Q.1 **The Dimensional formula of permittivity (ε_0) of free space is :** **[1]**

(a) $M^{-1}L^{-3}T^4A^2$ **(b) $M^{-1}L^{-2}T^2A$** **(c) $M^{-1}L^{-2}T^{-2}A$** **(d) $M^{-1}L^{-2}T^{-2}A^{-2}$**

Ans. **(a)**

$\because f = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$

$\Rightarrow \epsilon_0 = \frac{q_1q_2}{4\pi f r^2}$

so $[\epsilon_0] = \frac{AT \times AT}{M^1L^1T^{-2}L^2}$

$= [M^{-1}L^{-3}T^4A^2]$

Q.2 **Modem is a device which performs :** **[1]**

(a) Modulation **(b) Demodulation**

(c) Rectification **(d) Modulation and demodulation**

Ans. **(d)**

Modem consists of modulation and demodulation

Q.3 **1 k Wh is equal to :** **[1]**

(a) $36 \times 10^3 J$ **(b) $36 \times 10^5 J$** **(c) $36 \times 10^{-5} J$** **(d) $36 \times 10^{-3} J$**

Ans. **(b)**

1 kWh = 1000 W × 3600 sec

$= 36 \times 10^5$ walt sec

$= 36 \times 10^5 J$

Q.4 **Resonance occur in series L.C.R. circuit when :** **[1]**

(a) $X_L = X_C$ **(b) $X_L > X_C$** **(c) $X_L < X_C$** **(d) None of these**

Ans. **(a)**

At resonance $X_L = X_C$

Q.5 **What is the cause of Green house effect?** **[1]**

(a) infra red rays **(b) U. V. rays**

(c) X - rays **(d) radiowaves**

Ans. **(b)**

U. V. rays

Q.6 **To get five images of a single object one should have two plance mirror at an angle of :** **[1]**

(a) 30^0 **(b) 60^0** **(c) 90^0** **(d) 120^0**

Ans. **(b)**

$\because n = \frac{360^0}{\theta}$

If $\theta = 60^0$

then $n = \frac{360}{60}$

$= 6$

because ratio is 6 So no's of image will one less ie $N = 6 - 1$

$= 5$

Q.7 **$_7N^{14}$ os bombarded with $_2He^4$. The resulting nucleus is $_8O^{17}$ with the emission of :** **[1]**

(a) Neutrino **(b) Antineutrino** **(c) Proton** **(d) Neutron**

Ans. **(c) Proton**

In the give question,

$_7N^{14} + {}_2He^4 \rightarrow {}_8O^{17} + {}_ZX^A$

Acc to law of conservation of mass

14+4 = 17+A

$\Rightarrow A = 18 - 17 = 1$

& Acc to law of conservation of charge

7+2 = 8 + Z

$\Rightarrow z = 1$

So particle emitted is $_1H^1$ which is proton.

Q.8 **Which of the following logic gate is an universal logic gate ?** **[1]**

(a) OR **(b) AND** **(c) NOT** **(d) NOR**

Ans. **(d) NOR**

∵ Basic gates can be obrained from NOR gate.

Q.9 **Explain what is meant by quantization of electric charge?** **[2]**

Ans. Quantization of electric charge - It is the property by virture of which charge on a body is integral multiple of basis unit of charge

i.e. charge of a body is given by $Q = \pm ne$ where n is an integer and e is the basis unit of charge ie $e = 1.6 \times 10^{-19} C$

cause of quantization is that only integral multiple of electrons can be transferred from one body to another.

OR

How many electrons are present in one coulomb of charge?

Ans. Give $Q = IC$

& $e = 1.6 \times 10^{-19}$

$\because Q = nc$

$\Rightarrow n = \frac{Q}{C} = \frac{IC}{1.6 \times 10^{-19} C} = \frac{10}{16} \times 10^{19}$

$n = \frac{100}{16} \times 10^{18} = 6.25 \times 10^{18}$

$\Rightarrow n = 6.25 \times 10^{8}$ electrons

Q.10 **Why steel is used for making permanent magnet ?** **[2]**

Ans. Steel is used for making permanent magnet because of following reasons :

(1) It has high coercivity

(2) It has high retentivity so that magnet is strong

(3) It has high permeability so that it can be magnetised easily.

Q.11 A galvanometer of resistance 15Ω gives full scale deflection for a current of 2 mA. Calculate shunt resistance required to convert it into an ammeter of range (0-5) A. [2]

Ans. Given

$G = 15\Omega$

$I_g = 2mA$

$I = 5$

$S = ?$

Using formula

$S = \frac{I_g G}{I - I_g}$

$S = \frac{2\times10^{-3}\times15}{5-2\times10^{-3}}$

$S \approx \frac{2\times15\times10^{-3}}{5}$

$S = 6 \times 10^{-3}\Omega$

or $S = 6m\ \Omega$

Q.12 Distinguish between interference and differaction of light. [2]

Ans.

	Interference		Diffraction
1	Interference is due to superposition of two wave fronts from the cohercut sources of light	1	Diffraction is due to superposition of secondary wavelets from different points of same wavefrant
2	In the interferance intensity of all bright friryes or maxima is same	2	In this case intensity of bright fringes is not same ie it varies from central maximum
3	In the interference the width of fringes is equal	3	In this case width of central maximum is double than the width of other maxima
4	In this case bands are equally spaced	4	In the diffraction bands are unequally spacd.

Q.13 Distinguish between intrinsic semi- conductors and extrinsic semicondutors. [2]

Ans.

	Intrinsic Semicanductors		Extrinsic Semicanductors
1	Intrinsic semiconductors are the crystals of pure elements like Ge and Si	1	These are the semiconductors which are obtained by adding some desirable

			impurity atoms to intrinsic semiconductors like p −type & n −type semiconductors
2	The electrical conductivity of these semiconductors is law	2	The electrical conductivity of these semiconductors is high
3	Resistivity is higher	3	Resistivity is low
4	In the intrinsic semiconductor the number density of electrons is equal to number density of holes ie $n_e = n_h$	4	In this case number density of electrons is not equal to number density of holes ie $n_e \neq n_h$
5	electrical conductivity of these semiconductors depends upon the temperature	5	Electrical conductivity of these semiconductor depends upon temperature as well as inpurity added

Q.14 What are electromagnetic waves? Give their two properties. **[2]**

Ans. **Electromagnetic waves -** These are those waves in which there is sinusoidal variation of electric and magnetic field vectors at right angles to each other as well perpendicular to the direction of wave propagation.

Properties - (1) Electromagnetic waves are produced by accelerted or oscillating change.

(2) These waves are transverse in nature

(3) They do not require any material medium for propagation

(4) These waves travel in free space with speed $3 \times 10^8 ms^{-1}$

OR

What are X - Rays? Give their one use.

Ans. **X - Rays -** These are produced when high energy electorns are stopped suddenly an a metal of high atomic number.

They have high penetrating power.

Uses - (1) In surgery for the detection of fractures & stones in the human body.

(2) In Radio therapy, to cure untractable skin diseases etc

Q.15 Why sky appears blue in colour? **[2]**

Ans. Blue colour of sky - The sky appears blue because of scattering of light. The light from the sun while travelling through the atomsphere gets scattered by large no's of molecules in the atmosphere.

As particle size is very - 2 small as compare to wavelength of light ($x \ll \lambda$), Ray leigh scattering is valid &

$I \propto \frac{1}{\lambda 4}$. The wavelength of blue colour is shorter than red colour so blue colour is scattered much more Hence sky is blue.

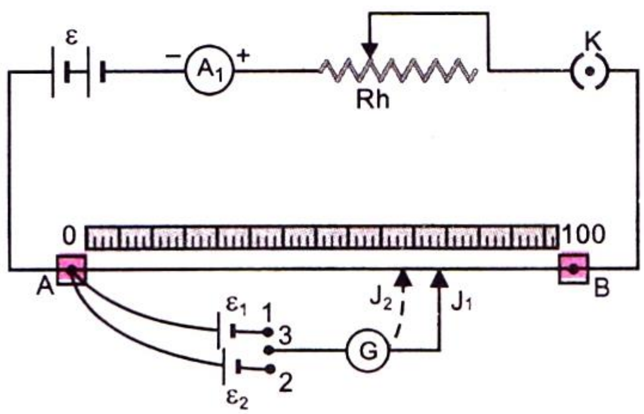
Q.16 Why a.c. is more dagerous than d.c.? Explain. [2]

Ans. A.C. is more dangeraus than d.c. because peak value of A.C. is more than the indicated value. Suppose we have 220 V a.c. and 220 V. d.c. then peak value of A.C. is given by $V_0 = \sqrt{2}\, V_{rns} = \sqrt{2} \times 220 \approx 311\, V$ while that of d.c. is only 220 V.

Q.17 What is the principle of Potentiometer? How it is used to compare the e.m.f. of two cells. [3]

Ans. Principle of potentiometer - It is based on the fact that fall of potential across any portion of potentiometer wire is directly proportional to length of that portion provided current is constant and area of cross section is unifrom.

Use of potentiometer to compare the e.m.f. of two cells.



The circuit diagram to compare the e.m.f. of two cells has been shown in the given fig. where an auxillary circuit is connected across AB. Then positive teminals of both cells is connected to A while negative terminals are connected to two terminals 1 & 2 of two way key, the common terminal 3 is connected to jockey J through galvanometer G. Intitially close the key 'K' and adjust suitable constant current in the potentiometer wire with the help of rhestat. Now insert the plug in the gap between terminals 1 & 3 so that cell of emf $\in_1$ is in the circuit. Adjust position of jocky on the wire where if it is pressed galvanometer gives null deflection. Let that point is J_1 s.t. $AJ_1 = L_1$. * It means emf of cell $\in_1$ is equal to the potential difference between the point A & J_1

i.e. $\in_1 = Kl_1$ (1)

Now plug is removed from gap between 1 & 3 and is introduced in the gap between 2 & 3 so that cell of emf $\in_2$ comes in the circuit again position of jockey is adjusted on the wire where if it is pressed galvanometer gives zero deflection. Let that point is J_2s.t. $AJ_2 = l_2$. Which means emf of cell $\in_2$ is equal to potential difference between point A & J_2 $\Rightarrow \in_2 = Kl_2$ (2)

Divide (1) by (2) we get

$$\frac{\in_1}{\in_2} = \frac{Kl_1}{Kl_2}$$

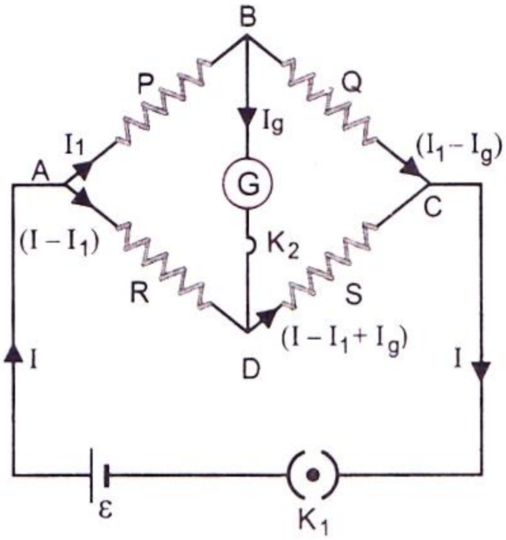
$$\Rightarrow \frac{\epsilon_1}{\epsilon_2} = \frac{l_1}{l_2}$$

OR

Derive the expression for balance condition of wheat stone bridge using Kirchhoff's second law.

Ans. Balance consitions of wheat stone bridge using kirchhoff's second law -

The circuit diag. for wheatstone bridge has been shown in iven figure P, Q, R, & S are the four resistances let I is current given bu the cells. This current is divided at A i.e.



I_1 current flows through P

$I - I_1$ current flows through R

At B I_1 is divided further i.e.

Ig current flows through galvanometer arm

$I_1 - I_g$ current flows through resistace Q

At D the currents with I_g & $I - I_1$ meets to give $(I - I_1 + I_g)$ current through S wich further combines with $I_1 - I_g$ to give total current I.

Apply kirchhoff's 2nd law in the loop ABDA we get

$$I_1 P + I_g G - (I - I_1)R = 0 \qquad (1)$$

Also apply Kirchhoff's 2nd law in the loop BCDB

i.e. $(I_1 - I_g)Q - \left(I - I_1 - I_g\right)S - I_g G = 0$ (2)

Now value of resistace 'R' is adjusted such that galvanometer gives zero deflection $i.e. I_g = 0$. So bridge is balanced.

Hence (1) & (2) relation become.

$$I_1 P - (I - I_1)R = 0$$

$$\Rightarrow I_1 P - (I - I_1)R \qquad (3)$$

& $I_1 P - (I - I_1)S = 0$

$\Rightarrow I_1Q - (I - I_1)S$ (4)

Divide (3) by (4) we get

$\frac{I_1P}{I_1Q} = \frac{(I-I_1)R}{(I-I_1)S}$

$\Rightarrow \frac{P}{Q} = \frac{P}{S}$

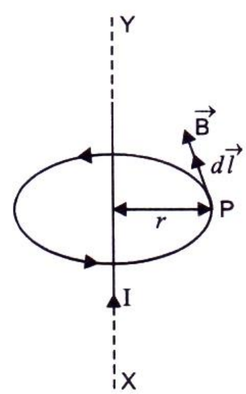
This is the required balance condition of wheats bridge

Q.18 State Ampere's cicuital law. By using it derive an expression for magnetic field intensity at a point due to a straight current carrying conduction. [3]

Ans. Statement of Ampere's circuital law - It states that line integral of magnetic field around any closed path in free space is equal to absolute permeability 'μ_0' times the net current enclosed by the path

i.e. $\vec{B}.\vec{dl} = \mu_0 I$

* Expression for magnetic field intensity due to straight current carrying conductor -



Consider a straight current carrying conductor. Let I is the current flowing through it from X to Y. A magnetic field is produced which is having same magnitude at all points which are equidistant from the conductor. Let 'P' is the point at $\perp r$ distance 'r' from straight conductor & $\vec{B}$ is the magnetic field at P which acts tangentially at 'P'. Consider an aperian loop of radius 'r' s.t. point 'P' lies on the loop. Let XY is the small element of loop i.e. $XY = dl$ Now $\vec{B}$ & $\vec{dl}$ are acting in the same direction ie $\theta = 0^0$

$\therefore$ line integral of $\vec{B}$ around closed loop is

$\oint \vec{B}.\vec{dl} = \oint Bdl \cos\theta$

$= \oint Bdl \cos 0^0$

$= \oint \vec{B}.\vec{dl} = B \oint dl$

$= B \times 2\pi r$

$= \oint \vec{B}.\vec{dl} = B \times 2\pi r$ (1)

Using Ampere's circutal law

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

Using (1) $\Rightarrow B \times 2\pi r = \mu_0 I$

$$\Rightarrow B = \frac{\mu_0 I}{2\pi r}$$

which is required expression for M.F.

Q.19 What is Mass defect, binding energy and binding energy pernucleon? [3]

Ans. **(1) Mass Defect -** It is defined as the difference between the mass of nucleons and mass of the nucleus. It is denoted by ΔM.

(2) Binding energy - It is defined as the total energy. required to separate the nucleons at infinite distane apart from nucleus so that they may not interact with each other.

(3) Bindiny energy per nucleon - At is defined as average energy required to release the nucleon from the nucleus. It is given by total Binding energy divided by mass number of nucleus.

Q.20 What is modulation? Explain the need of modulation. [3]

Ans. **Modulation -** It is the phenomenon of superimposing the low frequency message signal on a high frequency carrier wave.

Need of modulation -

(1) It increases operating range : The energy of the wave depends upon its frequency. The greater the frequency, the greater is the energy of the wave. Thus in order to transmit audio signals having lower frequency to larger distances, these are modulated with high frequency carrier wave.

(2) It allows wireless transmission: Wireless transmission is the basic requirement of radio transmission. Wireless transmission depends upon the radiation efficiency. Thus, for wireless transmission low frequency audio signal modulated with the high frequency carrier wave.

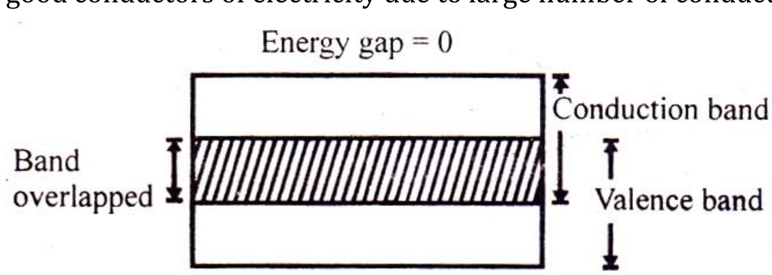
(3) It reduces the size of transmitting antenna: The length of the transmitting antenna is related to the frequency of the wave by the relation,

$$Length\ , L = \frac{7.5 \times 10^7}{Wave\ frequency}$$

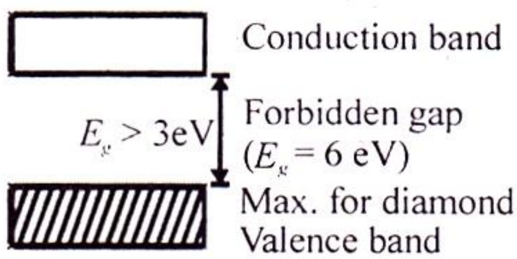
Thus, by modulating the low frequency audio signal by high frequency carrier wave, the length of the transmitting antenna reduces.

Q.21 On the basis of energy band diagram, distinguish between metal, insulator and semiconductor. [3]

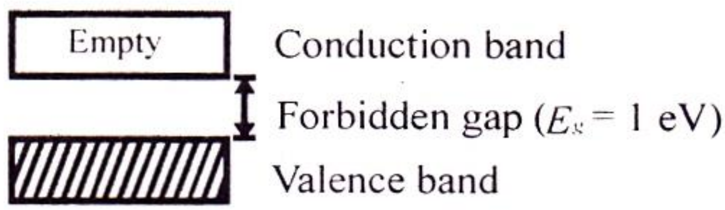
Ans. The valence and conduction bands overlap each other in case of conductors. There is no forbidden energy gap. Metals are good conductors of electricity due to large number of conduction electrons.



Insulator : In case of insulaors. the valence band is completely filled with electrons and conduction band is empty. Both bands are separated by a forbidden energy gap > 3eV 6 eV. Due to large forbidden gap, no electron is able to fo from valence to conduction band. Hence, in case of insulators there is no electrical conduction.



Semiconductor : In case of semiconductors, the valence band is completely filled and conduction band is empty. The forbidden gap between conduction and valence band is < 3eV. At room termperature, valence electrons jump from valence band to conduction band. So, semiconductors show some conductivity.



Q.22 Define threshould frequency. Explain the laws of Photoelectric emission. [3]

Ans. **Threshold frequency -** It is the minimum frequency below which no emission of photoelectrons is possible.

Explantion of law of photoelectric emission

(1) Since one incident photon may eject one photoelectron from a metal surface, therefore, number of photoelectrons emitted per second depends upon the number of photons falling on the metal surface per second which inturn depends on the intensity of the incident radiation. If the intensity of the incident radiation is increased, the number of incident photons increase, which results in an increase in the number of photo - electons ejected. this is the first law of photoelectric emission.

(2) We note that if $v < v_0$, max. K.E. is negative, which is impossible. Hence, photoelectric emission does not take place for the incident radiation below threshold frequency. This is the second law of photoelectric emission.

(3) We note that if $v < v_0$, max. K.E. $\propto v$. This means, maximum kinetic energy of photoelectron depends on the frequency (or wavelength) of incident radiation. If the intensity of the incident light radiation is increased, the number of incident photons falling per second on the metal surface increases but the energy of each photon remains the same. This the third law of photoelectric emission.

(4) The phenomenon of photoelectric emission has been conceived as an effect of an elastic collision between a photon and an electron inside the metal. As a result of it, the absorption of energy by the electron of metal from the incident photon is a single event which involves transfer of energy at once without any time lag. Due to it, there is no time lag between the incident photon and the ejected photoelectron. This is the fourth law of photoelectric emission.

OR

Deive an ecpression for de - Broglie wavelength of an electron moving under Potential difference of V volts.

Ans. Consider an electron of mass m and change e. Let v be the velocity acquired by electron when accelerated from rest through a potential difference of V volt. then

Gain in kinetic energy of electron $= \frac{1}{2}\, mv^2$;

work done on the electron = eV $\therefore \frac{1}{2}mv^2 = eV$ or $v = \sqrt{\frac{2eV}{m}}$

If λ is the de - Broglie wavelength associated with the electron, then

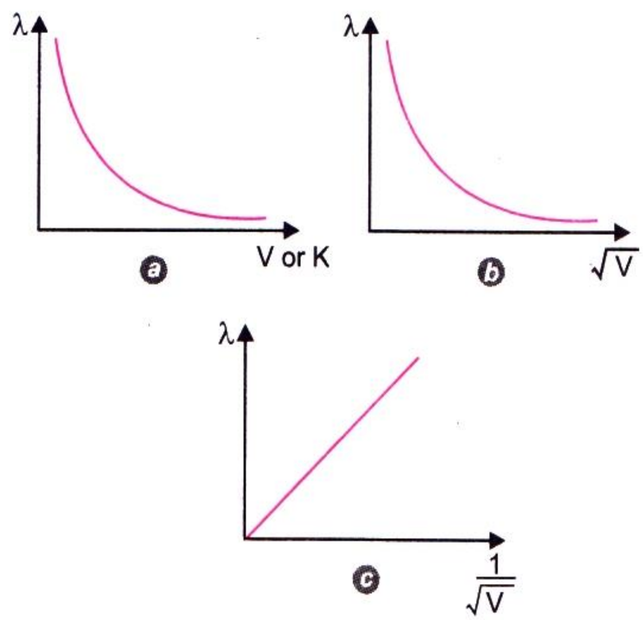
$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{2eV/m}} = \frac{h}{\sqrt{2\,meV}} \qquad \text{..... (18)}$$

Substituting the standerd values in (18) we get

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2\times9\times10^{-31}\times1.6\times10^{-19}\times V}}$$

$$= \frac{12.27}{\sqrt{V}} \times 10^{-10} m$$

$$= \frac{12.27}{\sqrt{V}} \text{Å}$$



For a moving electron the variation between λ and V (or λ and kinetic energy K) is shown in graph, Fig. (a) between λ and $\sqrt{V}$ is shown in Fig. (b) and between λ and $1/\sqrt{V}$ in Fig.

Q.23 Using Huygen's Principle prove the laws of refaction. [3]

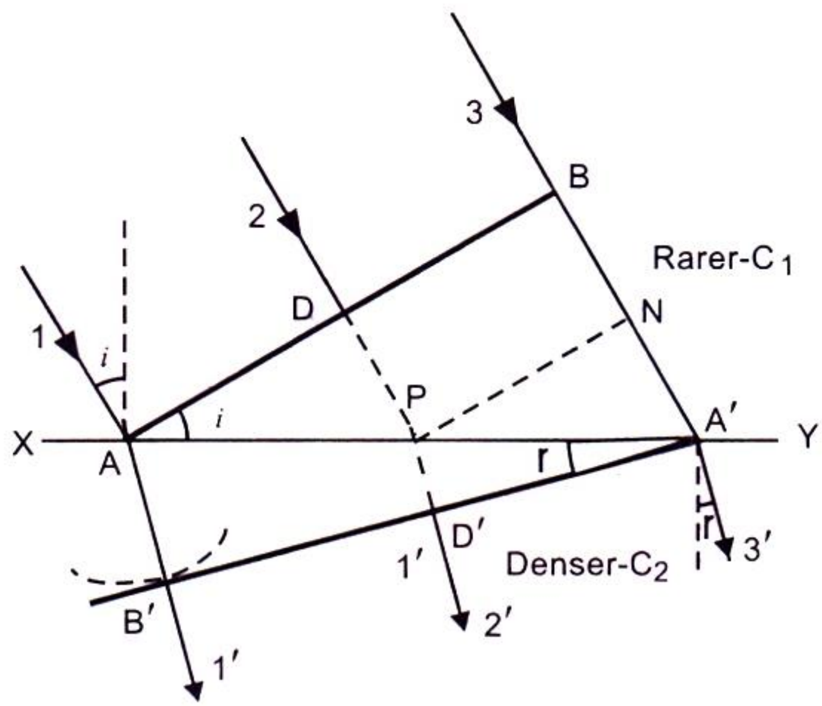
Ans. XY is a plane surface that separates a denser medium of refractive index μ from a rarer medium. If c_1 is velocity of light in rarer medium and c_2 is velocity of light in denser medium. then by definition,

$$\mu = \frac{c_1}{c_2} \quad \text{.... (4)}$$

AB is a plane wave front incident on XY at $\angle BAA' = \angle i$, 1, 2, 3 are the corresponding incident rays normal to AB.

According to Huygens principle, every point on AB is a source of secondary wavelets. Let the secondary wavelets from B strike XY at A' in t seconds

$$BA' = c_1 \times t \quad \text{.....(5)}$$



The secondary wavelets from A travel in the denser medium with a velocity c_2 and would cover a distance $(c_2 \times t)$ in t seconds. Therefore, with A as centre and radius equal to$(c_2 \times t)$, draw an arc B' From A', draw a tangent plane touching the spherical arc tangentially at B'. Therefore, $A'B'$ is the secondary wavefront after t sec. This would advance in the direction of rays $1', 2', 3'$, which are the corresponding refracted rays, perpendicular to $A'B'$.

We can show that the secondary wavelets starting from any other point D on the incident wavefront AB, after refraction at P, must reach the point D' on $A'B'$ in the same time in which the secondary wavelets from B reach A'.

Therefore, $A'B'$ is the true refracted wave front. Let r bethe angle of refraction. As angle of refraction is equal to the angle which refracted plane wavefront $A'B'$ makes with the refracting is equal to the angle which the refracted plane wavefront $A'B'$ makes wit the refracting surface AA', therefore, $\angle AA'B' = r$.

Let $\angle AA'B' = r$, angle of refraction

In $\Delta\, AA'B, \sin i = \frac{BA'}{AA'} = \frac{c_1 \times t}{AA'}$; In $\Delta AA'B', \sin r = \frac{AB'}{AA'} = \frac{c_2 \times t}{AA'}$

$\therefore \quad \frac{\sin i}{\sin r} = \frac{c_1}{c_2} = \mu$

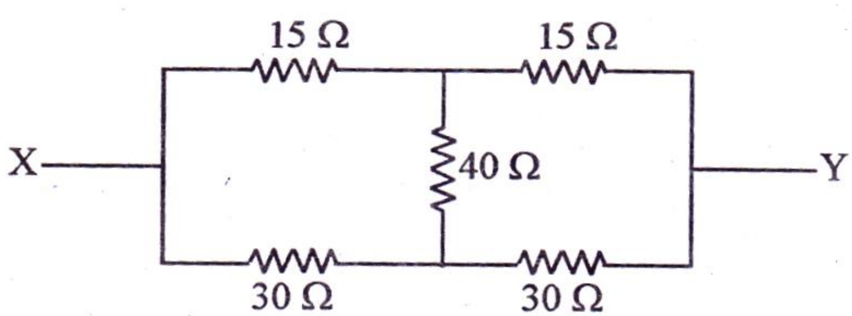
Hence $\mu = \frac{\sin i}{\sin r}$ ....(6)

Which proves Snell's law of refraction.

It is clear from Fig. that the incident rays, normal to the interface XY and refracted rays, all lie in the same plane. (i.e. in the plane of the paper). This is the second law of refraction.

Hence laws of refraction are established on the basis o fwave theory.

Q.24 Calculate equivalent resistance of the network between points X and Y. [3]



Ans. It is Balanced wheatstone bridge

i.e. $\frac{P}{Q} = \frac{R}{S} = 1$

From circuit diag

$R_s = 15 + 15$

$R_s = 30\ \Omega$

& $R_s = 30 + 30 = 60\ \Omega$

Now R_s & ${R_s}^1$ are in parallel to each other

so $\frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{{R_s}^1}$

$= R_p = \frac{R_s \times {R_s}^1}{R_s + {R_s}^1}$

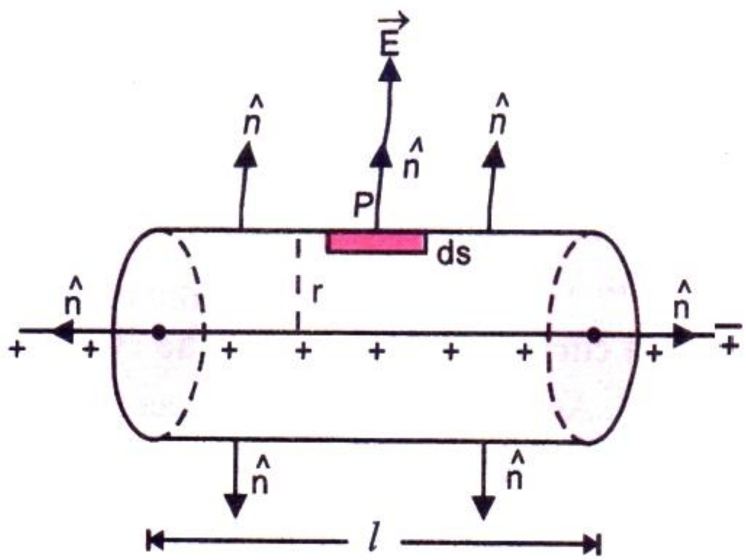
$= \frac{30 \times 60}{30+60} = \frac{30 \times 60}{90}$

$R_p = 20\ \Omega$

Q.25 DefineGauss's theorem. Using it derive an expression for electric field intensity at a point due to an infinitely long straight uniformly charged wire. [4]

Ans. Gauss's theorem - According to this theorem total electric flux over closed surface in vacuum is $\frac{1}{\epsilon_0}$ timesthe total charge enclosing the surface

i.e. $\phi_E = \oint_S \vec{E}.\overrightarrow{ds} = \frac{Q}{\epsilon_0}$



Consider an infinitely long thin wire with uniform linear change density λ. To calculate field due to this wire at any point P.

Let us consider a right circular closed cylinder of radius r and length l with the indinitely long line chanrge as its axis, Fig. The magnitude of electric intensity $\vec{E}$ at every point on rhw curved surface of the cylinder is the same, because all such points are at the same distance from the line charge.

Also, $\vec{E}$ and unit vector $\hat{n}$ along outward normal to curved surface are in the same direction, so that $\theta = 0^0$.

∴ Electric flux over the curved surface of the cylinder,

$\oint_S \vec{E}.\overrightarrow{ds} = \oint_S \vec{E}.\hat{n}\ ds = \oint_S E\ (ds) \cos 0^0\ \ ds\ \ E \oint_S ds = E(2\pi\, rl)$

Where $(2\pi\, rl)$ is area of the curved surface of the cylinder.

On the ends of the cylinder, angle between electric field intensity $\vec{E}$ and outward normal $\hat{n}$ is 90^0.

Therefore, these ends make no contribution to electric flux of the cylinder.

∴ total electric flux over the whole cylinder, $\phi_E = E(2\pi\, rl)$

Change enclosed in the cylinder = linear change density × length

$$q = \lambda l$$

According to Gauss's theorem, $\phi_E = \frac{q}{\epsilon_0}$ $\therefore E(2\pi\, rl) = \frac{\lambda I}{\epsilon_0}$

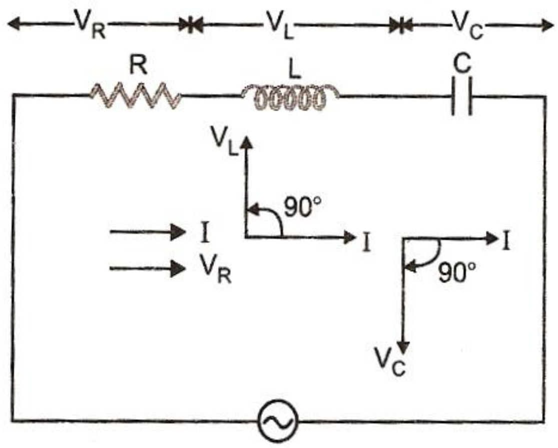
$$E = \frac{\lambda}{2\pi\epsilon_0 r}$$

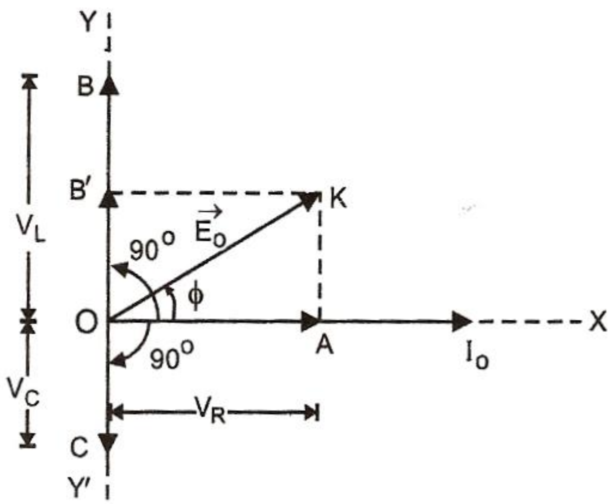
Clearly, $E \propto \frac{1}{r}$

Q.26 What do you mean by impedance of LCR series circuit? Derive an expression for it. What is the condition for resonance. [4]

Ans. Let a pure resistance R, a pure inductance L and an ideal capacitor of capacitace C be connected in series to a source of alternating e.m.f. F.g As R, L, C are in series, therefore, current at any instant through the three elements has the same amplitude and phase. Let if be represented by

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





(i) The maximum voltage across R is $\overrightarrow{V_R} = \overrightarrow{I_0}\, R$

In Fig. current phasor $\overrightarrow{I_0}$ is represented along OX.

As $\overrightarrow{V_R}$ is in phase with current, it is represented by the vector $\overrightarrow{OA}$, along OX.

(ii) The maximum voltage across L is $\overrightarrow{V_L} = \overrightarrow{I_0}\, X_L$

As voltage across the inductor leads the current by 90^0, it is represented by $\overrightarrow{OB}$ along OY, 90^0 ahead of $\overrightarrow{I_0}$

(iii) The masimum votage across C is $\overrightarrow{V_C} = \overrightarrow{I_0}\, X_C$

As voltage across the capacitor lags behind the alternating current by 90^0, it is represented by $\overrightarrow{OC}$ rotated clockwise through 90^0 from the direction of $\overrightarrow{I_0}$. $\overrightarrow{OC}$ is along OY'.

(iv) As the voltages across L and C have a phase differece of 180^0, the net reactive voltage is $(\overrightarrow{V_L} - \overrightarrow{V_C})$, assuming that $\overrightarrow{V_L} > \overrightarrow{V_C}$.

In Fig. it is represented by $\overrightarrow{OB'}$. The resultant of $\overrightarrow{OA}$ and $\overrightarrow{OB'}$ is the diagonal $\overrightarrow{OK}$ of the rectangle $OAKB'$.

Hence the vector sum of $\overrightarrow{V_R}, \overrightarrow{V_L}$ and $\overrightarrow{V_C}$ is phasor $\overrightarrow{E_0}$ represented by $\overrightarrow{OK}$, making on angle ϕ with current phasor $\overrightarrow{I_0}$.

As $\quad OK = \sqrt{OA^2 + OB^2} \qquad \therefore\ E_0 = \sqrt{V_R^2 + \left(\overrightarrow{V_L} - \overrightarrow{V_C}\right)^2} = \sqrt{(I_0\,R)^2 + (I_0X_L - I_0X_C)^2}$

$$E_0 = I_0\sqrt{R^2 + (X_L - X_C)^2}$$

The total effective resistance of RLC circuit is called Impedance of the circuit. It is represented by Z, where

$$Z = \frac{E_0}{I_0} = \sqrt{R^2 + (X_L - X_C)^2}$$

conditor for resonance - The series LCR circuit admits max current &

For resonance

$X_L = X_C$

So $\quad z = \sqrt{R^2 + (X_L - X_C)^2}$

$z = \sqrt{R^2 + 0}$

$z = R$

and $\tan d = \frac{X_L - X_C}{R}$

$\tan d = 0$

$\Rightarrow \phi = 0^0$

Q.27 Show that in Young's double slit experiment for interference of light, the widths of bright and dark fringes are equal. [4]

Ans. Fringe Width : Consider two slits A and B having distance d between them. Let these silts be illuminated by monochromatic light of wave length λ. MN is a screen at distance D from the slits A or B. Draw AE, OC and BF perpendicular to MN. The point C on the screen is at equal distance from A and B. Thus, path difference betweenthe two waves reaching C is zero and intensity at point c is maximum. It is called cental maximum. Consider a point P at a distance x from C.

The path difference between the two waves reaching P is given by

Path difference = $BP - AP$

$'O'$ is the mid point of AB, then AO = EC = OB = CF = $\frac{d}{2}$ and $CF = x + \frac{d}{2}$

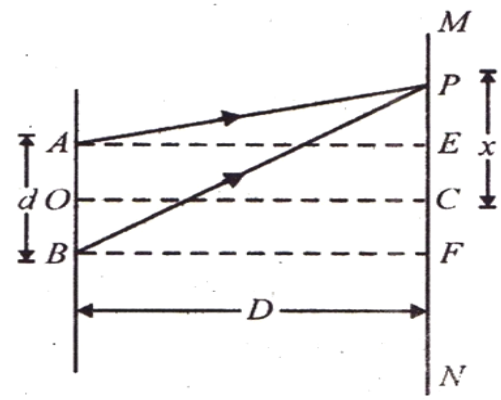
Also $\quad PE = PC - EC = x - \frac{d}{2}$ and $PF = PC + CF = x + \frac{d}{2}$

Now from $\Delta\, BPF$

$$BP = \sqrt{(BF)^2 + (PF)^2} = \sqrt{D^2 + \left(x + \frac{d}{2}\right)^2}$$

$$\Rightarrow BP = D\left[1 + \frac{\left(x+\frac{d}{2}\right)^2}{D^2}\right]^{\frac{1}{2}}$$

Applying binomial theorem, we get



$$BP = D\left[1 + \frac{1}{2}\frac{\left(x+\frac{d}{2}\right)^2}{D^2}\right] \quad ....(ii)$$

From $\Delta\ APE$,

$$AP = \sqrt{(AE)^2 + (PE)^2} = \sqrt{D^2 + \left(x - \frac{d}{2}\right)^2}$$

$$\Rightarrow \quad AP = D\left[1 + \frac{\left(x-\frac{d}{2}\right)^2}{D^2}\right]^{\frac{1}{2}}$$

Applying binomial theorem, we get

$$AP = D\left[1 + \frac{1}{2}\frac{\left(x-\frac{d}{2}\right)^2}{D^2}\right] \quad ....(iii)$$

Putting the values of equations (*ii*) and (*iii*) in equation (*i*), we get

$$\text{Path difference} = D\left[1 + \frac{1}{2}\frac{\left(x+\frac{d}{2}\right)^2}{D^2}\right] - D\left[1 + \frac{1}{2}\frac{\left(x-\frac{d}{2}\right)^2}{D^2}\right]$$

$$\text{Path difference} = D\left[1 + \frac{1}{2}\frac{\left(x+\frac{d}{2}\right)^2}{D^2} - 1 - \frac{1}{2}\frac{\left(x-\frac{d}{2}\right)^2}{D^2}\right] = D\left[\frac{\left(x+\frac{d}{2}\right)^2}{2D^2} - \frac{\left(x-\frac{d}{2}\right)^2}{2D^2}\right]$$

$$= \frac{D}{2D^2}\left[\left(x+\frac{d}{2}\right)^2 - \left(x-\frac{d}{2}\right)^2\right] = \frac{1}{2D}\left[(x^2 + \frac{d^2}{4} + xd) - (x^2 + \frac{d^2}{4} - xd)\right]$$

$$= \frac{1}{2D}\left[\left(x^2 + \frac{d^2}{4} + xd - x^2 - \frac{d^2}{4} + xd\right)\right] = \frac{1}{2D}(2xd)$$

$$\Rightarrow \quad \text{Path difference} = \frac{xd}{D}$$

For bright fringes

Path difference $= \frac{xd}{D} = n\lambda$, where $n = 0, 1, 2,$ --------- $\Rightarrow x = \frac{n\lambda D}{d}$

For central bright fringe ($n = 0$), $x_0 = \frac{0\lambda D}{d} = 0$

For first bright fringe ($n = 1$), $x_1 = \frac{\lambda D}{d}$

For second bright fringe ($n = 2$), $x_2 = \frac{2\lambda D}{d}$ and so on.

Fringe width

Fringe width is defined as the separation between the centres of two consecutive bright fringes. is denoted by β.

$$\beta = x_2 - x_1$$

or

$$\beta = 2\frac{\lambda D}{d} - \frac{\lambda D}{d} = \frac{\lambda D}{d} \qquad \text{.......}(iv)$$

For dark fringes

Path difference $= \frac{xd}{D} = (2n-1)\frac{\lambda}{2}$ where $n = 1, 2, 3,$------

$$\Rightarrow \quad x = \frac{(2n-1)\lambda D}{2d}$$

For first dark fringe ($n = 1$), $x_1' = \frac{\lambda D}{2d}$

For second dark fringe ($n = 2$), $x_2' = \frac{3\lambda D}{2d}$ and so on.

Fringe width

Fringe width is defined as the separation between the centres of two consecutive dark fringes. It is denoted by β'.

$$\beta' = x'_2 - x'_1 = \frac{3\lambda D}{2d} - \frac{\lambda D}{2d} = \frac{\lambda D}{d} \qquad \text{.......}(v)$$

Hence from equations (iv) and (v), we find that

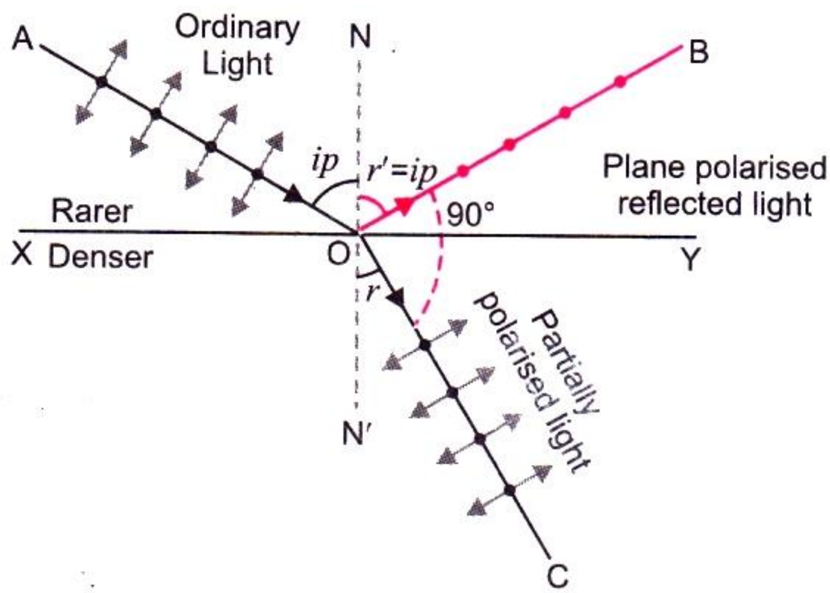
$$\beta = \beta' = \frac{\lambda D}{d}$$

That is, the fringe widths in case of bright and dark fringes are equal.

OR

What is meant by Polarisation of light? Derive Brewster's law of polarisation of light.

Ans. **Polarisation -** This phenomenon of restricting the vibrations of light (electric vector) in a particular direction, perpendicular to the direction of wave motion is called polarization of light. The tourmaline crystal acts as a polarizer.



Brewster's Law - According to this law, when unpolarized light is incident at polarizing angle, i_p on an interface separating air froma medium of refractive index μ, then the reflected light is fully polarized (perpendicular to the plane of incidence), provided

$$\mu = \tan i_p$$

This relation represents Brewster's Law.

Note that the parallel components of incident light do not disappear, but refract into the medium, with the perpendicular components.

It has been observed experimentally that when light is incident at polarizing angle, the reflected component along OB and refracted component along OC are mutually perpendicular to eachother. Thus, in Fig. $\angle BOY + \angle YOC = 90^0$

$(90^0 - i_p) + (90^0 - r) = 90^0$, where r is the angle of refraction. or $90^0 - i_p = r$

According to Snell' s law, $\mu = \frac{\sin i}{\sin r}$

When $i = i_p, r = \left(90^0 - i_p\right)$ $\therefore$ $\mu = \frac{\sin i_p}{\sin(90^0 - i_p)} = \frac{\sin i_p}{\cos i_p} = \tan i_p$