9. Define progressive wave & Derive progressive wave equation.

progressive wave: A wave that travels from one region of medium to another region carrying energy is called progressive wave. Both transvers & longitudinal waves are propagate with progressive wave.

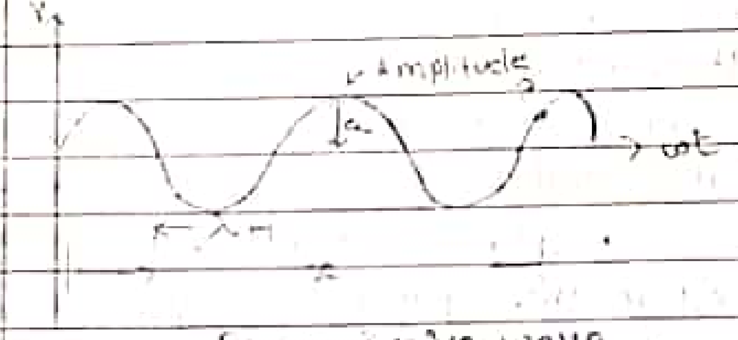

fig: progressive wave

Let us consider a wave is travelling from left to right as shown in fig. the displacement of the vibrating particle in the medium is given by,

$$y = a\sin\omega t \quad \text{(i)}$$

, Where a is amplitude, t is time and $\omega = 2\pi f$ and f is frequency of vibration. If ϕ be the phase angle of displacement with particles distance p' is given by,

$$y = a\sin(\omega t - \phi) \quad \text{(ii)}$$

Since, path diff λ, phase different is 2π
And for a path diff. x phase diff. is $\frac{2\pi}{\lambda}x$

i.e $\phi = \frac{2\pi}{\lambda}.x$

$$y = a\sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$$

$$y = a\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right) = a\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$$

$$y = a\sin(\omega t - kx) \quad \text{(iii)} \quad [k = 2\pi/\lambda]$$

If the wave is travelling from right to left then the displacement of particles is given by.

$$y = a\sin 2\pi\left(\frac{t}{T} + \frac{x}{\lambda}\right) \quad \text{(iv)}$$

eqn (iii) & (iv) is the progressive wave.

$\omega = 2\pi/T$

2. Use the principle of two waves to find the position of nodes and antinodes in a standing wave.

⇒ **Standing wave:** Whenever two progressive waves of the Same frequency & amplitude travel in opposite direction will be Same speed of in a medium & undergoes superposition is called standing wave.
When a standing wave is formed due to the superposition of two waves, the point of maximum and zero amplitude are resulted alternatively in the space. The point where the amplitude of vibration is maximum are called antinodes and those where the amplitude is zero is called nodes.
Let's us consider two plane progressive wave having Same amplitude (a), frequency f & velocity u are travelling towards Same point of a medium from opposite direction. Due to these two waves, the displacement of a particles of the medium at time(t) are -

$$y_1 = a\sin(\omega t - kx) \quad \text{—— (I)}$$
$$y_2 = a\sin(\omega t + kx) \quad \text{—— (II)}$$

By usinging principle of Superposition.

$$y = y_1 + y_2$$
$$y = a\sin(\omega t - kx) + a\sin(\omega t + kx)$$
$$= 2a\sin\omega t\cos kx$$
$$= 2a\sin\frac{2\pi}{T}t \cdot \cos\frac{2\pi}{\lambda}x$$

$$\therefore\ y = A\sin\frac{2\pi}{T}t \quad \text{—— (III)}$$

where $A = 2a\ \frac{2\pi}{\lambda}\cdot x$

Case I
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then
Thus

Case II

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Case I

for $x = 0, \lambda/2, 2\lambda/2, 3\frac{\lambda}{2} \ldots$

then $A = 2a$ is maximum amplitude.

Thus, these point are antinodes.

Case II

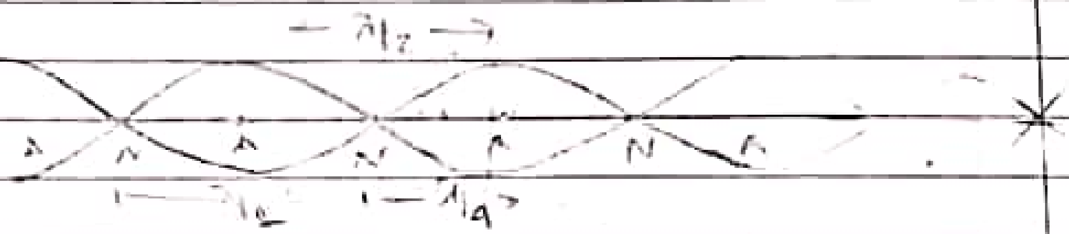
for $x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4} \ldots$

then, $A = 0$,

is minimum amplitude

Thus these point are nodes

∴ Distance betn two consective nodes and Antinodes



3. What is Newton's formula for the velocity of sound? What correction was made by Laplace?

⇒ Newton's formula: Newtons assumed that sound wave propagates in gas medium in from of compression and rarefaction. This process is very slow process. So sound wave propagates in medium by isothermal process.

for isothermal process

$$PV = \text{Constant}$$

Differentiality above eqn

$$d(PV) = d(\text{constant})$$

$$PdV + VdP = 0$$

$$\therefore P = \frac{-dP}{dV/V} = \text{Bulk modulus}$$

We have
Speed of sound wave in a gas medium

$$v = \sqrt{\frac{B}{\rho}} \quad \text{--- (ii)}$$

from eqⁿ (i) & (ii)

$$v = \sqrt{\frac{P}{\rho}} \quad \text{--- (iii)}$$

This is a Newtons formula for speed of velocity of ~~light~~ Sound in a gas medium

For air medium air at NTP

$T = 273K \qquad P = 1.013 \times 10^5 pa. \quad \rho = 1.293 kg/m^2$

Speed of sound air at NTP

$$v = \sqrt{P/\rho}$$

$$= \sqrt{\frac{1.013 \times 10^5}{1.293}}$$

$$\simeq 280 m/s$$

But experimentally speed of sound is found to be 332m/s air in NTP. This calculated value from Newton's formula is low so the formula corrected by laplace.

Laplace correcting:

Assumation made by Newton was corrected by Laplace for speed of sound wave in a gas medium. Laplace assumed that the process of formalation of compression and rarefaction is very rapid process while sound wave propagrating through the gas medium. So it is not isothermal. It is abiabatic process.

PV^{γ} = constant , $\gamma = \frac{C_P}{C_V}$

differentating both sides

$$d(PV^{\gamma}) = d(\text{constant})$$

$$\therefore \gamma P V^{\gamma-1} + V^{\gamma} dP = 0$$

$$\text{or, } \gamma P = \frac{-dP}{dV/V} = B = \text{Bulk modulus} \quad \text{——— (I)}$$

We have,

Speed of Sound wave in gas medium

$$v = \sqrt{\frac{B}{\rho}}$$

(I) & (II)

$$v = \sqrt{\frac{\gamma P}{\rho}} \quad \text{——— (II)}$$

This is Laplace corrected formula for air medium at NTP.

$$P = 1.013 \times 10^5 P \qquad \rho = 1.293\ kg/m^3$$

$$T = 273K \qquad \gamma = 1.41$$

Speed of Sound in air NTP

$$v = \sqrt{\frac{\gamma P}{\rho}}$$

$$= \sqrt{\frac{1.4 \times 1.013 \times 10^5}{1.293}}$$

$$\approx 332\ m/s$$

This value is nearly equal to experimental value (332 m/s). So Laplace formula is accepted.

4. Derive the fringe width for Young's doubles slit experiment.

→ The principle and experiment arrangement of young's doublos slit experiment is shown in fig.

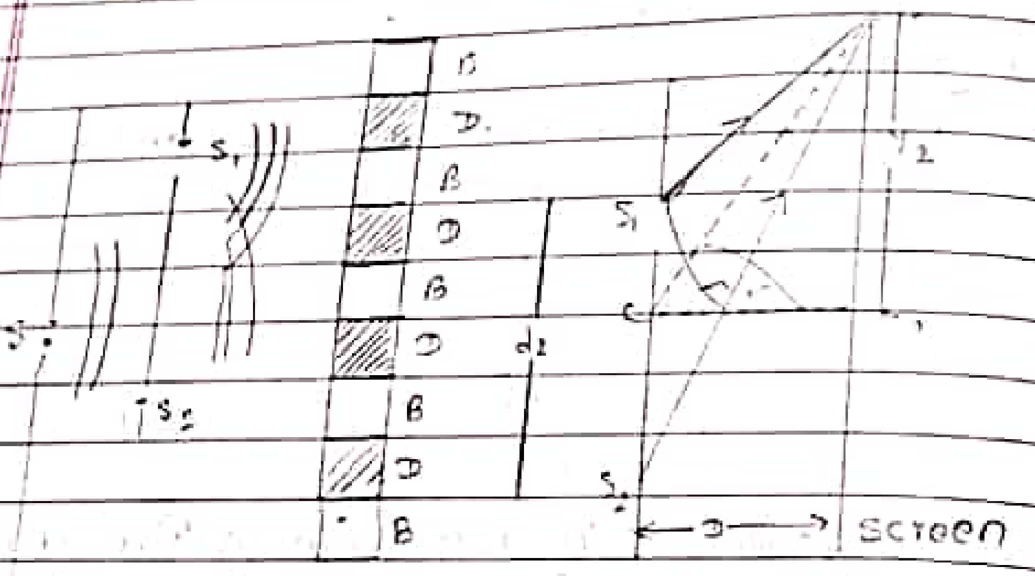


fig: Young's double slit expesiment for interference phenomena.

In fig S is monochromatic bright source of light wave S_1 & S_2 are two slits that are equi-distance from S, they acts as coherent Source of light. Light wave froms S_1 & S_2 superpose on the screen & dark & bright frienges are obtained on the screen due to interference of light waves.

'O' is centre of the screen at which bright fringes is formed. Let 'p' be the any point of the depend upon path difference betn. light waves coming from S_1 & S_2 or from the Source.

The path difference betn light waves from the Sources at point 'p' is

$x = S_2P - S_1P$

$x = S_2M$

$x = d\sin\theta$ ~ (i) [d = distance betn slits]

From fig,

$\tan\theta = y_n/D$ ~ (ii)

y_n = position of point p from the Centre of Screen 'o'

D = distance betn screen & slit

As θ is very small

$\sin\theta \approx \tan\theta$.

So from (i) & (ii) we get,

path difference $(x) = d y_n / D$ ~ (A)

Case I

At point A, when constructive interference is formed or maximum intensity is formed at point 'p'.

For the path difference is formed at point is produce, the path difference must be

$x = n.\lambda$ — (B)

λ = wave length

$n = 0, 1, 2, 3, 4, \ldots$

So, from (A) & (B)

$$\frac{d y_n}{D} = n.\lambda$$

$$\therefore y_n = \frac{n\lambda D}{d} \quad \text{~ (C)}$$

This is the position of nth bright fringes from Centre of the Screen.

The width of the bright fringes (β) is,

$$\beta = y_{n+1} - y_n$$

$$= \frac{(n+1).\lambda D}{d} - \frac{n\lambda D}{d}$$

$$\boxed{\therefore \beta = \frac{\lambda D}{d}} \sim (D)$$

Case II

For the dark fringe at point 'P' when the distructive interference is formed at point 'P'. The path difference must be,

$$x = (2n-1) \cdot \frac{\lambda}{2} \text{ --- } (E)$$
$$(n = 1, 2, 3 \ldots)$$

So from eqn (A) & E we get,

$$\frac{d y_n}{D} = (2n-1) \cdot \lambda/2$$
$$\therefore y_n = (2n-1) \times \frac{\lambda \cdot D}{2d} \sim (F)$$

This is the position of nth dark fringes from centre of the Screen.

The width of the dark fringes (β) $= y_{n+1} - y_n$

$$= (2n+1) \cdot \frac{\lambda D}{2d} - (2n-1) \cdot \frac{\lambda d}{2d}$$
$$= \lambda D/d \sim (G)$$

Again,

Similarly $\beta = \lambda D/d \sim (4)$

This is required Solution for Doubles slit experiment of Young's.

Diffraction of light through the single slit.

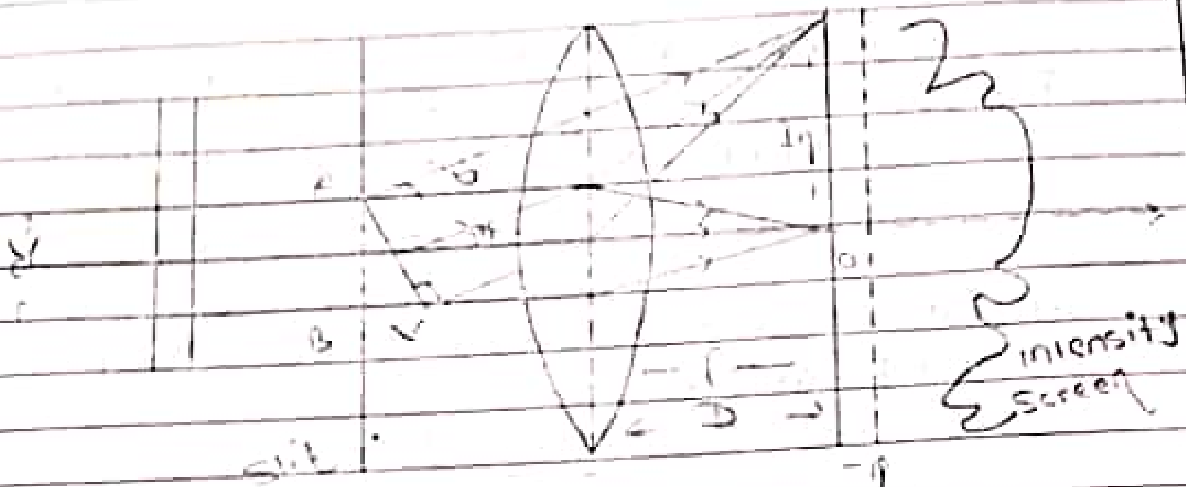


fig: diffraction of light through a single slit.

Let us consider a plane wave fronts of monochromatic light (λ) is incident on slit AB of width d. The secondary wave fronts from AB go straight & focus at the point O on the screen by lens 'L'. They are in the same phase so the intensity at 'O' is maximum called central maxima.

The diffracted rays through an angle θ with incident direction are focused at point P on the screen. The point P may be maxima or minima depend upon the path difference betn diffracted ray's.

The path difference by betn diffracted ray's at point P is,

$$BN = d \sin\theta \quad \text{--- (1)}$$

The point P will be secondary minima if the path difference betn n is BN

$$BN = d \sin\theta = n\lambda \quad \text{--- (2)} \quad n = 1, 2, \ldots$$

Because the contributions from all the secondary wave lets cancel out.

The point P will be maxima called Secondary maxima if the path difference BN is

$$d\sin\theta = (2n+1)\cdot\frac{\lambda}{2} \quad \text{——} \quad (3) \quad n = 0,1,2,\ldots$$

From fig. $\tan\theta = \frac{y_n}{D}$, y_n = Distance betn P from.
D = distance betn slit & Screen

The intensity of maxima goes on decreasing in increasing order.

θ is very small.

$$\sin\theta \simeq \tan\theta \quad \text{——} \quad (A)$$

From minima.

from eqn (A) & (2)

$$\frac{d\,y_n}{D} = n\cdot\lambda$$

$$y_n = \frac{n\lambda D}{d} \quad \text{——} \quad (4)$$

As, Secondary minima occours betn two Consecutives Secondary maxima,

∴ Width of Secondary maxima.

$$\boxed{\beta_{max} = \frac{\lambda D}{2}} \quad \text{——} \quad (5)$$

Width of Central maxima occours betn two 1st Secondary minima.

The lienear width $\beta = y_1 + y_2$

$$= \frac{2\lambda D}{d} \quad [\text{from } 4]$$

$$\boxed{\therefore \beta_{max} = \frac{2\lambda D}{d}}$$

The angular width ω is from (2) for $n = 1$, $\omega = 2\theta$

$$= \frac{2\lambda}{d}$$

For maxima
eqn (1)
y_n =
y_n =
The second

Q.6 What is ... differ fro...

→ The bend... of an ob... region of diffraction.

Types of ...

(a) Fresnel
(b) Fraunhofer

$$\therefore w = \frac{2\lambda}{d} \quad \text{—— (7)}$$

For maxima

eqⁿ (4) & (5) We get.

$$y_n = (2n+1)\cdot\frac{\lambda D}{2d}$$

$$y_n = \frac{(2n+1)\lambda D}{2d} \quad \text{—— (8)}$$

The secondarly minima(β_{min}) = $y_{n+1} - y_n$

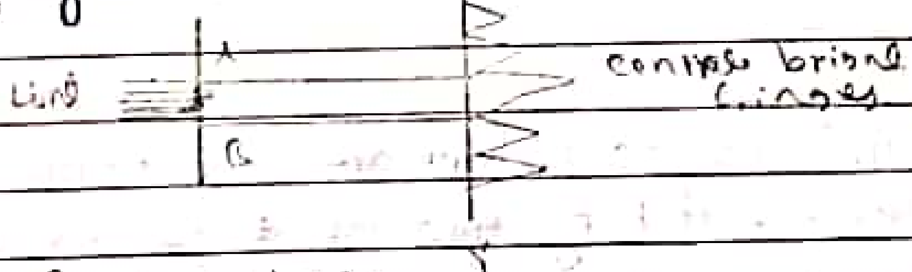
$$= \frac{(2n+3)\lambda D}{2d} - \frac{(2n+1)\lambda D}{d} \quad (8)$$

$$= \frac{\lambda D}{d}$$

$$\boxed{\therefore \beta_{min} = \frac{\lambda D}{d}}$$

Q.6 What is diffraction of light? How does it differ from interference of light

→ The bending of the light round the corners of an obstacles and the spreading into the region of geometrical shadow is called diffraction.



Diffraction of Light

Types of diffraction

(a) Fresnel diffraction:
(b) Fraunhofer diffraction.

(a) Fresnel diffraction : The diffraction in which the Source and the Screen are at finite distance from the obstacles is called fresnel diffraction. no lenes is required to observe it.

(b) Fraunhofer diffraction: The diffraction in which the Source and Screen are placed at a grater distance from the obstacles is Fraunhofer diffraction.

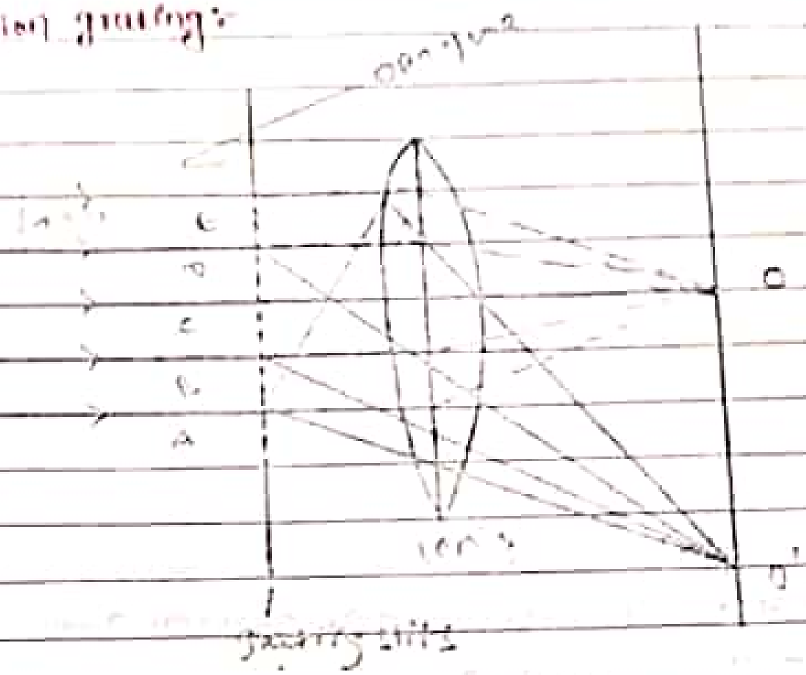
Interference	diffraction
(i) It is due to Superposition of wavelets of different wavelets.	It is due to Superposition of wavelets of Same wave lets.
(ii) points of minimum intensity are perfectly dark.	point of minimum intensity aren't perfectly dark.
(iii) All bright band are of unifrom intensity.	All bright aren't of the Same intensity.

1. What is coherent Sources.

The two Sources of light are Said to be coherent Sources if they emit light waves of Same frequency wave length, & always maintain constant Phase difference.

example: lesser light.

Diffraction grating:-



A diffraction grating is a large number of close paraller equidistant slits ruled or glass or metal.

If width of a slit 'a' and the thickness of an space is b spacding d of the slit is (a+b). A large number of find equidistant paralle's slit can be obtained by drawing series.

The figure shows the section of grating whose slit are perpendicular to the palpe of paper.

Let a = the width of each slit

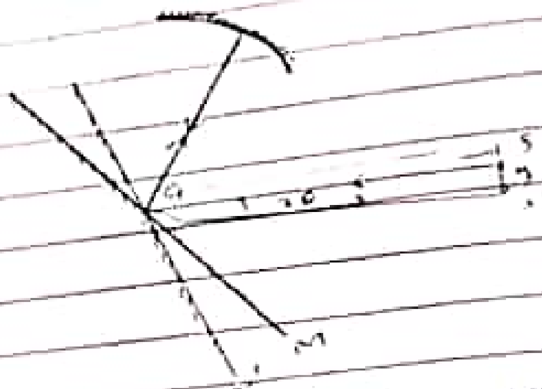
b = distance betn slit. Here (a+b) is grating space or element. If N is the number of lines per inch of the grating

$$a+b = \frac{1\,inch}{N} = \frac{2.54}{N}\ cm.$$

$$(a+b)\sin\theta_n = n\lambda \quad \text{where } n = 1,2,3\ldots$$

if n=0, the central maxima is formed

3. Experimental determination of Speed of light using Foucault's method.



The principle & experimental arrangement of foucault's method for experimental determination of speed of light as shown in fig. In which P, O, S are pole of fixed concave mirror. 'O' is rotating axis of rotating mirror (M) and bright sources of light respectively. The fixed mirror O is at distance 'd' from 'M' and O is also centre of curvature of C.

When the ray from bright sources 'S' incident on rotating mirror it get reflected along OP and fall on the mirror C at it's pole. It returns back along OS & from S image S'. When the light ray travels from 'O' to P' and return's back at O, at the same time mirror displace through an angle (θ) which as shown in fig.

Time taken by light to travels distance d is

$$t_1 = 2d/c \quad \text{—— (1)}$$

c = speed of light is to be determined.

If f is rotation of frequency of rotating mirror (M) then time taken by the mirror

to displace th

Being both

from fig.

eqn (5)

Equation with fa

2. Experiment michelson

to displace through an angle θ is

$$t_2 = \frac{\theta}{2\pi f} \quad \text{— (2)} \quad [t = \theta/2\pi f]$$

Being both time is equal.

$$\therefore t_1 = t_2$$

$$\frac{2d}{c} = \frac{\theta}{2\pi f}$$

$$\frac{4\pi d f}{\theta} = c \quad \text{— (3)}$$

From fig. if y is displacement of image then

$$2\theta = \frac{SS'}{OS} = y/a$$

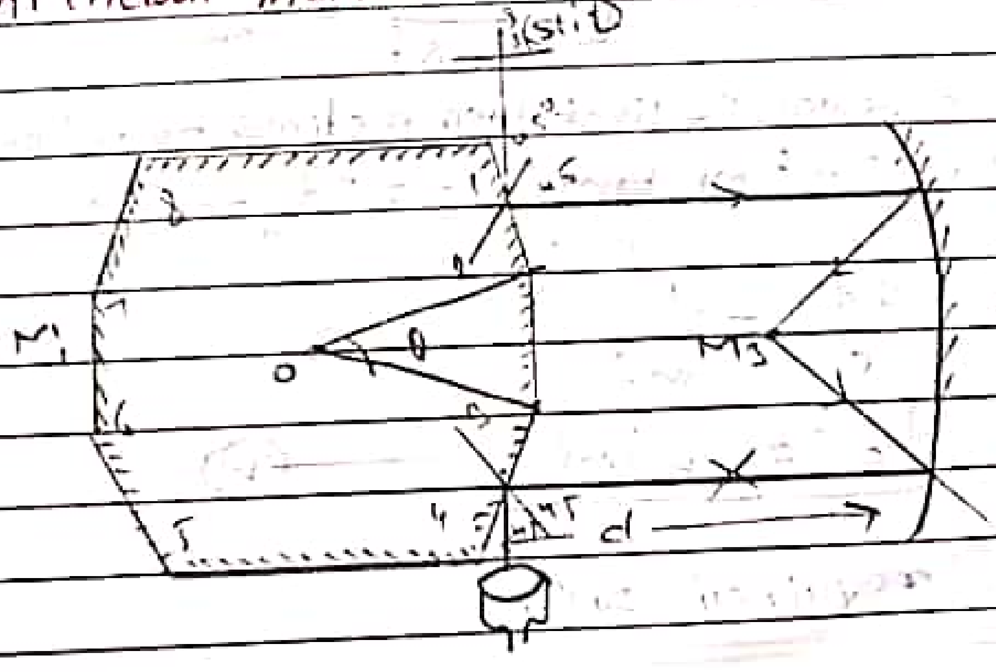
$$\therefore \theta = y/2a \quad \text{— (4)}$$

eq^n (3) & (4) we get.

$$\boxed{c = \frac{4\pi d a f}{y}} \quad \text{— (5)}$$

Equation (5) is required sol^n for speed of light with faucault's method.

2. Experimental Determination of speed of light with michelson method.



The principle and experimental arrangement for determination of light by this method is shown in fig. It consists of regular octagonal mirror by which rotates about the axis that passed through the centre O. It also consists of narrow bright sources of light S' Telescope T for mirror fixed m_1 & plane mirror m_2 with focus plane of mirror m_1.

When the ray from bright sources S' falls on rotating of m_1 to m_2, m_2 to m_1, m_3 to m_2 & m_2 to m_1. The ray's intemi's into the telescope when the returning ray's from the mirror m_2 falls on the mirror m_2 at 45°c. The speed of rotating mirror is so adjusted in a such way that the face occupied by the face 3 earlier during the time when the ray's travels from m_1 to m_2 & return to m_1.

The angular displacement (θ) of mirror at time t is

$$t = \theta/\omega = \theta/2\pi f \quad \text{——} (i)$$

f = frequency

for regular polygon, $\theta = 2\pi/m$ —— (ii)

m = no. of surface.

(i) & (ii) we get,

$$t = \frac{2\pi/m}{2\pi f} = 1/mf$$

If c be the velocity of light then the time travels from m_1 to m_2 & m_2 to m_1 $\quad t = 2d/c$ —— (iii)

$$\therefore \frac{2d}{c} = \frac{1}{mf}$$

$$\boxed{c = 2dmf} \quad \text{——} (iv)$$

eq^n (iv) is required soln.

10.

→ The reflecte... ordinary lig... r angle of... angle of... medium. Th... the nature... the light...

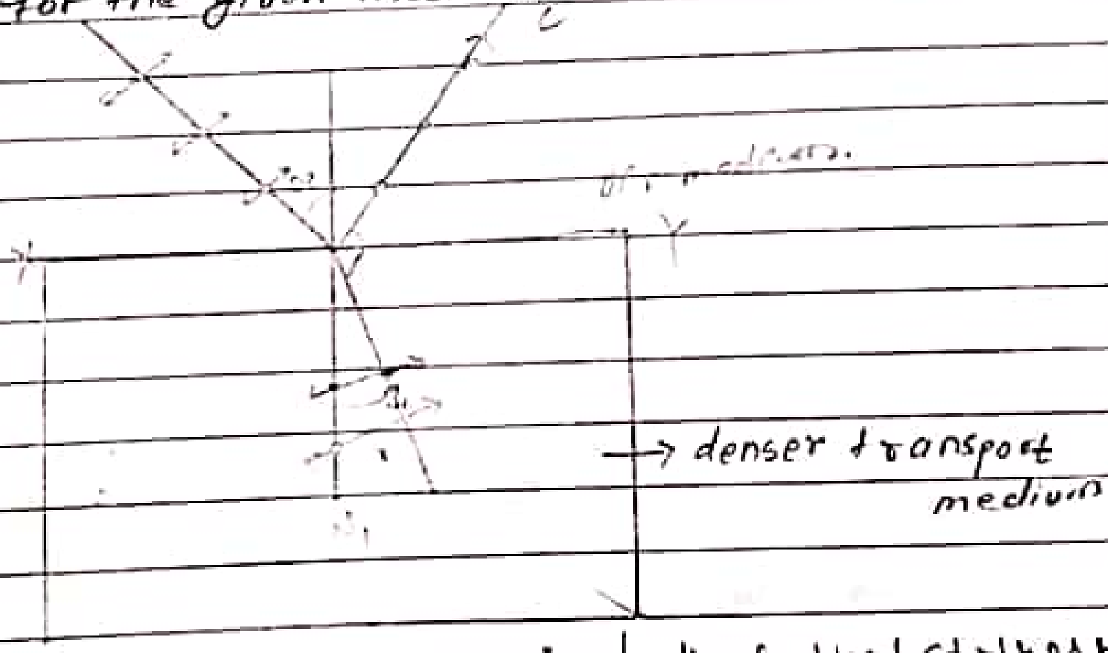
B... angles. He... a medium... Angle for...

Let AB... Surface XY... from air... the mediu... which as...

10.

→ The reflected light is Completely polarized when the ordinary light falls on the transparent medium at particular angle of incidence. The angle of incidence is called angle of polarization or Brewster angle for that medium. The value of polarizing angle depends upon the nature of reflecting medium & wavelength of the light used.

Brewster gave the law about polarizing angles. He Stated that "The refractive index of a medium is equal to the tangent of the polarizing angle for the given medium.



Let AB be incident unpolarized light that strikes the Surface XY seperating the transparent medium having R.I (μ) from air medium. If θ_p be the angle of polarization for the medium the reflected light is completely polarized which as shown in fig.

From snell's law

$$\mu = \frac{\sin\theta_p}{\sin r}$$, r = angle of reflection in denser medium.

(1)

For polarizing angle, the reflected ray & refracted ray are perpendicular to each other

i.e

$$\theta_p + r = 90$$

$$\text{or, } r = 90 - \theta_p \text{ ——— (ii)}$$

From (i) and (ii)

$$\mu = \frac{\sin\theta_p}{\sin(90-\theta_p)}$$

$$\mu = \frac{\sin\theta_p}{\cos\theta_p}$$

$$\therefore \boxed{\mu = \tan\theta_p} \text{ - - - - - - - (iii)}$$

... pipe:

Such hollow wodden metalic tube used producing sound is called organ pipe. Two types of organ pipe they are open organ pipe and close organ pipe.

1. closed organ pipe:

Such organ pipe whose one ends is closed in the other ends is open is called closed organ pipe. e.g flute

When distrubance is supply to the ends closed organ pipe from the open end stationary wave is formed at resonance & sound is produce. The different mode of vibration of closed organ pipe are-

<i> First mode of vibration (Fundamental mode)

याद गर्नु

$\boxed{N - AN \Rightarrow \frac{\lambda}{4}}$

Let L be the length of closed organ pipe. Let f_1 and λ_2 be the frequency and wavelength in the 1st mode of vibration. In this mode one Antinode is formed at the open end and one node is formed at closed end.

$$\therefore f_1 = \frac{v}{\lambda_1} \quad ------ \langle i \rangle$$

From fig.

$$L = \text{distance bet}^n \ N - AN$$

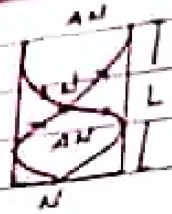
$$\text{or, } L = \frac{\lambda_1}{4} \quad \therefore \lambda_1 = 4L$$

From <i> ______ (ii)

$$\therefore f_1 = \frac{v}{4L}$$

This is called 1st harmonics or fundamental frequency.

(ii) <u>Second mode of vibration:</u>



Let f_2 and λ_2 be the frequency and wave length in the Second mode of vibration. In this mode two nodes & Two Antinodes are formed.

$$\therefore f_2 = \frac{v}{\lambda_2} \quad \text{------ (i)} \qquad \left[N\text{-}N = \frac{\lambda}{2},\ N\text{-}AN = \frac{\lambda}{4} \right]$$

From fig,

$L =$ distance betn N-N + N-AN

$$L = \frac{\lambda}{2} + \frac{\lambda}{4}$$

$$L = \frac{3\lambda_2}{4}$$

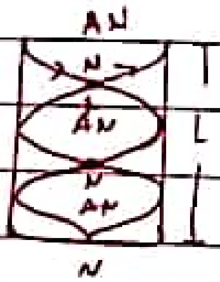
$$\therefore 4L = 3\lambda_2$$

$$\therefore \lambda_2 = \frac{4L}{3}$$

$$\therefore f_2 = \frac{v}{\frac{4L}{3}} = \frac{3v}{4L} = 3f_1$$

This is called third harmonics or 1^{st} overtone.

(iii) <u>Third mode of vibration:</u>



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Let f_3 & λ_3 be the frequency and wavelength in this mode of vibration. In this mode 3 nodes & 3 Antinodes are formed.

$$\therefore f_3 = \frac{v}{\lambda_3} \quad \text{.........(i)}$$

From. Fig.

L = distance betn [N-N + N-N + N-AN]

$$\text{or, } L = \frac{\lambda_3}{2} + \frac{\lambda_3}{2} + \frac{\lambda_3}{4}$$

$$\text{or, } L = \frac{5\lambda_3}{4}$$

$$\text{or, } \lambda_3 = \frac{4L}{5}$$

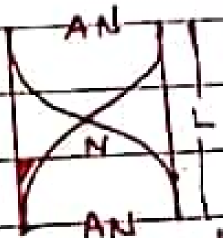
$$\therefore f_3 = \frac{5v}{4L} = 5f_1$$

This is called fifth harmonics or Second overtone. In generals $f_1 : f_2 : f_3 : f_4 = 1:3:5:7$ i.e only odd harmonic are present in the vibration of closed organ pipe & even harmonics are missing So the quality of Sound from closed organ pipe is minimum.

Open organ pipe: Such organ pipe whose both ends are opened called open organ pipe.

(i) First mode of vibration (Fundamental mode)

Let L be the length of open organ pipe set into vibration. Let f_1 & λ_1 be the frequency & wavelength in this mode of vibration, Two Antinodes are formed & one nodes are formed.



$$\therefore f_1 = \frac{v}{\lambda_1} \quad \text{— (i)}$$

From, fig.

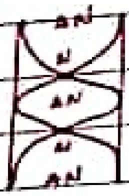
L = distance bet^n AN – AN

$L = \frac{\lambda_1}{2}$

$\therefore \lambda_1 = 2L$

from (i) $\therefore \boxed{f_1 = \frac{v}{2L}}$ This is called 1st harmonics or fundamental frequency.

(ii) <u>Second mode of vibration:</u>



Let f_2 & λ_2 be the frequency & wavelength in second mode of vibration. Three Antinode & Two node are formed.

i.e

$$f_2 = \frac{v}{\lambda_2} \text{ ---------- (i)}$$

from fig,

L_2 = distance bet^n AN – AN + AN – AN

$= \frac{\lambda_2}{2} + \frac{\lambda_2}{2}$

$= \frac{2\lambda_2}{2}$

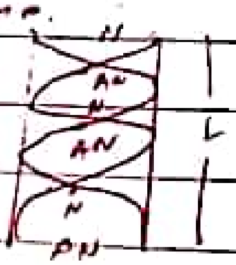
$\therefore L_2 = \lambda_2$

From (i)

$$f_2 = \frac{v}{L} = 2 \cdot f_1$$

$$\therefore f_2 = f_1 \text{ ----- (ii)}$$

This is called second harmonics or 1st overtone.



$$f_3 = \frac{3v}{2L}$$

1. Describe an experiment to verify Joule's law of heating.

Joule's law of heating: The amount of the heat produced in a conductor due to flow of current is,

(a) directly proportional to square of current passing through it i.e $H \propto I^2$

(b) directly proportional to resistance R of conductor i.e $H \propto R$

(c) directly proportional to time 't' for which current is passed through it. i.e

$H \propto t$

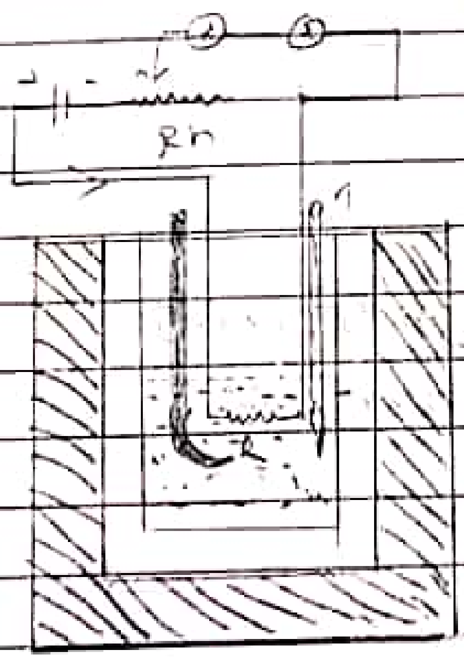
combining both relation

$H \propto I^2 R t$

$H = \frac{I^2 R t}{J}$ where J is constant.

$H = I^2 R t$ [in SI unit]

Experimental verification of Joules Law:



Experimental arrangement for the verification of Joule's law of heating is shown in fig. A coil of copper is placed in a partially filled calorimeter with water. When the circuit is closed, electric current I flow in the circuit & there is rise in tempr of water. The current can be varied with the help of rheostat. It is found that for constant mass of water heat produced at a fixed time is proportional to square of current flow,

i.e $\frac{H}{t} \propto I^2$ —— (I)

If we replace the coil of copper by another coil of different length but of same diameter. It is found that rate of heat produced, by a given current is proportional to the length of wire used. Thus

$\frac{H}{t} \propto R$ —— (II)

The amount heat produced can be estimated by measuring the raise in tempr during experiment.

from (I) & (II)

$$\frac{H}{t} \propto I^2 R$$

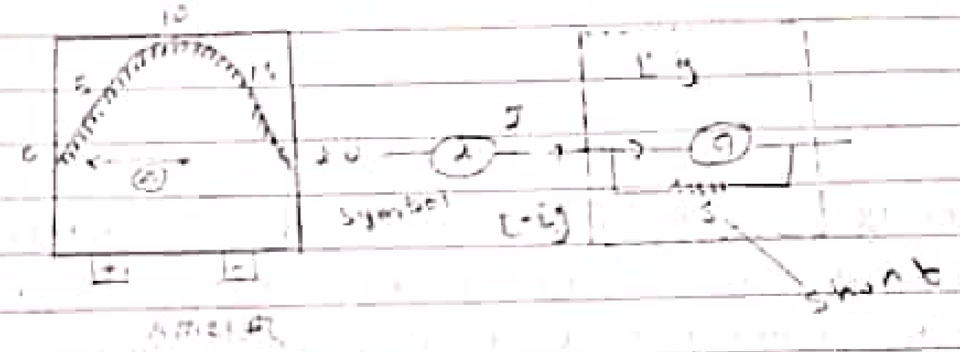
$$\frac{H}{t} = \frac{I^2 R}{J}$$

$\therefore H = I^2Rt$ [in SI unit]

Thus Joule's law is verified.

Q. What is shunt? How to conversion of galvanometer into ameter.

→ A Galvanometer can be modifired to convert it into Ameter by Connecting a low resistance known as Shunt.



A meter is electrical device which is used to measure current. It has very low resistance.
A Galvanometer can be modifired to converted into Ammeter by connecting a low resistance known as shunt. In such case, current is devided shows Galvanometer is safe from high current. Let I_g be Galvanometer current, r_g be Galvanometer resistance; S be shunt resistance & I be current to be measured. In parraller Combination are equal i.e

$$I_g \cdot r_g = (I - I_g)S$$

$$\therefore S = \frac{I_g r_g}{I - I_g} \quad (1)$$

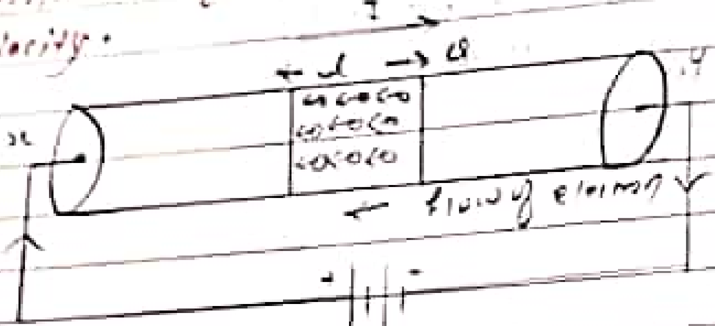
The resistance Ammeter becomes

$$\frac{1}{R_a} = \frac{1}{r_g} + \frac{1}{S}$$

$$\frac{1}{R_a} = \frac{S + r_g}{r_g \cdot S}$$

$$\therefore R_a = \frac{r_g \cdot S}{S + r_g} \quad (ii)$$

Q. Define current density & Drift velocity. expression mechanism of metallic conduction & drift velocity.



Let xy is a conductor connected with battery. A be area of cross-section, e be electronic charge n be number of electron perunite volume & I be current flowing. When the battery is connected, negative terminal of the battery repalled the electrons hence electron's moves toward's the positive terminals of the battery conventionally current is following from positive to negative.

We know, current is define as rate of flow of charge i.e $I = \text{charge}/\text{time}$

$$= q/t \quad \text{--- (I)}$$

charge q = e × No. of electron in PQ

or, $q = e \times n \times V$ [V be the volume of PQ]

or, $q = e.n.A.l$ --- (II)

from (I) & (II)

$$I = \frac{enAl}{t}$$

$$\boxed{\therefore I = venA} \quad \text{--- (III)}$$

current density: It is define as current flowing perunite area of cross-section. i.e

$$J = \frac{I}{A}$$

$$\text{or, } J = \frac{VenA}{A}$$

$$\text{or, } J = Ven \quad \text{—— (iv)}$$

Drift velocity : The average velocity of electron inside the conductor under electric feild is known as drift velocity. It is given by

$$I = VenA$$

$$V = I/enA \quad \text{—— (v)}$$

Q. What is the difference between an electromotive force and the terminal potential difference? How they are related?

Electromotive froce: The emf of a source is define as the work done in moving a unit positive charge through the source from low potential end to high potential end. It is cause, independent to r.

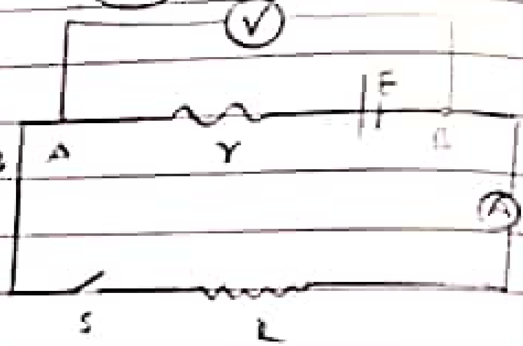
Terminal potential difference: The ~~te~~ potential different betn two terminals of a cell in a close circuit is called terminal potential difference of the cell. It is equal to the p.d across - external resistance of the circuit. It is effect, depends on r.

Relaiation betn emf, internal Resistance and Terminal p.d of cell

Let E be the emf of a cell, r be the its internal resistance & R be the external resistor connected in series with the cell. V is voltameter which measure p.d betn two point A & B of the circuit. S is the switch, when the circuit is open, no current flows through the circuit. The reading of the voltameter gives emf(E) of the cell. When circuit is closed, the current I flowing through the circuit is given by.

$$I = \frac{E}{R+r} \quad \text{— (i)}$$

$$E = IR + Ir \quad \text{— (ii)}$$



Terminals p.d, V = p.d across external resistance

$$V = IR \quad \text{— (iii)}$$

from (ii) & (iii)

$$V = E - Ir \quad \text{— (v)}$$

Where Ir is potential p.d drop across internal resistance of the cell. This is the required relation shift bein E, V & r.

---

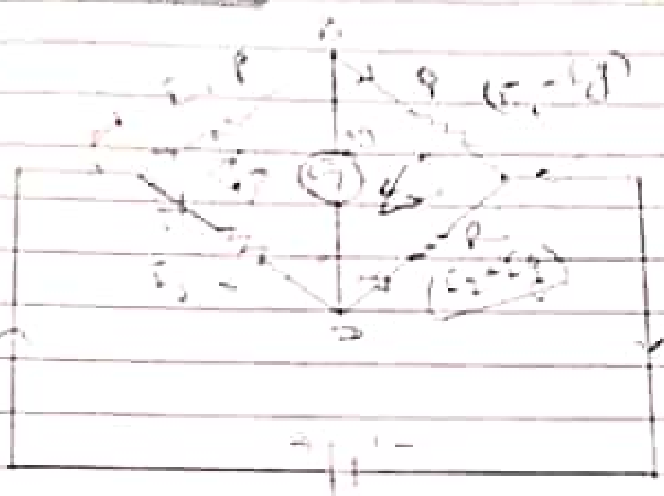
3. What is Wheatstone bridge? Useing kirchof's law, Derive the principle of wheatstone bridge.

Wheatstone bridge: It is an electrical circuit which can be used for accurate measurment of resistance of conductor. The principle of wheatstone bridge is that, When the bridge is balanced, products of resistance of opposite arms of circuits are equal. ie

$$P/Q = X/R$$

where P, Q, R are known resistance, X be unknown resistance.

Balance condition :



Which wheastone brigde is the suitable arrangement of 4 resistances in the 4 arms of [illegible] . It was discovered by wheatstone it is said to be Bridge because galvanometer connected betn B & D bridging path of current. It consist of 4 resistance P, Q, R & X connected in 4 arms of the quadrilateral ABCD. Galvanometer is connected betn point B & D & cell is connected point A & C.

Applying KVL in closed path ABDA

$$\Sigma E = \Sigma IR$$

$$\text{or } 0 = -I_1 P + (-I_g r_g) + I_2 \cdot X$$

$$\text{or } I_1 P + I_g r_g - I_2 \cdot X = 0 \quad \text{—— (i)}$$

Applying KVL in closed path BCDB

$$\Sigma E = \Sigma IR$$

$$0 = -(I_1 - I_g) \cdot Q + (I_2 + I_g) \cdot R + I_g r_g \quad \text{(ii)}$$

$$(I_1 - I_g) \cdot Q - (I_2 + I_g) \cdot R - I_g r_g = 0 \quad \text{—— (ii)}$$

The value of resistances are selected in such a way that galvanometer gives zero deflection i.e.

$$I_g = 0$$

from (i) & (ii)

$$I_1 P - I_2 \cdot X = 0 \quad \text{—— (iii)}$$

$$I_1 \cdot Q = I_2 \cdot R \quad \text{—— (iv)}$$

Dividing (iii) by (iv)

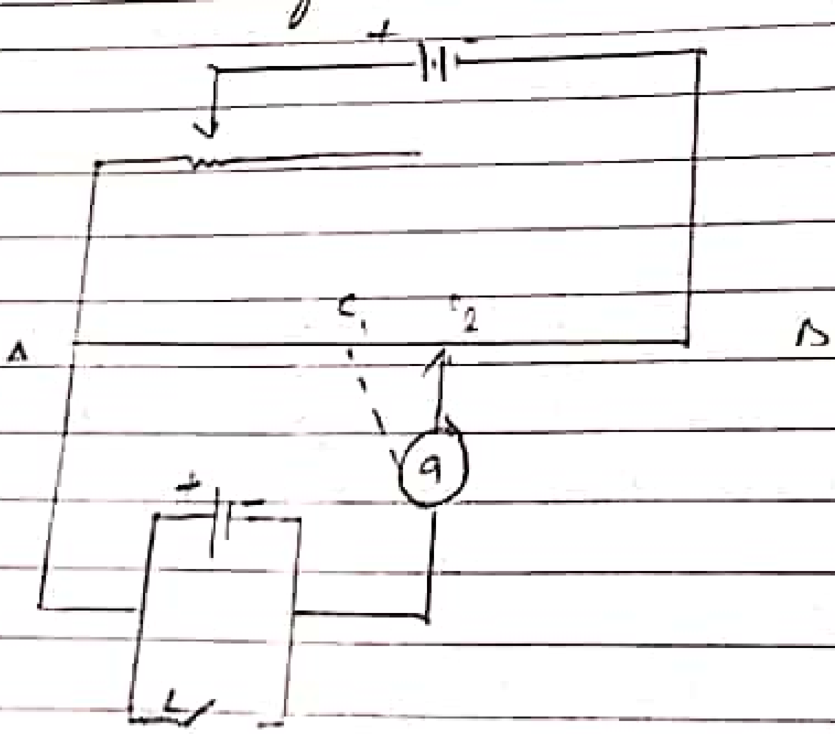
$$\frac{I_1 \cdot P}{I_1 \cdot Q} = \frac{I_2 \cdot X}{I_2 \cdot R}$$

$$\boxed{\therefore \; P/Q = \frac{X}{R}}$$ proved

Q.6 Discuss the principle of potentiometer and it to determine the internal resistance of a cell.

→ **principle of potentiometer:** When a constant current is passed through a wire of uniform area of cross-section of potentiometer ~~& negative terminals~~ its, the potential drop across any positive of a wire is directly proportional to the length of that portion. i.e $V = IR = I\rho^{l}/_{A}$ i.e $V \propto l$ which is principle of potentiometer.

Determination of internal resistance of battery.



To measure ... as shown ... streched ... during ... The cel... is connec... Galvanom...

A ... open for ... blanching ...

open cir... Now, B... l_2 be ...

Q.7 State ... It is ... wire ...

⇒ A mete... string ... of w...

To measure internal resistance of a cell, circuit is connected as shown in fig. It consists of 10m resistance wire streched betn metalic strip on a wooden board A during battery is connected with rheostant betn A & B. The cell whose internals resistance is to be measure is connected along with externals resistance, switch & Galvenometer.

At 1st bleancing length is taken with the key open for zero deflection in Galvanometer. let l_1 be the blanching length then

$$E \propto l_1$$

$$\therefore E = k l_1 \quad \text{---(i)}$$ [emf is measured in open circuit]

Now, Blancing length is again taken with the close key l_2 be the balancing length.

$$V \propto l_2$$

$$\therefore V = k l_2 \quad \text{---(ii)}$$ [p.d in measured in pd in closed circuit]

Dividing (i) by (ii)

$$\frac{E}{V} = \frac{l_1}{l_2} \quad \text{---(iii)}$$

where, $r = \left(E/_V - 1\right) \cdot R$

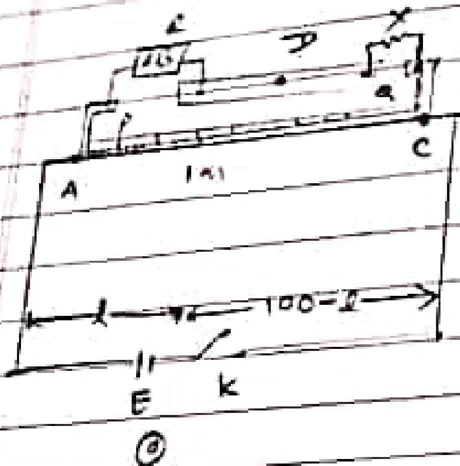
$$\boxed{\therefore r = \left(\frac{l_1}{l_2} - 1\right) \cdot R}$$

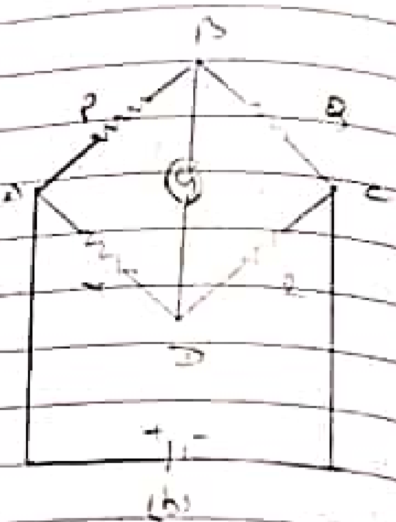
Q.7 State principle of meter bridge. Describe how it is used to determine the resistance of wire.

⇒ A meter Bridge is an electrical device used for measuring unknown resistance. It works on the principle of wheatstone bridge which state for balanced condition of circuit as:

$P/Q = R/X$

Where P, Q, R are known resistance & X is unknown resistance. Meter bridge is used to determine unknown resistance.





Meter bridge consists of a wire AC of 1m long. points A & C are connected to a cell & B and D are connected to Galvanometer 'G'. A resistance box is connected betⁿ A & B and an unknown resistances X is connected betⁿ D & C. A sliding jockey is connected on galvanometer as shown in fig. When the jockey is sliding on the wire at balance condition 'D', the Galvanometer shows zero deflection. At this condition

$$P/Q = R/X$$

$$\frac{\text{Resistance of AB}}{\text{Resistance of BC}} = \frac{P}{Q}$$

i.e resistance $\propto$ length i.e $P \propto l$ & $Q \propto (100-l)$

i.e $P/Q = \frac{l}{100-l} = R/X$

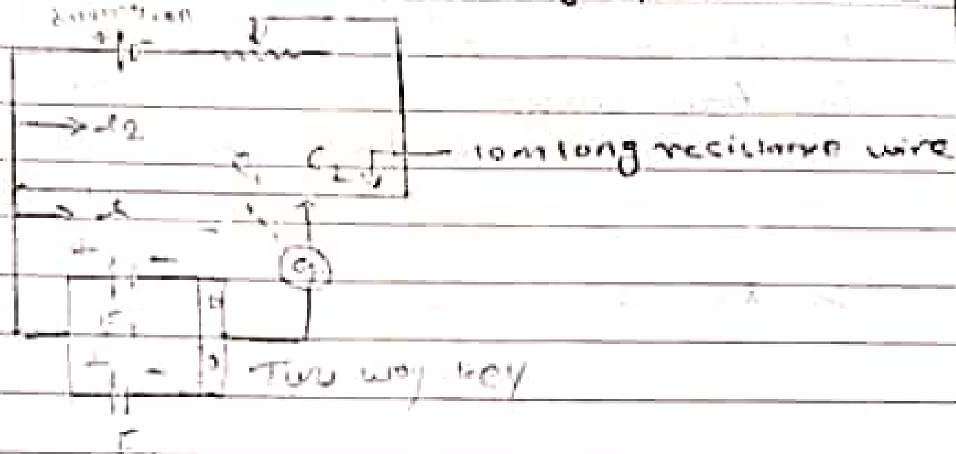
$$\therefore X = \frac{(100-l) \times R}{l}$$

Hence, the value of X is calculated at different values of l & R is calculated.

Q.8 What is a potentiometer? Explain how you compare the emf of two cells using a potentiometer.

→ A potentiometer is a sensitive electronic device used to measure emf of cell, find internal resistance of cell & to compare the emf of two cells.

Comparison the emfs of two cells using a potentiometer.



potentiometer can be used to compare emf of two cell. fig shows the experimental arrangement to compare emf of cell. It consists of 10 m long resistance wire stretched bet^n metallic strip. A driving cells is connected bet^n rheostat bet^n A & B. The two cells whose connected bet^n A & jockey (ε_1 & ε_2) along with Galvanometer & two way key.

At 1st cells ε_1 is connected in the circuit. Blancing length is then taken for zero deflection in galvanometer. Let l_1 be the balancing length.

$$E_1 \propto l_1$$

$$E_1 = k l_1 \quad \text{--- (I)}$$

cells E_2 is connected in the circuit. Blancing length then taken for zero deflection in galvanometer. Let l_2 be the balancing length.

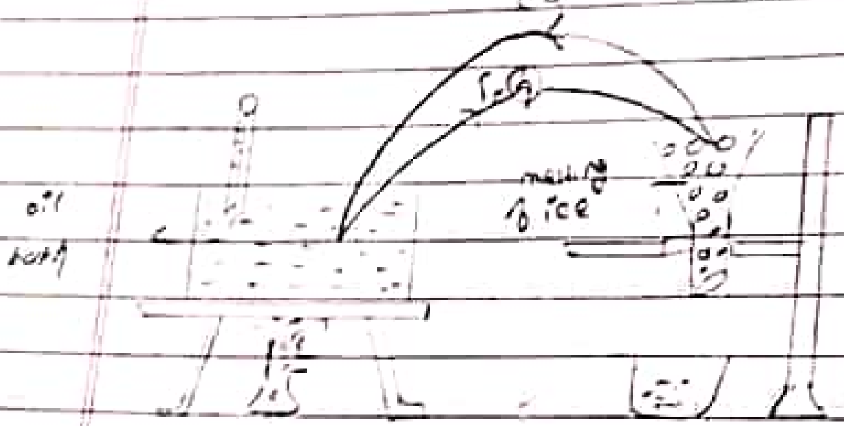
$$E_2 \propto l_2$$

$$\therefore E_2 = k l_2 \quad \text{--- (II)}$$

Dividing, $\boxed{E_1/E_2 = \frac{l_1}{l_2}}$ Hence emf of cells two cell compare.

Q9 What is Seebeck effect : Variation of thermo emf with temperature of hot junction.

→ If 1 junction of thermo couple is heated & another junction is cooled small amount of current is flowing through the thermo couple is known as thermo ~~couple~~ electric current & emf is known as thermo emf. This effect is according to law of conservation of energy i.e Heat energy in the hot junction is converted into electrical energy. cause
(i) Thermolagitation
(ii) Contact p.d.



Thermo electric emf varies with temp of hot junction to study the variation experimentaly. Set up as shown in fig. It consists of copper iron thermocouples connected with galvanometer. One junction of thermocouple is heated by oil bath another junction of thermo couple is cooled by melting ice. Thermo meter is also filled with temp.

When the temp of hot junction is increas thermo electrical emf each also found to be increas & becomes maximum. This temp of hot junction is known as neutral temp ~~of hot J~~. When the temp of hot junction is again increase the value of thermo emf is decrease & becomes zero.

This temp^r of hot junction is known as temperature of inversion. After this temp^r direction of thermo emf is negative. If we plot a graph bet^n thermo emf & temp^r of hot junction. The nature of graph is as shown in fig.

Here,

$$\theta_n = \frac{\theta_i + \theta_c}{2}$$

The emf given by,

$$E = \alpha\theta + \frac{1}{2}\beta\theta^2$$

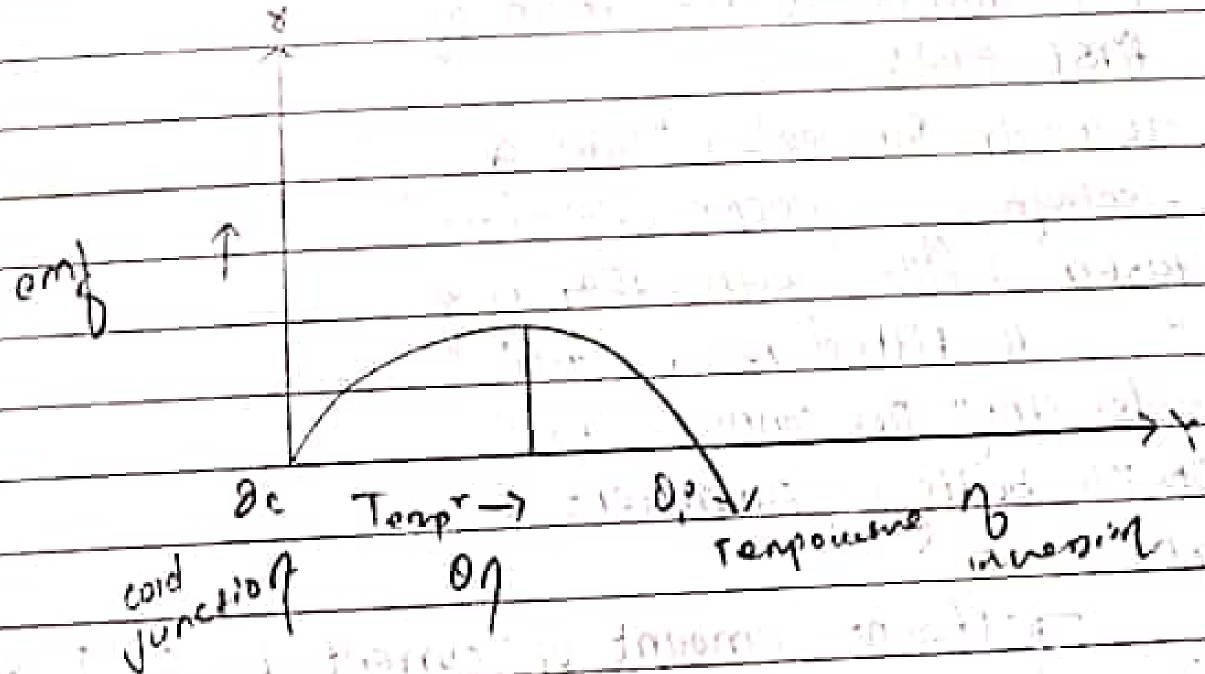
were α & β are Constant & θ is the temp^r of hot junction.

Case I When, $\theta = \theta_n$

$$\frac{dE}{d\theta} = 0$$

Case II When $\theta = \theta_i$

$$E = 0$$



1. State and explain Faraday's laws of electrolysis. Hence define Faraday's Constant.

They are two laws of electrolysis, they are state as:

(a) **Faraday's 1st law**: It state that " mass of the ion's deposited is electrolysis is found to be directly proportional to the amount of charge."

i.e $m \propto q$

$m = Zq$ where Z is electrochemical equivalent.

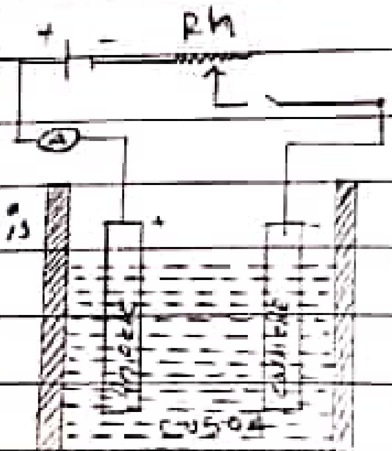
$\therefore m = ZIt \quad [q = It]$

(b) **Faraday's Second law**: It state that " mass of the ion's deposited in the electrogen is found to be directly proportional to chemical equivalent of substance

i.e $m \propto E$

$\frac{m}{E} = \text{constant} \left[E = \frac{\text{Atomic wt}}{\text{valence}}\right]$

Experimental verification of first law:



To verify Faraday's 1st law of electrolysis in copper voltameter is taken it filled with $CuSO_4$ sol^n of $2/3$. It fitted two metallic rods. They are connected with switch, battery, Ammeter's & rheostat.

Differant amount of current I_1, I_2, I_3 are passed in voltameter's for constant time & crossponding amount of mass of the ions deposited in the electron are measured by experimentaly it is found that,

$$\frac{m_1}{q_1} = \frac{m_2}{q_2} = \frac{m_3}{q_3} = \text{Constant} = \text{constant}$$

Which is verified 1st law of electrolysis.

Second law of verification.

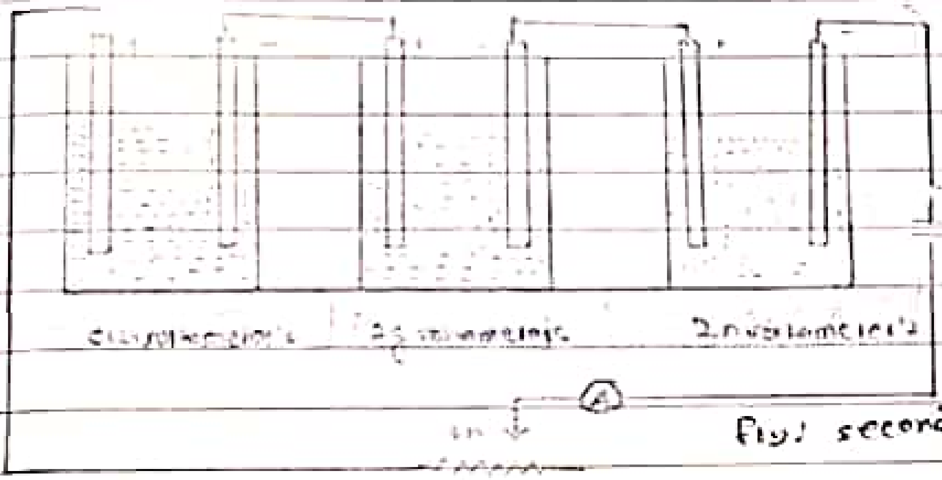


Fig: second law verification

To verified second law there voltameter are taken & connected in series with switch, battery, Ammeter & rheostat. They are filled with corresponding salt solⁿ. Current is passed in the voltameter's for constant time & masses of the ion's deposited in the electrode are measured. Let m_1, m_2, m_3 in the masses of the of deposited & E_1, E_2, E_3 be the chemical equivalance. Experimentaly it is found that,

$$\frac{M_1}{E_1} = \frac{M_2}{E_2} = \frac{m_3}{E_3} = \text{Constant}$$

Whose verified second law.

Faraday's Constant: Chemical equivalence is directly proportional to electro chemical equivalence of substance i.e

$$E \propto Z$$

$E = FZ$ F is farday's constant

$F = E/Z$ But $Z = \frac{m}{q}$

$$\therefore F = \frac{Eq}{\ }$$

If F = m

∴ F = ?
Hence Faraday's constant is define as amount of charge required to deposited mass of the ion's which is equal to chemical equivalent if value of SI system is 96500 coulomb/mol.

Group B

Effect of current.

Magnetic Field of Currents

1. Obtained magnetic feild strength at a point on the axis of circular coil current loop by using Biot and Savart law.

→ **Biot Law:** This law gives the magnitude of the magnetic feild $\vec{B}$ due to current flowing through the conductor's. Mathematically, Biot and Savart law states that,

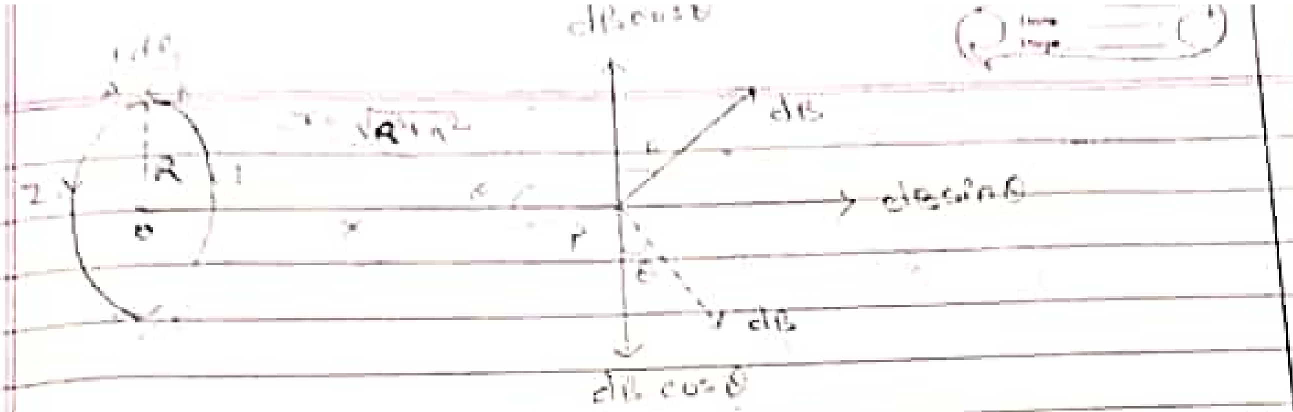
$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\,dl\,\sin\theta}{r^2}$$

The total flux density at any point P is given by.

$$B = \int dB = \int \frac{\mu_0}{4\pi} \cdot \frac{I\,dl\,\sin\theta}{r^2}$$

This is the mathmetical form of Biot and Savart's law.

Strength at a point on the axis



Let a circular coil of radius 'R' is carrying I amount of current. To find the magnetic feild on the axis. Let AB = dl be small current element whose centre is C join CP, CO and OP. CO = R, CP = r = $\sqrt{R^2+x^2}$ OP = x. In this case dBcosθ vertical componemet of magnetic feild and dBsinθ is horizontal component of magnetic feild. If we take another element of magnetic feild below the centre dBcosθ will be cancelled out being equal and opposite hence the resultant magnetic feild we be intergration of dBsinθ

i.e

$$B = \int_0^{2\pi R} dB\sin\theta \quad \text{———} \quad (I)$$

According to Biot and Savart Law magnetic feild due to small current element is given by.

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I dl \sin\theta}{r^2}$$

$$dB = \frac{\mu_0}{4\pi} \frac{I dl}{r^2} \quad [\sin 90 = 1] \quad \text{———} \quad (II)$$

Then,

$$B = \int_0^{2\pi R} \frac{\mu_0}{4\pi} \frac{I dl}{r^2} \sin\theta$$

$$B = \frac{\mu_0}{4\pi} \frac{I}{r^2} \int_0^{2\pi r} dl \cdot \frac{R}{r} \quad \left[\sin\theta = \frac{CO}{CP}\right]$$

$$B = \frac{\mu_0 I R}{4\pi r^3} \left[l \right]_0^{2\pi r}$$

$$B = \frac{\mu_0}{4\pi} \cdot \frac{IR}{r^3} \cdot 2\pi R$$

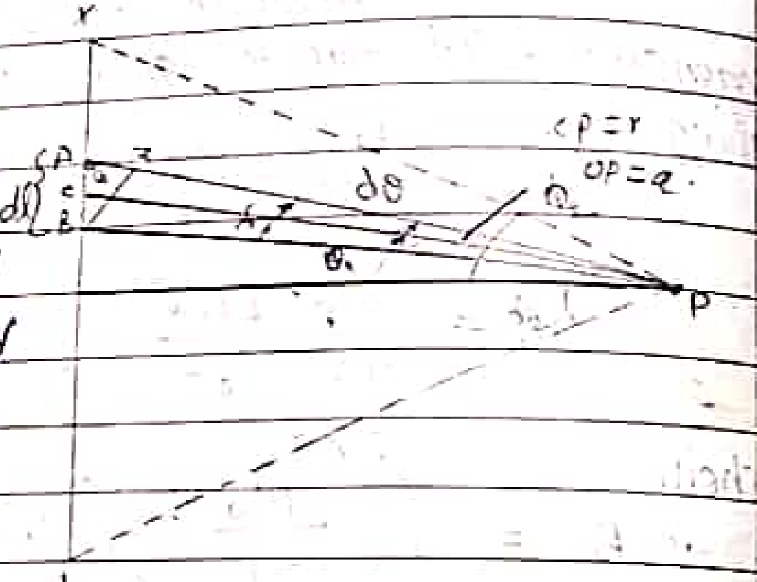
$$B = \frac{\cancel{2}\mu_0 IR^2}{2 \cancel{4} r^3}$$

In CPO, $r = \sqrt{R^2+x^2}$

$$\boxed{\therefore B = \frac{\mu_0 IR^2}{2(R^2+x^2)^{3/2}}}$$

This gives the required formula of magnetic feild on the axis of current carring conductor's. This gives the required formula of magnetic feild round...

2 Derive an expression for the magnetic feild at a point due to a long straight conductor carrying current.



Let xy is a straight conductor's carrying I amount of current. To find the magnetic feild due to straight conductor's. Let AB = dl be the small current element of the conductor's whose centre is C. Joining XP, YP, AP, CP, BP and OP also draw a perpendicular BN.

According to Biot and Savart's law

magnetic feild due to small current element is given by,

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I dl \sin\theta}{r^2} \quad \text{---} \quad (1)$$

In ΔBAN,

$$\sin\theta = \frac{BN}{AB}$$

$$\sin\theta = \frac{BN}{dl} \qquad \left[\begin{aligned} d\phi &= \frac{BN}{r} \\ BN &= r\,d\phi \end{aligned} \right]$$

$$BN = dl\sin\theta$$

$$r\,d\phi = dl\sin\theta$$

From (1)

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I r\,d\phi}{r^2}$$

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\,d\phi}{r}$$

In ΔCPO

$$\cos\phi = \frac{OP}{CP} = \frac{a}{r}$$

$$r = \frac{a}{\cos\phi}$$

$$dB = \frac{\mu_0 I}{4\pi} \cdot \frac{d\phi}{a\cos\phi} = \frac{\mu_0 I}{4\pi a} \cdot \cos\phi\, d\phi$$

Total magnetic feild,

$$\int dB = \int_{-\phi_1}^{\phi_2} \frac{\mu_0 I}{4\pi a} \cos\phi\, d\phi$$

$$B = \frac{\mu_0 I}{4\pi a} \Big[\sin\phi \Big]_{-\phi_1}^{\phi_2}$$

$$B = \frac{\mu_0 I}{4\pi a} \cdot \Big[\sin\phi_2 + \sin\phi_1 \Big]$$

For very long Conducator's

$\phi_1 = \pi/2$, $\phi_2 = \pi/2$

$$\therefore B = \frac{\mu_0 I}{4\pi a}\left[\sin\frac{\pi}{2} + \sin\frac{\pi}{2}\right]$$

$$= \frac{\mu_0 I}{4\pi a}\left[1+1\right]$$

$$= \frac{\mu_0 \cdot I}{\cancel{4}_2 \pi a} \times \cancel{2}$$

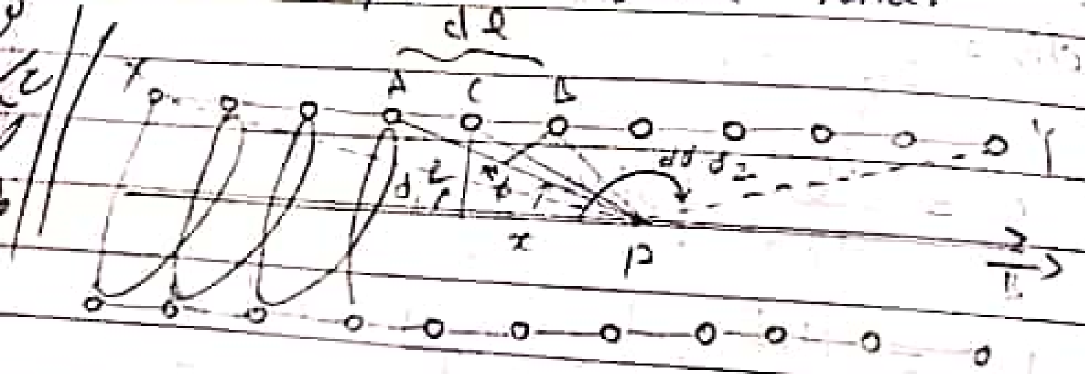
$$= \frac{\mu_0 \cdot I}{2\pi a}$$

$$\boxed{\therefore B = \frac{\mu_0 \cdot I}{2\pi a}}$$

This is required magnetic feild intensity.

3 State and explain Biot Savart's law to find the magnetic field due to a current carrying Solenoid at it's Centre.

⇒ Solenoid: Solenoid consists of large no. of circular coil made by insultaing metallic wire. It is used to produce magnetic feild.



Let a long solenoid XY of radius R' no. of turns per unit length n' carrying 'I' amount of current. To find the magnetic feild at point P'. let dB=dl be small portion of solenoid whose centre is O'. Join XP, AP, CP, BY, YP and CO also draw at BN on AP. Now, Magnetic feild due to the coil element is given by.

$$dB = \frac{\mu_0 \cdot I \cdot R^2}{2r^3} \text{ No. of turns in } dl$$

$$dB = \frac{\mu_0 \cdot I R^2}{2r^3} \cdot n \cdot dl \quad \text{———————— (i)}$$

In $\triangle ABN$

$$\sin\phi = \frac{BN}{AB} = \frac{BN}{dl}$$

$$\because BN = dl\sin\phi$$

$$d\phi = \frac{BN}{r}$$

$$BN = r\,d\phi$$

$$r\,d\phi = dl\sin\theta$$

$$dl = \frac{r\,d\phi}{\sin\theta}$$

$$\text{from (1)}, \quad dB = \frac{\mu_0 I R^2}{2r^3} \cdot n \cdot \frac{r\,d\phi}{\sin\theta}$$

$$= \frac{\mu_0 I R^2 n\,d\phi}{2r^2 \sin\phi}$$

In $\triangle CPO$ $\quad \sin\phi = \frac{CO}{CP} = R/r$

$$\text{or,} \quad dB = \frac{\mu_0 I R^2 n\,d\phi}{2r^2 \cdot \sin\phi} = \frac{\mu_0 \cdot I \sin^2 n\,d\phi}{2\sin\phi}$$

$$= \frac{\mu_0 I \sin\phi \, n\,d\phi}{2}$$

Total magnetic feild

$$\int dB = \frac{\mu_0 I n}{2} \int_{\phi_1}^{\phi_2} \sin\phi\,d\phi$$

$$= \frac{\mu_0 I n}{2} \left[-\cos\phi\right]_{\phi_1}^{\phi_2}$$

$$B = -\frac{\mu_0 I n}{2}\left[\cos\phi_2 + \cos\phi_1\right]$$

For very long solenoid, $\phi_1 = 0$, $\phi_2 = 180$

$$\therefore = -\frac{\mu_0 I n}{2}\left[\cos 180^\circ - \cos 0^\circ\right]$$

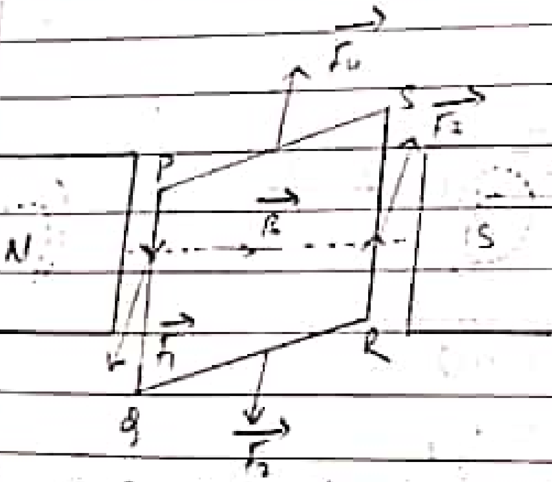
$$= -\frac{\mu_0 I n}{2}[-1-1]$$

$$= \mu_0 I n$$

$$\boxed{\therefore B = \mu_0 I n}$$

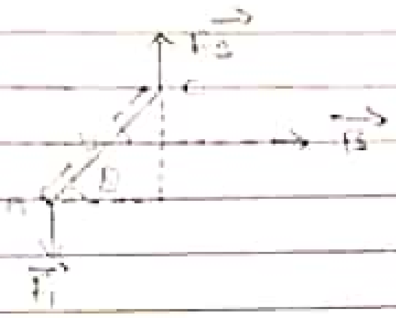
This gives the required expression of magnetic feild due to Solenoid.

Q4 Find an expression for torque on rectangular coil in a uniform magnetic field.



Let P, Q, R, S be a rectangular coil carring I amount current l be the length, b be the breadth. N be it's no. of turn in the coil It is placed inside the magnetic feild of Strength B. when current is passed each sides of coil experienced froce as a result a Torque is produced Froces on side QR & SP are equal and opposite PQ and RS

Combined together to produced Torque.



we know that,

Torque is given by,

$$T = \text{Force} \times \perp \text{ distance}$$
$$= BIl \sin 90^\circ \times AB$$
$$T = BIl \times AB \text{ ---------- (1)}$$

In ABC,

$$\cos\theta = \frac{AB}{AC} = b\cos\theta = AB$$

$$T = BIl \cdot b\cos\theta$$
$$T = BIA\cos\theta$$

If N is the No. of turns.

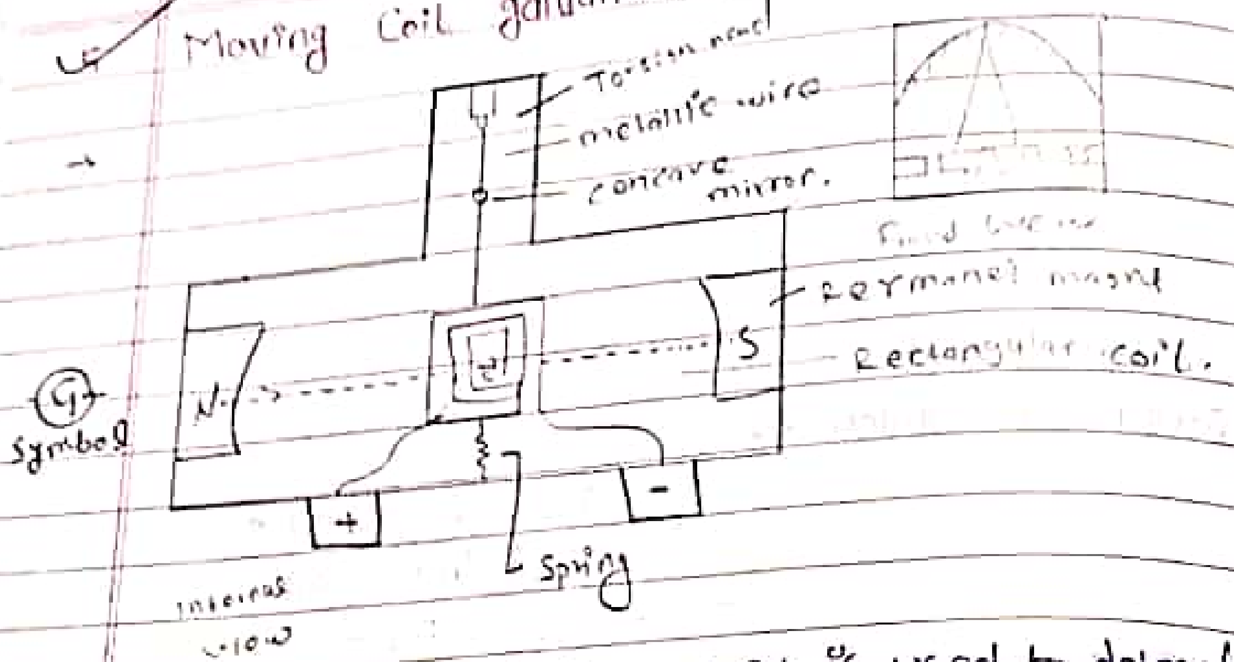
$$\boxed{T = BINA\cos\theta}$$

where θ is the angle betn plane of the coil and magnetic feild. If angle is taken perpendicular to the plane and magnetic feild Torque is

$$\boxed{T = BINA\sin\theta}$$

This gives the required expression of torque acting in the rectangular Coil.

Moving Coil gallanometer Describe [2010]



It is an electrical device which is used to detecd small amount of current works on the principle of Torque acting in the rectangular coil.
It consists of rectangular coil place betn coil of suspended from a metallic wire through the Torsion head the coil is connected with spring. The two terminals of coil are taken out to passed current. The poles of magnet of cut in concave shape to produces radial feild.

When current is passed in the coil deflecting Torque is produced.

$$\tau = BINA \cos\theta \quad \text{------ (1)}$$

where B is strength of magnetic feild, I is current, N No. of turn and A be area of coil, θ be the angle betn plane of coil and magnetic feild. when the coil is rotated toresion and screen produces restoring Torque.

Restoring Torque $= k\theta$ —— (1)

Deflecting and restoring Torque is equal in magnitude i.e

$$BINA\cos\theta = K\theta$$

For radial field, $\cos\theta = 1$

i.e

$$BINA = K\theta$$

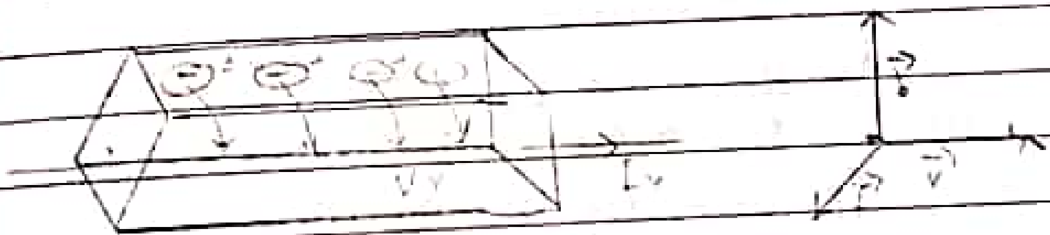
$$I = \frac{K\theta}{BNA}$$

$[\because I \propto \theta]$ ∴ $\left(\frac{K}{BNA}\right)$ is constant.

Hence current flowing in directly proportional to deflection produces.

What is Hall effect? Explain and deduce expressions for Hall Voltage and Hall electric field.

→ **Hall effect**: It offering carring conductor's each place inside the magnetic feild a Voltage is developed betn layer's of Conductor's is Hall voltage and the effect is Hall effect.



Let a conductor's of thinckness(t), broadth (b) area of cross-section A, carrying I amount of current each placed inside the magnetic feild acting perpendicular the Conductor's. In such case electron experience force is given by.

$$F_m = Bev \quad \text{——— (1)}$$

Due to this force electron in shifted in down ward direction. Hence there is formation of positive ions is upper layer negative ions in lower layer. A voltage developed in two layer's and electric feild set up.

Now, Force due to electric feild

$$F_e = eE \text{ ---------- (i)}$$

Electric force and magnetic force are to be equal.

$$Bev = eE$$

$$Bv = \frac{V}{t}$$

$$V = Bvt$$

But $I = venA$

$$\therefore \frac{I}{enA} = Bvt$$

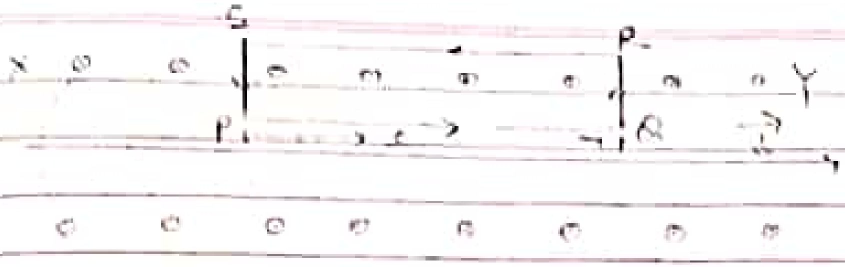
$$\boxed{\therefore V = \frac{BIt}{enA}}$$

Hence the required Hall effect.

State and explain Ampere's theorem and hence use it to find the magnetic feild intensity due to a long current carrying Solenoid.

It state that " the line intergral of total ma. field around the close path closing a current is equal to the line the total current enclose i.e

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I$$



Ampere's therom can be used to find the magnetic field due to a long Solenoid. Let xy be the long Solenoid Carrying I amount of current. To Find the magnetic field. Let's draw a closed path P, Q, R, S of length 'l'. Let n be the no. of turns perunite length of the Solenoid. According to Ampere's theorem.

or, $\oint \vec{B} \cdot \vec{dl} = \mu_0 \times$ current enclosed

or, $\int_P^Q \vec{B} \cdot \vec{dl} + \int_Q^R \vec{B} \cdot \vec{dl} + \int_R^S \vec{B} \cdot \vec{dl} + \int_S^P \vec{B} \cdot \vec{dl} = \mu_0 \cdot I \times$ no. of turns

or, $\int_P^Q B\, dl \cos 0 + \int_Q^R B\, dl \cos 90 + \int_R^S B\, dl \cos 0 + \int_S^P B\, dl \cos 90 = \mu_0 \cdot I \cdot n \cdot l$ $[\cos 90^\circ = 0]$

or, $\int_P^Q B \cdot dl + \int_R^S B \cdot dl = \mu_0 \cdot I \cdot n \cdot l$

But $\int_R^S B \cdot dl = 0$ since It is out side the Solenoid.

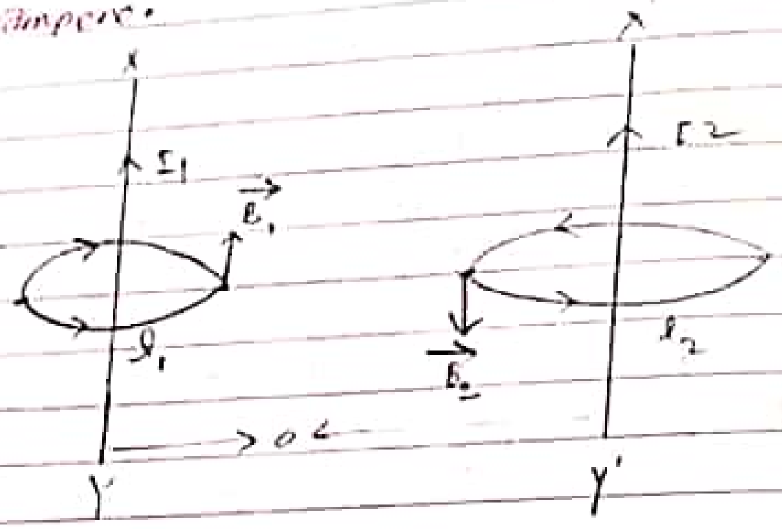
Now, $\int_P^Q B \cdot dl = \mu_0 \cdot I \cdot n \cdot l$ 12-22

$B \cancel{l} = \mu_0 \cdot I \cdot n \cdot \cancel{l} \rightarrow$

$\boxed{\therefore \quad B = \mu_0 \cdot I \cdot n}$

which is gives the required expression for long Solenoid to be determine magnetic feild.

1. Derive an expression for the force per unite length between two infinitely long parallel straight wires carrying current in the same direction. Hence define one ampere.



Force betn current carrying conductor's, Let two conductor's XY and X'Y' carrying current I_1 and I_2 of length l_1 and l_2 are at a distance 'a'.

Now, magnetic field due to 1st conductor's.

$$B_1 = \frac{\mu_0 I_1}{2\pi a} \text{ ——— } (I)$$

Similarly magnetic field due to Second conductor's

$$B_2 = \frac{\mu_0 I_2}{2\pi a} \text{ ——— } (II)$$

As, current I_1 and I_2 are acting in same direction magnetic feild due to them in the nearer distance are oppositely directed so say ~~cancelled~~ togeter's Force experience by the 1st conductor's inside the magnetic feild of Second conductor's.

$F_1 = B_2 I_1 l_1 \sin 90$

$F_1 = \frac{\mu_0 \cdot I_2}{2\pi a} I_1 l_1$ ——— (iii)

Force experience by the Second conductor's inside the magnetic field of 1st conductor's.

$F_2 = B_1 I_2 l_2 \sin 90^\circ$

$F_2 = \frac{\mu_0 \cdot I_1}{2\pi a} \cdot I_2 l_1$ ——— (v)

Force per unit length will be,

$\frac{F_1}{l_1} = \frac{\mu_0 \cdot I_1 I_2}{2\pi r}$ ——— (v)

$\frac{F_2}{l_2} = \frac{\mu_0 \cdot I_1 I_2}{2\pi a}$ ——— (vi)

This gives the required experience for the force experience by the current carrying conductor's.

The Force betn per unit length betn two current carrying conductor's is written as,

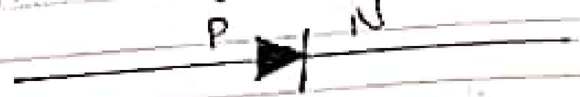
$$F = \frac{\mu_0 \cdot I_1 I_2}{2\pi r}$$

when $I_1 = I_2 = 1A$, $r = 1m$ then

$$F = \frac{4\pi \times 10^{-7} \times 1 \times 1}{2 \times r} = 2 \times 10^{-7} N$$

Hence one Ampere current is define as the current which when passed through two parallel conductor's separated by 1m experience a force $2 \times 10^{-7} N$ per unite length on each other.

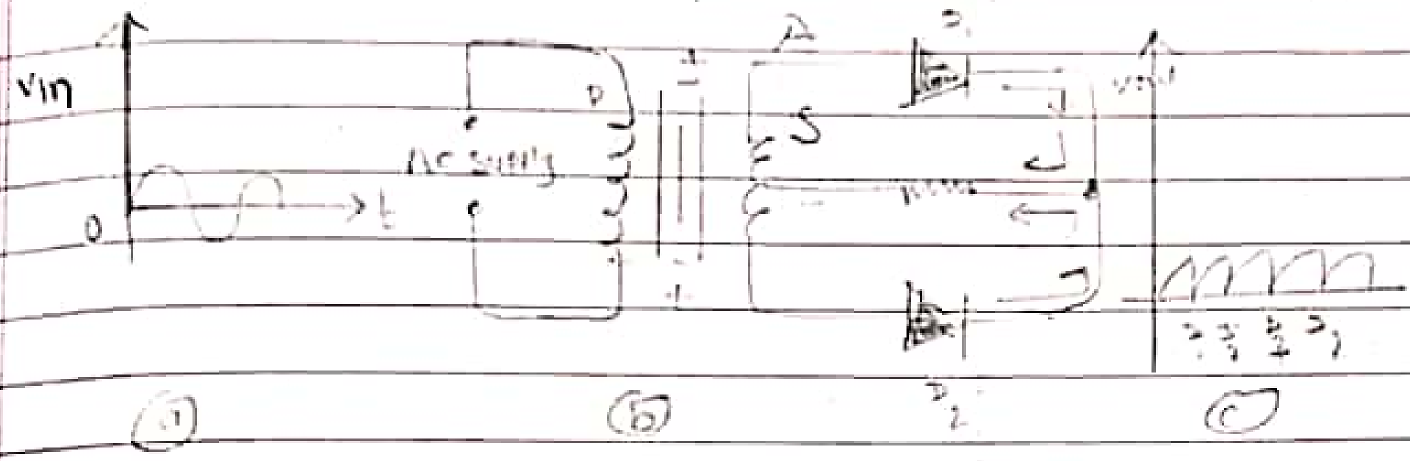
P-N Junction diode : It is Semiconductor's device in which P-type Semiconductors is in contact with a N-type Semiconductors. It has two terminals namely anode and cathode. The anode refer's P type region and cathode refer's to the N type region.



Semiconductor's Diode as Full wave rectifier:

When current passed through the diode, it gains the unidirectional property i.e the current motion moves in one direction. The characteristic's of the diode is used in rectification. The device which is used for rectification is called rectifier. There are two types of rectifier. They are one is the full wave rectifier and another is half wave rectifier. The half wave rectifier has only one half cycles of ac into dc while full wave rectifier converted's the both half cycles (positive and negative half cycles) of ac into dc.

The circuit diagram of the full wave rectifier is shown in fig. It consists of a transformer with central traped secondary coil. The two diodes D_1 and D_2 are connected at upper & lower ends of Secondary Coil of transformer's respectively. The centre tap of the transformer's and common point of the n-region of diode are connected to the load resistance from which output taken.



During the positive half cycles of Secondary voltage, the upper diode D_1 is forward biased and the lower diode D_2 is reversed biased. Thus, the current flows through the diode D_1 & load resistors. During the negative half cycle of Secondary ~~coil~~ voltage. The upper diode D_1 is reverse biased and the lower diode D_2 is forward biased. Thus the current flows through the Diode D_2 & the load resistors R_L.

Fig shows the output voltage obtained at load resistor R_L. The current flows through R_L for both half cycles of input voltage. The voltage through resistors R_L is in the same direction both case.

PN Junction is ~~Semiconductors~~ ~~chain. The resis having the~~

Electromagnetic Induction

1. State the laws of electromagnetic induction. Derive an expression for the emf induced in a conductor moving in a magnetic feild.

- **First law:** "Whenever magnetic flux linked with a circuit changes, induced emf is produced. The induced emf lasts as long as the change in the magnetic flux continues." So first law gives the state in which the induced emf is obtained.

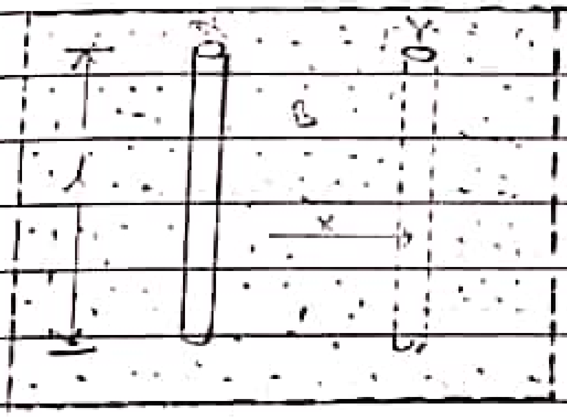
Second Law: The magnitude of induced emf in a coil is directly proportional to the rate of change of magnetic flux."

Let ϕ_1 and ϕ_2 be the magnetic flux linked with a coil initially and after time 't' then the rate of change of magnetic flux is

$$\varepsilon = \frac{\phi_1 - \phi_2}{t} = -\frac{d\phi}{dt}$$

Thus faraday's second law of electromatic induction gives the measurement of induced emf.

Straight conductor's



Let us consider a uniform conducting rod of length l is place inside the magnetic feild of flux density B in the direction perpendicular to the direction of magnetic feild. Suppose, this conductor's is moved from x to Y convering a distance 'x'. Then total flux linkage in the conductor change by

$$\phi = B \cdot A = B \cdot L \cdot x$$

from Faraday's law of electromagnetic induction,

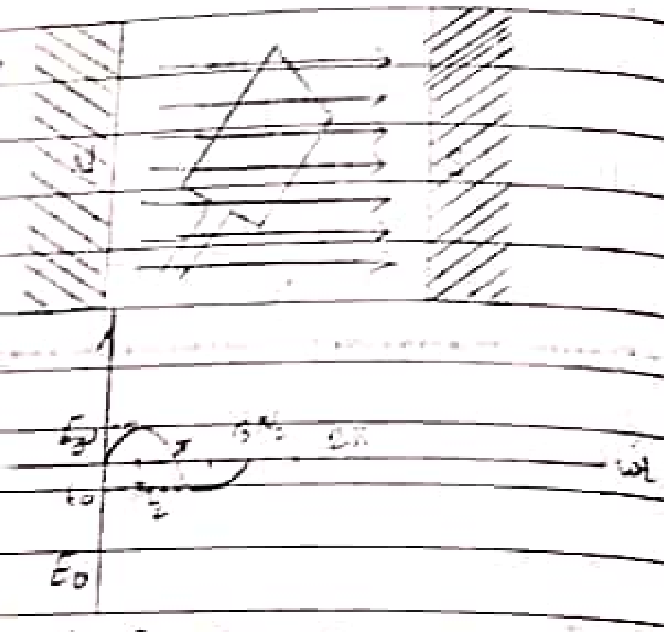
Now

$$E = \frac{d\phi}{dt} = \frac{d(B.L.x)}{dt} = B.L.\frac{dx}{dt} = B.L.v$$

$$\therefore E = B.L.v$$

This is required expression for emf induced in a conductor moving in a magnetic field.

- Deduce an expression for induced emf in a coil rotating in a magnetic field.



We consider a rectangular coil of area A and N number of turns is rotating in a magnetic field provided by two pole pieces N and S of a strong magnet such that the to normal to the component of field 'B' at right angle to the plane of the coil is $B\cos\theta$. The total flux through the coil is

$$\phi = NAB\cos\theta \text{ ---------- (i)}$$

If the coil turns about an axis perpendicular to the field direction with a constant angular velocity $\left(\omega = \frac{\theta}{t}\right)$ then emf induced the coil is,

$$E = \frac{-d\phi}{dt} = \frac{-d(NAB\cos\theta)}{dt}$$

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

$= NAB \sin \omega t \frac{d(\omega t)}{dt}$

$= NAB\omega \sin \omega t$ ------- (ii)

Therefore, $E = E_0 \sin \omega t$,

where, $E_0 = \omega NAB$ is the peak value of E.

This sinusoidal varying emf is called induced emf in the coil rotating in the magnetic field.

The instanoous induced current in the circuit is given by,

$$I = \frac{E}{R} = \frac{E_0 \sin \omega t}{R}$$ R is resistance of the coil

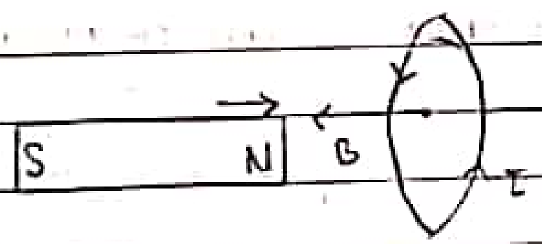
$\therefore I = I_0 \sin \omega t$ -------- (iii)

where, $E_0/R = I_0$ is maximum value of the induced current.

Equation (ii) and (iii) are the required sol^n for eq^n.

5. State Lenz's law and explain how this law leads to the conservation of energy principle.

→ **Lenz's law:** It states that, " the direction of induced current in a coil in such that it always oppose the cause which produces it". This law is used to find the direction of flow of current due to induced emf.



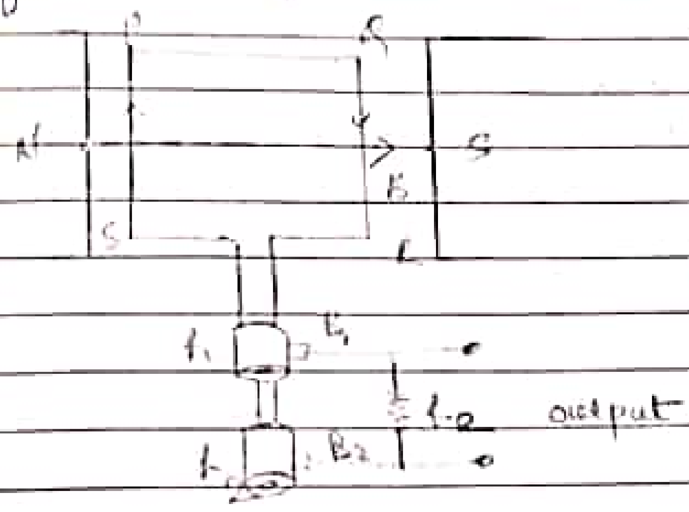
Explanation: Consider a coil toward's which a magnet with it's north pole is moved. This induced emf is in the coil will send current in, such a direction in the coil that it will produced magnetic field from right to left so as to oppose the magnet. In case the magnet is moved back, the magnetic field will be produced due to induced emf current from left to right & the current will be flow in the opposite direction. In this way, the induced emf produced in the coil opposed the cause which produced it.

Lenz's law and Conservation of Energy: Lenz's law is an example of the principle of conservation of Energy. The electrical energy in the form of induced emf is produced at the cost of mechanical work. As the magnet is moved toward's the coil, the induced emf causes current to flow in such a direction that the resulting magnetic field oppose the moment of magnet. The amount of work done is moving the magnet against the force results in the form of induced emf in the coil. Hence the induced emf is set up in the coil at the expense of mechanical energy spent by the external agent. That's why, the Lenz's law is in accordance with the law of conservation of energy.

Describe the theory and working of an ac generator.

A.C generator:- An electrical machine used to convert mechanical energy into electrical energy is known as A.C generator.

Principle: It works on the principle of electromagnetic induction i.e, when a coil is rotated in a uniform magnetic field, an emf is induced in it.



Construction: The a.c generator's consists of following components as shown as in fig. below.

(i) Armature: Armature coil (P,Q,R,S) consists of a large no of turns of insulated copper wire wound over soft iron core of area A and N turns.

(ii) Strong field magnet: The armature is rotated in a strong uniform magnetic field provided by powerful permanent magnet NS. The axis of rotation is perpendicular to the field.

(iii) Slip rings: The two ends of the armature coil are connected to two brass slip rings slip rings R_1 & R_2. This ring rotated along the armature coil.

(iv) Brushes: The two carbon burches (B_1 & B_2) are pressed against the slipringe. The burshes remain fixed while slip rings rotate along with the armature. This brushes are connected with the load through wire output is obtained.

Working: When the armature coil $P_1Q_1R_1S$ rotates in the magnetic field provided by the strong field magnet, it cuts the magnetic lines of force. The magnetic flux linked with the coil changes due to the rotation of the armature & hence emf induced in the coil. The direction of induced emf or the current in the coil is determined by Fleming's right hand rules.

The current flows out through the brush B_1 in one direction of half of the revolution & through the brush B_2 in the next half revolution in the reversed direction. This process is the repeated. Therefore, emf produced is of alternating nature.

THEORY: Concider the plane of the coil to be perpendicular to the magnetic field $\vec{B}$. Let the coil be rotated anticlockwise with a constant angular velocity ω. Then angle betn the normals to the coil & $\vec{B}$ at any time (t) is given by, $\theta = \omega t$.

The component of magnetic field normals to the plane of the coil $= B\cos\theta = B\cos\omega t$.

magnetic flux linked with a single coil $= B\cos\omega t\, A$.

where A is area of the coil. So magnetic flux linked with N coil $\phi = NBA\cos\omega t$.

From Faraday's law of electromagnetic induction, the induced emf in the coil is given by,

$$\varepsilon = -\frac{d\phi}{dt} = -\frac{d(NBA\cos\omega t)}{dt} = NBA\sin\omega t\,\omega$$

$$\therefore \varepsilon = NBA\omega\sin\omega t \quad \text{--------- (i)}$$

The magnitude of induced emf. will be maximum i.e ε_0, when $\sin\omega t = 1$. So

$$\varepsilon_0 = NBA\omega$$

The eq^n (i) becomes

$$\varepsilon = \varepsilon_0 \sin\omega t \quad \text{———— (ii)}$$

Instantaneous current in the circuit is given by,

$$I = \frac{\varepsilon}{R} = \frac{\varepsilon_0 \sin\omega t}{R}$$

$$\therefore I = I_0 \sin\omega t$$

Where $\varepsilon_0/R = I_0$ is maximum value of current.

---

5. Describe the phenomena of self and mutual induction. Describe the construction and explain the action of a transformer.

→ When the switch is on, the current in the coil increasing due to which flux linkage around the coil. The direction is such that it oppose the growth of current in the coil. When the key is off, current in the coil starts decreasing due to which magnetic flux around coil changes & induced emf is set up that oppose the decay of current. Such property of coil is called self induction.

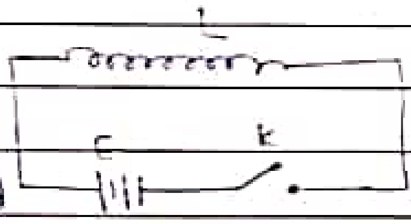
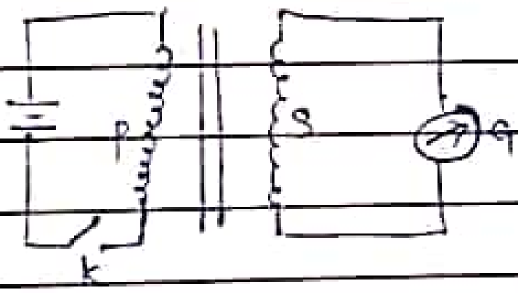


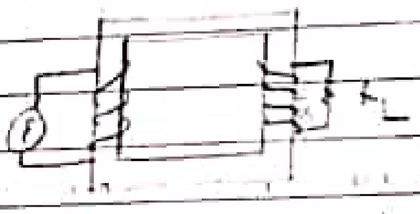
diagram of self inductances

Mutual inductances is the phenomenon of inducting emf in a given coil due to rate of change of current.



mutual induction betn coil.

In the fig, primary coil p is connected with battery and Secondary coil s is connected to a galvanometer. When the key is pressed, current increases & magnetic field around primary coil increases. As a result, magnetic flux linked with secondary coil increases changes. Due to this, emf is induced in secondary coil changes. Due to this emf is induced in Secondary coil & current flows through coil. This phenomenon of inducing emf is called mutual induction.



Transformer is a device used to convert low alternating voltage at high current into high alternating voltage at low current & vice versa. There are two types of transformer (i) step up tranfer (ii) step down transformer.

Let N_p and N_s be the numbers of turns in primary coil & secondary coil respectively. From Faraday's law of electromagnetic induction.

$$E_p = -N_p \frac{d\phi}{dt} \text{ ----- (i)}$$

This induced emf is secondary is given by

$$E_s = -N_s \frac{d\phi}{dt} \text{ ---- (ii)}$$

Dividing (ii) by (i)

$$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

Where $\frac{N_s}{N_p} = \sqrt{\frac{L_s}{L_p}} = K$ is transformation ratio.

general re

$S = k \log \Omega.$

Fundamental postulates of statistical theory

...e of each cell is Same

...r of molecules is Constant.

...rostates corresponding to

...ates are equally

... gas corres.

Where L_s is the self induction for secondary coil and L_p is the self induction for primary coil.

For stepdown transformer, $k < 1$ so $N_s < N_p$ and $E_s < E_p$

For step up transformer $k > 1$ $N_s > N_p$ $E_s > E_p$.

For ideal no loss of energy,

output power = input power

$$E_s I_s = E_p I_p$$

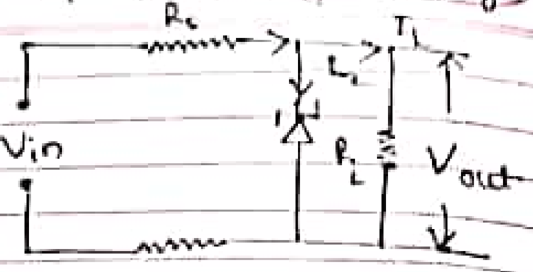
$$\frac{E_s}{E_p} = \frac{I_p}{I_s}$$

What is meant by self inductance? Derive an expression for energy stored in an inductor.

v.v.I

Zener diode: A zener diode is a properly ~~doped~~ heavily doped crystal diode having sharp breakdown voltage.

fig: Symbol of zener diode.



Zener diode as voltage regulator's.

Use of zener diode as voltage regulator's:

Voltage regulation is the ability of circuit to maintain constant ~~that~~ output voltage irrespect of the variation of input voltage and load resistance. The circuit used to regulate voltage is called voltage regulator's.

A resistor's R_s connected in series with the diode limits the current through the circuit and is called series current limitting resistor's. For the proper operation, the input voltage must be greater than the zener voltage ($V_{in} > V_z$) with insure that the zener diode shunt oprate in reverse breakdown region.

series current limiting resistor's.

The current through the resistor R_s is,

$$I = \frac{V_{in} - V_z}{R_s}$$

Also $V_z = V_L$ or V_0

and $I = I_L + I_z$

where I_L is load current and I_z is the zener current. When the input voltage is less than the zener breakdown voltage. Hence the output voltage, $V_L = I_L R_L$ is remains constant.

Nuclear fission	Nuclear fusion
(i) It is the single stage rxn	It is the multistage rxn
(ii) Fission induced by neutrons	Fusion is induced by protons
(iii) The source of fission are limited	Source of fusion are unlimited
(iv) It can be used to make nuclear bomb	It can be used to make hydrogen bomb.

The current through the resistor R_s is

$$I = \frac{V_{in} - V_z}{R_s}$$

also $V_z = V_L$ or V_0

and $I = I_z + I_L$

series current limiting resistor's.

$V_L = I_L R_L$ remain constant

Voltage regulation is the ability of circuit to maintain constant output voltage irrespect of the variation of input voltage & load resistance. The circuit used to regulate voltage is called voltage regulator's.

A resistor's R_s connected in series with the diode limits the current through the circuit & is called series current limiting resistor's. For the proper operation, the input voltage ($V_{in} > V_z$) will insure that the zener diode shunt operate in reverse breakdown region.

$$I = \frac{V_{in} - V_z}{R_s}, \quad V_z = V_L \text{ or } V_0$$

Laws of Radioactive Disintegration:

(i) In all known radioactive disintegration either an α-particles or β-particles is only emmitted but it is never that both the particles are ejected simultaneously. γ-rays are emitted after each emmision of α or β particles if the atoms is already in excited state.

(ii) The rate of disintegration is independent of externals factor's like tempr, Pressure etc.

(iii) The rate of disintegration of radioactive substances at any time is directly proportional to the number of atoms present at that instant.

Let N be the number of atoms present in a particular radioactive element at any instant t. If dN is the number of disintergration in time dt, then rate of disintegration is directly proportional to the number of atoms present at that instant.

i.e

$$\frac{dN}{dt} \propto N \Rightarrow \frac{dN}{dt} = -\lambda \cdot N$$

λ is decay constant.

$$\frac{dN}{N\cancel{dt}} = -\lambda \cdot dt$$

on intergrating, we get

$$\int \frac{dN}{N} = \int -\lambda \cdot dt$$

$$\ln N = -\lambda \cdot t + c \quad c \text{ intergral constant}$$

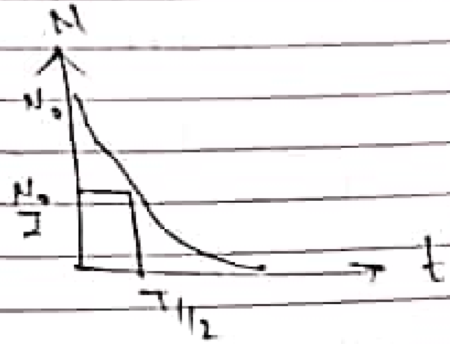
At first,

$t = 0$, $N = N_0$ (initial number of atoms)

$\ln N_0 = c$

on substitution, we get

$\ln N = -\lambda t + \ln N_0$



$\ln N - \ln N_0 = -\lambda \cdot t$

$\ln \frac{N}{N_0} = -\lambda \cdot t$

$\frac{N}{N_0} = e^{-\lambda \cdot t}$

Therefore $N = N_0 e^{-\lambda t}$

Relation half life & decay constant:

The half life of a radioactive element is define as the time interval during which half the radioactive atoms disintegrate.

If $T_{1/2}$ is the half period of a radioactive Substance, then

$$N = \frac{N_0}{2} \text{ at } t = T_{1/2}$$

Since, $N = N_0 \cdot e^{-\lambda t}$

$$\frac{N_0}{2} = N_0 \cdot e^{-\lambda T_{1/2}}$$

$$\frac{1}{2} = e^{-\lambda T_{1/2}} \Rightarrow 2 \Rightarrow e^{\lambda T_{1/2}}$$

$$\ln 2 = \lambda T_{1/2}$$

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

$$\therefore T_{1/2} = \frac{0.693}{\lambda}$$

This is the required half life of radioactive materials.

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1. What is a junction diode & Discuss it's applications as full wave rectifier. ?

P-N Junction diode: It is a semi conductor's device in which p-type semiconductor's is in contact with a N-type semiconductor's. It has two terminals namely anode & cathode. The anode refer's to the p-type region and cathode refer's to the N-type region. It's symbol as soon in fig:

Semiconductor's Diode as ~~used~~ full wave rectifier :-

When current passed through the diode, It gains the unidirectional property i.e the current moves in one direction. The characteristic of the diode is used in rectification. The conversion of the alternating current to direct current is called rectification. The device which is used for rectification is called rectifier. There are two types of rectifier. One is full wave rectifier & half wave rectifier.

The circuit diagram as the full wave rectifier. It consists of transformer with centre trapped secondary coil. Two diodes D_1 & D_2 are connected at the upper & lower ends of the secondary coil of the transformer respectively. Centre-tapped of the transformer & common point of the n-region of diodes are connected to the load resistances from which output is taken.

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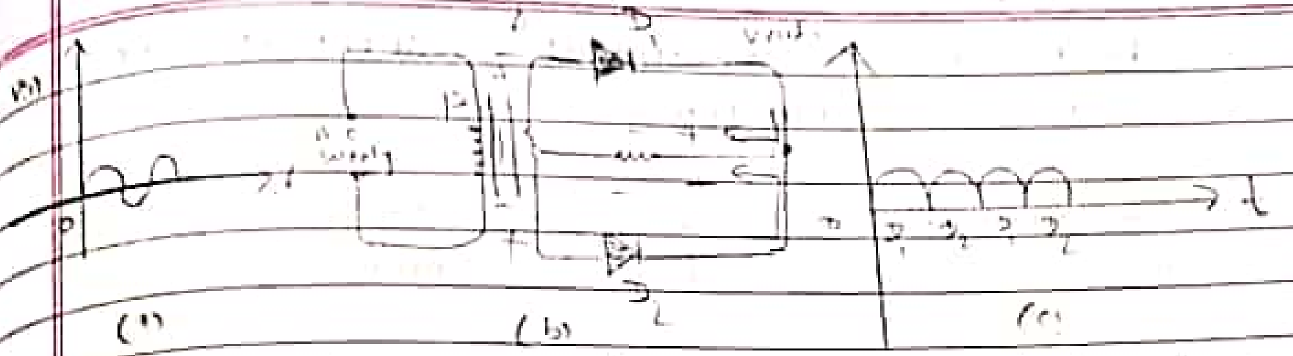

During the positive half cycle of secondary voltage & the upper diode D_1 is forward baised & D_2 is lower has reverse biased, the current flow through the diode D_1 & load resistors. During the negative half cycles of secondary voltage, the upper diode D_1 & resistor's R_L.

Figure shows the output voltage obtained at the load resistors R_L. The current flows through R_L for both half cycle of input voltage. The voltage through the resistor's R_L same directional in both case. Thus the output current through the load is said to unidirectional current. we can consider that a full wave rectifier is like two back half wave rectifiers with one rectifier working in the 1st half cycle & the other working in the alternate half cycles.

1. Hubble's Law : The Hubble's law state that the speed of recession of a galaxy is proportional to it's distance from us i.e

$$v \propto r$$

where v is velocity of galaxy &

r is distance from earth.

or, $V = H_0 r$

where H_0 is hubble's constant.

It's value is $2.3 \times 10^{-18}\ sec^{-1}$. The reciprocal of h_0 is measure the time taken to universe.

2. Black hole : Everything is trapped by the star & even light can't escape out. The star becomes dark is called black hole. If initial mass of star was more than five solar mass, the red gaint becomes a black hole.

Cosmic rays : The high energy radiations coming toward's earth surface from outer space are called Cosmic rays. They are many times stronger than gamma rays. They are two types of cosmic rays. i.e is primary & Secondary Cosmic Rays.

Energy crisis:- The shortage of essential energy of the earth is called "energy crisis." Due to energy Crisis, the humman begins has to face several difficulties & the develoment of society will be slow down, alternative source is developed in the earth.

5 Does the universe have a Centre ? Explain

→ Yes, the centre of universe was given by two famous theories, geocentric theory and Helio centric theory. So we can consider our galaxy as the Centre of the universe. This is because the universe looks more or less the same from all locations.

Long question

The Source of energy which can be reproduced in short time & can be used continuously for long time are called renewables source of energy. e.g biomass

The source of energy which cannot produced in short time & cannot be used constinously for long time is called non. renewables source of energy. e.g coal energy, firewood, peronal energy.

Nepal

Types of energy source	consumption %
Biomass	78
Electricity	3
coal	4
petroleum product	12
modern renewables energy	3
Total	100

Formula

1. Mass defect:

$$\Delta m = [Zm_p + (A-Z)m_n - M_N]$$

ii) B.E $= \Delta m \times c^2 = [Zm_p + (A-Z)m_n - M_N]c^2$

iii) Radius of Nucleus,

$$R = R_0 \cdot A^{1/3}$$

$$R_0 = 1.3\times10^{-15} m$$