KENDRIYA VIDYALAYA SANGATHAN

JAIPUR REGION

LAST MINUTE REVISION STUDY MATERIAL

CLASS - XII

SUBJECT - (042) PHYSICS (2020—21)

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LASS XII (2020-21) (PHYSICS - THEORY)

Time: 3 hrs. **Max Marks: 70**

Unit	Name of Unit	Marks
I	Electrostatics	16
II	Current Electricity	
III	Magnetic Effects of Current and Magnetism	17
IV	Electromagnetic Induction & A C	
V	Electromagnetic Waves	18
VI	Optics	
VII	Dual Nature of Radiation and Matter	12
VIII	Atoms and Nuclei	
IX	Electronic Devices	07
	Total	70

Last Minute Revision study material

Chapter No -1 Electric charges and field

1.Coulomb's law – It states that force of attraction or repulsion between two-point charges is proportional to the product of magnitude of two charges and inversely proportional to the square of distance between them. $F = K\frac{Qq}{r^2}$, if the distance between two equal point charges is doubled and their magnitude are also doubled,
then F' = F (force will remain same)

2. Principal of superposition of charges – It states that force on a particular charge is the vector sum of forces due to all other charges. $\mathbf{F_i = f_{i1} + f_{i2} + f_{i3} + ------ + f_{in}}$

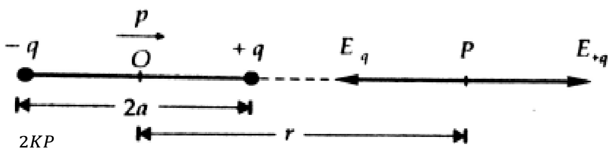
3. Electric field due to point charge Q at distance r is $E=K\frac{Q}{r^2}$ Its unit is NC^{-1}, It is a vector quantity.{ where $k = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ Nm^2C^{-2}$.

4.Electric field line – It is a path, straight or curved, such that tangent to the path at any point gives us the direction of electric field at that point. Electric field lines don't form the close loop. They never intersect with each other. Electrostatic field is a conservative field. Or it starts from a positive charge and end on a negative charge.

5.Electric dipole – a system of two equal and opposite charges separated by a small distance.

6.Electric dipole moment P = qx**2a**, it is a vector quantity. its direction from (-) to (+) and SI unit Coulomb x meter (Cm)

7. Electric field on axial line due to electric Dipole

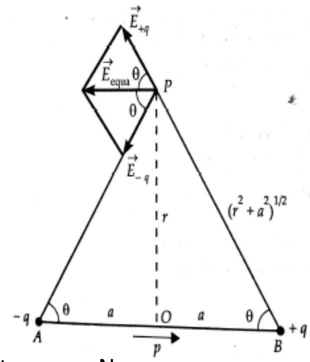


Electric field due to –q charge at point P is $E_1 = \frac{-Kq}{(r+a)^2}$

Electric field due to +q charge at point P is $E_2 = \frac{Kq}{(r-a)^2}$

So Net electric field on point P is $E_p = E_1 + E_2$ when 2a <<r then $E_{axial} = \frac{2KP}{r^3}$

8. Electric field at point P on equatorial line



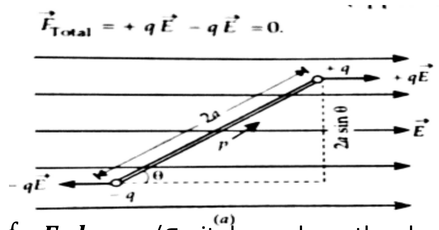
Magnitude of Electric field due to –q charge at point P = $\frac{Kq}{\sqrt{(r^2 + a^2)}}$

Magnitude of Electric field due to +q charge at point P = $\frac{Kq}{\sqrt{(r^2 + a^2)}}$

Net electric field When 2a <<r, then $E_{equ..} = \frac{KP}{r^3}$

$\mathbf{E_{axial} = -2 E_{equatorial}}$ { - sign indicates the direction of electric field}

9.Torque on an electric dipole placed in a uniform electric field (E) is τ = **PE** SinΘ , SI unit of torque = Nm



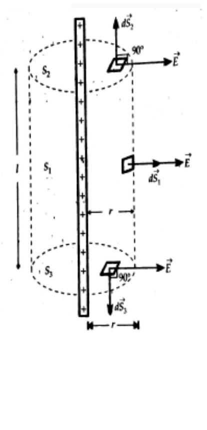
(a) ifΘ = 0^0 then Torque = 0

(b) ifΘ = 90^0 then Torque = PE (max) = $\tau_{max.}$

(c) ifΘ = 180^0 then Torque = 0

10. Gauss's theorem – Total electric flux through the closed Gaussian surface is $\oint_s \mathbf{E.ds} = q/\epsilon_0$, it depends on the charge enclosed in the closed loop. Does not depends on the shape and size of the close loop.

***Electric field due to thin infinitely long straight linear charge distribution of uniform charge density of λ C/m.**



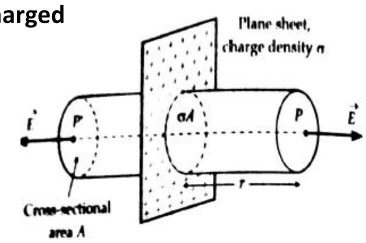
$\oint_s E.ds = q/\epsilon_0$

$E.\ 2\pi r l = \frac{\lambda l}{\varepsilon_0}$

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

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

***Electric field due to uniformly charged infinite plane sheet**



The flux passing through the Gaussian surface = EA + EA = 2EA
And the charge enclosed in the Gaussian surface q = Aσ
Then according to the Gauss law
$\emptyset = q/\epsilon_0$
then $E = \frac{\sigma}{2\epsilon_0}$
(where σ is the surface charge density)

E is independent on r

Q1. Define the electric dipole moment and write its SI unit. Derive an expression for the electric field at any point on the axial line of an electric dipole. (2019)

Q2. The two identical point charges, +Q each are kept distance 2r apart in air. A third unknown point charge q and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of q. (2019)

Hint: $K\frac{Qq}{x^2} = K\frac{Qq}{(r-x)^2}$, So x = r/2 and Charge q should be opposite of charge Q and q = - Q/4

Q3. An electric dipole is held in a uniform electric field. (2019)

(a) Show that no translator force acts on it. (b) Derive an expression for the torque acting on it.

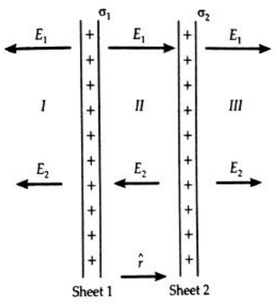
Q4. State the Gauss's law and by using It find the electric field of a thin infinitely long straight-line charge with a uniform charge density of λ C/m.

Q5. Two infinite parallel planes have uniform charge densities of $+\sigma_1$ and $+\sigma_2$. Determine the electric field at points.
(i) to the left of the sheets (ii) between them and (iii) to the right of the sheets.

Hint: (i) $E_I = -\frac{\sigma 1}{2\epsilon 0} - \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 1 + \sigma 2)}{2\epsilon 0}$

(ii) $E_{II} = \frac{\sigma 1}{2\epsilon 0} - \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 1 - \sigma 2)}{2\epsilon 0}$

(iii) $E_{III} = \frac{\sigma 1}{2\epsilon 0} + \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 1 + \sigma 2)}{2\epsilon 0}$



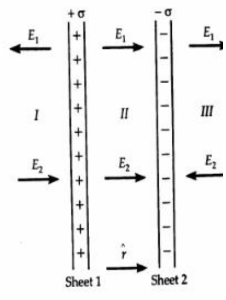
Hint: (i) $E_I = -\frac{\sigma 1}{2\epsilon 0} + \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 2 - \sigma 1)}{2\epsilon 0}$

(ii) $E_{II} = \frac{\sigma 1}{2\epsilon 0} + \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 1 + \sigma 2)}{2\epsilon 0}$

(iii) $E_{III} = \frac{\sigma 1}{2\epsilon 0} - \frac{\sigma 2}{2\epsilon 0} = \frac{(\sigma 1 - \sigma 2)}{2\epsilon 0}$

If $\sigma 1 = \sigma 2 = \sigma$ then (i) $E_I = E_{III} = 0$

and $E_{II} = \frac{\sigma}{\varepsilon_0}$



Chapter No – 2 Electric Potential & Capacitance

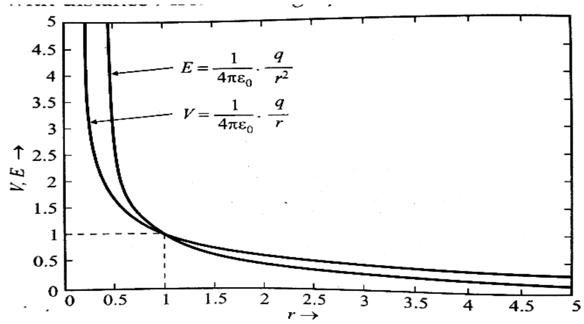
1. Electric potential = work (w)/ Charge(q) It is a scalar quantity and SI unit = volt or J/C

2. Relation between electric field (E) and electric potential (V) is $E = -\frac{dV}{dr}$

3.Electric potential due to a point charge q is

$V = k\frac{q}{r}$

Variation in electric field (E), Electric potential(V) with distance (r)



4.Electric potential at a point due to an electric dipole $V = \frac{kpCos\Theta}{(r^2 - a^2cos^2\Theta)}$, if 2a<<r then $V = \frac{kpCos\Theta}{r^2}$

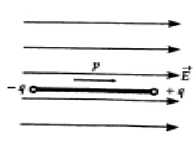
(i) On the axial point Θ = 0, So $V = V_{max} = \frac{kp}{r^2}$ (ii) On the equatorial point Θ = 90, So V = 0

5. Electric potential energy of two point system charges $U = K\frac{Qq}{r}$, its SI unit is joule.

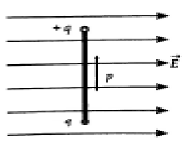
6. Potential energy of a dipole in uniform electric field is $U = pE\,(Cos\Theta_1 - Cos\Theta_2)$ or $U = -pECos\Theta$

(i) when $\Theta = 0$, U = -p$ECos0$ = -pE (min) this is the stable equilibrium. (ii) when $\Theta = 90$, U = -p$ECos90$ = 0

(iii) when $\Theta = 180$, U = -p$ECos180$ = + pE (Mix) this is the most unstable equilibrium.

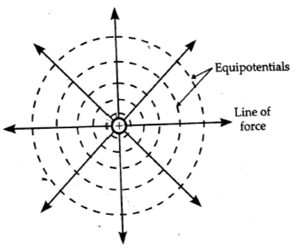


For (i) & (iii)

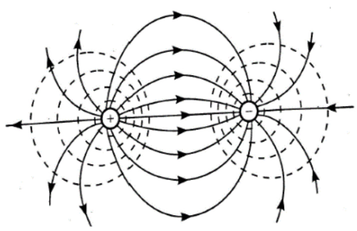


For (ii)

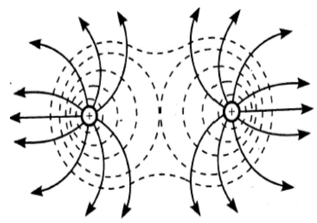
7. Equipotential surface – it is a surface on which the potential has same value at each and every point.



(+) Charge



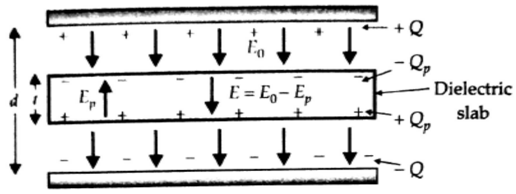
Electric dipole



Two (+) charges

8.Capacitance or capacity – Ability of a conductor to store the charge. It is the ratio of charge to the potential. $C = \frac{Q}{V}$ or Q = CV . The SI unit of capacitance is farad (F).

9. Capacity of an isolated spherical body of radius R is $C = 4\pi\varepsilon_0 R$



10. Capacitance of a parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$

11. When medium between plates has dielectric constant K then C′= KC

12. Capacity of a parallel plate capacitor with dielectric slab of thickness t (t<d) then $C = \frac{A\varepsilon_0}{[d - t\left(1 - \frac{1}{K}\right)]}$

13. Combination of capacitors – (i) **In Series** $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \text{-------} + \frac{1}{C_n}$ (ii) **In Parallel** $C_{eq} = C_1 + C_2 + C_3 + \text{------} + C_n$

14. Energy stored in a capacitor is $U = \frac{q^2}{2C} = \frac{CV^2}{2} = \frac{qV}{2}$ **15. Common potential** = $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

16. Loss of energy in sharing the charge = $\frac{C_1C_2(V_1 - V_2)^2}{2\,(C_1 + C_2)}$

17. Effect of dielectric on various Parameters -

Parameters	Battery disconnected to the capacitor	Battery Connected from the capacitor
Charge	Q (Remains same)	$Q = KQ_0$
Potential	$V = \frac{V_0}{K}$	$V = V_0$ (Remains same)
Electric field	$E = \frac{E_0}{K}$	$E = E_0$ (Remains same)
Capacitance	$C = K\,C_0$	$C = K\,C_0$
Energy	$U = \frac{U_0}{K}$	$U = KU_0$

Q1. When a slab of thick ness t and dielectric constant K is inserted between the plates then derive an expression for the capacitance of a parallel plate capacitor. (2020)

Q2. A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab with its thickness equal to the plate separated is inserted between the plates. What change, in any will take place in (i) Charge on the plates (ii) Electric field intensity (iii) the capacitance of the capacitor(iv) potential difference (v)Energy stored in the capacitor? Justify your answer. (2010,14,15,18)

Q3. Derive the expression for the energy stored in a parallel plate capacitor. Hence obtain the expression for the energy density of the electric field. (2015, 2018)

Q4. Derive an expression for the electric potential at any point (r, Θ) of a dipole.

Q5. Derive an expression for the potential energy of a dipole in a uniform electric field. Discuss the conditions of stable and unstable equilibrium.

Chapter No – 3 Current electricity

1. Electric current $(I) = \frac{q}{t}$, SI unit of current is Ampere **2. Current density** $(j) = \frac{I}{A}$, It is a vector quantity and SI unit is Am^{-2}

3. Drift Velocity - The average velocity with which the electrons move in a conductor under the application of an external electric field. $V_d = \frac{-eE}{m}\tau = \frac{-eV}{ml}\tau = \frac{I}{neA}$

4. Mobility (μ) $= \frac{V_d}{E}$, Mobility is defined as the drift velocity per unit electric field.

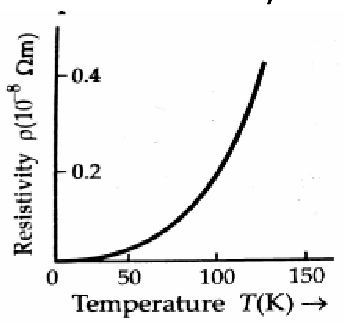
5. Ohm's law – V α I or V = IR where R = resistance of conductor its SI unit is (Ω). **6. Electrostatic form of Ohm's Law** $J = \sigma E$

7. Resistivity $(\rho) = \frac{RA}{l} = \frac{m}{ne^2\tau}$ It depends on the temperature and nature of material. Independent on size and shape of conductor. Its SI unit is Ωm.

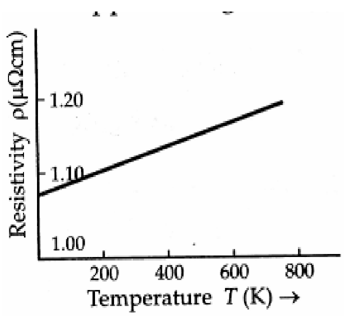
8. Electric energy –Total work done to maintain the current in an electric circuit for a given time.

Electric energy = P x t = $I^2Rt = \frac{V^2t}{R}$, Its SI unit is joule and commercial unit is KWh {1 KWh = 3.6 x 10^6 Joule}

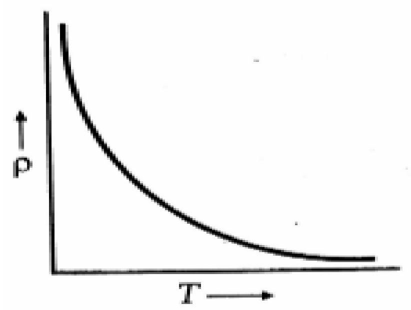
9. Variation of resistivity with temperature –



(i) For Copper



(ii) For Nichrome



(iii) For Semi-conductor

10. e. m .f – The potential difference across the terminals of a cell when no current flows from the cell or the cell is not connected in the circuit. It is denoted by E (volt)

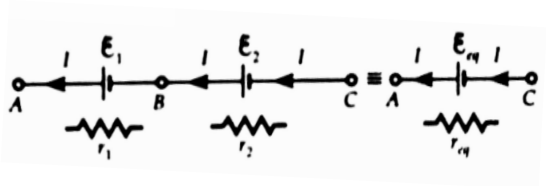
11. Terminal Potential difference - The potential difference across the terminals of a cell when current is drawn from cell. It is denoted by V (volt) V = E – ir r = $(\frac{E-V}{V})$ R Where R – external resistance

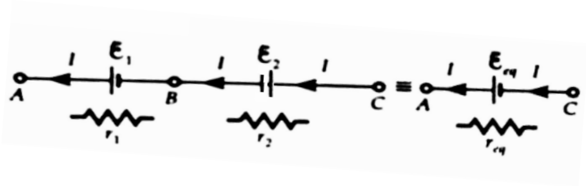
V = E + ir During Charging mode

12. Internal resistance (r) – The resistance offered by the electrolyte of a cell in flow of current between its electrodes. It depends on (I) nature of electrolyte (ii) concentration of the electrolyte (iii) Distance between the electrodes (iv) common area of electrodes dipped in the electrolyte and (v) temperature of the electrolyte.

13. The equivalent emf of Series Combination of 2 cells

(i) $\varepsilon_{eq}= \varepsilon_1 + \varepsilon_2$ and $r_{eq} = r_1 + r_2$ (ii) $\varepsilon_{eq}= \varepsilon_1 - \varepsilon_2$ and $r_{eq} = r_1 + r_2$

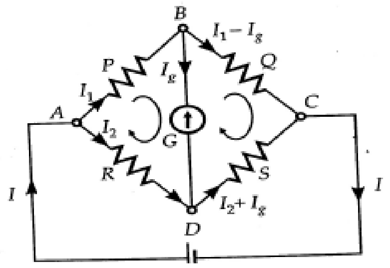




14. The equivalent emf of Parallel Combination of 2 cells $\varepsilon_{eq} = (\varepsilon_1 r_2 + \varepsilon_1 r_2)/$ ($r_1 + r_2$) and $r_{eq} = \frac{r_1 r_2}{r1 + r2}$

15. Kirchhoff's Law – (i) **Current law/Junction law/kirchhoff's 1st law** – The algebraic sum of currents at any junction is zero OR the sum of currents entering a junction is equal to the sum of currents leaving that junction. It is based on the principle of conservation of charge $\sum I = 0$. The currents flowing towards the junction taken positive and away from the junction taken negative.

(ii) **Loop rule/ Kirchhoff's 2nd law** – The algebraic sum of the emfs in any loop is equal to the sum of potential drop. $\sum \varepsilon = \sum I$ R. The emf of cell is taken positive if the direction of travels is from its negative to positive terminal. It is based on the principle of energy conservation.

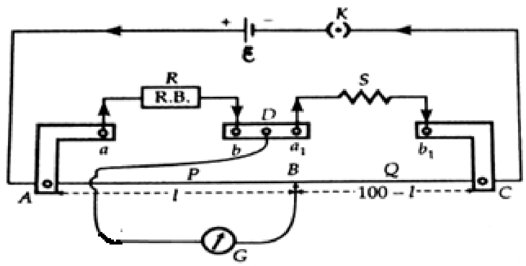


16.Wheatstone bridge: It is an arrangement of four resistors.

When $V_B = V_D$ $then$ $\frac{P}{Q} = \frac{R}{S}$ (Balance Condition)

It work as a sensitive device when all four resistances are of the same order.

17.The meter bridge/sliding wire bridge - It is a device that based on the principle of Wheatstone bridge.



The unknown resistance S = $\frac{QR}{P}$

In the sliding wire bridge if balance point obtained at l cm from point A then $\frac{P}{Q} = \frac{R}{S} = \frac{l}{100-l}$

Then S = $\left(\frac{100-l}{l}\right)$R

The thick copper strips are used for connection because

To minimize the resistance of copper strips. If in the balancing condition the cell and galvanometer are inter change then there is no change in the balancing point.

18.Potentiometer: The Potentiometer is used to measure the potential difference / emf of a cell accurately as based on the null deflection method. It behaves as an ideal voltmeter. **Its principle -** When a constant current flows through a wire of uniform cross section area, then **V ∝ l Or V = k l**

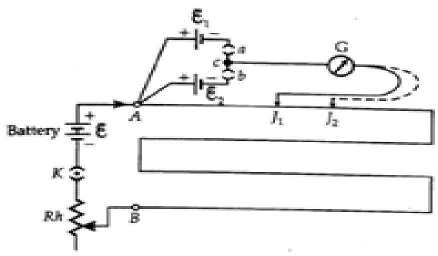
Or k = $\frac{V}{l}$ = Potential gradient and its SI unit V/m.

Its sensitivity increases by increasing the length of the wire. It can be used

(i) To compare the emfs of two cells

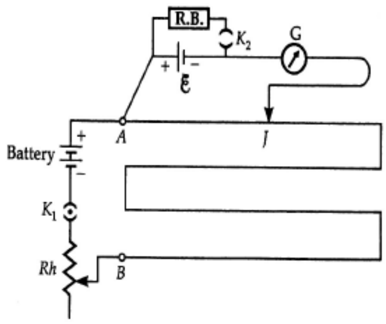
$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$$

if one of the two cells is a standard cell of known emf, then emf of the other cell can be determined.



$$\varepsilon_1 = \frac{l_1}{l_2}\varepsilon_2$$

(ii) To find the internal resistance of a cell



$$r = R\left[\frac{l_1 - l_2}{l_2}\right]$$

Q1. Derive an expression for drift velocity of free electrons in a conductor in terms of relaxation time. and establish a relation between current and drift velocity. (2015,2018)

Q2. State the working principle of a potentiometer. Explain with the help of a circuit diagram, how the emfs of two primary cells are compared by using a potentiometer. How can the sensitivity of a potentiometer be increased? (2015, 2018)

Q3. Two cells of emfs 1.5 V and 2.0 V and internal resistances 1 Ω and 2 Ω respectively are connected in parallel so as to send current in the same direction through an external resistance of 5Ω.

(i) Draw the circuit diagram. (ii) Using Kirchhoff's law calculate

(a) Current through each branch of the circuit. (a) P.D. across the 5 Ω resistance. (2015, 2017,2019)

Q4. In the given circuit diagram of a potentiometer for determining the emf ε of a cell of negligible internal resistance. (2016, 2018)

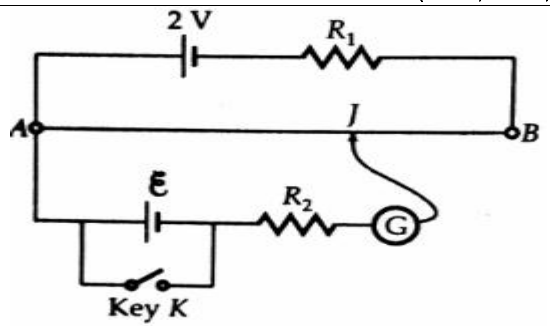
(i) What is the purpose of using high resistance R_2?

(ii) How does the position of balancing point change when the resistance R_1 is increased.

(iii) Why cannot the balance point be obtained.

(a) when the emf ε is greater than 2 V and

(b) when the key K is closed?



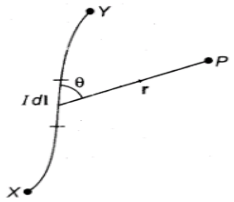
Q5. State, with the help of a suitable diagram, the principle on which the working of the meter bridge is based. Under what condition is the error in the determining the unknown resistance minimized? [2013-15]

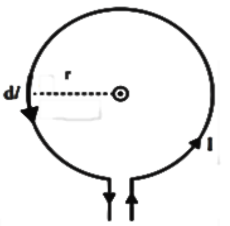
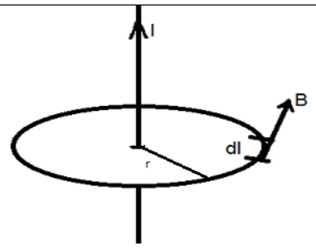
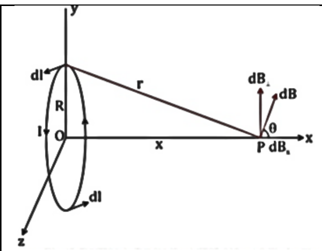
Chapter 4,5 Magnetic effect of current and Magnetism

Biot-Savart law: This law gives the magnetic field at some point in space in terms of the current that produces the field. The magnitude of magnetic field induction dB at point P due to current elements depends upon

(1) dB ∝ dl (2) dB ∝ Sin ϴ (3) dB ∝ I (4) dB ∝ $\frac{1}{r2}$

dB = K $\frac{Idl\,Sin\theta}{r^2}$ Here K is a constant of proportionality depends upon nature of the medium and the system of units chosen. **K** = $\frac{\mu_0}{4\pi}$ (μ_0 is the permeability of free space)

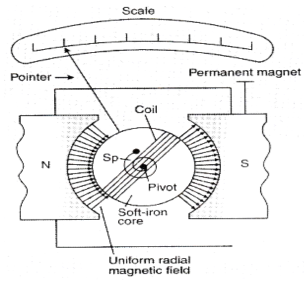


		
Magnetic field at the centre of a current carrying circular loop **B=**$\frac{\mu_0 I}{2r}$ (r = radius of the loop)	Magnetic Field due to a straight current carrying wire of infinite length **B** = $\frac{\mu_0 I}{2\pi r}$	Magnetic field on the axial line of a current carrying circular loop **B** =$\frac{\mu_0 I R^2}{2(R^2+x^2)^{\frac{3}{2}}}$

1. Force F on a straight conductor of length l and carrying a steady current i placed in a uniform external magnetic field B is given as $\vec{F}$ = i ($\vec{l}\ x\ \vec{B}$)
2. **Lorentz Force**: Force on a charge q moving with velocity v in the presence of magnetic field$B$ is given as $\vec{F}$ = q ($\vec{v}\ x\ \vec{B}$)
   (a) When ($\vec{v} \parallel \vec{B}$) path of moving charge will be straight line **(b)** When ($\vec{v} \perp \vec{B}$) path of moving charge will be circular
3. **Ampere's Circuital Law**: For an open surface S bounded by a loop C, then the Ampere's law states that **∫(** $\vec{B}\,.\,\vec{dl}$) = μ_0I
   Where **I** refers to the current passing through S.
4. Magnetic field B inside a long Solenoid carrying a current i is given as B= $\mu_0 ni$, where $n$is the number of turns per unit length.
5. **Magnetic Moment of a Planar Loop**: Magnetic moment **M** of a planar loop carrying a current I, having N closely wound turns, and an area A, is **M = NIA.**

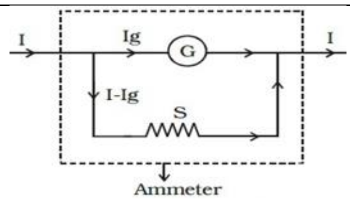
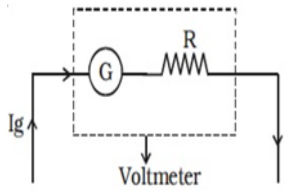
6. **Magnetic Moment of a revolving Electron**: An electron moving around the nucleus has a magnetic moment μ_l is given by
$\mu_l = \frac{e}{2m} l$. Here l is the magnitude of the angular momentum of the circulating electron about the nucleus. The smallest value of μ_l is called the Bohr Magneton μ_b.

7. **Moving Coil Galvanometer:** ~~In a~~ moving coil galvanometer the deflecting torque due to current in the coil is balanced by the restoring couple due to elasticity of spring supporting the coil. So if C is the restoring couple per unit twist and ϕ is the deflection of the coil, then we can say **BINA = Cϕ**. **I = Kϕ** with **K = C/BNA (Galvanometer constant)**
Current sensitivity $\frac{\phi}{I} = \frac{BNA}{C}$ Obviously for greater current sensitivity of galvanometer the number of turns N, area of coil A and magnetic field B produced by pole pieces should be larger and torsional rigidity C should be smaller. That is why the suspension wire is used of phosphor bronze for which torsional rigidity C is smaller.
Voltage sensitivity $\frac{\phi}{V} = \frac{BNA}{RC}$ is defined as the deflection produced in the galvanometer when unit voltage is applied across the two terminals of the galvanometer.
Concept of radial magnetic field: Radial magnetic field is that field, in which the plane of the coil in all positions is parallel to the direction of the magnetic field.

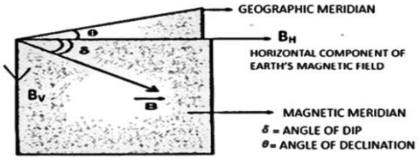


8. **Bohr Magnetron or magnetic dipole moment of an atom due to revolving electron**: A revolving electron is like a loop of current, which has a definite magnetic dipole moment. If e is the charge n an electron revolving in an orbit of radius r with uniform angular velocity ω, then equivalent current
I = $\frac{e}{T}$ ⟹ I = $\frac{e\omega}{2\pi}$ area of orbit **A = πr²**, so magnetic moment of the atom is given as **M** = $\frac{1}{2}e\omega r^2$
Bohr Magneton: Minimum value of magnetic dipole moment associated with an atom due to orbital motion of an electron in the first stationary orbit f the atom. μ_b **= 9.27 x10⁻²⁴ ampere meter²**

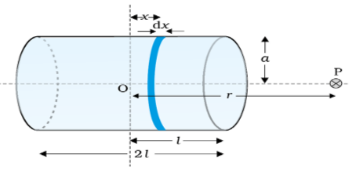
9.

	
Conversion of galvanometer into an ammeter: A galvanometer can be converted into an ammeter by using a low resistance wire in parallel with the galvanometer. Value of shunt resistance S = $\frac{Ig}{I-Ig}$ G, Effective resistance of an ammeter $\frac{1}{R} = \frac{1}{G} + \frac{1}{S}$	**Conversion of galvanometer into voltmeter:** A galvanometer can be converted into a voltmeter by connecting a high resistance in series with galvanometer. Value of resistance R = $\frac{V}{Ig} - G$, Effective resistance of voltmeter= R+ g

10. <u>**Magnetic elements of earth**</u>: Quantities which describe completely in magnitude as well as in direction, the magnetic field of earth at that place.
Magnetic declination: The angle between magnetic axis and geographical axis at a place is defined as the magnetic declination at that place. It is also known as the angle between magnetic meridian and geographical meridian at that place.

Magnetic meridian: A vertical plane passing through the N-S line of a freely suspended magnet. **Geographical meridian**: Vertical plane passing through the geographical N-S direction. **Magnetic dip**: Angle which the direction of the total strength of earth's magnetic field makes with a horizontal line in magnetic meridian. Angle of dip on the magnetic equator is zero and at the magnetic pole is 90^{0}. **Horizontal component of earth magnetic field: $B_H = B \cos \delta$** **Vertical component of earth magnetic field: $B_V = B \sin \delta$**	

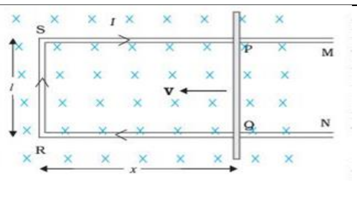
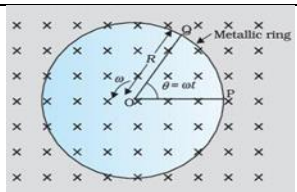
11. **Bar magnet as an equivalent solenoid**: Magnetic field lines of a bar magnet and a current carrying solenoid resembles very closely. Therefore, a bar magnet can be thought of as a large number of circulating currents in analogy with a solenoid. Magnetic field on the axial line of a solenoid and a bar magnet is same given as $B = \frac{2KM}{r^3}$



12. When a charge particle enters in a uniform magnetic field perpendicularly it moves on a circular path, the necessary centripetal force is provided by magnetic force, so **$qvB = mv^2/r$** using this relation we can find the radius of circular path.
Radius of circular path= $\frac{mv}{qB}$ Angular velocity $\omega = \frac{qB}{m}$ Frequency of rotation = $\frac{qB}{2\pi m}$ Time period of revolution = $\frac{2\pi m}{qB}$
13. **Force between two parallel current carrying conductors**: Two linear parallel current conductors carrying current in the same direction attract each other, while in opposite direction repel each other. Using right hand rule and magnetic field due to a straight infinite long conductor we can derive force per unit length of a conductor $F = \frac{\mu_0}{2\pi r} I_1 I_2$
$F = 2\times10^{-7}$ N/m

Chapter 6 Electromagnetic Induction

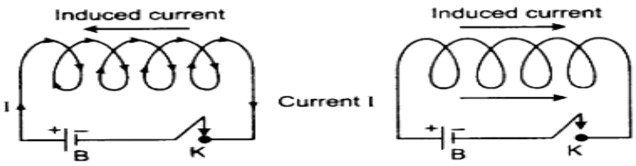
1. **Magnetic flux**: The magnetic flux linked with any surface is equal to total number of magnetic lines of force passing through it. It is a scalar quantity. **SI** unit of flux is **Weber** and **CGS** unit is **Maxwell**. **1Weber = 10^8 Maxwell**.
2. **Faradays law of EMI:** whenever magnetic flux linked with the closed loop or circuit changes, an emf is induced in the loop or circuit which lasts so long as change in flux continues.
Second law: The induced emf in a closed loop is directly proportional to the rate of change of magnetic flux linked with the close loop. The induce emf is given as $\varepsilon \propto \frac{d\phi}{dt}$ or $\varepsilon = N\frac{d\phi}{dt}$, where N is the number of turns in loop.
3. **Lenz's law**: The direction of induced emf or induced current is such that it always opposes the cause that produce it i.e. change in flux linked with the loop or circuit. Lenz law is a consequence of law of conservation of energy.
Induced current: $I = \frac{\varepsilon}{R} = -\frac{N}{R}\frac{d\phi}{dt}$ and induce emf is given as $\varepsilon = -N\frac{d\phi}{dt}$
4. **Motional Emf**

	
The emf induced in a conductor of length l moving with velocity v in a direction perpendicular to magnetic field **B** is given by $\varepsilon = Bvl$	The induce emf developed between two ends of conductor of length **l** rotating with angular velocity **ω** about one end in a direction perpendicular to magnetic field **B** is given by the relation $\varepsilon = \frac{e\omega l^2}{2}$

5. **Eddy currents:** These are loops of electric current induced in a bulk piece of conductors by a changing magnetic field in the conductor. According to the Lenz law of induction it causes the heating of the conductor.

6. **Self-induction:** whenever the electric current passing through a coil changes, the magnetic flux linked with it also change. As a result of this, in accordance with faraday law an emf is induced which opposes the changes that causes it. This phenomenon is called **self-induction** and the emf induced is known as **back emf**.

ϕ ∝ I or **ϕ = LI,** L is called coefficient of self-induction which depends on number of turns, material of coil and area of cross section. **L =** $\frac{\phi}{I}$ or **L = --** $\frac{\varepsilon}{dI/dt}$ **unit – Henry**



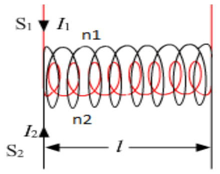
(a) Key is pressed (b) Key is opened

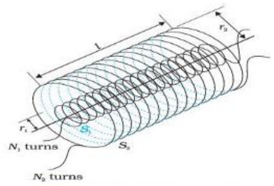
7. **Mutual induction:** The phenomenon of generation of induced emf in secondary coil when current linked with primary coil changes, **ϕ ∝ MI** or **M =** $\frac{\phi}{I}$ here M is the coefficient of mutual induction. Unit --- Henry

8. **Self-induction coefficient of a long solenoid:** A long solenoid is that whose length is very large as compare to its area of cross section. The magnetic field B at any point inside a solenoid is given as **B =** $\frac{\mu_0 NI}{l}$

- Flux linked with solenoid **ϕ = NAB =** $NA\frac{\mu_0 NI}{l} = \frac{\mu_0 N^2 IA}{l}$ compare with **ϕ = LI** we get **L =** $\frac{\mu_0 N^2 A}{l}$

9. **Mutual induction coefficient of two long coaxial solenoids:** Let n_1 be the number of turns per unit length of inner solenoid S_1 of radius r_1, n_2 be the number of turns per unit length of outer solenoid S_2 of radius r_2. A changing current I_2 in coil S_2 produces a changing flux through S_1. So $\boldsymbol{\phi_1 = M_{12} I_2}$. Flux through S_1 is $\boldsymbol{\phi_1 = B_2 A_1 N_1 = \mu_0 n_2 I_2 (\pi r^2)(n_1 L)}$ so we get from these two relations of ϕ_1 the expression of M_{12} which is equal to $\boldsymbol{M_{12} = \mu_0 n_1 n_2 \pi r^2 L}$**.**





10. **Magnetic energy stored in an inductor U =** $\frac{LI^2}{2}$

Consider an inductor of inductance L, carrying alternating current through It. Suppose at any instant of time an emf induced in the inductor is $\boldsymbol{\varepsilon = L\frac{dI}{dt}}$. To maintain the growth of current through the inductor, power has to be supplied from external source**. P =** $\frac{dW}{dt} = \varepsilon I = LI\frac{dI}{dt}$**.** Total amount of work done to build up current from zero to I is $\boldsymbol{W = L\int_0^I IdI.}$

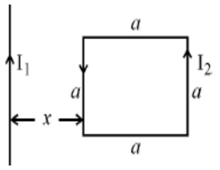
This work is stored as magnetic energy in the inductor**. U =** $\frac{LI^2}{2}$ **Energy density in magnetic field =** $\frac{B^2}{2\mu_0}$

Q1. An electric current is flowing in a circular coil of radius a. at what distance from the centre on the axis of the coil will the magnetic field be 1/8th of its value at the center.

HINT. Magnetic field at the axis at a distance x is $\boldsymbol{B_1 = \frac{\mu_0 2\pi nI\ a^2}{4\pi(a^2+x^2)^{3/2}}}$**,** magnetic field at the centre $\boldsymbol{B_2 = \frac{\mu_0 2\pi nI}{4\pi a}}$

$B_1 = B_2/8$ after substitution we get $\boldsymbol{x = a\sqrt{3}}$

Q2. A square loop of side a carrying a current I_2 is kept at a distance x from an infinitely long straight wire carrying a current I_1 obtain the expression for the resultant force acting on the loop.



Force on side at distance x from straight conductor $F_1 = \frac{\mu_0 I_1 I_2 a}{2\pi x}$

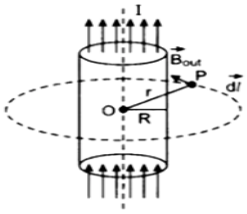
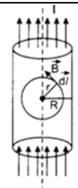
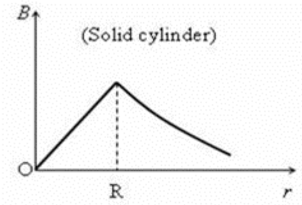
Force on side at distance (x+a) from straight conductor $F_2 = \frac{\mu_0 I_1 I_2 a}{2\pi(x+a)}$

Net force $F = F_1 - F_2$

Q3. A proton, a deuteron and an alpha particle, whose kinetic energies are same, enter perpendicularly a uniform magnetic field. Compare the radii of their circular paths.

HINT: mass of proton $\boldsymbol{m_p = m}$, mass of deuteron $\boldsymbol{m_d = 2m}$, mass of alpha particle $\boldsymbol{m_\alpha = 4m}$, charge on proton $\boldsymbol{q_p = e}$, charge on deuteron $\boldsymbol{q_d = e}$, charge on alpha $\boldsymbol{q_\alpha = 2e}$. Radius $\boldsymbol{r = \frac{mv}{qB}}$, ratio of radii $\boldsymbol{r_p : r_d : r_\alpha = \frac{\sqrt{m_p}}{q_p} : \frac{\sqrt{m_d}}{q_d} : \frac{\sqrt{m_\alpha}}{q_\alpha}}$ so $\boldsymbol{1 : \sqrt{2} : 1}$

Q4. Magnetic field due to current through a very long circular cylinder at a point lying inside cylinder and at a point lying outside the cylinder.

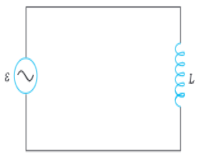
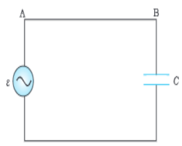
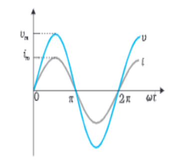
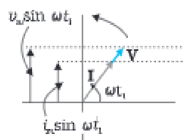
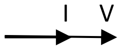
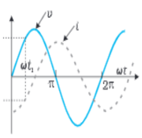
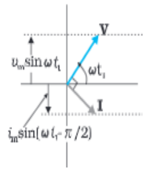
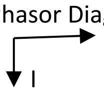
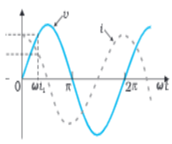
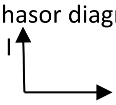
When point is outside the cylinder: Applying ampere circuital law $\int (\vec{B}.\vec{dl}) = \mu_0 I$ $\int Bdl \cos\theta = \mu_0 I$ $B\int dl = \mu_0 I$ $B \times 2\pi r = \mu_0 I$	**When point is inside the cylinder:** $\int Bdl\cos\theta = \mu_0 I''$ or $B\int dl = \mu_0 I''$ or $B \times 2\pi r = \mu_0 I''$ or $B \times 2\pi r = \frac{\mu_0 I r^2}{R^2}$ so we get $B = \frac{\mu_0 \mu_r I r}{2\pi R^2}$
	 Calculation of Magnetic Field at a Point Inside the Cylindrical Conductor 

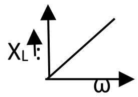
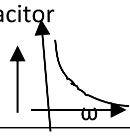
Chapter -7 Alternating current

1. Basic Formulae

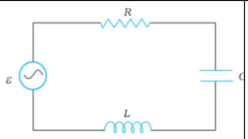
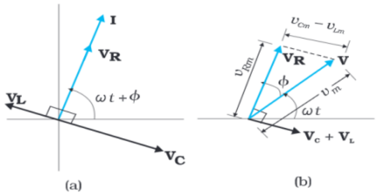
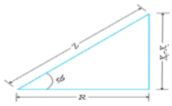
Alternating current $I = I_m \sin \omega t$	Alternating Voltage $V = V_m \sin \omega t$	Power in AC Circuit $P_{av} = V_{rms} I_{rms} \cos\phi$
1.(I_{mean} or I_{av}) full cycle = 0	1. (V_{mean} or V_{av}) full cycle = 0	(ϕ is angle between phase difference in voltage and current) $P_{av} = \frac{1}{R}(V^2_{rms})$ (for R) $P_{av} = 0$ (for L or C)
2.(I_{mean})half cycle Or(I_{av}) = $(\frac{2}{\pi})I_m$ = 0.6361 I_m	2.(V_{mean}) half cycle Or (V_{av}) = $(\frac{2}{\pi})V_m$ =0.6361 V_m	
3. (I_{rms}) = $(\frac{1}{\sqrt{2}}) I_m$ = 0.707 I_m	3. (V_{rms}) = $(\frac{1}{\sqrt{2}}) V_m$ = 0.707 V_m	

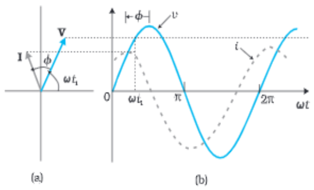
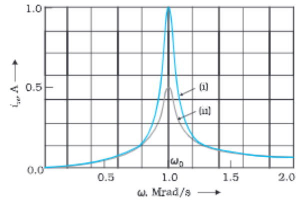
2. AC Circuits

(A) Pure Resistive Circuit		(B) Pure Inductive Circuit		(C)Pure Capacitive Circuit	
	$I = I_m \sin \omega t$ $V = V_m \sin \omega t$		$I = I_m \sin(\omega t - \frac{\pi}{2})$ $V = V_m \sin \omega t$		$I = I_m \sin(\omega t + \frac{\pi}{2})$ $V = V_m \sin \omega t$
2. $I = \frac{V}{R}$, $I = \frac{V_m}{R} \sin \omega t$, $\mathbf{I = I_m \sin \omega t}$ (where $I_m = \frac{V_m}{R}$)		$V_m \sin \omega t = L\frac{dI}{dt}$, Integrating it, $\mathbf{I = I_m \sin(\omega t - \frac{\pi}{2})}$ (where $I_m = \frac{V_m}{X_L}$)		$V_m \sin \omega t = \frac{q}{C}$, $q = C V_m \sin \omega t$, $I = \frac{dq}{dt}$ differentiating, $\mathbf{I = I_m \sin(\omega t + \frac{\pi}{2})}$,where $I_m = \frac{V_m}{X_C}$	
3.There is **NO** Phase difference between V and I **(ϕ=0)** . Current and voltage are in same phase		There is Phase Difference $\boldsymbol{\phi = \frac{\pi}{2}}$ between V and I. Current **lags** behind voltage by $\frac{\pi}{2}$ **.**		There is Phase Difference $\boldsymbol{\phi = \frac{\pi}{2}}$ between V and I. Current **leads** voltage by $\frac{\pi}{2}$.	
 4. Graph of V and I Vs ωt	 Phasor diagram I V 	 Graph of V and I Vs ωt	 Phasor Diagram  V I	 Graph of V and I Vs ωt	 Phasor diagram  I V

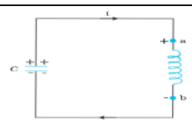
5. Impedance Z = resistance R	5. Impedance Z= X_L = ωL = 2πνL (X_L =Inductive Reactance) Opposition offered by inductor in the flow of AC through it. Unit-Ω 	5. Impedance Z = $X_C = \frac{1}{\omega C} = \frac{1}{2\pi\nu C}$ (X_C = Capacitive Reactance) X_C :Opposition offered by Capacitor in the flow of AC through it. Unit- Ω 

3. Series LCR Circuit

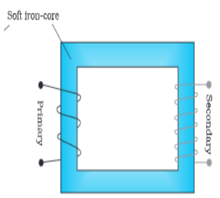
Circuit diagram	Phasor diagram	Impedance(Z) in LCR circuit	Phase difference(ϕ) between V ansd I
		$\mathbf{V_L + V_R + V_C = V}$ $V^2_m = I^2_m (R^2 + (X_C - X_L)^2)$ $I_m = \frac{V_m}{\sqrt{(R^2+(X_C-X_L)^2}} = \frac{V_m}{Z}$ $\mathbf{Z= \sqrt{R^2 + (X_C - X_L)^2}}$ Z: Opposition offered by L, C, R in flow of AC through them. Unit-Ω	$\tan\phi = \frac{V_C - V_L}{V_R}$ $\phi = \tan^{-1}(\frac{X_C - X_L}{R})$ 

Graph between V and I Vs ωt	Resonance condition	Resonant Frequency	Quality Factor Q:	Graph of I_m Vs ω
	$X_C = X_L$, (i) Z=R (minimum), (ii)current maximum , (iii)tan ϕ = $\frac{0}{R}$, ϕ=0, (iv)No Phase difference	$\omega_0 = \frac{1}{\sqrt{LC}}$, $\nu_0 = \frac{1}{2\pi\sqrt{LC}}$	It determines nature of sharpness of resonance. $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ It has no unit	

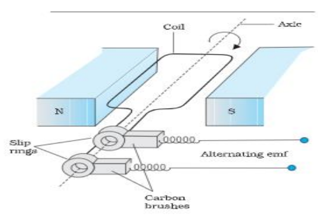
4. LC Oscillations

	Electrical Energy stored in charged Capacitor = $U_E = \frac{1}{2}\frac{q^2}{C}$. The capacitor discharge through Inductor. Electric Energy converts Into magnetic energy. $U_B = \frac{1}{2} LI^2$. Energy oscillates between inductor and capacitor in the form of electric and magnetic field.	Frequency of oscillations $\nu = \frac{1}{2\pi\sqrt{LC}}$

5. Transformer :

	A device used to increase or decrease alternating voltage or alternating current. **Principle**: It works on the principle of Mutual Induction. Whenever magnetic flux of a coil changes due to changing current, then emf is induced in the neighbouring coil.	Induced emf in Primary coil : $\varepsilon_p = -- N_p \frac{d\Phi}{dt}$ Induced emf in Secondary coil : $\varepsilon_s = -- N_S \frac{d\Phi}{dt}$ $\frac{\varepsilon_p}{\varepsilon_s} = \frac{N_p}{N_s}$ --(1) if output power= Input power $\frac{\varepsilon_p}{\varepsilon_s} = \frac{I_S}{I_P}$ --(2)	from (1) and (2), $\frac{\varepsilon_p}{\varepsilon_s} = \frac{N_p}{N_s} = \frac{I_S}{I_P}$ For step up, $N_S > N_p$, $I_S < I_P$ For step down, $N_S < N_p$, $I_S > I_P$ Transformer ratio $\frac{N_S}{N_P}$ =K <u>Losses</u>: Copper heating loss, Eddy currents, flux leakage, hysteresis Efficiency = $\frac{output\ power}{input\ power}$ X 100

6 . **AC Generator :**

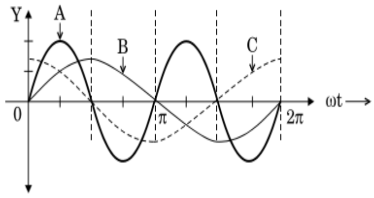
	A device which converts Mechanical energy into Electrical energy. **Principle:** It is based on Electro Magnetic Induction. When a coil rotates continuously in magnetic field, then variation of magnetic flux with time results in production of an alternating emf in the coil.	$\phi = N(\vec{A}\cdot\vec{B}) = NAB\cos\theta$ $= NAB\cos\omega t$ $\varepsilon = -\frac{d\Phi}{dt} = -\frac{d}{dt}(NAB\cos\omega t)$ $\varepsilon = \omega NAB\sin\omega t$	$\varepsilon = \varepsilon_0 \sin\omega t$ $\varepsilon = \varepsilon_0 \sin 2\pi\nu t$, ν- frequency of rotation of generator coil

Q1. An alternating voltage of 220 V is applied across a device X, a current of 0.25 A flows, which lag behind the applied voltage in phase by π/2 radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage. (i) Name the devices X and Y. (ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y. (5 marks , CBSE 18,19)

Q2. (a) State the principle of working of a transformer. (b) Define efficiency of a transformer. (c) State any two factors that reduce the efficiency of a transformer. (d) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is 440 Ω. (5 marks 18, 19, 20)

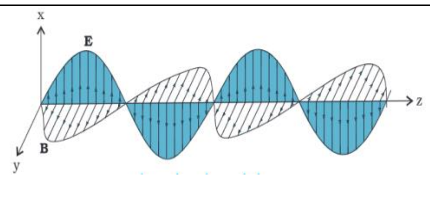
Q3. In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the ac source. (b) What is the phase difference between the voltages across inductor and the capacitor at resonance in the LCR circuit ? (c) When an inductor is connected to a 200 V dc voltage, a current of 1A flows through it. When the same inductor is connected to a 200 V, 50 Hz ac source, only 0.5 A current flows. Explain, why ? Also, calculate the self inductance of the inductor . (5 marks) CBSE 2019

Q4. Draw a labelled diagram of an AC generator. Obtain the expression for the emf induced in the rotating coil of N turns each of cross-sectional area A, in the presence of a magnetic field B 3 marks (2019)

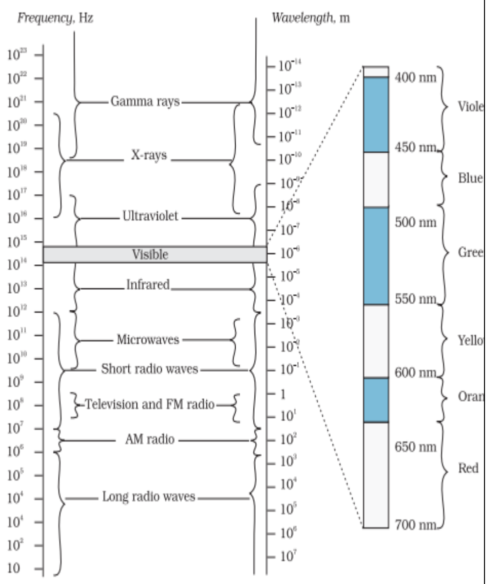
Q5. A device 'X' is connected to an ac source $V = V_0 \sin\omega t$. The variation of voltage, current and power in one cycle is shown in the following graph (a) Identify the device 'X'. (b) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit ? Justify your answer. (c) How does its impedance vary with frequency of the ac source ? Show graphically. (d) Obtain an expression for the current in the circuit and its phase relation with ac voltage. 5Marks (2017)	

Chapter- 8 Electromagnetic waves

Characteristics of EM waves:

1.Waves propagating in space through electric and magnetic fields varying in space and time simultaneously. 2. $\vec{E}$ and $\vec{B}$ are perpendicular to each other as well as to the direction of propagation of wave. So, EM waves are transverse waves. EM waves are produced by accelerating charged particles. 3. Speed of EM waves is given by a) $\frac{E}{B} = c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3 \times 10^8$ m/s (in free space) b) b) $v = \frac{1}{\mu\varepsilon} = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{c}{n}$, n is refractive index of medium (in medium) 4. EM waves are neutral so , they are not deflected by Electric and Magnetic fields. 5. The average value of electric energy density and magnetic energy density are equal $(\frac{1}{2}\varepsilon_0 E^2)_{av} = (\frac{1}{2}\frac{B^2}{\mu_0})_{av}$ EM waves carry Energy and momentum. $E = \frac{hc}{\lambda}$, P= mc	 Equations of Electric and magnetic field: $\vec{E} = E_0 \sin(\omega t - kz)\ \hat{i}$ $\vec{B} = B_0 \sin(\omega t - kz)\ \hat{j}$

Spectrum of EM waves



Uses of EM Waves

Waves	Production	Uses
1. Gamma Rays	Radio active decay of nucleus	Treatment of cancer, finds flaw in metals, sterilize equipment's
2. X- Rays	Transition of electrons from higher energy level to lower energy level.	Diagnostic tool in medicine, to study crystal structure, to find fracture in bones.
3.Ultra violet Rays	Moving electrons from higher energy level to lower	Used in water purifier, burglar alarms, finger prints, detect forgery, LASIK
4. Visible light	Accelerated charged particle	Photosynthesis and plant growth, LASER and optical fibers, to see objects
5. Infra red	Vibrations of atoms and molecules of hot bodies	Photography through haze fog, weather forecasting, Physiotherapy, green house effect
6. Micro waves	Produced in Klystron Valve or Magnetron valve	RADAR system, microwave oven, Communication
7.Radio Waves	Accelerated charged Particle	Radio communication, Radio Astronomy

Q1. How are EM waves produced by oscillating charges ? Draw a sketch of linearly polarized EM waves propagating in the Z-direction. Indicate the directions of the oscillating electric and magnetic fields. 3Marks (2016)

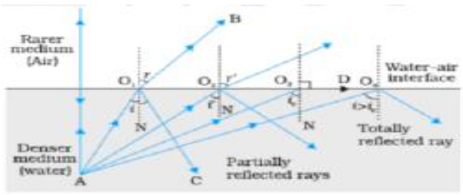
Q2. (a) Identify the part of the electromagnetic spectrum used in (i) RADAR and (ii) LASIK eye surgery. Write their frequency range.. 3Marks (2019)

Q3. Give one use of electromagnetic radiations produced in nuclear disintegrations. 1 Marks (2018)

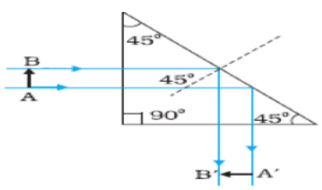
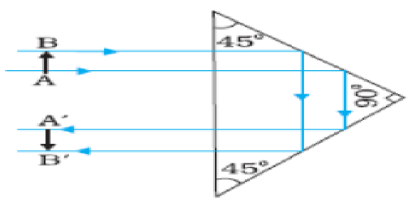
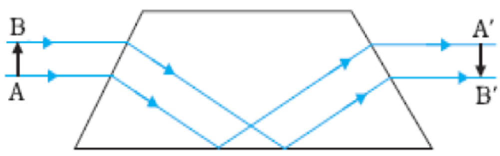
Q4. How are infra red waves produced? Write their 1 important use. 2 Marks(2016,19)

Q5. How are infra red waves produced? Write their 1 important use. 2 Marks(2016,19)

Chapter 9 Ray Optics and optical Instruments

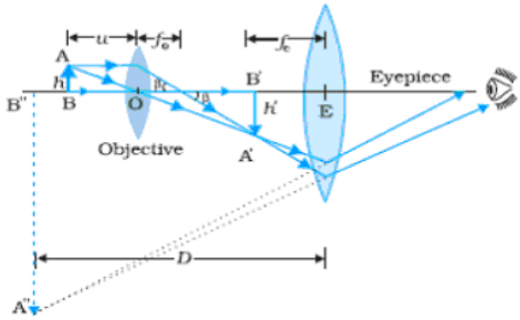
1.Total internal reflection. The phenomenon of reflection of light that takes place when a ray of light traveling in a denser medium gets incident at the interface of the two media at an angle greater than the critical angle for that pair of media **Conditions :** (a) Ray should travel from denser medium to rarer medium. (b) Angle of incidence should be greater than the critical angle for the pair of media ($i>i_C$)	.  *Total internal reflection*	Relation between refractive index and critical angle for a given pair of media Relation At $i=i_C$ and $r=90^0$ According to snell's law $\mu_2 \sin i = \mu_1 \sin r,\ \mu = \frac{\mu_2}{\mu_1} = \frac{\sin r}{\sin i}$ $= \frac{\sin 90}{\sin i_C}$ $\mu = \frac{1}{\sin i_C}$

2. Deviation of ray through right isosceles prism (Condition : the critical angle i_c the prism must be less than 45°.

(i) A ray deviates through 90°	**(ii) A ray deviates through 180°**	**(iii) invert an image without deviation using totally reflecting prism**
 (a)	 (b)	 (c)

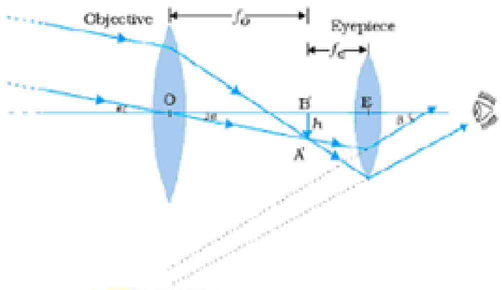
5. A compound microscope, when the final image is formed at LDDV
objective lens: very small focal length, small aperture, eye piece: large focal length and large aperture

Magnifying power $M = -\frac{L}{f_o}\left(1+\frac{D}{f_e}\right)$



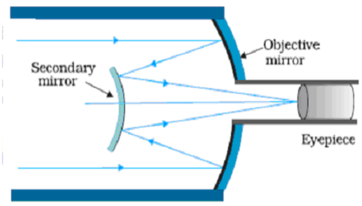
6. A refracting telescope at Normal adjustment.
Objective lens: very large focal length, large aperture, eye piece: small focal length and small aperture

Magnifying power in normal adjustment,
$M = -\frac{f_o}{f_e}$



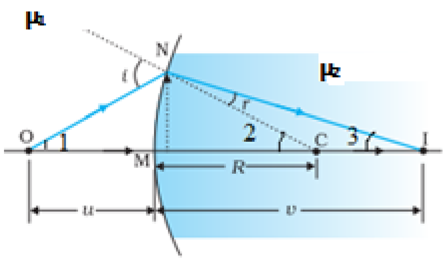
7. A Reflecting type telescope.
Objective: large concave parabolic mirror
eye piece: placed on the axis of the telescope

Magnifying power: $M = -\frac{f_o}{f_e}$



8. Power of a lens. It is defined as the reciprocal of the focal length of the lens .Its S.I. unit is Dioptre (D)
(i) $P = \frac{1}{f}$; (ii) $P = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

9. Refraction through spherical surface
Assumption (i) Point object lying on principal axis,(ii) small aperture,(iii) small angle of incidence and angle of refraction.
When object is situated in the rarer medium



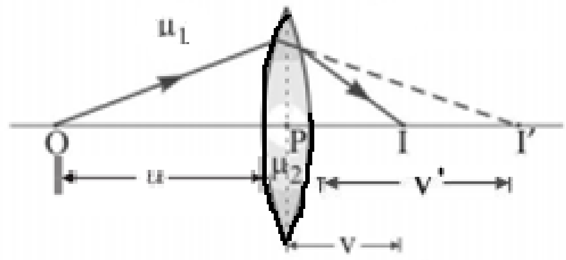
$i = \angle 1 + \angle 2 = \frac{MN}{OM} + \frac{MN}{MC}$, $r = \angle 2 - \angle 3 = \frac{MN}{MC} - \frac{MN}{MI}$
By Snell's law $\mu_1 \sin i = \mu_2 \sin r$ or for small angles $\mu_1 i = \mu_2 r$
Substituting i and r and using sign convention
OM = –u, MI = +v, MC = +R

$$\frac{-\mu_1}{u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$$

(ii) When object is situated in the denser medium

$$\frac{-\mu_2}{u} + \frac{\mu_1}{v} = \frac{\mu_1 - \mu_2}{R}$$ (obtained by interchanging μ_1 and μ_2)

10.Lens maker's formula



By refraction through first surface

$$\frac{-\mu_1}{u} + \frac{\mu_2}{v'} = \frac{\mu_2 - \mu_1}{R_1} \quad ....(1)$$

$$\frac{-\mu_2}{v'} + \frac{\mu_1}{v} = \frac{\mu_1 - \mu_2}{R_2} \quad ....(2)$$

Adding (1) and (2)

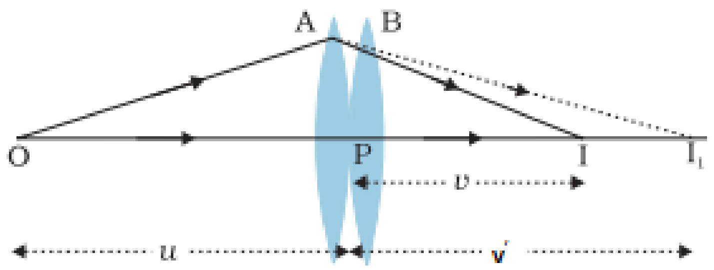
$$\frac{-\mu_1}{u} + \frac{\mu_1}{v} = (\mu_2 - \mu_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

Dividing by μ_1,we get

$$\frac{-1}{u} + \frac{1}{v} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{(where } \mu = \frac{\mu_2}{\mu_1}$$

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

11. Combination of thin lenses in contact



$$\frac{1}{f_1} = \frac{1}{v'} - \frac{1}{u}$$

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v'}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$P = P_1 + P_2$

questions Q1. Draw a schematic ray diagram of reflecting telescope showing how rays coming from a distant object are received at the eye-piece. Write its two important advantages over a refracting telescope **(2016,17)**

Q2.Draw a ray diagram depicting the formation of the image by an astronomical telescope in normal adjustment

Q3. Under what conditions is the phenomenon of total internal reflection of light observed ? Obtain the relation between the critical angle of incidence and the refractive index of the medium **(2019)**

Q4. There are three lenses. Which two lenses will you use as an eyepiece and as objective to construct a compound microscope? **(2017)**

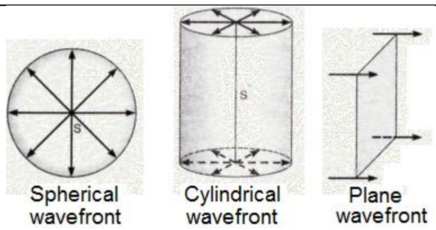
Lenses	Power (D)	Aperture (cm)
L_1	3	8
L_2	6	1
L_3	10	1

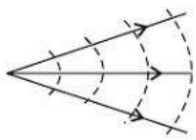
Q5 .A triangular prism of refracting angle 60^o is made of a transparent material of refractive index $2/\sqrt{3}$.A ray of light is incident normally on the one of its face. Trace the path of the ray as it passes through the prism and calculate the angle of emergence and angle of deviation**. (2019)**

Chapter 10 WAVE OPTICS

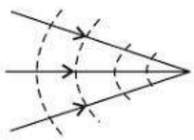
1. Wavefront. The locus of the points in the medium, which at any instant are vibrating in the same phase.

Types of wave fronts (i) spherical (ii) cylindrical (iii) plane (iv) Diverging (iv) converging wave front





Diverging rays
(Diverging spherical wavefront)

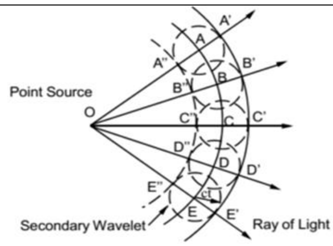


Converging rays
(Converging spherical wavefront)

2. **Huygens' principle**

a. Each point on a given wave front acts as a source of secondary wavelets, sending out disturbance in all directions in a similar manner as the original source of light does.

b. The new position of the wave front at any instant is the forward envelope of the secondary wavelets at that instant.

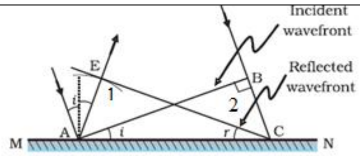


3**. Laws of reflection on the basis of Huygens's principle**.

AB = EC =ct, ∠1 =∠2 = 90° and AC is common

ΔAEC ≅ΔCBA

therefore ∠i= ∠r



Reflection of a plane wave AB by the reflecting surface MN. AB and CE represent incident and reflected wavefronts.

4. **Laws of refraction on the basis of Huygens's principle**

sin i = v_1t/AC

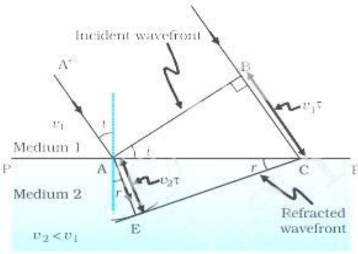
sin r= v_2t/AC

$= \frac{\sin i}{\sin r} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2}$

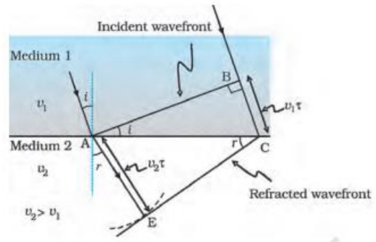
$\mu_1 = c/v_1$, $\mu_2 = c/v_2$,

$\frac{v_1}{v_2} = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r}$ = μ (snell's law)

(i) Rarer to denser



(ii) Denser to rarer



5. Coherent sources of light: Sources of light emitting waves of same frequency having zero or constant phase difference.

6. **Interference of light**: Redistribution of the intensity, when two light waves of same frequency having zero or constant phase difference superimpose on each other. (Resultant intensity: $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\emptyset$)

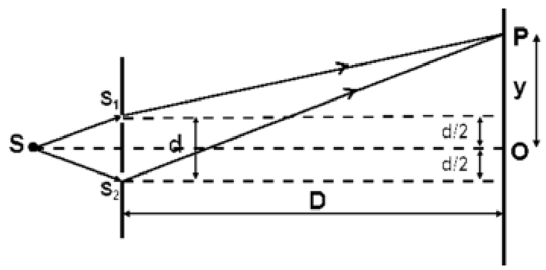
If $I_1 = I_2 = I_o$; $I = 2(1+\cos\emptyset) = 4 I_o \cos^2\frac{\emptyset}{2}$

Constructive interference	**Destructive interference**
The interference taking place at points of maximum intensity	The interference taking place at points of minimum intensity.
Condition : Phase difference, $\phi = 2n\pi$	Condition : Phase difference, $\phi = (2n-1)\pi$
Path difference, $\Delta = n\lambda$ where, n = 0, 1, 2, 3,…	Path difference, $\Delta = (2n-1)\lambda/2$ where, n = 1, 2, 3, …
Resultant intensity at the point of observation will be maximum	Resultant intensity at the point of observation will be minimum
$I_{max} = 4I_0$	$I_{min} = 0$

7. Sustained interference pattern: Position of maxima and minima of intensity on the screen do not change with time.

Conditions :(i) Sources should be coherent;(ii) amplitude of the interfering waves should be same;(iii) Source should be monochromatic ;(iv) distance between the sources should be small and large distance between sources and scree

8. Expression of interference fringe width in YDSE



Path difference $\Delta = S_2P - S_1P$

$S_2P^2 - S_1P^2 = \left[D^2 + \left(y + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(y - \frac{d}{2}\right)^2\right]$

$(S_2P - S_1P)(S_2P + S_1P) = 2yd$

$(S_2P - S_1P) = \Delta = \frac{2yd}{2D} = \frac{yd}{D}$ **(as $S_2P \approx S_1P \approx D$)**

Position of bright fringe:

$\Delta = \frac{yd}{D} = n\lambda$ $y_n = \frac{n\lambda D}{d}$ where, n = 0, 1, 2, 3,…

Position of dark fringe: $\Delta = \frac{yd}{D} = (2n-1)\lambda/2$ $y_n = \frac{(2n-1)\lambda D}{2d}$

where, n = 1, 2, 3,…

9.Fringe Width :The distance between the centres of two consecutive bright or dark fringes is called the fringe width. $\beta = \frac{\lambda D}{d}$

The angular fringe width is given by $\theta = \frac{\beta}{D} = \lambda / d$.

Width of a dark fringe $y_n - y_{n-1} = \beta = \frac{\lambda D}{d}$

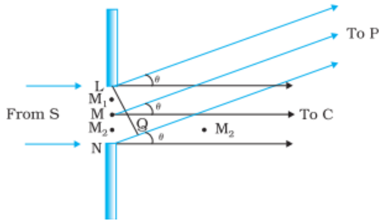
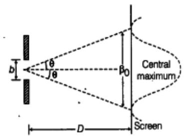
Width of a bright fringe $y'_n - y'_{n-1} = \beta = \frac{\lambda D}{d}$

10. **Ratio of slit widths in YDSE** $\frac{\omega_1}{\omega_2} = \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2}$

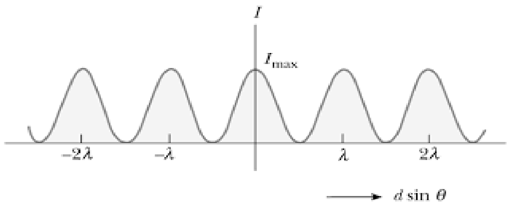
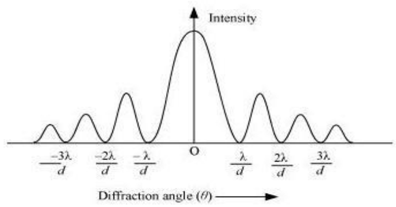
11. **Intensity at maxima** $I_{max} \propto (a_1 + a_2)^2$

12. **Intensity at minima** $I_{min} \propto (a_1 - a_2)^2$

13. **Intensity ratio at maxima and minima,** $\frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \left(\frac{r+1}{r-1}\right)^2$ where r $=\frac{a_1}{a_2}$

14. Single slit diffraction : bending of light at sharp corners  	Path difference NP – LP = NQ =LN sinθ = a sinθ **Condition for Minima b sinθ = nλ ,n=1,2,3……** **Condition for secondary Maxima b sinθ =(2 n + 1)λ/2 ,n=1,2,3……** **Angular width = θ = λ/b** **Angular width of Central Maximum = 2θ = 2 λ/b** **Linear width =** $\frac{2\lambda D}{b}$

15. Difference between Diffraction and Interference

Interference	Diffraction
It is due to superposition of two distinct waves coming from two coherent sources.	It is due to superposition of the secondary wavelets that emerge from the different parts of the same wave front.
The intensity of all the points on maxima is of similar intensity	Intensity goes on decreasing as diffraction band increases
The intensity of minima is generally zero.	The intensity of minima is never zero.
The widths of the fringes are equal.	Width of central maxima is twice the width of other fringes
	

1. Derive the expression for the intensity at a point of the interference pattern in YDSE. **(2018,2019)**
2. Define the term wave front. Using Huygens's wave theory, verify the law of reflection. **(2019)**
3. Define the term, "refractive index" of a medium. Verify Snell's law of refraction when a plane wave front is propagating from a denser to a rarer medium. **(2017,2019,2020)**
4. In the diffraction due to a single slit experiment, the aperture of the slit is 3 mm. If monochromatic light of wavelength 620 nm is incident normally on the slit, calculate the separation between the first order minima and the 3rd order maxima on one side of the screen. The distance between the slit and the screen is 1.5 m **(2019)**
5. Describe any two characteristic features which distinguish between interference and diffraction phenomena. Derive the expression for the intensity at a point of the interference pattern in Young's double slit experiment. **(2019)**

Chapter-11 Dual nature of Matter and Radiation

1. Concept of photon—

(i) Light is propagated in terms of bundles of energy called photons. (ii) Rest mass of photon is zero. (iii)Energy of photon is E= hv =h $\frac{c}{\lambda}$ (iv)Linear momentum of photon is p = h/λ = h $\frac{\nu}{c}$

2. Photo Electric effect—

Phenomenon of emission of electrons from a photo sensitive metallic surface, when photons of suitable energy (above threshold frequency) are incident upon it.

3. Laws of Photoelectric Emission—

(i) Photon requires a minimum threshold frequency to eject the electrons from metal surface.
(ii) Number of ejected electrons per unit time is proportional to the intensity of incident photons.
(iii) Kinetic Energy of ejected electrons depends upon frequency of photons and not on intensity of photons.
(iv) It is an instantaneous process.
(v) It is one to one interaction, i.e. one photon can eject maximum one electron.

4. Important Formulae:

(i) **Einstein's Photo Electric Equation**: $eV_0 = h\nu - \phi_0$, where ϕ_0(work function) = $h\nu_0$(ν_0 is threshold frequency)

(ii) **de- Broglie Wavelength** $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m\,E_k}} = \frac{h}{\sqrt{2mqV}}$,

where E_k = Kinetic energy of particle, V = potential associated with charged particles

5. Definitions:

(i) **Intensity of Radiation**: photon energy incident per m^2 per sec. S.I. Unit - W/m^2 or $J/s\,m^2$
(ii) **Threshold frequency (ν_0)** : Minimum frequency of incident radiation for photo electric emission.
(iii) **Stopping potential or cut off Voltage (V_0)** : Minimum retarding potential of anode for which photocurrent becomes zero.
(iv) **Work function (ϕ_0)** : Minimum Energy required to free an electron from metallic surface.

6. Characteristics of Photo Electric Emission :

Effect of intensity:	Variation of photo current with potential (at constant frequency)	Variation of stopping potential with frequency (at constant current)	Variation of stopping potential with frequency

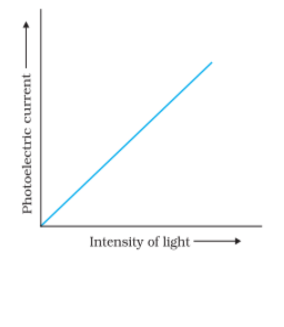
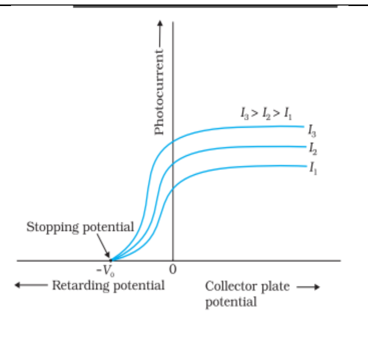
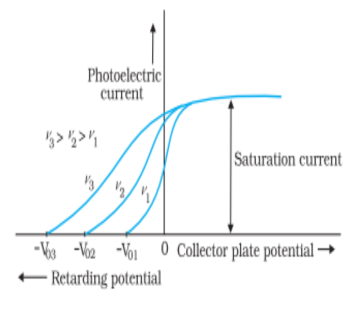
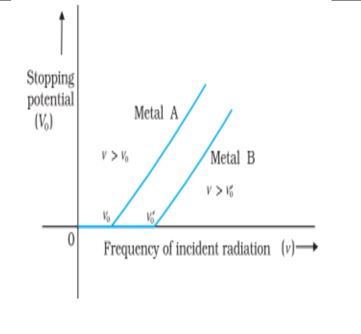

			

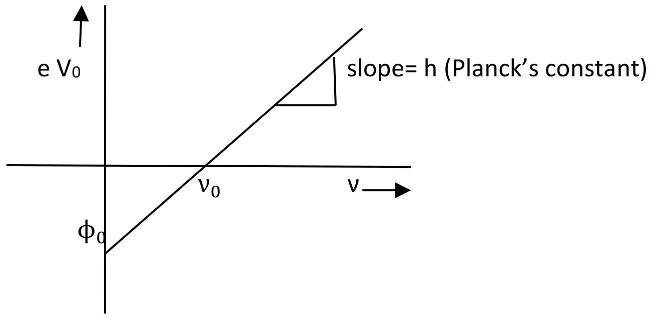
Photo electric current increases with increase in intensity of incident photon.	With the increase in intensity, saturation current increases but stopping potential remains the same.	(i)With the change in frequency, stopping potential changes but saturation current remains same. (ii)The stopping potential is more negative for higher frequencies of incident radiation.	(i) The stopping potential V_0 varies linearly with the frequency of incident radiation for a given photosensitive material. (ii) There exists a certain minimum cut-off frequency ν_0 for which the stopping potential is zero.

From above graphs, it is observed that,

(i) The maximum kinetic energy of the photoelectrons varies linearly with the frequency of incident radiation, but is independent of its intensity.
(ii) For a frequency ν of incident radiation, lower than the cut-off frequency ν_0, no photoelectric emission is possible even if the intensity is large.

7.Einstein's Photo Electric Equation:
The equation is based on conservation of energy.

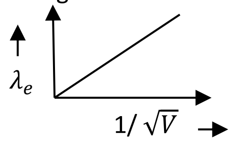
$$h\nu = \phi_0 + \frac{1}{2} m v^2$$
$$\frac{1}{2} m v^2 = eV_0 = h\nu - \phi_0$$
$$V_0 = \frac{h}{e}\nu - \frac{\phi_0}{e}$$



8. Matter waves:

The waves associated with moving particles is regarded as matter waves. According to de Broglie, the wavelength associated with the moving particle is: $\lambda = \frac{h}{p}$, $\lambda = \frac{h}{mv}$, $\lambda = = \frac{h}{\sqrt{2m E_k}} = \frac{h}{\sqrt{2mqV}}$

de Broglie wavelength of electron is $\lambda_e = \frac{12.27}{\sqrt{V}}$



9. Questions:

Q1. Write 3 characteristic features of photo Electric Effect, which cannot be explained by wave theory. (13, 15, 16, 17, 19)

Ans: (i) K.E is independent of intensity of incident light (ii) No emission of electrons takes place, if frequency of incident light is below threshold frequency. (iii) Photo electric Effect is an instantaneous process.

Q2. A proton and an alpha particle are scattered through the same potential. Which of the two has –

(i) greater de Broglie wavelength (ii) less kinetic energy? (CBSE 14, 16, 17, 20)

Ans: (i) $\lambda = \frac{h}{\sqrt{2mqV}}$, for same potential, $\lambda \propto \frac{1}{\sqrt{mq}}$, $m_\alpha = 4\, m_p$, $\lambda_p : \lambda_\alpha = 2\sqrt{2} : 1$ so $\lambda_p > \lambda_\alpha$

(ii). $E_k = q\, V_0$, for same potential V_0 , E (p) : E (α) = $q_p : q_\alpha$ = 1: 2 so, proton has less KE than alpha particle.

Q3. Draw a graph between the frequency of the incident radiation and maximum kinetic energy of electrons emitted from the surface of photo sensitive metal. Use it to determine, (i)Planck's constant (ii) work function of metal. (CBSE 16, 18, 19)

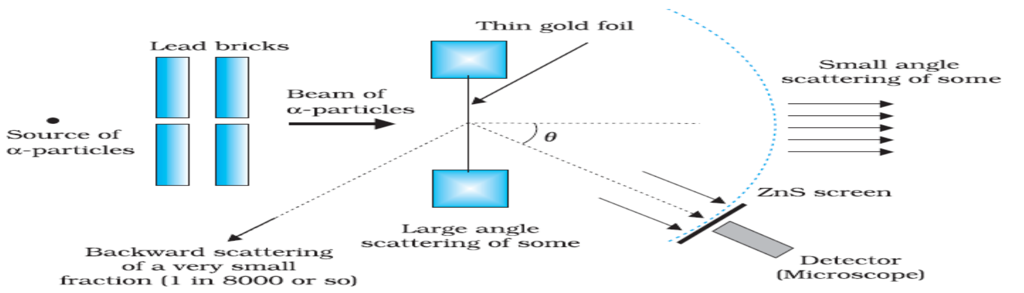
Q4. Show the variation of photo current with collector plate potential for different frequencies but same intensity of incident radiation. (CBSE 12,17)

Q5. Explain Photo Electric effect of current on the basis of Einstein's Photo Electric Equation. (CBSE 10,15,17)

Chapter 12 Atoms

1**. Alpha particle scattering experiment OR Gold- foil experiment OR Geiger Marsden experiment-**

(i) Experimental set up:



(ii) Observations of the experiment:

(a)Most of the α particles pass without any deviation and some of them deviate by small angles.

(b)Very small no of α-particle scattered through much larger angle (more than 90°).

(c)It was found that 1 out 8,000 (approximately) α- particles were deflected through 180°

(iii) Conclusion (Rutherford's atomic model):

On the basis of observation of α- particles scattering Rutherford proposed an atomic model.

(a)Most of the space in the atom is empty (b) Total positive charge is concentrated at the center within a very small volume , that is known as nucleus(c)Electron revolves around the nucleus(d)Size of atom (10^{-10} m)and size of nucleus is (10^{-15} m) .Size of nucleus is only 10,0000th part of the size of atom.

2.Drawback of Rutherford atomic model: -

(i)this model could not explain stability of electron.

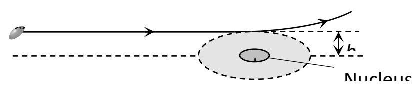
(ii)this model could not explain line spectrum of hydrogen atom.

3. Distance of nearest approach:- The minimum distance up to which α-particle approach towards the nuclei is called distance of nearest approach. As α-particle move towards nucleus, its kinetic energy will convert into electrostatic Potential Energy. At distance 'r_o' K.E will complete converted into P.E .

Distance of nearest approach **$r_0 = 2KZe^2/E$** It is approximately equal to the radius of the nucleus.

4. Impact parameter (*b*) : The perpendicular distance of the velocity vector of the α-particle from the centre of the nucleus when it is far away from the nucleus is known as impact parameter. It is given as

$$b = \frac{Ze^2 \cot(\theta/2)}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)} \quad \Rightarrow b \propto \cot(\theta/2)$$



For large *b*, α particles will go un-deviated and for small *b* the α-particle will suffer large scattering. And when b=0 angle of scattering is 180^0

5. Bohr atomic model: - Fundamental postulates of Bohr atom model are following.

(i). Stationary orbit: - Electrons revolve around the nucleus in particular orbits. At the time of revolution in particular orbit there is no loss or gain of energy of electron.

(ii) Quantization condition: - Electron can move only in those orbits for which angular momentum is an integral multiple of h/2π . Angular momentum L = m v r = n h/2 π

Where h is a Planck's constant, m=mass of electron,
V = velocity of electron, r = radius of permitted orbit n =1,2,3---------

(iii)Transition: - Whenever an electron makes a transition from one orbit to other , it emits or absorbs a photon of energy hν, which is given by $E_f - E_i = h\nu$. This is called Bohr's frequency condition.

6. Expression for radius , speed and energy of electron using Bohr's atomic model:–

(i) Radius of orbit : $r_n \propto \frac{n^2}{Z}$ (ii) Speed of electron: $v_n = \frac{2\pi k Z e^2}{n h} = \frac{Z e^2}{2\varepsilon_0 n h} = \left(\frac{c}{137}\right).\frac{Z}{n} = 2.2\times10^6 \frac{Z}{n} m/sec$

(iii) Total energy: kinetic energy $K = \frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{(Ze)e}{r}$. Electrostatic potential energy, $U = \frac{1}{4\pi\varepsilon_0}\frac{(Ze)(-e)}{r}$

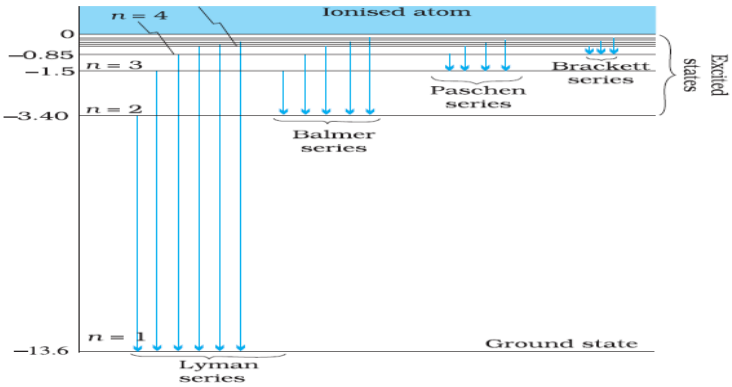
Total energy $E = -\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r_n}$ OR $E_n = -13.6\frac{Z^2}{n^2}eV$ E_1=-13.6eV, E_2=-3.46eV, E_3=-1.51eV, E_4=-0.856eV

Note:– Total energy=-(Kinetic energy), potential energy=2 (total energy)

7. Explanation of line spectrum of hydrogen atom.

When an electron makes transition from higher energy level to a lower energy level then a photon of frequency ν and wave length λ is emitted. Wave length is given by $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ Where $\frac{1}{R}$ = 911 A^0

S. No.	Series observed	Value of n_1	Value of n_2	Position in the spectrum
1.	Lyman series	1	2, 3, 4, …, ∞	Ultraviolet
2.	Balmer series	2	3, 4, 5, …, ∞	Visible
3.	Paschen series	3	4, 5, 6, …, ∞	Infra-red
4.	Brackett series	4	5, 6, 7, …, ∞	Infra-red
5.	Pfund series	5	6, 7, 8, …, ∞	Infra-red



8. Excitation energy =E_1-E_2 = Energy difference, Excitation potential = excitation energy/e

9. Ionization energy =E(infinity)- En ,Ionization potential = Ionization energy/e

10. Limitation of Bohr's theory: - (i) Bohr model is applicable only for single electron system.

(ii) It does not explain the fine structure and splitting of spectral lines.

Important questions

1. Write postulates of Bohr atomic model and derive an expression for radius and velocity of electron in n^{th} orbit.
2. Using Bohr atomic model find out expression of energy of electron in n^{th} orbit.
3. Draw labeled diagram of Geiger Marsden Experiment and write its conclusion.
4. State Bohr's quantization condition of angular momentum. Calculate the shortest wavelength of the Bracket series and state to which part of the electromagnetic spectrum it belongs. **(2019)**
5. Calculate the ratio of the frequencies of the radiation emitted due to transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level and (ii) highest permitted energy level to the second permitted level. **(2018)**

Chapter13 Nuclei

1. **Atomic Nucleus:** -The atomic nucleus was first discovered by Rutherford. Nucleus is a small, central, massive and positively charged core Nucleus is made of two types of elementary particles proton and neutron which are combined known as nucleons

.

Name of particle	Proton	Neutron
Mass	m_p=1.6725 ×10^{-27} kg =1.007277amu	m_n =1.6748×10^{-27} kg, m_n=1.008665amu.
Charge	+1.6×10^{-19} Coulomb	ZERO
Discovered by	Goldstein	James Chadwick
Deflected by electric and magnetic field	YES	NO

Any element X can be represented as $_ZX^A$

Where A is mass Number, Z is atomic no and N is number of neutrons. A= Z + N

Isotope	Isobar	Isotone
Nuclei having same atomic number	Nuclei having same mass number	Nuclei having same Neutron number
$_1H^1$, $_1H^2$, $_1H^3$	$_6C^{14}$, $_7N^{14}$	$_6C^{13}$, $_7N^{14}$, $_8O^{15}$

2. Atomic mass unit OR amu : It is defined as $\frac{1}{12}th$ mass of carbon 12 atom. 1 *amu* (or 1 *u*) = 1.6605402 × 10^{-27} *kg*.

3. Nuclear size: -Nucleus is nearly spherical. Volume of nucleus is directly proportional to mass no A.

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

R_o =10^{-15} m, is constant. 1 Fermi (F) =10^{-15} m

4. Einstein's mass energy relation: According to this relation mass can be converted into energy .Energy equivalent to 1 amu mass is given by E = Δm c^2 = 931.5 MeV

5. Nuclear density: - Volume of nucleus = 4/3πr^3 =4/3×3.14× $(10^{-15})^3$ mass of H_2 atom M=1.6723×10^{-27}kg.

So density of lightest nucleus hydrogen $d = \frac{m}{V} = \frac{1.6 \times 10^{-27}}{\frac{4}{3} \times \frac{22}{7} \times (10^{-15})^3} = 10^{17}\ Kg/m^3$

Hence density of nucleus is of order of 10^{17} kg/$m^3$and it is same for all nuclei. Hence nuclear density is independent of mass number and it is extremely high.

6. Mass defect :If M is mass of the nucleus than it is found that total mass of the nucleus is always less than the total mass of the constituent nucleons in free state .Difference between the mass of the constituent nucleons and the mass of nucleus is known as mass defect. Δm =[Z ×M_p + (A–Z) × M_n] – M

7. Nuclear force: - There is a force inside the nucleus, which is attractive and strong enough to overcome the repulsive force called nuclear force.

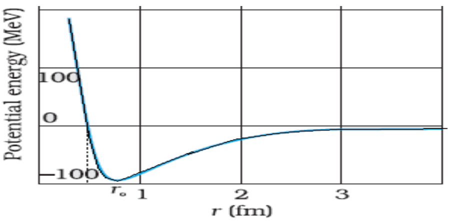
Properties of nuclear force -

(i) It is a short-range force. (ii) It is spin independent (iii) It is the strongest force in nature $F_g : F_{elec} : F_{nucl}$ = 1 : 10^{36} : 10^{38}

(iv) Nuclear force is charge independent and act between p-p , p-n and n-n with same magnitude (v)It is attractive force

(vi) Nuclear forces are non-central force. (vii) Nuclear forces are exchange forces**:** Nuclear force between the two nucleons is the result of the exchange of particles called mesons between the nucleons.

(viii) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres. The potential energy is a minimum at a distance *r*0 of about 0.8 fm. This means that the force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm.



Nuclear Fusion	**Nuclear Fission**
Two lighter nuclei combines to form a heavier nucleus with release of tremendous amount of energy **$_1H^2$ +$_1H^2$ ⟶ $_2He^4$ + energy (24 MeV)**	Splitting of a Heavy nuclei like uranium into two nuclei when bombarded with neutrons. **^1_0n + $^{235}_{92}U$ = $^{92}_{36}Kr$ + $^{141}_{56}Ba$ + 3^1_0n + Energy (200MeV)**
Reaction takes place at higher temperature (10^7 K) therefore this is also known as thermonuclear reaction.	Reactions take place at normal temp.
The energy released per nucleon is more as compare to energy released in fission	The energy is less as compare to energy released in fusion.

Fusionable materials are light particles H_2 etc so easily available.	Fissionable material U, Pu etc are limited on earth.
Fusion cannot be controlled and its energy is not utilized.	Fission can be controlled. Energy is used in nuclear reactor.
Hydrogen bomb is based on nuclear fusion.	Atom bomb is based on nuclear fission

Important questions

1. Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions where the nuclear force is (i) Attractive and (ii) repulsive. (2018)

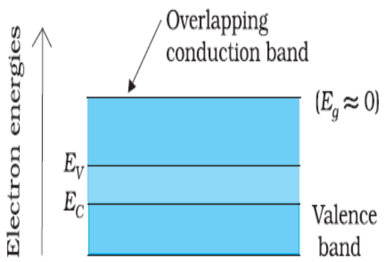
2. From the relation $R = R_0 A^{1/3}$, where R_0 is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A. (2015)

3. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. (2015)

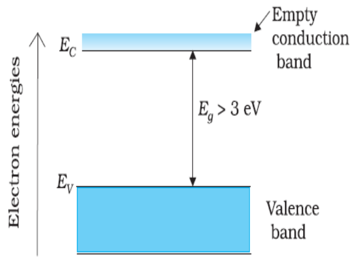
4. The nuclear radius of Al (13,27) is 3·6 fermi. Find the nuclear radius of Cu (29, 64). (2020)

Chapter 14: Semiconductor Electronics

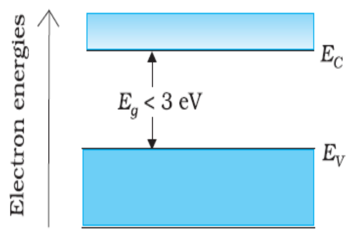
1. Energy band diagrams for conductors, insulator and semiconductor with their band gap.



(i) for conductors



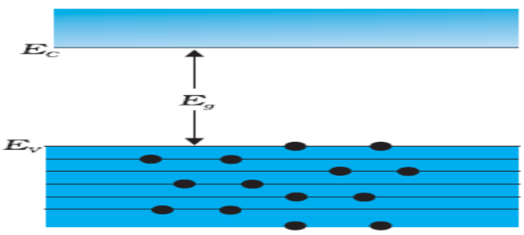
(ii) For Insulators



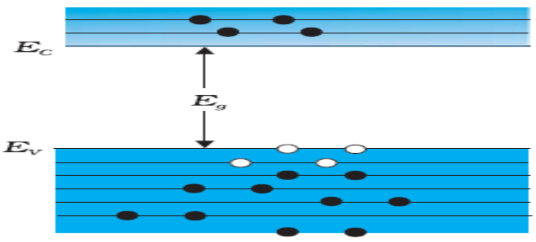
iii) For semiconductors

2. Energy band diagrams for intrinsic semiconductor at

(i) at zero Kelvin



(ii) Greater than zero Kelvin

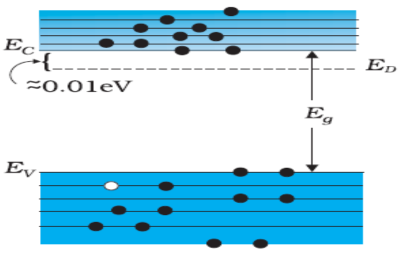


3. Intrinsic semiconductors and extrinsic semiconductor

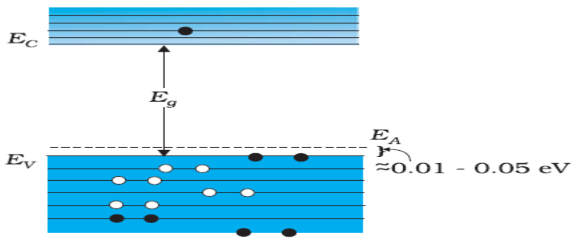
(i) Pure semiconductors are called **intrinsic semiconductors**. At zero Kelvin they behave like Insulator. But as temperature increases covalent bond breaks and electron hole pairs are produced and hence its conductivity increases. For intrinsic semiconductors, number of electrons (n_e) =number of holes (n_h)

(ii)The conductivity of intrinsic semiconductor can be increase by addition of very small amounts of trivalent or pentavalent impurities. The process of mixing impurities in a pure semiconductor is called doping and such type of semiconductor is known as is called **extrinsic** (doped) semiconductor.

4. Energy band diagrams for n-type semiconductor and p-type semiconductor.



(a) $T > 0K$



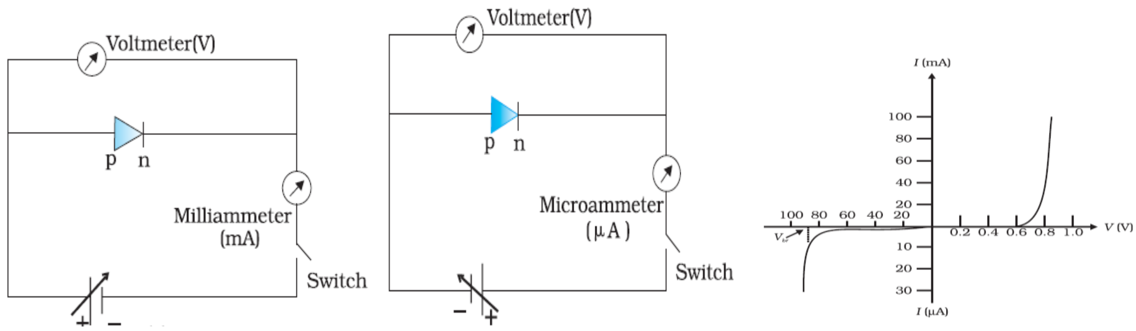
(b) $T > 0K$

(a) In N type semiconductor donner energy level is slightly below the lowest level of conduction band(b) In P type semiconductor acceptor energy level is slightly above the highest level of valance band

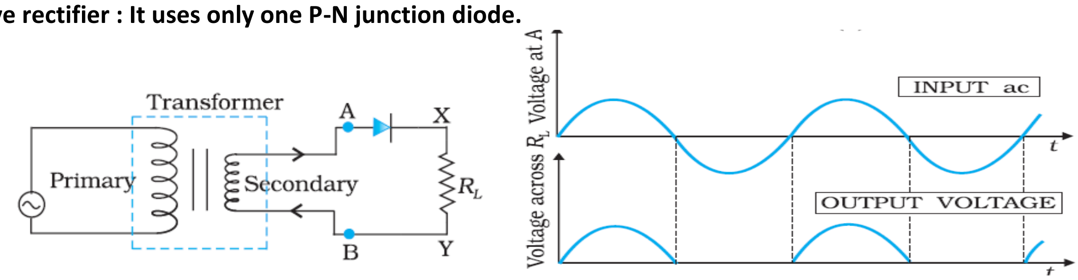
5. Differences between N type and P type semiconductor.

N type semiconductor	P type semiconductor
1. It is formed by doping of suitable pentavalent Impurity like Arsenic (As), Antimony (Sb), Phosphorous (P). 2. It Consist of majority electrons, minority holes and donner ions. 3. Number of excess electrons is equal to donner ions so it is electrically neutral.	1. It is formed by doping of suitable trivalent Impurity like Indium (In), Boron (B), Aluminum (Al). 2. It Consist of majority holes, minority electrons and acceptor ions. 3. Number of excess holes is equal to acceptor ions so it is electrically neutral.

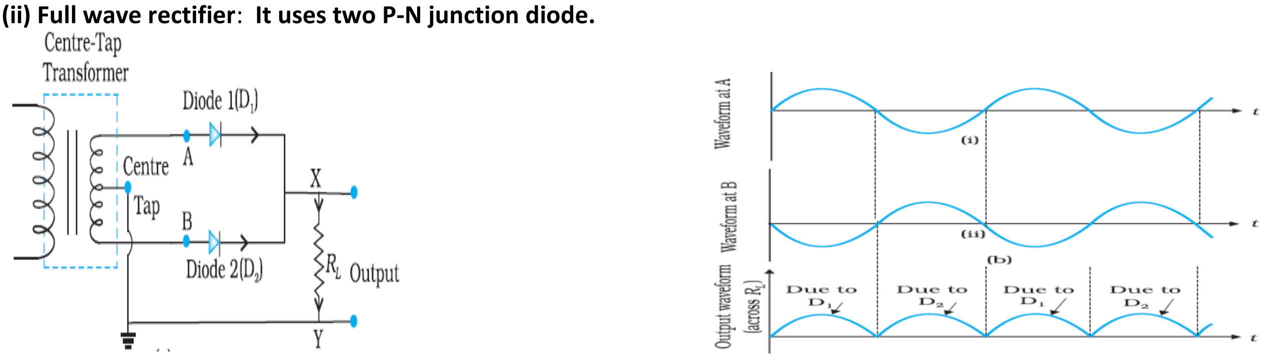
6. Formation of p-n junction:
(i)Two Important processes take place during formation of PN Junction
(a)**Diffusion:** Motion of holes and electron due to the concentration gradient is known as diffusion. Holes diffuse from p-side to n-side while electrons diffuse from n-side to p-side. The direction of diffusion current is from p-side to n-side.
(b)**Drift:** The motion of charge carriers due to the electric field is called drift. Holes drift from n-side to p-side while electrons drift from p-side to n-side. The direction of drift current is from to n-side to p-side.
(ii)Depletion layer: The space-charge region on either side of the junction together which is free from mobile charge carriers and contains only immobile donner and acceptor ion is known as depletion region or depletion layer. Potential difference across the depletion layer is known as **barrier potential.**
(iii)Break down voltage: The value of reverse voltage applied to a PN junction for which junction breakdown and current increase significantly without increasing voltage and is known break down voltage.
7. Characteristic curve of a p-n Junction diode:



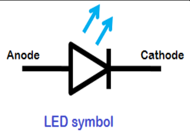
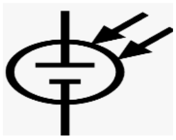
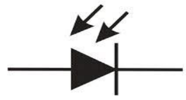
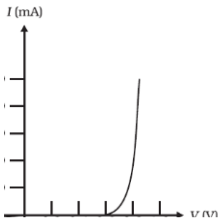
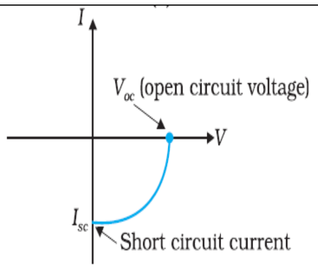
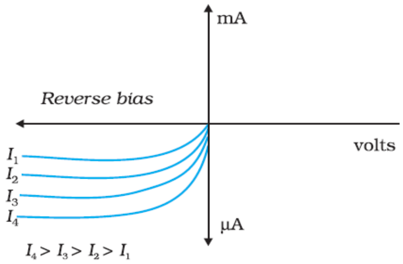
(i) During forward bias width of depletion layer decreases and current flows hence a diode offer very small resistance in forward bias
(ii) During reverse bias width of depletion layer increases and no current flows hence a diode offer very high resistance in reverse bias
(iii) In forward bias positive terminal of battery should be connected with P side and negative terminal with N side while in reverse bias positive terminal of battery should be connected with N side and negative terminal with P side
8. Rectifier: A device which converts ac into dc is known as rectifier. Rectifier is of two types.
A P-N junction diode conducts in forward bias and does not conduct in reverse bias. This property of P-N junction diode is used in rectifier.
(i)Half wave rectifier : It uses only one P-N junction diode.



(ii) Full wave rectifier: **It uses two P-N junction diode.**



9. Special purpose junction diode (Optoelectronic junction devices):– Semiconductor diodes in which carriers are generated by photons (photo-excitation) are called *optoelectronic devices*.
(***i) Photodiodes*** (***photodetectors***):– A junction diode made from light sensitive semiconductor is called photodiode. It is used for detecting optical signal.it works when photon of energy greater than band gap of semiconductor is incident on it.
(ii) ***Light emitting diodes*** (**LED**):– A diode, which emits visible radiation when forward bias applied, is called LED. It converts electrical energy into light. It is a heavily doped p-n junction which under forward bias emits spontaneous radiation.
(iii) S***olar cells*** (**Photovoltaic cell)** *:*– A solar cell is basically a p-n junction which generates emf when solar radiation falls on the p-n junction. Here light energy can be used to produce current.

 LED	Solar cell 	Photo diode 
Used in Forward bias	Used with no bias	Used in reverse bias
		 Here I_1,I_2,$I_3$and I_4 are different light intensities

Important questions

Q1. Draw the diagram of full wave rectifier. Draw the input and output waveforms.2015, 2017, 2019)

Q2. Draw the energy band diagrams for conductors, insulator and semiconductor, also write their band gap.

Q3. Draw the circuit diagram for the characteristic curve of a p-n Junction diode. Draw the characteristic curve also.

Q4. Draw I –V Characteristics and biasing of LED, solar cell and Photo diode and in which bias they are used?

Q5. Why Si and GaAs are preferred materials for solar cells?