (1) with respect to t

$$\frac{dL}{dt} = \frac{d}{dt}(r \times p)$$

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$$\frac{dL}{dt} = r\frac{dp}{dt} + p\frac{dr}{dt}$$

from Newtons 2nd Law

$$\frac{dp}{dt} = F$$

$$\frac{dr}{dt} = v$$ The rate of change of Position is velocity

$$\frac{dL}{dt} = rF + mv\frac{dr}{dt} \quad \text{——— (3)}$$

eq^n (3) becomes

$$\frac{dL}{dt} = r \times F + m \times v \times v$$

$v \times v = 0$
Product rule of vector for deff

$$\frac{dL}{dt} = r \times F$$

$$\boxed{\frac{dL}{dt} = \tau} \quad \text{——— (4)}$$

Centre of Mass

Centre of mass is the average Point of the partical where Partical are suppose to be concentrated known as centre of mass. It is also reffered as balance Point.

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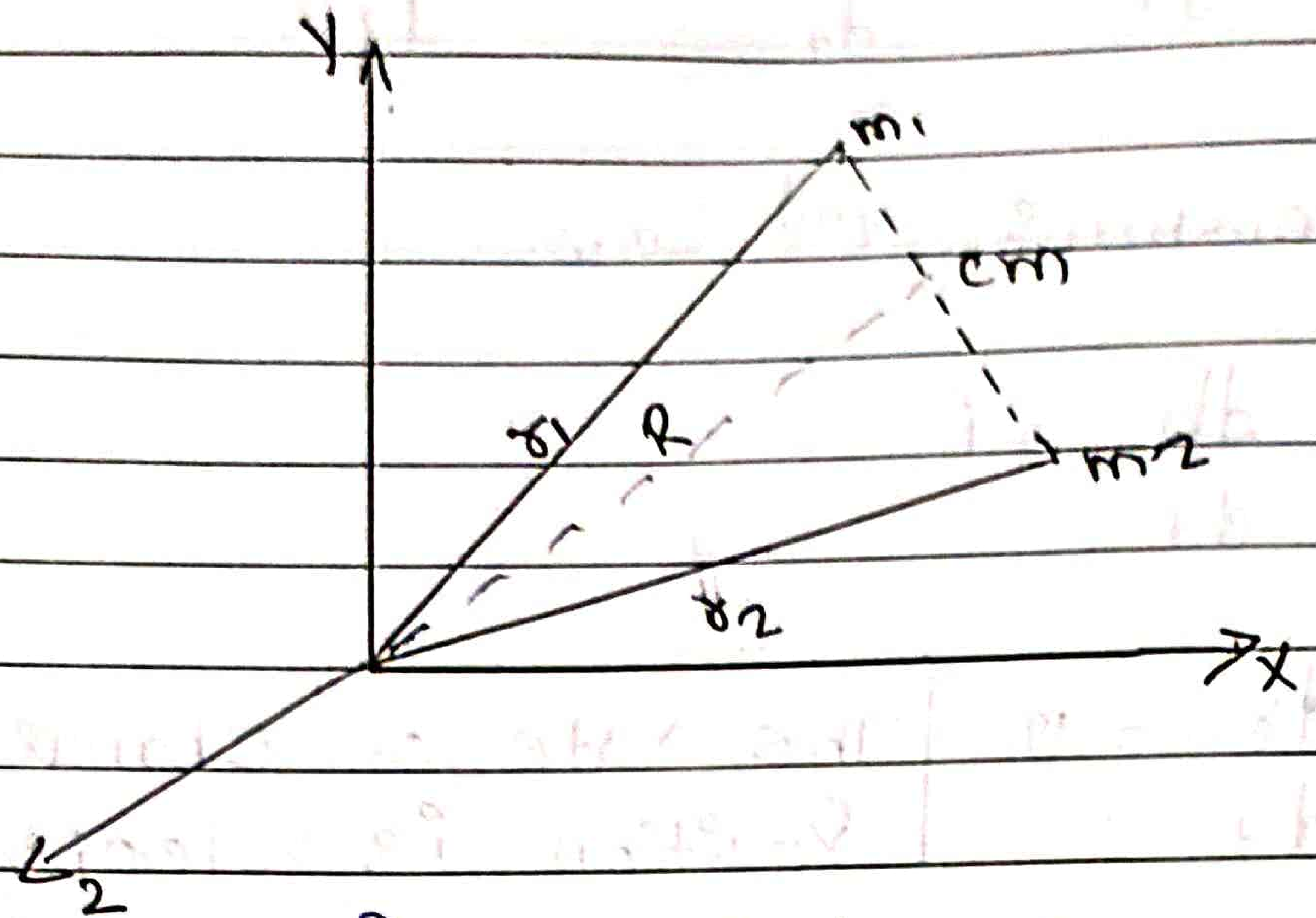
Centre of mass of two Particals.



$$R_{cm} = \frac{m_1 r_1 + m_2 r_2 - - - - - - m_n r_n}{m_1 + m_2 \qquad\qquad m_n}$$

Q Two bodies of masses 1kg and 2kg are located at $(\overset{x_1}{1}, \overset{y_1}{2})$ and $(\overset{x_2}{-1}, \overset{y_2}{-3})$. Calculate co-ordinate of the centre of mass.

$\Rightarrow m_1 = 1\ kg$; $m_2 = 2\ kg$

In x-axis,

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$$= \frac{1 \times 1 + 2 \times (-1)}{1+2}$$

$$= \frac{1 - 2}{3} = \frac{-1}{3}$$

In Y axis

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$$y_{cm} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m}$$

$$= \frac{1 \times 2 + 2 \times (-3)}{1+3}$$

$$= \frac{2 + (-6)}{3}$$

$$= \frac{-4}{3}$$

Q Three Particals of masses 1 gm, 2gm and 3 gm are located
The Position vectors are

$$r_1 = 2\hat{i} + 2\hat{j} + 2\hat{k}$$
$$r_2 = \hat{i} + \hat{j} + \hat{k}$$
$$r_3 = 2\hat{i} - 0\hat{j} + 0\hat{k}$$

$R_{cm} = ?$

$m_1 = 1gm, m_2 = 2gm, m_3 = 3gm$

$$cm = \frac{m_1 \vec{r}_1 + m_2 \vec{r}_2 + m_3 \vec{r}_3}{m_1 + m_2 + m_3}$$

Law of conservation of momentum :-

When a system of Partical rotate about a fixed Point the change in its angular velocity can be brought by applying external

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Torque

$$\boxed{\frac{dL}{dt} = \tau}$$

$$\frac{dL}{dt} = F x$$

If external torque in zero ($\tau = 0$) then L will be constant the Angular momentum of system is remain constant or conserved when Torque applyed on a system will be zero.

Eg:- The electrostotic force is also a central force because the Angular momentum therefore the angular momentum revolving in an orbit around the nucleus remain conserved (constant).

(ii) Angular momentum of Planet around the sun remain constant and same. Also the Angular momentum of satelight remain conserved.

Moment of Inertia (I)

It is a quantity expressing a body tendency to res angular accelaration or velocity it is the Product of mass of the Partical and square of

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the distance from axis of rotation. It is denoted by 'I'.

$$I = mr^2$$

Elastic constants and their relation

Elastic :- It is the Property by virtue of which the material regain their original shap and size After deforming force is removed. Deforming force that is an external force acts on a body which changes the shape. size Length and volume.

Elastic Deformation :- Deformation of a body in which the body regain with origonial shape and size after the removeble of Deformation force called as Elastic Deformation.

Stress :- When Deforming force applied on a body it changes the configaration of a body by changing the normal Position of the body. As a result the internal restoring force which tence to bring the body the back its original configaration.

$$\text{Stress} = \frac{\text{Restoring force}}{\text{Area}}$$

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$$\boxed{S = \frac{F}{A}}$$

Types of Stress

(i) Normal Stress
(ii) Tantential Stress

(i) Normal Stress
Restoring force Per unit area

Restoring force Per unit area which is Parallel to the surface called as Toniential Stress.

Strain :- when Deforming force act on a body the body change as in its shape, size, length and volume so Strain is defined as change in configaration devided by orignal configaration

Types of strain

(i) Longitudinal strain
(ii) volume strain
(iii) Shearing strain

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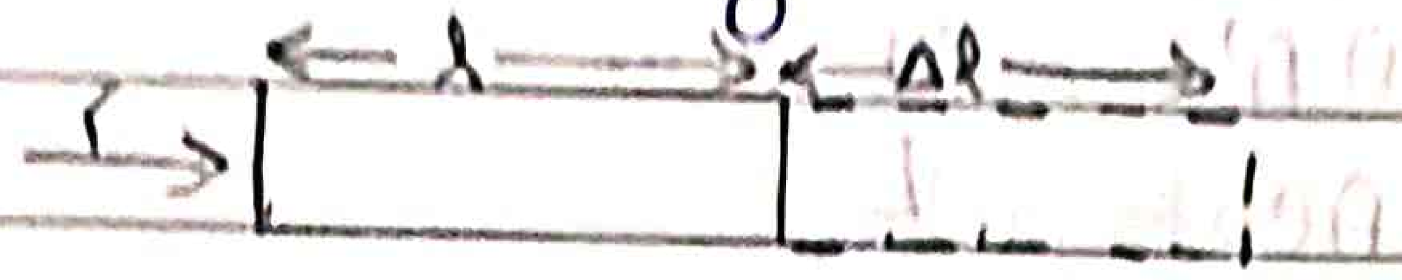
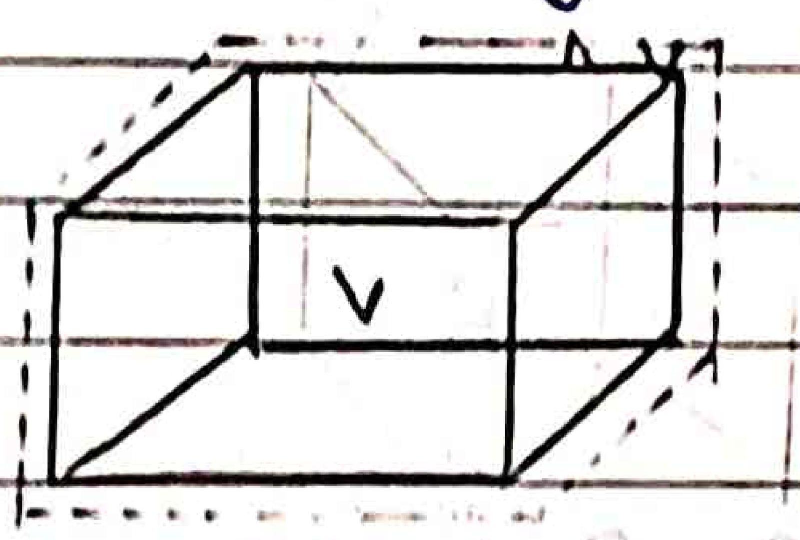
(i) Longitudinal strain :- It is the ratio change in length to the orignal length



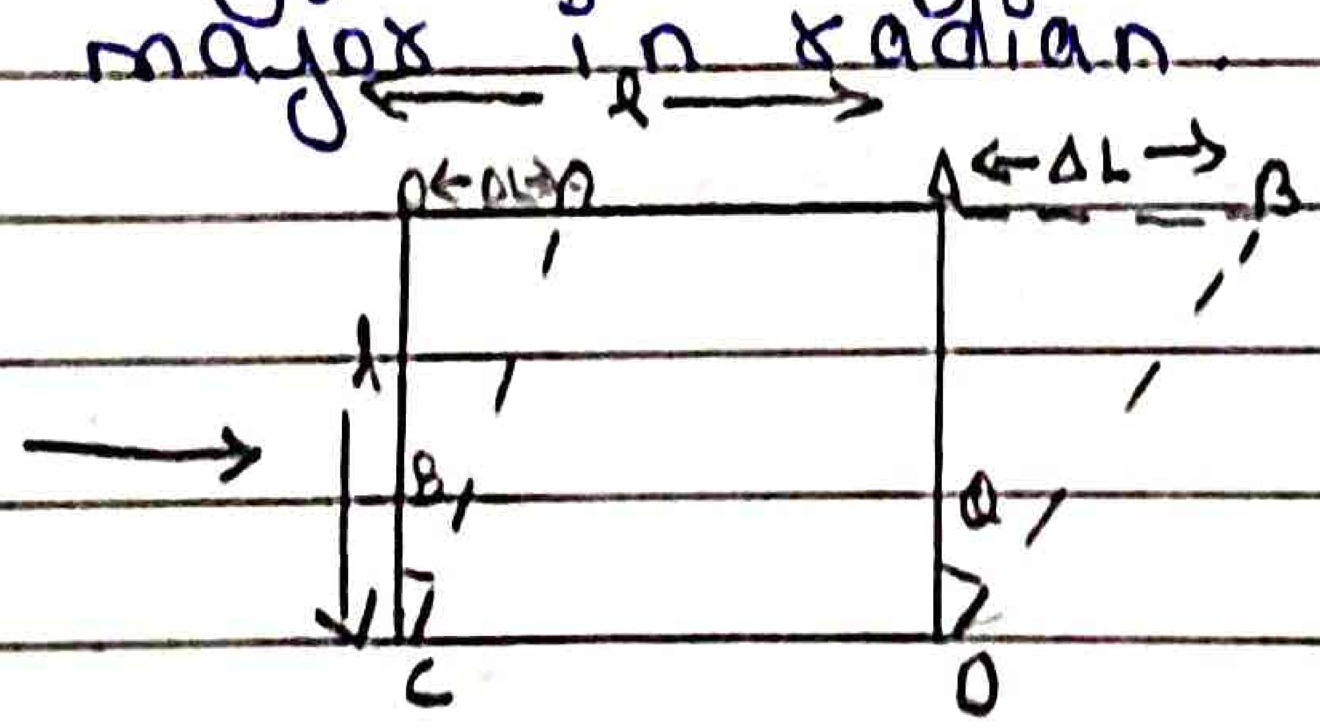
longitudinal strain = $\frac{\Delta L}{L}$

(ii) Volume strain :- It is the ratio of change in volume to the orignal volume.



$= \frac{\Delta V}{V}$

(iii) shearing strain :- It is the angle through which a line orignally Perpendicular to the fixed Plane turned as a major of shearing strain. Shearing strain is actually the angle of shear angle θ. It is major in radian.



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$$\theta = \tan\theta$$

$$\theta = \frac{AA'}{AC} = \frac{\Delta L}{L}$$

θ = Longitudinal Strain

Hooke's Law

Stress α Strain
Stress = E Strain

$$E = \frac{\text{Stress}}{\text{Strain}}$$

when E is constant of Proportionality known as modulus of elastic.

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There are three types of modulus of elasticity (E)

(i) Young's Modulus of Elasticity (Y)
(II) Bulk Modulus of Elasticity (K)
(III) Modulus of rigidity (n)

(i) Young's Modulus of Elasticity (Y) :

$A = \pi r^2$

$F = mg$

Fig ①

Let a wire of radius r and length (L) It force (F) is applied on the wire along its length as in fig. ①. After appling force length of the ~~p~~ wire increased ΔL Therefore Young Modulus of Elasticity

$$Y = \frac{\text{Normal stress}}{\text{Longitudinal strain}}$$

$$Y = \frac{F/A}{\Delta L/L}$$

$$Y = \frac{FL}{A\Delta L}$$

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(ii) Bulk Modulus of elasticity (K) :-

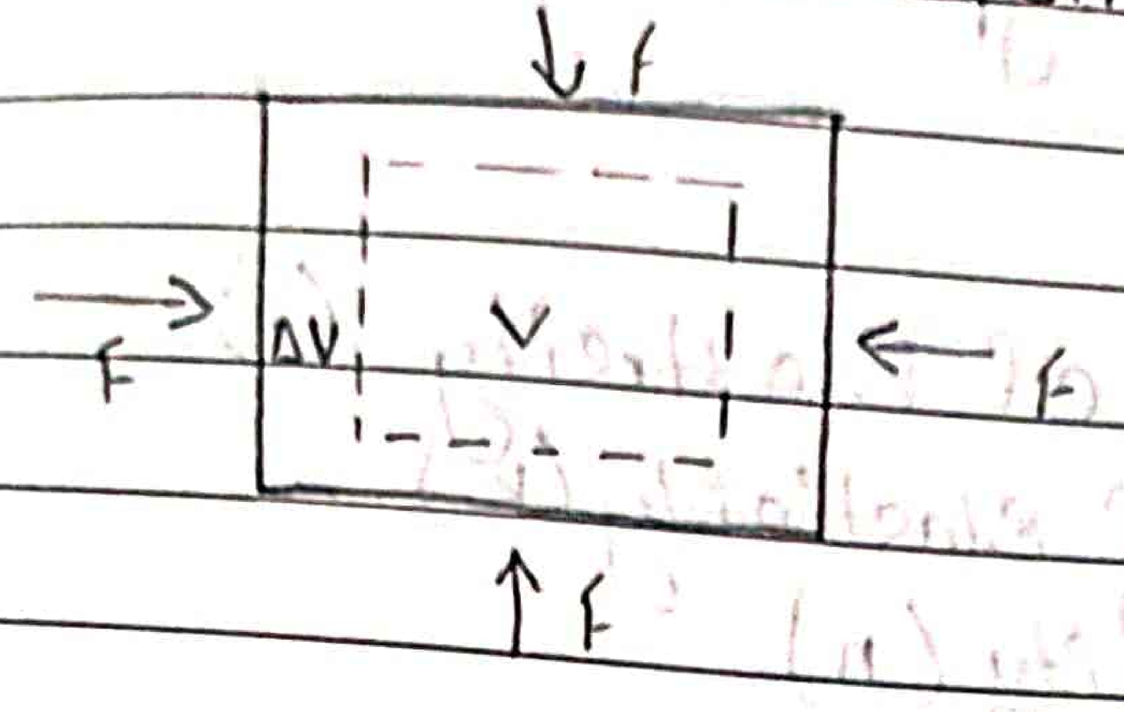

fig.2

Let a body of volume V and surface area A. If the force (F) acts uniformally over the all surface of the body. And the volume changes by ΔV. So the Bulk Modulus of Elasticity

$$K = \frac{\text{Normal stress}}{\text{volume strain}}$$

$$K = \frac{F/A}{\Delta V/V}$$

$$K = \frac{FV}{A\Delta V}$$

Since we known

$$\therefore P = F/A$$

$$\boxed{K = \frac{-PV}{\Delta V}}$$

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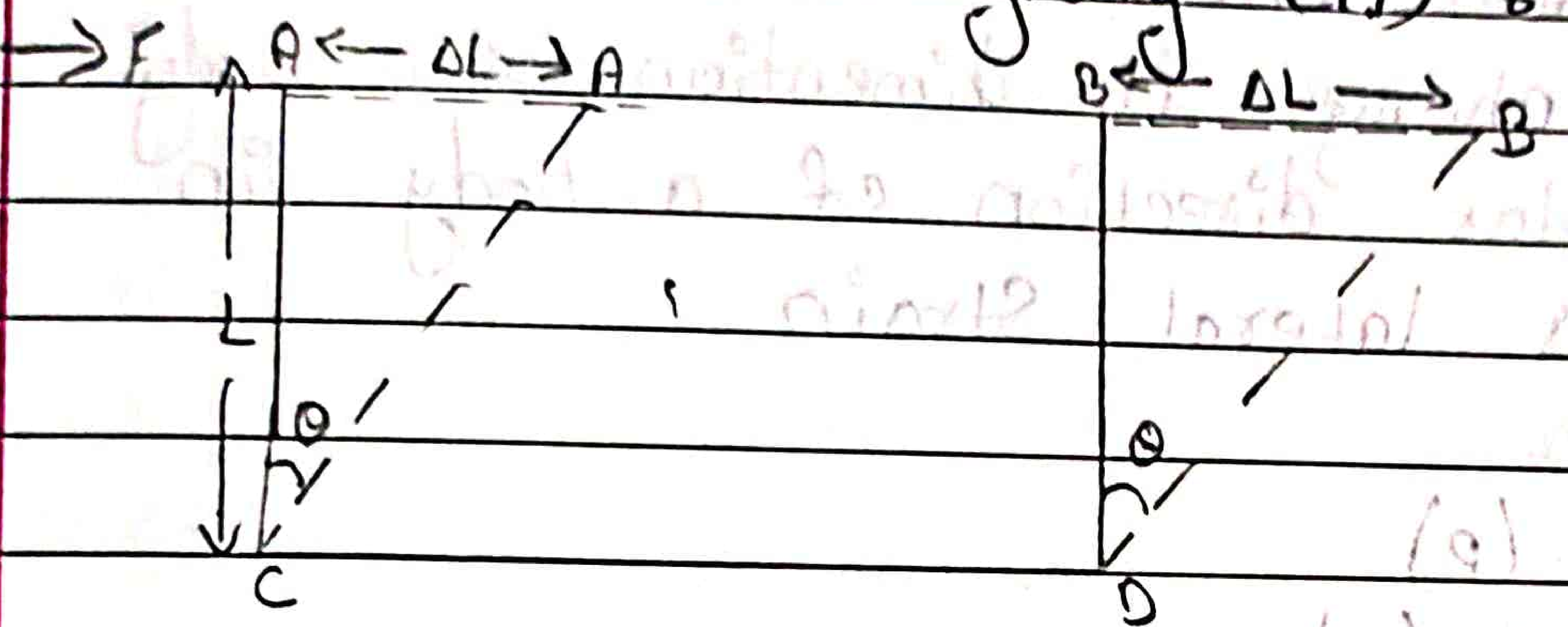
here -ve (Negative) sign shows that volume decreases when Prassure increases on a liquid.

In other worlds. It is defined as the hydrolic Stress to the hydrolic strain.

(iii) Modulus of rigidly (n) :-



Let the vertical sides of the cube shift through an angle θ called as shearing angle.

$$n = \frac{\text{Tongential Stress}}{\text{Shear angle}}$$

$$n = \frac{F}{A\theta}$$

$$\therefore \tan\theta \approx \theta = \frac{AA'}{AC} = \frac{\Delta L}{L} = \text{longitudinal strain}$$

$$\therefore n = \frac{F/A}{\Delta L/L}$$

$$n = \frac{FL}{A\Delta L}$$

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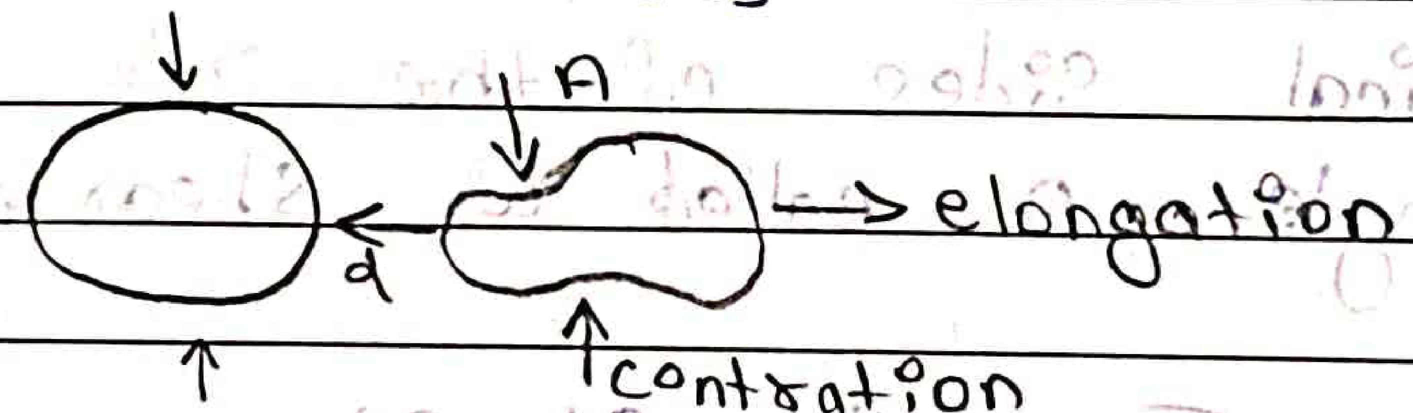
Compressibility (k) = compressibitity is the reciprocal of Bulk Modulus of elasticity

$$k = \frac{1}{K}$$

Position ratio :- when ever a body is subjects to a force in a Particular direction their is a change in dimention of a body in other Particular direction of a body in ~~other~~ known as lateral Strain

lateral strain (β)
Longitudinal Strain (α)



$$\alpha \propto \beta$$
$$\alpha = a\beta$$

$$\therefore \boxed{a = \frac{\beta}{\alpha}}$$

* Comparision between Linear and rotational motion.

Linear Motion	Rotational Motion
(1) when a body moves on a straight line	when a body rotation about a fixed Point

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or by taking some turned in the Path is called Linear Motion.	then it is a rotation motion.
(ii) Eg:- when we walk, motion of car.	(ii) Eg: fan about rotate its axis, earth rotate.
(iii) It is along a straight Path	(iii) It is along a fixed rotational axis.
(iv) Displacement is linear. which is measured in the unit of length meter(m).	(iv) Displacement is angular and it is measured in the Unit
(v) force formula $F = ma$	(v) $\tau = F \times r$ $\tau = rF \sin(\theta)$ angular momentum
(vi) $P = mv$ linear momentum = Mass x velocity	(vi) $L = r \times P$ r = angular distance
(vii) kinetic energy in a linear motion $K.E = \frac{1}{2} mv^2$	(vii) kinetic energy in a angular motion. $K.E = \frac{1}{2} I \omega^2$
(viii) Linear velocity is the rate of change of Position. $V = \frac{dr}{dt}$ (r = Position)	(viii) Angular velocity $\omega = \frac{\theta}{t}$ or $\frac{v}{r}$

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or by taking some turned in the Path is called Linear Motion.	then it is a rotation motion.
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(iv) Displacement is linear. which is measured in the unit of length meter(m).	(iv) Displacement is angular and it is measured in the Unit
(v) Force formula $F = ma$	(v) $\tau = F \times L^{r} \gamma$ $\tau = rF \sin(\theta)$ angular momentum
(vi) $P = mv$ linear momentum = Mass x velocity	(vi) $L = r \times P$ r = angular distance
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(viii) linear velocity is the rate of change of Position. $v = \frac{dr}{dt}$ (r = Position)	(viii) Angular velocity $\omega = \frac{\theta}{t}$ or $\frac{v}{r}$

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Rigid body : A body is set to be rigid when its constituent Particals retsin there Position even then they move under the action of external force.

Rigid body is execute two kind of motion.

(i) Translation motion
(ii) Rotational motion

Numerical on Centre of Mass :

Q) Three Particals of masses 1 gm, 2gm, 3gm are located in space. Their Position vector are $r_1 = 2i + 2j + 2k$

$r_2 = \hat{i} + \hat{j} + \hat{k}$ and $r_2 = 2\hat{i} + \hat{j} + 4\hat{k}$ respectively. Find the Position vectors of the center of mass.

$\Rightarrow m_1 = 1 gm$, $m_2 = 2$, $m_3 = 3$

$$r = \frac{m_1 r_1 + m_2 r_2 + m_3 r_3}{m_1 + m_2 + m_3}$$

$$= \frac{1(2\hat{i} + 2\hat{j} + 2\hat{k}) + 2(\hat{i} + \hat{j} + \hat{k}) + 3(2\hat{i} - 2\hat{i} + 4\hat{k})}{1+2+3}$$

$$= \frac{(2\hat{i} + 2\hat{j} + 2\hat{k}) + (2\hat{i} + 2\hat{j} + 2\hat{k}) + (6\hat{i}\ 6\hat{j} + 12\hat{k})}{6}$$

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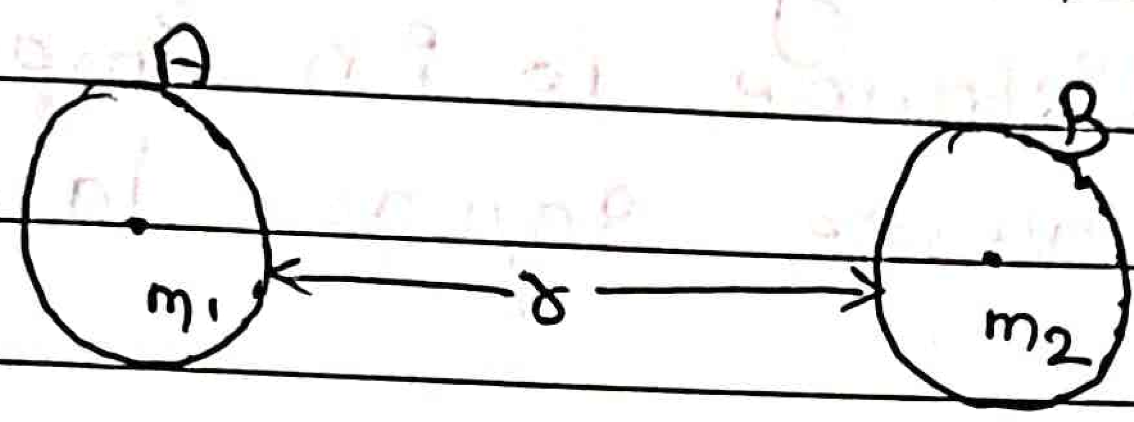
$$= \frac{10\hat{i} - 2\hat{j} + 16\hat{k}}{6}$$

$$= \frac{\cancel{2}(5\hat{i} - \hat{j} + 8\hat{k})}{\cancel{6}\ 3}$$

$$= \frac{5\hat{i}}{3} - \frac{\hat{j}}{3} + \frac{8\hat{k}}{3}$$

Gravitational force of attraction



$F \propto m_1 m_2$ ——— (1)

$F \propto \frac{1}{r^2}$ ——— (11)

From eq (1) and (11)

$$F \propto \frac{m_1 m_2}{r^2}$$

$$F = G \frac{m_1 m_2}{r^2}$$

G = Universal gravitation constant.

$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$

$g = 9.8\ m/s^2$

Every Partical which have mass attraction each other in these universe. These

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is a force act between all the masses this force is directly Proportional to the Product of their masses and inversely Proportional to the square of a distance between them.

Properties of Gravitional force of attraction

(i) It is always attractive in nature.
(ii) It is long rang force.
(iii) Mass and distance is in important
(iv) It obeys inverse square law.
i.e.

$$I \propto \frac{1}{d^2}$$

* Acceleration due to gravity (g)

Gravity is a force with which the earth attracts a body towords in centre's Acceleration due to gravity is the acceleration gained by an object due to gravition force. In other words accelaration Produced (setup) in the body when it falls freely under the effect of gravity is known as accleration due to gravity. It is denoted by g. An it value on a earth is $9.8\ m/s^2$

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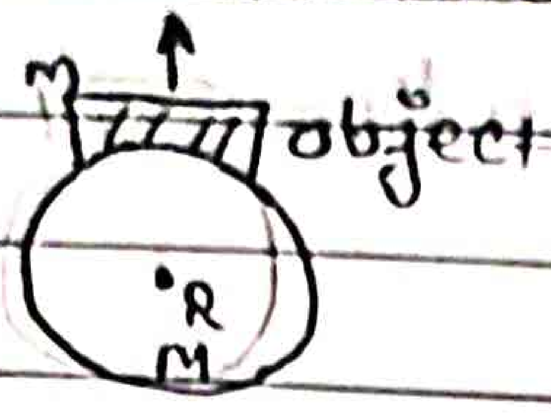
It varies with altitude and depth



$F = mg$

From fig 1. Let an object of mass m Placed at the surface of the earth.

According to gravitational force of attraction is

$$F = \frac{GMm}{R^2} \quad \text{—— (1)}$$

Also a force is acting down word

$$F = mg \quad \text{—— (11)}$$

From eq^n (1) and (11)

$$\frac{GM\cancel{m}}{R^2} = \cancel{m}g$$

$$\boxed{\frac{GM}{R^2} = g}$$

Where $G = 6.67 \times 10^{-11} \ Nm^2/k^2$

M = mass of the earth

$= 6 \times 10^{24}$ kg

R = Radius of the earth

$= 6.4 \times 10^6$ m.

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$$= \frac{6.67\times10^{-11}\times 6\times10^{24}}{6.4\times10^{6}}$$

effect of height.

$g_h = ?$

$g = 9.8\ m/s$

since we known

$$\therefore\ g = \frac{Gm}{R^2} \quad \text{——— (I)}$$

A next equation

$$g_h = \frac{GM}{(R+h)^2}$$

dividing eq^n (I) with (II)

$$\cancel{GM}$$

$$= \frac{\frac{\cancel{GM}}{(R+h)^2}}{\frac{\cancel{GM}}{R^2}} = \frac{R^2}{(R+h)^2}$$

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$$\frac{g_h}{g} = R^2\left(\frac{1}{2Rh+h^2}\right)$$

$$\frac{g_h}{g} = \frac{R^2}{R^2}\left(\frac{1}{\left(1+\frac{h}{R}\right)^2}\right)$$

$$\frac{g_h}{g} = \frac{1}{\left(1+\frac{h}{R}\right)^2}$$

$$\frac{g_h}{g} = \left(1+\frac{h}{R^2}\right)^2 \text{ —— (III)}$$

·sin Bi-nomial theorm

$$\frac{g_h}{g} = 1-\frac{2h}{R^2}$$

$$\therefore g_h = g\left(1-\frac{2h}{R^2}\right) \text{ —— (IV)}$$

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kepler's Law's of Planetory motion

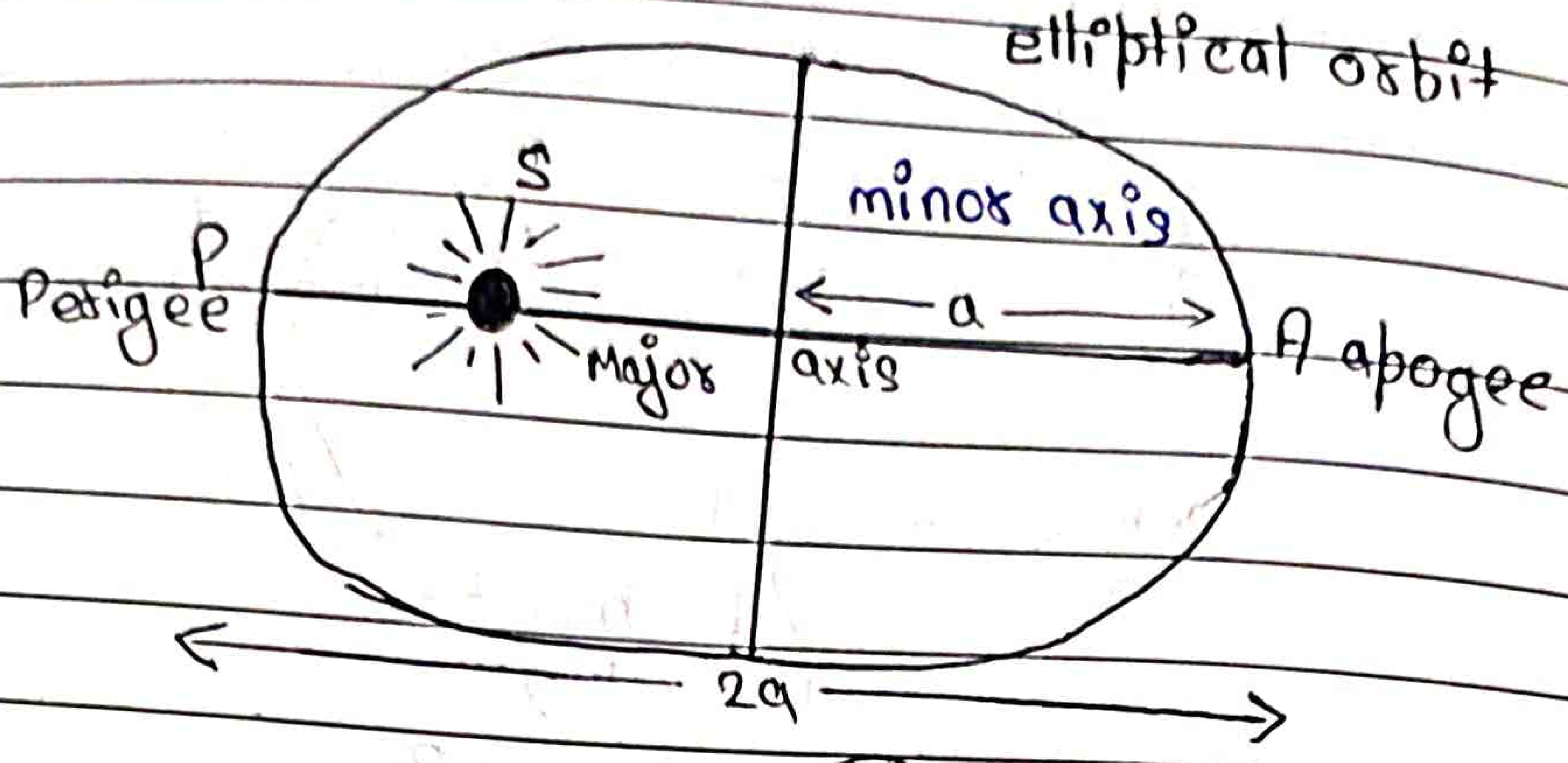

fig (1)

kepler's 1st Law of planitary motion (Law of orbit) :-

According to kepler's first Law all the Planets move in an elliptical orbit with the sun situated at one of the focus of the ellips. This law indicates that the distance between the sun and the Planet on constantally the sun and the Planet on constantally changing as the Planet goes around its orbit shown in fig -(1). The closest Point of the sun is known as Perigee or Perihilion and the furthest Portion of the sun is known as Apihilion or Apogee

The length of the major axis is equal to the sum of the distance of Perihilion that is 2a. The half of the

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distance (a) is a semi major axis.

Kepler's 2nd Law of Planetary motion (Law of area):-

The speed of Planet varies in such a way that the radius drawn from the sun to the Planet sweeps out equal area in equal interval of time. ie the areal velocity of the Planet around the sun is constant, from -(2). If a Planet the word area A1, A2, A3, A4, in equal interval of time.

$A_1 = A_2 = A_3 = A_4 =$ constant

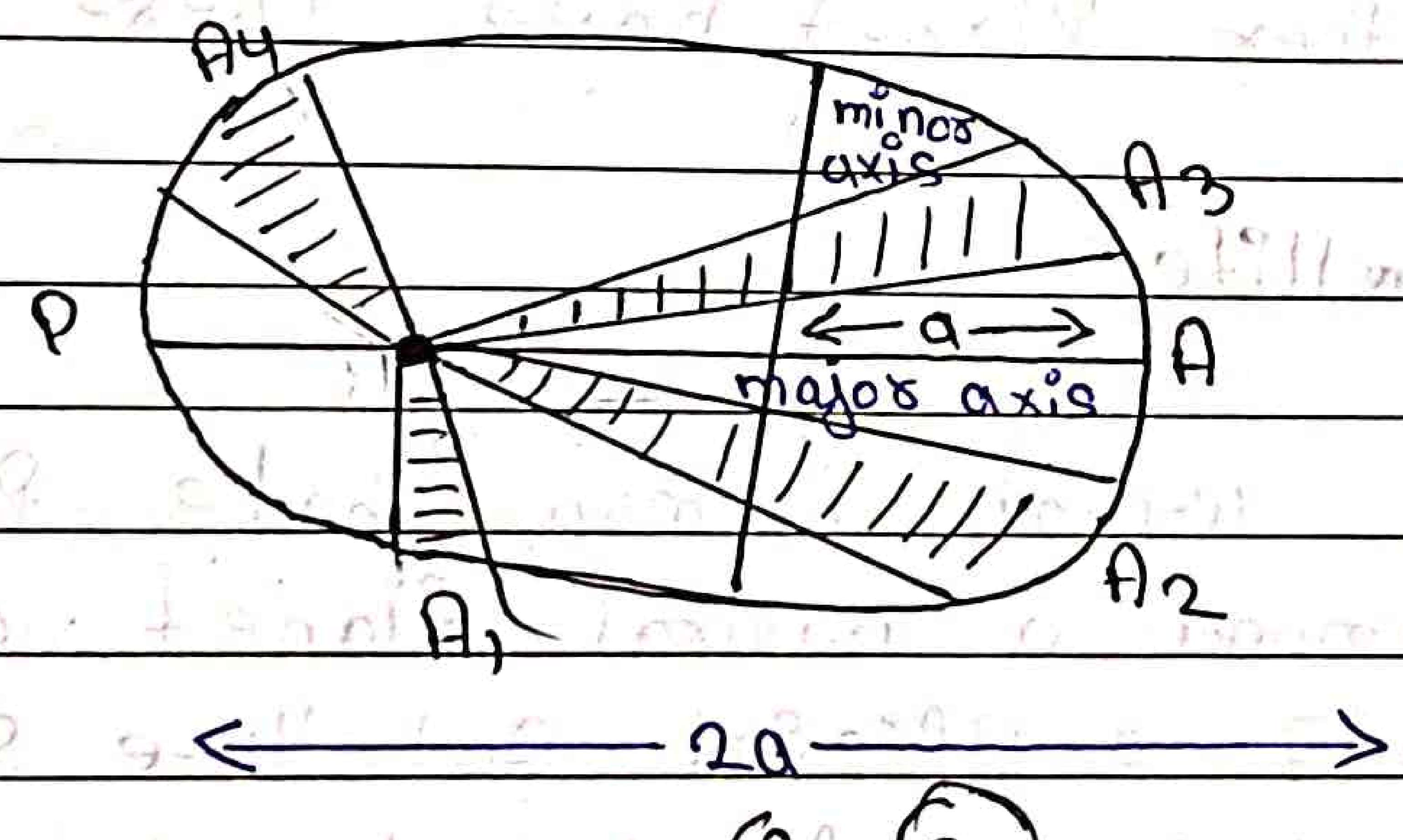
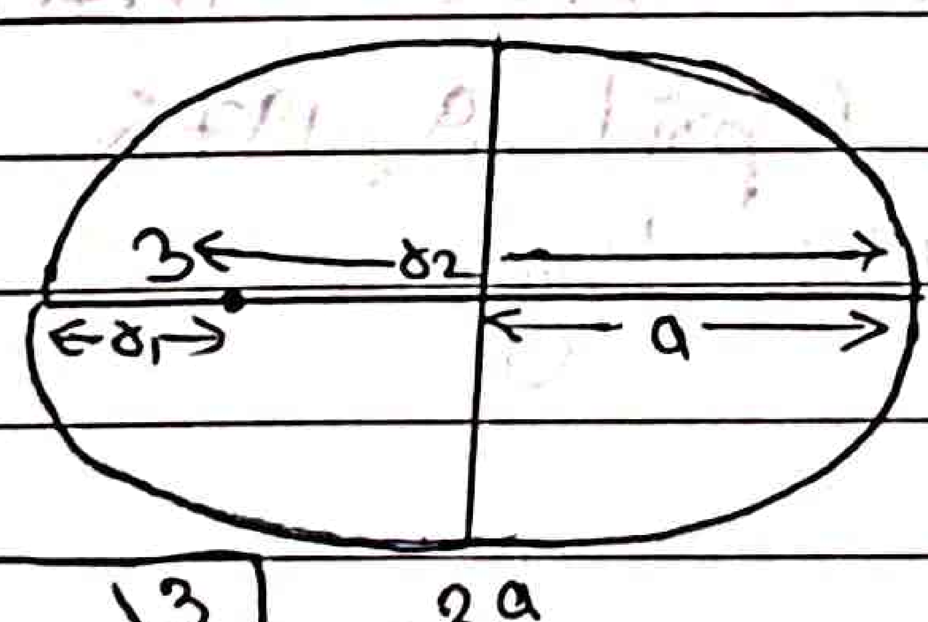


fig.(2)

Kepler's 3rd law of Planetory motion (law of Period)

i.e $T^2 \propto a^3$

$T^2 = ka^3$



$PA = PS + SA$

$2a = r_1 + r_2$

$a = \frac{r_1 + r_2}{2}$

$$\boxed{T^2 = k \left(\frac{r_1 + r_2}{2}\right)^3}$$

Fig.(3)

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According to this low, the saquare of the time Period of the revolution of the Planet around the sun is directly Proportional to the cube of time semi major axis of it ellipical axis

Satellities :- A havenly body revoluing around a Planet in a statble orbit is called as natural satellites in solar system. There are eight Planet (Mercury, venus, Earth, Mars, Jupiter, saturn, Uranus and Neptune) which revolve around them except Murcury and venus other Planet have there satellite

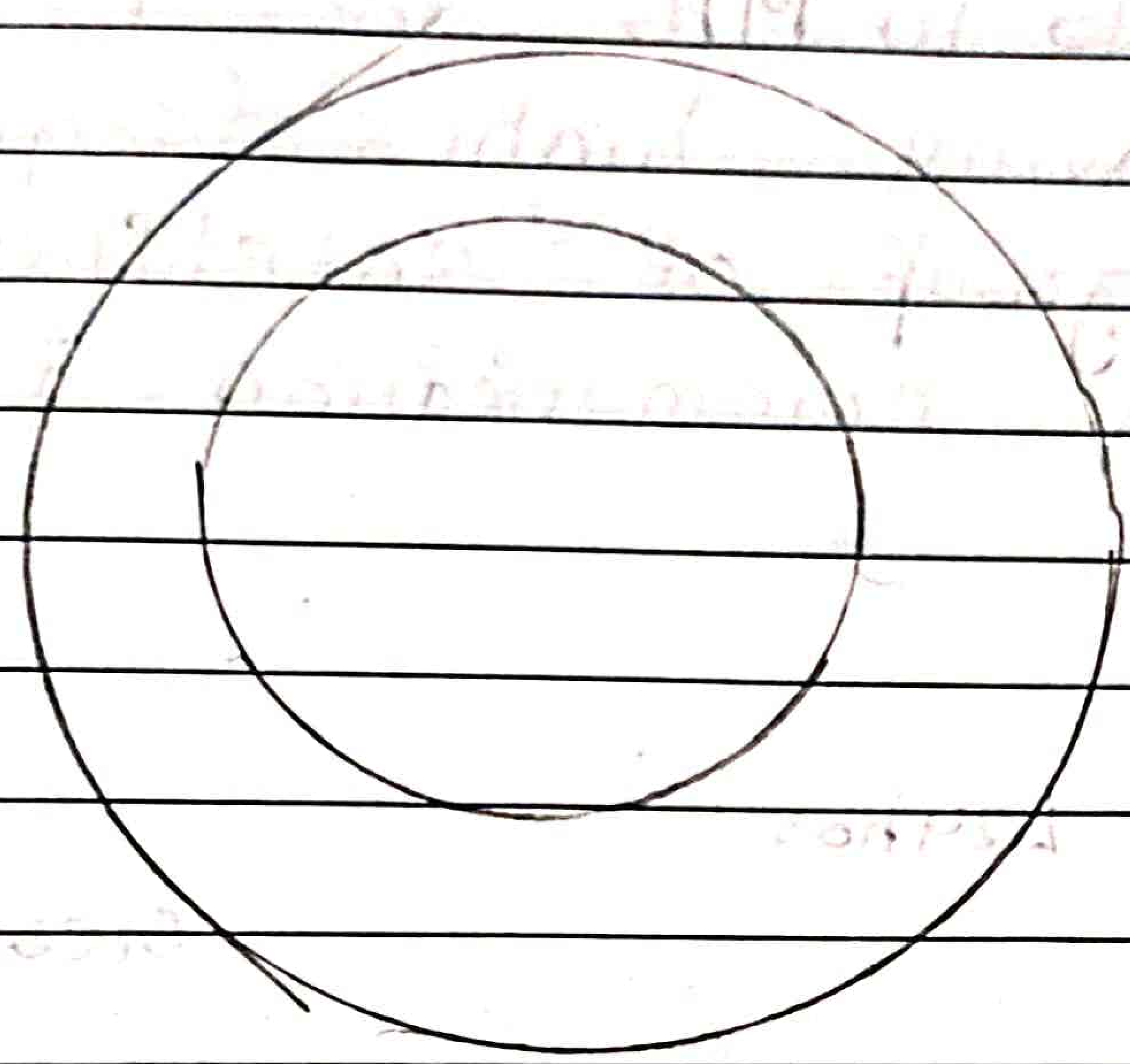
Artificial Satellite :-

A satellite which is man made Put into it orbit around a natural Planet. On October 4, 1957 artificial satellite SPUTNIK-I weighting 83.6 kg of launch around the earth's orbit.

India also launch first Artificial Satellite Aryabhatta on April 19, 1975 weight of the satellite is 360 kg

Page No.

Types of satellite orbit



LEO (Lower Earth oribt)

LEO dencialy populated with 1000 of is today's operation addressing, imaging low bound with tally communicating.

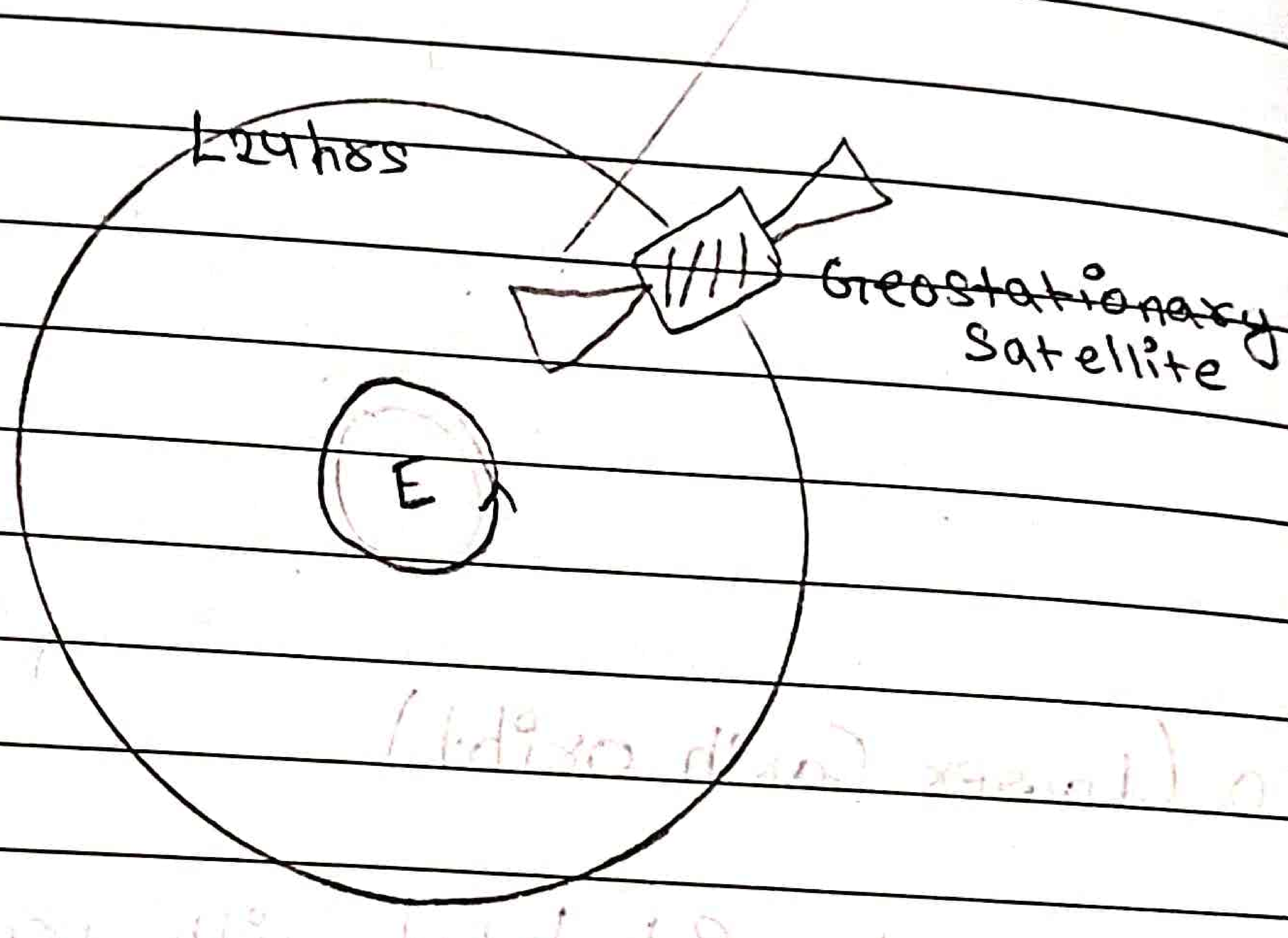
MEO (Middle earth orbit)

It is used for GPS or other navigation operation. More recently high bound with data conectivity to server Provider goverment agency and comercial Proviolor

Date __ / __ / __

GEO (Geostationary Earth orbit)

It is use for communcition Purpose such as radio waves within the frequency rang 2 MHz to 10 MHz for TV brodcasting communication having higher frequency. The INSET group of satellite are widely use for telly communication in India.



Parking orbit

It is also known as Geostationary satellite.

This satellite alway stay over the same Place above the earth. It apears stationary due to its 0 relative velocity. The orbit Geostationary Parking orbit its time Period of revolution als same as that of earth.

Date ___/___/______

GPS (Global Positioning System)

Global Positioning System (GPS) is a navigation system based on satellite. It has created the revolution in navigation and Positioning navigation monitoring and surveying application