KENDRIYA VIDYALAY SANGTHAN AHMEDABAD REGION

STUDENT SUPPORT MATERIAL

(WITH ASSERTION REASONING AND CASE BASED QUESTIONS)

CLASS-XII PHYSICS

Session 2020-21

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Session 2020-21

PHYSICS CLASS-XII

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DELETED TOPICS

(for Session 2020-21)

PHYSICS CLASS XII

01	**Electric charges and fields**	uniformly charged thin spherical shell (field inside and outside).
02	**Current Electricity**	Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors
03	**Moving Charges and Magnetism**	Cyclotron
04	**Magnetism and Matter**	magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field; Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths, permanent magnets.
05	**Alternating Current**	power factor, wattless current
06	**Electromagnetic Waves**	Basic idea of displacement current
07	**Ray Optics and Optical Instruments**	Reflection of light, spherical mirrors,(recapitulation) mirror formula , Scattering of light - blue colour of sky and reddish appearance of the sun at sunrise and sunset. resolving power of microscope and astronomical telescope, polarisation, plane polarised light, Brewster's law, uses of plane polarised light and Polaroids.
08	**Dual Nature of radiation and matter**	Davisson-Germer experiment
09	**Nuclei**	Radioactivity, alpha, beta and gamma particles/rays and their properties; radioactive decay law, half life and mean life binding energy per nucleon and its variation with mass number
10	**Semiconductor Electronics: Materials,**	Zener diode and their characteristics, zener diode as a voltage regulator

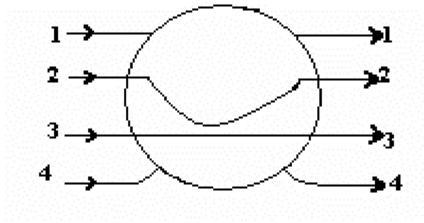
STUDENT SUPPORT MATERIAL

UNIT-1 : ELECTROSTATICS

Objective type :

1. Eight dipoles of charges of magnitude e are placed inside a cube. The total electric flux coming out of the cube will be-

(a) $16e/\varepsilon_0$ (b) $8e/\varepsilon_0$ (c) zero (d) e/ε_0



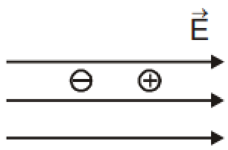
2. A metallic solid sphere is placed in a uniform electric field. In the figure, which path will the lines of force follow?
(a) 2 (b) 1 (c) 3 (d) 4

Ans: (d) 4

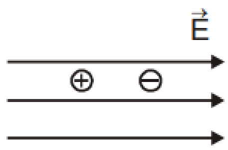
3. Diagrammatically represent the position of a dipole in (i) stable (ii) unstable

equilibrium when placed in a uniform electric field.

Ans:



Stable equilibrium



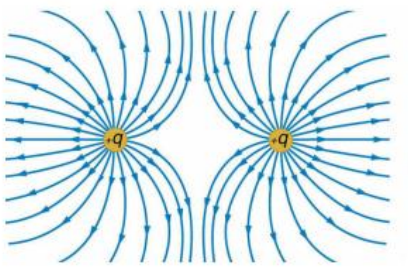
Unstable equilibrium

4. What is the unit of permittivity of free space (ϵ_0) ?

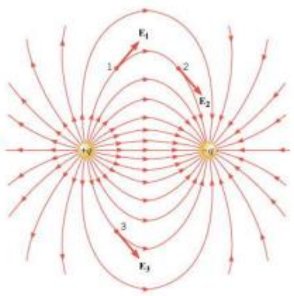
Ans: $C^2 N^{-1} m^{-2}$

5. Sketch field lines due to (i) two equal positive charges near each other (ii) a dipole.
Ans:

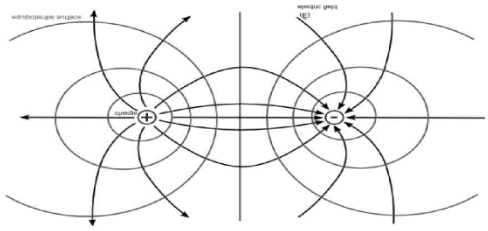
(i)



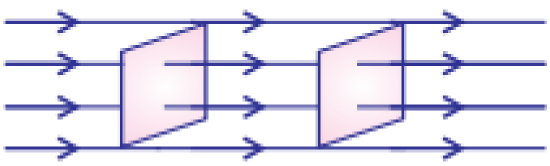
(ii)



6. Draw equipotential surface for a dipole.
Ans:



7. Draw schematically an equipotential surface of a uniform electrostatic field along x-axis.
Ans:



8. On inserting a dielectric between the plates of a capacitor, its capacitance is found to increase 5 times. What is the relative permittivity of the dielectric?
Ans: It is given that the capacitance increases by 5 times on inserting a dielectric between the plates of a capacitor, therefore relative permittivity of dielectric is given by

$\varepsilon_r = k = C/C_0 = 5$

9. What is the electric potential due to an electric dipole at an equatorial point?

Ans: zero

10. Distinguish between electric potential and potential energy.

Ans: **Electric potential** at a point is the amount of work done in moving a unit positive charge with zero acceleration from infinity to that point.

Potential energy is the energy possessed by the charge by virtue of its particular position. It is equal to the amount of work done in carrying the total charge from infinity to that position, against the electrostatic forces.

Thus, potential energy = Electrostatic potential x charge

Assertion and Reason based Question

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is NOT the correct explanation of A

c) A is true but R is false

d) A is false and R is also false

11. Assertion: Electric field inside a conductor is zero.

Reason: The potential at all the points inside a conductor is same.

Ans: (b) Both A and R are true but R is NOT the correct explanation of A

12. Assertion: Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.

Reason: Electrostatic force is a non-conservative force.
Ans: (c) A is true but R is false

13. Assertion: Polar molecules have permanent dipole moment.

Reason: In polar molecules, the centres of positive and negative charges coincide even when there is no external field.
Ans: (c) A is true but R is false

14. Assertion: A dielectric is inserted between the plates of a battery connected capacitor. The energy of the capacitor increases.

Reason : Energy of the capacitor, $U=\frac{1}{2}CV^2$

Ans: (a) Both A and R are true and R is the correct explanation of A

15. Assertion: If electric flux over a closed surface is negative then the surface encloses net negative charge.

Reason : Electric flux is independent of the charge distribution inside the surface.
Ans: b) Both A and R are true but R is NOT the correct explanation of A

CASE BASED QUESTION

Q16.

An electric dipole is a system consisting of the two equal and opposite point charges seperated by a small and finite distance. If dipole moment of this system is $\vec{p}$ and it is placed in a uniform electric field $\vec{E}$.

(i) Write the expression of torque experienced by a dipole.

(ii) Identify two pairs of perpendicular vectors in the expression.

(iii) Show diagrammatically the orientation of the dipole in the field for which the torque is

(a) Maximum.

(b) Half the maximum value.

(c) Zero.

Ans:

(i) $\vec{\tau} = \vec{p} \times \vec{E}$

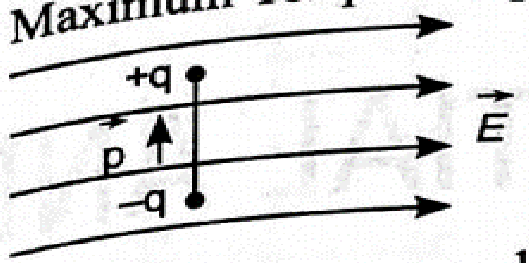
or $\tau = p\,E \sin\theta$

here $p = 2aq$

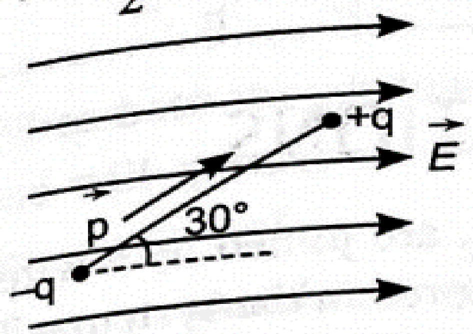
(If point charges are q and $-q$ separated by a distance $2a$.)

(ii) Torque is perpendicular to dipole moment and electric field. $\vec{\tau} \perp \vec{p}$ and $\vec{\tau} \perp \vec{E}$

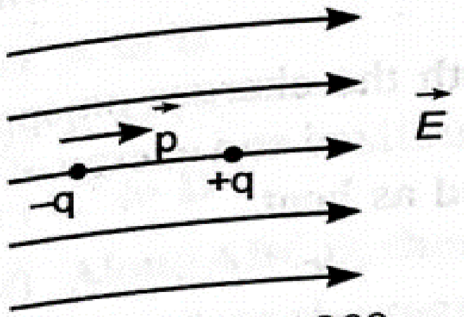
(iii) (a) Maximum Torque $\tau = pE$ when $\theta = 90°$



(b) $\tau = \dfrac{pE}{2}$ when, $\sin\theta = \dfrac{1}{2}$ *i.e.*, $\theta = 30°$ or $150°$



(c)

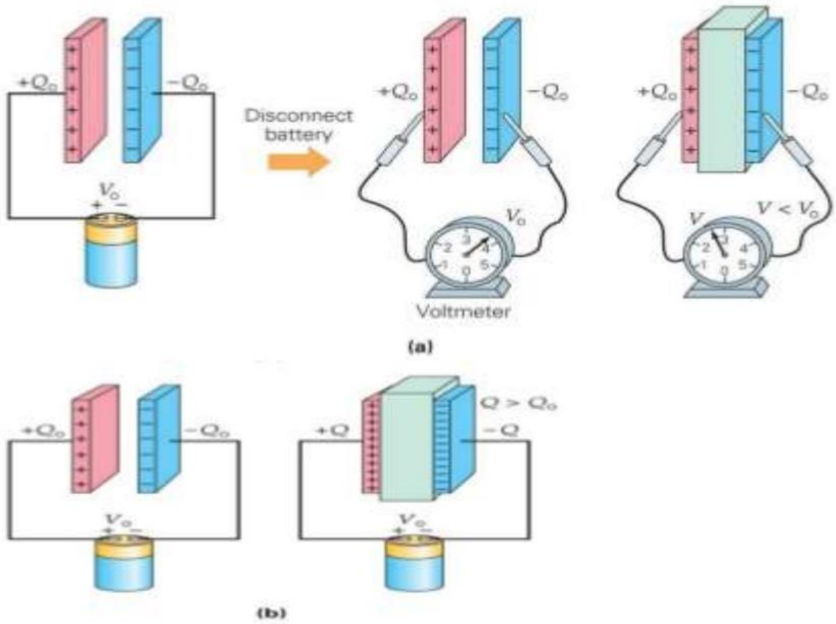


$\because \theta = 0°$ or $180°$

$\therefore \tau = pE \sin 0° = 0$

$\therefore \tau =$ minimum

Q17) **Effect of dielectric on plates when voltage or charge is held constant**



Inserting a dielectric between the plates of capacitor while either the voltage or charge is held constant has the same effect that is the ratio of charge to voltage increases.

(i) Capacitance of a parallel plate air capacitor does not depend on

a. Thickness of conducting plates

b. Charge on the conducting plates

c. Area of the conducting plates

d. Distance of separation between the conducting plates
Ans: (a)

(ii) A parallel plate air capacitor with no dielectric between the plates is connected to the constant voltage source. How would capacitance and charge change if dielectric of dielectric constant K=2 is inserted between the plates. C_0 and Q_0 are the capacitance and charge of the capacitor before the introduction of the dielectric.
a. $C=C_0/2$; $Q=2Q_0$
b. $C=2C_0$; $Q=Q_0/2$

c. $C=C_0/2$; $Q=Q_0/2$

d. $C=2C_0$; $Q=2Q_0$
Ans: (d)

(iii) A parallel plate air capacitor is connected to a battery. The quantities charge, voltage, electric field, and energy associated with this capacitor are given by Q_0, V_0, E_0 and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with battery still in connection. The corresponding quantities are now given by Q, V, E and U are related to previous quantities as
a. $Q> Q_0$

b. $V> V_0$

c. $E> E_0$

d. $U=U_0$
Ans. (a)

(iv) The effective capacitance of a capacitor is reduced when capacitors are connected in

a. series

b. parallel

c. series-parallel combination

d. none of the above
Ans: (a)

18. **The oil drop experiment**

In 1909, Robert Millikan and Harvey Fletcher conducted the oil drop experiment to determine the charge of an electron. They suspended tiny, charged droplets of oil between two metal electrodes by balancing downward gravitational force with upward drag and electric forces. The density of the oil was known, so Millikan and Fletcher could determine the droplets' masses from their observed radii (since from the radii they could calculate the volume and thus, the mass). Using the known electric field and the values of gravity and mass, Millikan and Fletcher determined the charge on oil droplets in mechanical equilibrium. By repeating the experiment, they confirmed that the charges were all multiples of some fundamental value. They calculated this value to be 1.5924×10^{-19} Coulombs (C), which is within 1% of the currently accepted value of $1.602176487 \times 10^{-19}$ C. They proposed that this was the charge of a single electron.

(a) What was determined from Millikan's oil drop experiment?

(1) Electric Charge of alpha particle (2) Electric charge of oil drop

(3) mass of electron (4) None of these

Ans: (4) None of these

(b) What is the currently accepted value of electric charge of an electron?

(1) 1.5924×10^{-19} C (2) 9.1×10^{-31} C (3) $1.602176487 \times 10^{-19}$ C (4) None of these

Ans: (3) $1.602176487 \times 10^{-19}$ C

(c) How was the mass of an electron determined?

(1) By the calculation of electric charge (2) by the calculation of density and Volume

(3) By the calculation of electric field (4) By the calculation of gravitational force

Ans: (2) by the calculation of density and Volume

(d) Does an electron have mass?

(1) No (2) yes

Ans: (2) yes

(e) What was the conclusion of Millikan's oil drop experiment?

(1) Electric charge is integral multiple of fundamental charge

(2) Electric charge is integral multiple of charge of alpha particle

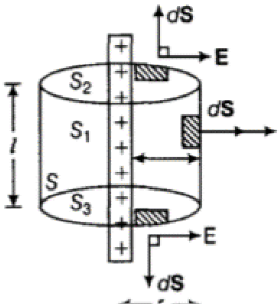
(3) No result (4) All of the above

Ans: (1) Electric charge is integral multiple of fundamental charge

<u>2- MARKS QUESTION</u>

19. Using Gauss's theorem, derive an expression for electric field intensity due to an infinitely long, straight wire of linear charge density λ C/m.

Ans: Consider a thin cylindrical Gaussian surface S with charged wire on its axis and point P on its surface.



Then net electric flux through surface S is

$$\phi = \oint_s E \cdot ds = \underset{\textit{Upper plane face}}{\int EdS\cos 90^\circ} + \underset{\textit{Curved surface}}{\int EdS\cos 0^\circ} + \underset{\textit{Lower plane face}}{\int EdS\cos 90^\circ}$$

$\phi = 0 + EA + 0$ or $\phi = E \cdot 2\pi l$

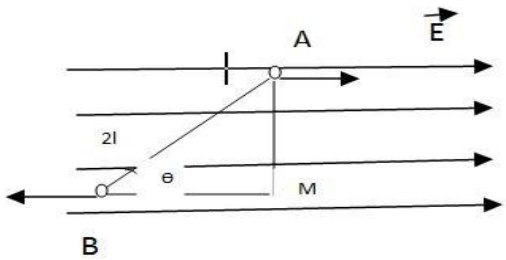
But by Gauss's theorem, $\phi = q/\varepsilon_0 = \lambda l/\varepsilon_0$ where, q is the charge on length l of wire enclosed by cylindrical surface S and λ is uniform linear charge density of wire.

$\therefore \quad E \times 2\pi l = \frac{\lambda l}{\varepsilon_0}$

$\Rightarrow \quad E = \frac{\lambda}{2\pi\varepsilon_0 r}$

Thus, electric field of a line charge is inversely proportional to distance directed normal to the surface of charged wire.

20. An electric dipole of dipole moment **p** is placed in a uniform electric field **E**. Obtain the expression for the torque experienced by the dipole. Identify two pairs of perpendicular vectors in the expression.



Ans: Consider a dipole of length 2l is placed at angle θ with the direction of uniform electric field **E**. Force acts on positive and negative charges in the direction of field and opposite to the field direction as shown in the diagram.
Magnitude of force on the charges at A and B are given by F = qE

As the forces are equal and opposite, so net force is zero but due to different lines of action these produce torque.

Torque = Force x perpendicular distance
τ = qE × AM

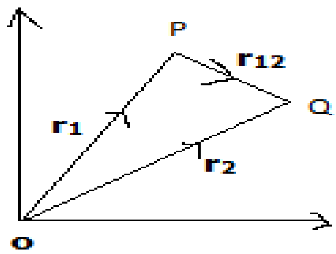
NOW, AM = AB sinθ = 2l sinθ

τ = qE × 2l sinθ = pE sinθ= **P**X**E**

Two perpendicular vectors are force vector and component of dipole moment along AM.

21. Two points charges q_1, q_2 initially at infinity are brought one-by-one to points P and Q in specified position vectors $\mathbf{r_1}$ and $\mathbf{r_2}$ relative to some origin. What is the potential energy of this charge configuration?

Ans.



Suppose first charge q_1 is brought from infinity to the position r_1. There is no

external field against which work needs to be done, so work done in bringing q_1 from infinity to r_1 is zero. So $W_1=0$ -------------(i)

but This charge produces a potential in space at position Q, is given by

$V=(1/4\pi\varepsilon_0)(q_1/r_{12})$ ------------------(ii)

work done in bringing charge q_2 from infinity to the point r_2 is q_2 times the potential at r_2

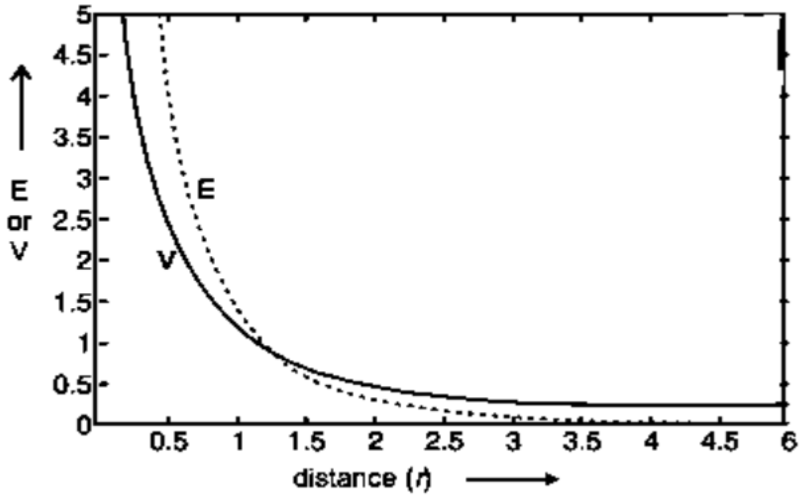
due to q_1: $W_2= Vq_2 = (1/4\pi\varepsilon_0)(q_1/r_{12})q_2 = (1/4\pi\varepsilon_0)(q_1 q_2/r_{12})$ ---------(iii)

net work done is stored as potential energy $W= W_1 + W_2 = 0+(1/4\pi\varepsilon_0)(q_1 q_2/r_{12})$

so, $U= (1/4\pi\varepsilon_0)(q_1 q_2/r_{12})$

22. Draw a plot showing the variation of (i) electric field (E) and (ii) electric potential (V) with distance r due to a point charge Q.
Ans:

Electric field E due to a point charge Q,
$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}, E \propto \frac{1}{r^2}$
Electrostatic potential V due to a point charge Q,
$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r} \Rightarrow V \propto \frac{1}{r}$
A graph showing variation of electric field (E) and electric potential (V) with distance (r) are shown below:



3 - MARKS QUESTION

23. Define the term electric dipole moment. Is it a scalar or vector? Deduce an expression for the electric field at a point on the equatorial plane of an electric dipole of length 2a.

Ans: Electric dipole moment of an electric dipole is equal to the product of its either charge and the length of the electric dipole. It is denoted by p.

Unit of dipole moment is C-m.

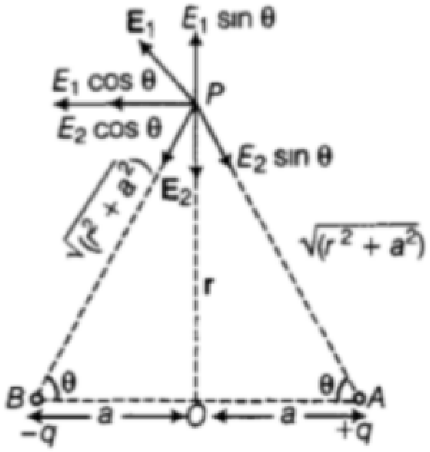
It is a vector quantity, and its direction is from a negative charge to positive charge.

Let an electric dipole AB consists of two charges +q and -q separated by a distance 2a.

Electric field at point P due to charge +q,

$$E_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{\left[\sqrt{r^2+a^2}\right]^2}$$

$$E_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{(r^2+a^2)} \text{ along AP}$$



Electric field at point P due to charge -q placed at B

$$E_2 = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+a^2} \text{ along PB}$$

On resolving E_1 and E_2 into rectangular components, we get the resultant electric field at point P. Here vertical components of electric field will cancel each other, so resultant electric field will be towards left which can be calculated as -

$$E = E_1 \cos\theta + E_2 \cos\theta$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q}{(r^2+a^2)} \cos\theta + \frac{1}{4\pi\varepsilon_0} \times \frac{q}{(r^2+a^2)} \cos\theta$$

$$= 2 \times \frac{1}{4\pi\varepsilon_0} \times \frac{q}{(r^2+a^2)} \times \frac{a}{\sqrt{(r^2+a^2)}}$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q.2a}{(r^2+a^2)^{3/2}}$$

$$\therefore E = \frac{1}{4\pi\varepsilon_0} \times \frac{p}{(r^2+a^2)^{3/2}}$$

If r >> a, i.e., for short dipole we have

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{p}{r^3}$$

This equation shows that electric field due to dipole at a distance 'r' from its perpendicular bisector decreases with r and proportional to dipole moment.

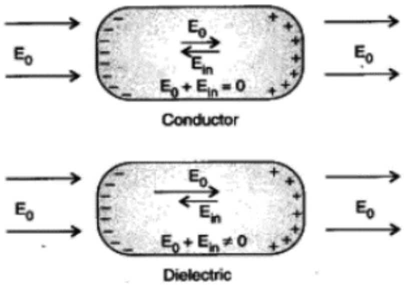
24. Explain using suitable diagrams, the difference in the behaviour of a

(a) conductor and (b) dielectric in the presence of external electric field. Define the terms polarisation of a dielectric and write its relation with susceptibility.

Ans: a. In the presence of electric field, the free charge carriers, in a conductor, move the charge distribution in the conductor re-adjusting itself so that the net electric field within the conductor becomes zero.

b. In a dielectric, the external electric field induces a net dipole moment, by stretching/reorienting the molecules. The electric field, due to this induced dipole moment, opposes, but does not exactly cancel, the external electric field.

Polarisation: Induced dipole moment, per unit volume, is called the polarization. For linear isotropic dielectrics having a susceptibility χ, we have P= χ E

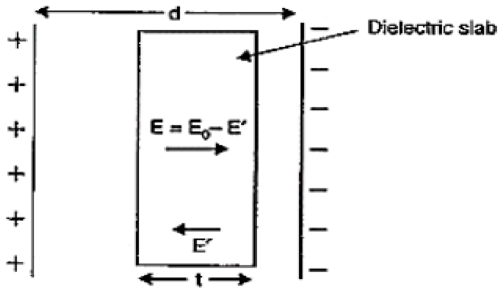


25. A dielectric slab of thickness 't' is kept in between the plates, each of area 'A', of a parallel plate capacitor separated by a distance 'd'. Derive an expression for the capacitance of this capacitor for t < < d.

Ans:

. Let A is the area of the two plates of the parallel plate capacitor and d is the separation between them. A dielectric slab of thickness t < d and area A is kept between the two plates. The total electric field inside the dielectric slab will be:

$E = \frac{E_0}{K} = E_0 - E'$ where E' is the opposite field developed inside the slab due to polarization of slab. Total potential difference between the plates,



$V = E_0(d - t) + Et$

$= \frac{\sigma}{\varepsilon_0}(d - t) + \frac{\sigma}{k\varepsilon_0}t$

$= \frac{\sigma}{\varepsilon_0}\left[(d - t) + \frac{t}{k}\right]$

$V = \frac{q}{A\varepsilon_0}\left[(d - t) + \frac{t}{k}\right]$

where q is the charge on each plate.

Since, $C = \frac{q}{V}$

or $C = \frac{q}{\frac{q}{A\varepsilon_0}\left[(d-t) + \frac{t}{k}\right]}$

or $C = \frac{A\varepsilon_0}{\left[(d-t) + \frac{t}{k}\right]}$

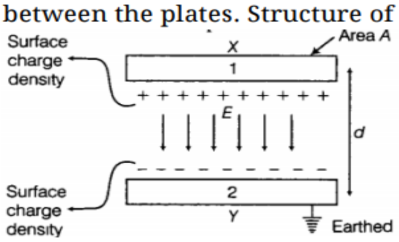
5-MARKS QUESTION

26. (i) Derive the expression for the capacitance of a parallel plate capacitor having plate area A and plate separation d.

(ii) Briefly describe the process of transferring the charge between the two plates of a parallel plate capacitor when connected to a battery. Derive an expression for the energy stored in a capacitor. Hence, obtain the expression for the energy density of the electric field.

Ans: (i)

i. Parallel plate capacitor consists of two thin conducting plates each of area A held parallel to each other at a suitable distance d. One of the plates is insulated and other is earthed. Say, there is vacuum or air between the plates. Structure of a parallel plate capacitor is shown below:



Suppose, the plate X is given a charge of +q coulomb. By induction, -q coulomb of charge is produced on the inner surface of the plate Y and +q coulomb on the outer surface. Since, the plate Y is connected to the earth, hence the relatively weak charge +q residing far away i.e. on the outer surface flows to the earth. Thus, the plates X and Y have equal and opposite charges +q and -q respectively

Suppose, the surface density of charge on each plate is σ, We know that the intensity of electric field at a point between two plane parallel sheets of equal and opposite charges is = $\frac{\sigma}{2\epsilon_0} - (-\frac{\sigma}{2\epsilon_0}) = \sigma/\varepsilon_0$ [$\frac{+\sigma}{2\epsilon_0}$ and $\frac{-\sigma}{2\epsilon_0}$ are electric field intensities in between the two plates due to charges +q and -q on the two plates of the capacitor respectively], where ε_0 is the permittivity of free space. The intensity of electric field between the plates will be given by, $E = \frac{\sigma}{\varepsilon_0}$

The charge on each plate is q and the area of each plate is A. Thus,

$\sigma = \frac{q}{A}$ and $E = \frac{q}{\varepsilon_0 A}$............(i)

Now, let the potential difference between the two plates be V volt. Then, the electric field between the plates is given by

$E = \frac{V}{d}$ or $V = Ed$.....(ii)

Substituting the value of E from equation (i) into equation (ii), we get

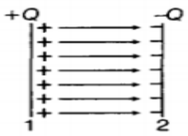
$V = \frac{qd}{\varepsilon_0 A}$

Now capacitance of the parallel plate capacitor is

$C = \frac{q}{V} = \frac{q}{qd/\varepsilon_0 A} = \frac{\varepsilon_0 A}{d}$

Where, $\varepsilon_0 = 8.85 \times 10^{-12} C^2 - Nm^{-2}$ is the permittivity of vacuum or air.

Let the total charge on the plates of the below capacitor is +Q and -Q respectively.



∴ The potential difference between the plates of the above capacitor of capacitance C for an infinitesimal charge q is q/C.

∴ Potential of condenser = q/C

Small amount of work done in giving an additional charge dq to the condenser,

$dW = \frac{q}{C} \times dq$

∴ Total work done in giving a charge Q to the condenser,

$W = \int_{q=0}^{q=Q} \frac{q}{C} dq = \frac{1}{C}\left[\frac{q^2}{2}\right]_{q=0}^{q=Q} \Rightarrow W = \frac{1}{C}\frac{Q^2}{2}$

As, an electrostatic force is conservative, this work is stored in the form of potential energy (U) of the condenser.

$U = W = \frac{1}{2}\frac{Q^2}{C}$

$\because \quad Q = CV \Rightarrow U = \frac{1}{2}\frac{(CV)^2}{C} = \frac{1}{2}CV^2$

$\because \quad CV = Q \Rightarrow U = \frac{1}{2}QV$

Hence, $U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$

Energy density (u) is defined as the total energy per unit volume of the condenser.

i.e., $u = \frac{\text{Total energy } (U)}{\text{Volume } (V)} = \frac{\frac{1}{2}CV^2}{Ad}$

Using, $C = \frac{\varepsilon_0 A}{d}$ and V = Ed (Where V is the potential difference and E is the Electric field existing between the plates)

We get, $u = \frac{1}{2}\left(\frac{\varepsilon_0 A}{d}\right)\left(\frac{E^2 d^2}{Ad}\right) = \frac{1}{2}\varepsilon_0 E^2$

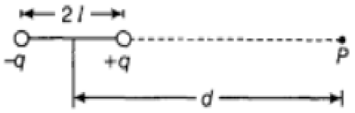
Here, Energy density between plates of capacitors is directly proportional to electric field that exists between the plates of capacitor.

27. (i) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.

(ii) Sketch the pattern of electric field lines due to a conducting sphere having negative charge on it

Ans: (i)

Let electric potential is to be determined at a point P lying on the axis of an electric dipole of dipole length 2l at a distance d from the centre of the dipole as shown in the figure.



Potential at P due to +q charge of the dipole $= \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{(d-l)}$

Potential at P due to -q charge of the dipole

$= \frac{1}{4\pi\varepsilon_0}\frac{-q}{(d+l)}$

Total potential at P due to both the charges of the dipole

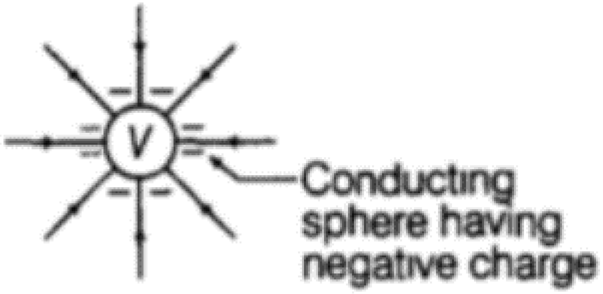
$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{(d-l)} - \frac{1}{(d+l)}\right]$

$= q \times \frac{2l}{4\pi\varepsilon_0} \times \frac{1}{\left(d^2-l^2\right)} = \frac{p}{4\pi\varepsilon_0} \times \frac{1}{\left(d^2-l^2\right)}$

where, the scalar value of dipole moment (p) = q × 2l

If l << d, then neglecting l^2 we get, final value of the electric potential to be, $V = \frac{1}{4\pi\varepsilon_0}\frac{p}{d^2}$

(ii) Electric field lines are paths taken by unit positive charge to travel. Electric field lines due to a conducting sphere are shown in figure in which electric field lines are terminating perpendicular to the surface and inside the sphere they are zero. Negative charge on sphere attracts electric field.



UNIT : 2 CURRENT ELECTRICITY

OBJECTIVE TYPE QUESTION

1. According to Ohm's law

a) The electric current I flowing through a substance is proportional to the voltage V across its ends

b) The electric current I flowing through a substance is proportional to the square of voltage V across its ends

c) The electric current I flowing through a substance is inversely proportional to the voltage V across its ends

d) The electric current I flowing through a substance is independent of the voltage V across its ends

Ans: (a)

2. Kirchhoff's first law, i.e., $\Sigma I = 0$ at a junction, deals with the conservation of

a) Energy b) Momentum c) Angular momentum d) Charge

Ans: d) Charge

3. Mobility is defined as

a) the number of charges in motion per unit electric field

b) the magnitude of the drift velocity per unit voltage

c) the magnitude of the drift velocity per unit charge

d) the magnitude of the drift velocity per unit electric field

Ans: d) the magnitude of the drift velocity per unit electric field

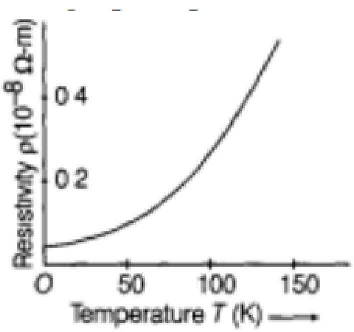
4. Name the two factors on which the resistivity of a given material depends.

Ans: Resistivity depends upon:

i. The number density of electrons and ii. Temperature or The average relaxation time.

5. Show variation of resistivity of copper as a function of temperature in graph.

Ans:



6. State the underlying principle of a potentiometer?

Ans: Principle of potentiometer: If a constant current is flowing through a wire of uniform area of cross-section at a constant temperature, the potential drop across- any portion of wire is directly proportional to the length of that portion. i.e; $V \propto I$.

7. In a meter bridge, two unknown resistances R and S when connected in the two gaps, give a null point at 40 cm from one end. What is the ratio of R and S?
Ans: A meter bridge consists of a wire of length 1m i.e. 100 cm.

The meter bridge works on the principle of Wheatstone bridge.

Given that null point is obtained at 40 cm from one end. So, l = 40cm

For meter bridge, ratio of unknown resistances is given by,

$$\frac{R}{S} = \frac{l}{(100-l)} = \frac{40}{60} = \frac{2}{3}$$

$$\frac{R}{S} = \frac{2}{3}$$

$$\Rightarrow \mathrm{R : S = 2 : 3}$$

8. Would the galvanometer show any current if the galvanometer and cell are interchanged at the balance point of the bridge?
Ans: No, the galvanometer will not show any current. When the galvanometer and cell are interchanged at the balance point of bridge then no current would flow through the galvanometer because of no deflection.

9. State Kirchhoff's laws.

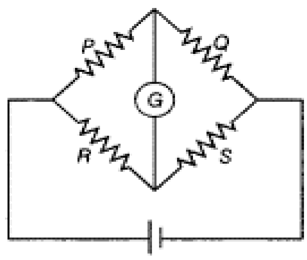
Ans: **Kirchhoff's first rule:** The algebraic sum of the electric currents at any junction of electric circuit is equal to zero, i.e. the sum of current entering into a junction is equal to the sum of current leaving the junction. $\sum I = 0$

Kirchhoff's second rule or loop rule : In any closed mesh of electrical circuit, the algebraic sum of emfs of cells and the product of currents and resistances is always equal to zero.

i.e $\sum E + \sum IR = 0$

10. Write the principle of working of a metre bridge.

Ans: The principle of meter bridge is Wheatstone bridge condition.



when a wheat stone bridge is in balanced condition then,

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

11. What is the cause of resistance of a conductor?

Ans. While drifting, the free electrons collide with the ions and atoms of the conductor i.e., motion of the electrons is opposed during the collisions, this is the basic cause of resistance in a conductor.

12. A large number of free electrons are present in metals. Why there is no current in the absence of electric field across?

Ans: In the absence of an electric field, the motion of electrons in a metal is random.

There is no net flow of charge across any section of the conductor. So no current flows in the metal.

Assertion and Reason based Question

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is NOT the correct explanation of A

c) A is true but R is false

d) A is false and R is also false

13. Assertion: For a given conductor, electric current does not vary even if it's cross-sectional area varies.

Reason: A conductor remains uncharged when current flows through it.

Answer: (b) Both A and R are true but R is NOT the correct explanation of A .

14. Assertion: The voltage across a battery may be less, equal or more than the emf of the battery.

Reason: Voltage across a battery also depends on the magnitude and direction of current.

Answer: (a) Both A and R are true and R is the correct explanation of A.

15. Assertion: Ohm's law is universally applicable for all conducting elements.

Reason: All conducting elements show straight line graphic variation on (I–V) plot.

Answer: (d) A is false and R is also false.

16. Assertion: Alloys of metals usually have greater resistivity than that of their constituent metals.

Reason: Alloys usually have much lower thermal coefficient of resistance than pure metals.

Answer: (b) Both A and R are true but R is NOT the correct explanation of A.

17. Assertion: When temperature of a metallic wire is increased, its resistance increases.

Reason: As the temperature is increased, average relaxation time increases.

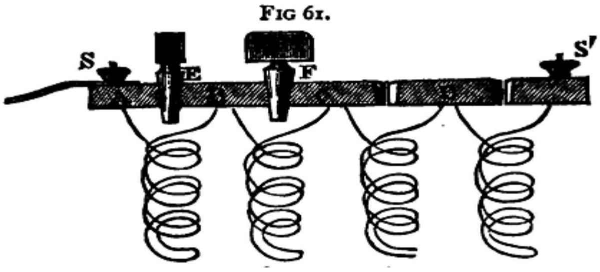
Answer: (c) A is true but R is false

CASE BASED PROBLEMS

18. **Resistance box** :The **box** which contains the resistors of different values for estimating and comparing the **resistance** is known as the **resistance box**. The accuracy of the **resistance box** is very high. The main advantage of the **resistance box** is that the variable resistances are available at one point

Resistance values are adjusted by removing the brass pegs. The **box** is constructed with the pegs in parallel with precision wound **resistance** coils-with the peg in place the current flows through the peg (approx. 0 ohms), when removed the current flows through the resistor.

If the length of material is small then surely, **resistance** will be low and current flows through that material will be high. and if the cross- section area of material is small then; **resistance** will be low and current flows thought material will be high.



Answer the questions: -

(I) The resistances in a resistance box are arranged in-
(a) Series Combinaton
(b) Parallel combination
(c) Mixed grouped
(d) None of the above.

Ans: (a)Series Combinaton

(II) How can the values of resistors applied to a circuit be changed in a resistance box?
(a) By inserting the keys
(b) By removing the keys
(c) By changing the connections.
(d) By changing the coils inside the resistance box.

Ans: (b)By removing the keys

(III) Which statement is correct-
(a) Resistance box is used to apply variable resistance and Rheostat is used to apply constant resistance
(b) Rheostat is used to apply variable resistance and the Resistance box is used to apply constant resistance.
(c) In resistance box, the value of applied resistance is known.
(d) In rheostat, the value of applied resistance is known.

Ans: (c) In resistance box, the value of applied resistance is known.

(IV) Why wire is double folded in resistance box?
(a) to nullify the inductance effect.
(b) To increase the resistance
(c) For space arrangement
(d) to increase the inductance effect.

Ans: (a) to nullify the inductance effect

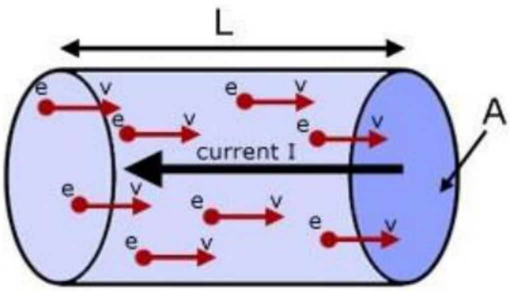
(v) Which of the following resistance has least length-

(a) 1 ohm (b) 10 ohm

(c) 100 ohm (d) 500 ohm

Ans: (a) 1 ohm

19. A cylindrical copper conductor AB of length ‘l’ and area of cross section ‘A’ has a large number of free electrons which at room temperature move at random within the body of the conductor, like the molecules of a gas. The average thermal speed of the free electrons in random motion at room temperature is of the order of 10^{-5} m/s. When a potential difference ‘V’ is applied across the two ends of a given conductor, the free electrons in the conductor experience a force and are accelerated towards the positive end of the conductor. On their way they suffer frequent Collisions with the ion/atoms of the conductor and lose their gained kinetic energy. After each collision the free electrons are again accelerated due to electric field towards the positive end of the conductor and lose their gained kinetic energy in the next Collision with the Ion/atom of the conductor. The average speed of free electrons with which they drift towards the positive end of the conductor under the effect of applied electric field is called Drift velocity of the electron.



(1) When the potential difference is applied across the two ends of the conductor then electric field exists-

(a) outside the conductor (b) inside the conductor

(c) both outside and inside the conductor (d) no where.

Ans: (b) inside the conductor

(2) The motion of electrons in between two successive collisions with the atoms/ ion Follows:

(a) straight path (b) circular path (c) elliptical path (d) curved path

Ans: (a) straight path

(3) The drift speed of the electrons depend on -

a) dimension of conductor b) number density of free electron in the conductor

c) both (a) and (b) d) none of these above

Ans: a) dimension of conductor

(4) The current in the conductor is due to-

a) Thermal motion of free electrons

b) acceleration of the electrons towards the positive end of the conductor

c) Drifting of electrons towards positive end of the conductors

d) None of the above

Ans: (c) Drifting of electrons towards positive end of the conductors

2-MARKS QUESTION

20. Define the term current density of a metallic conductor. Deduce the relation connecting current density (J) and the conductivity (σ) of the conductor, when an electric field E, is applied to it.

Ans: Current density is defined as the current flowing per unit area of the conductor.

Mathematically, the current density is given by the expression, $J = \frac{I}{A}$.

But $I = \frac{V}{R}$ and $R = \frac{\rho l}{A} = \frac{l}{\sigma A}$

Substituting in the above relation, we have

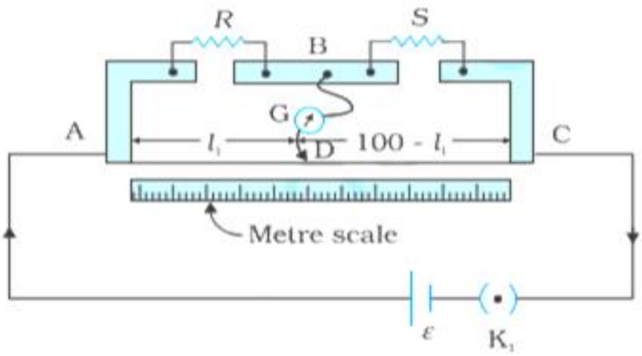
$J = \frac{I}{A} = \frac{V}{A\,l} \times \sigma A = \frac{V}{l} \times \sigma = \sigma E$

Hence, the required relation is, $J = \sigma E$

21.(i) Draw a circuit diagram for a metre bridge to determine the unknown resistance of a resistor.

(ii)Why are the connections between the resistors of a metre bridge made of thick copper strips?

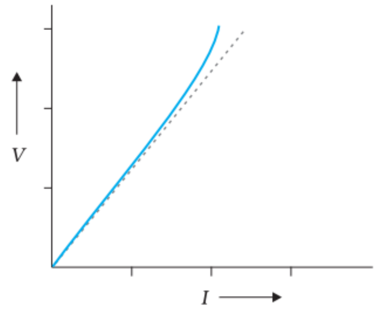
Ans: (i)

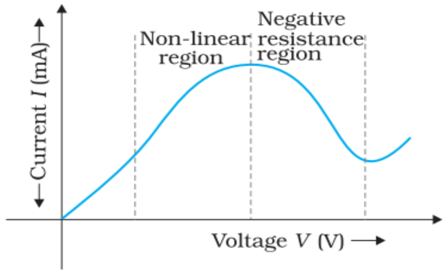


(ii) Connections between resistors are made of thick copper strips so that the resistance of the resistors remains unchanged.

22. Draw V-I graph for ohmic and non- ohmic materials.

Ans: ohmic (conductors) non- ohmic (GaAs.)





23. Mention the factors on which internal resistance of a cell depend.

Ans: The internal resistance of a cell depend on (1) The nature of the electrolyte (2) nature of electrodes (3) temperature (4) concentration of electrolyte (5) distance between the electrodes (6) area of electrodes immersed in electrolyte.

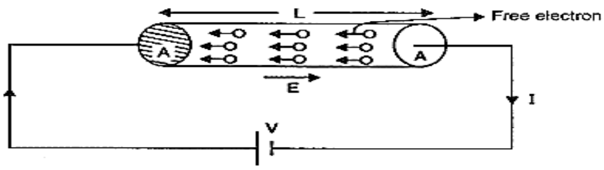
24. Terminal potential difference is less than the emf of a cell. Why?

Ans: When circuit is open, the terminal potential difference is equal to emf of the cell . When current is drawn from the cell, some potential drop takes place due to internal resistance of the cell. Hence terminal potential difference is less than the emf of a cell and is given by $V = \varepsilon - Ir$.

3- MARKS QUESTION

25. Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons.

Ans: Consider a conductor of length l and area of cross section A having n electrons per unit length, as shown in the figure.



Volume of the conductor = Al

Total number of electrons in the Conductor = Volume electron density = Aln

If e is the charge of an electron, then total charge contained in the conductor,

Q = enAl

Let the potential difference V is applied across the conductor.

The resulting electric field in the conductor is given by

$$E = \frac{V}{l}$$

Under the influence this field E, free electrons begin to drift in a direction opposite to that of the field. Time taken by electrons to cross over the conductor is

$t = \frac{l}{v_d}$

Where v_d is the drift velocity of electrons. Therefore, current through the conductor is given by

$I = \frac{Q}{t} = \frac{enAl}{l/v_d}$

or $I = neAv_d \Rightarrow \frac{I}{A} = n_e v_d$ or $J = n_e v_d$

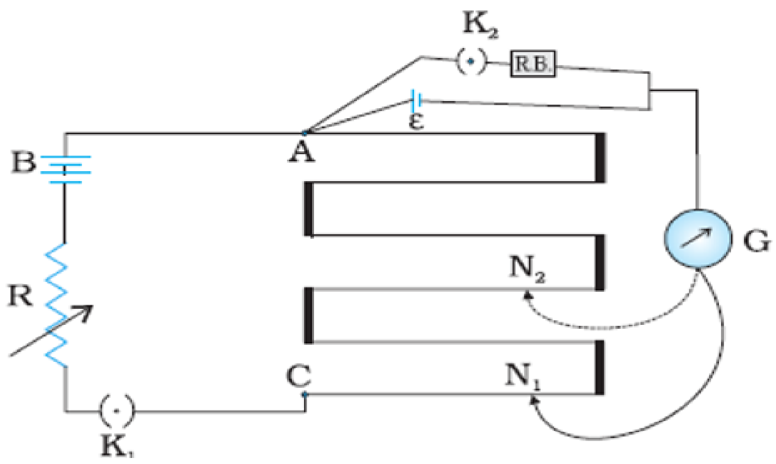
$\Rightarrow J \propto v_d$ [$\because$ n, e, A are all constant]

Thus, current density is proportional to drift velocity.

26. (a) Describe briefly, with the help of a circuit diagram, the method of measuring the internal resistance of a cell.

Ans:

(a) Circuit diagram:



Brief description: Plug in the key k_1 and keep k_2 unplugged and the find the balancing length l_1 such that: $E = kl_1$ (1)

With the key k_2 also plugged in find out balancing length l_2 again such that:

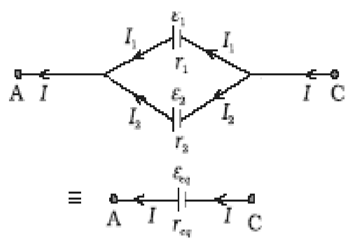
$V = kl_2$ (2)

As $r = \left(\frac{E}{V} - 1\right)R$

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

27. Describe the formula for the equivalent EMF and internal resistance for the parallel combination of two cells with EMF E_1 and E_2 and internal resistances r_1 and r_2 respectively. What is the corresponding formula for the series combination?

Ans: (a) $I = I_1 + I_2$ ---------(1)



Terminal p.d. across first cell, $V = E_1 - I_1 r_1 \Rightarrow I_1 = \frac{E_1 - V}{r_1}$

Terminal p.d. across second cell, $V = E_2 - I_2 r_2 \Rightarrow I_2 = \frac{E_2 - V}{r_2}$

Putting the values of $I_1 \& I_2$ in (1)

$$I = \frac{E_1 - V}{r_1} + \frac{E_2 - V}{r_2} = \frac{E_1}{r_1} + \frac{E_2}{r_2} - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right) \Rightarrow V = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2} - I\frac{r_1 r_2}{r_1 + r_2} \text{ ---------- (2)}$$

If we replace the combination by a single cell, between *A* and C of emf E_{eq} and internal resistance r_{eq}, then $V_{eq} = E_{eq} - Ir_{eq}$ ----------- (3)

Comparing (2) & (3), $E_{eq} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$ and $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$

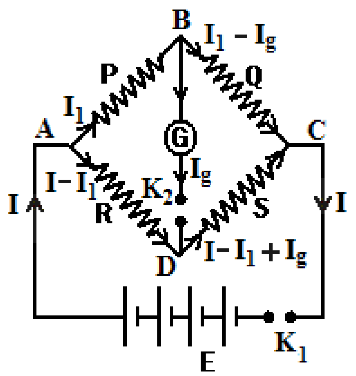
For series combination, $E_{eq} = E_1 + E_2$ and $r_{eq} = r_1 + r_2$

5- MARKS QUESTION

28.(i) State the principle of meter bridge. Derive the balanced condition of Wheatstone Bridge Circuit.

(ii)Draw a circuit diagram for a meter bridge two determine the unknown resistance of a resistor.

Ans: (i) A set of four resistances P, Q, R and S arranged in the manners shown, is known as wheat stone bridge. Principle of this bridge is that when ratio of resistances P and Q equals that of R and S, then points B and D are at the same potential i.e. potential difference between B and D is zero when $\frac{P}{Q} = \frac{R}{S}$.



In this position, the bridge is said to be balanced and no current flows, if a galvanometer is connected between B and D. To prove this principle, let a current I is drawn from the battery, of which a part flows across P i.e. I_1 and remaining $I - I_1$ finds its route through R. I_1 further gets divided into I_g and $(I - I_g)$ at pinot B. At point D, $(I - I_1)$ and I_g combine to flow through S as $(I - I_1 + I_g)$, which further combines with $(I_1 - I_g)$ at point C to come out of bridge at I again.

Now an applying loop rule to the circuit ABDA (going clockwise)

We get $I_1 P + I_g R_g - (I - I_1). R = 0$ -------------------- (1)

[R_g = resistance of galvanometer]

Similarly, for BCDB we have

$(I_1 - I_g). Q - (I - I_1 + I_g). S - I_g R_g = 0$ -------- (2)

When bridge gets balanced, then $I_g = 0$, hence equation (1) and (2) reduce to

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

or $I_1 P = (I - I_1). R$ ------------------------------------- (3)

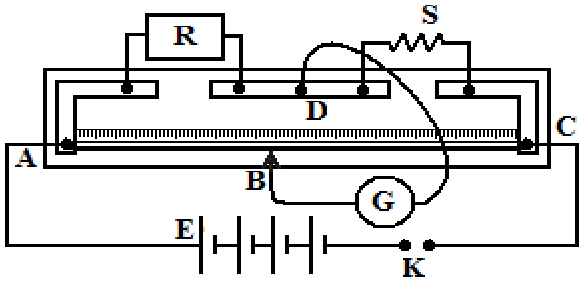
and $(I_1 - 0) Q - (I - I_1 + 0). S - 0.Rg = 0$

or $I_1 Q = (I - I_1) . S$ -------------------------------------- (4)

Dividing equation (3) by (4) we get:

$$\frac{I_1P}{I_1Q} = \frac{(I - I_1).R}{(I - I_1).S} \qquad \text{or} \qquad \boxed{\frac{P}{Q} = \frac{R}{S}}$$

(ii) Slide Wire Bridge Or Meter Bridge: - It is practical form of wheat-stone bridge. A wire AC of constantan or Manganin, 1m in length and of uniform cross-section is stretched over a wooden board. A meter scale runs along the wire. Copper strips are fitted with gaps for resistance box 'R' and unknown resistance 'S'. A jockey than can slide over the wire is connected to point D, through a sensitive galvanometer.



Working: Key K is closed and jockey is slid over the wire to get the balance point, i.e. where current through the galvanometer is zero. Now part AB of the wire acts as 'P' and remaining part BC as resistance Q. If length of AB is 'l' then total of BC = (100 – l). Hence resistances P and Q can be written as

P = $\rho\frac{l}{A}$ and Q = $\rho\frac{(100-l)}{A}$ where ρ and A are resistivity and area of cross-section or wire

$$\frac{P}{Q} = \frac{\rho\frac{l}{A}}{\rho\frac{(100-l)}{A}} = \frac{l}{100-l}$$

At balance point $\frac{P}{Q} = \frac{R}{S}$ or $\frac{l}{100-l} = \frac{R}{S}$

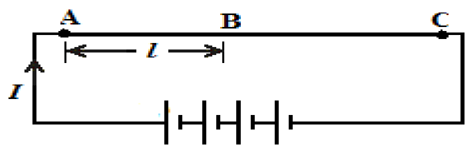
Hence $S = \frac{100-l}{l}.R$

29. (i)State the working principle of a potentiometer.

(ii) Explain, with the help of a circuit diagram, how the emfs of two primary cells are compared by using a potentiometer.

(iii)Why is the use potentiometer preferred over that of a voltmeter for the measurement of emf of a cell?

Ans: (i) It is based on the principle that a current carrying wire of uniform area of cross-section has a potential difference across any two points on it, which is directly proportional to length of the wire between these two points.



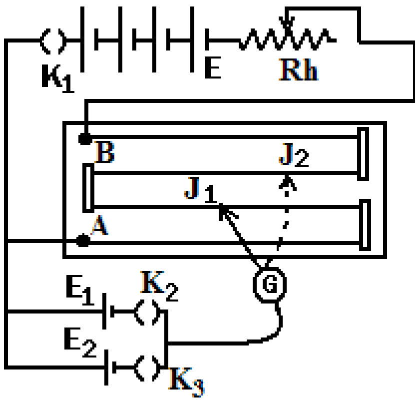
Consider a wire of uniform cross-sectional area 'a', carrying a current 'I', Let 'ρ' be the resistivity of the wire. According to Ohm's law potential difference 'V' between points A and B is

V = I x (resistance between points A and B)

$= I \rho \frac{l}{a}$, where l is length of wire between points A and B But current I, ρ and area of cross-section are constant. Hence $V \propto l$ or $V = k\,l$.

i.e. Potential difference between point A and B is directly proportional to the length of the wire between A and B.

(ii) Comparison of E.M.F.s of two cells, using Potentiometer:



Ends AB of the potentiometer wire are connected to the battery of e.m.f. E (> E_1, E_2), through a rheostat, ammeter, and a key.

Positive terminals of both the experimental cells to be compared are connected to point A. However –ve terminals are connected to a two-way key, which in turn allows to connect any of these cells to point J_1 or J_2 through a galvanometer 'G'. Connect key K_1 and adjust the current using rheostat. Insert key K_2 now and slide the jockey along length AB. Let the balance point be obtained at J_1 and length $AJ_1 = l_1$ say. Hence e.m.f. of the cell E_1 is equal to potential difference across length l_1 i.e.

$E_1 = kl_1$ - --------------------------------- (1)

Let the other cell is balanced at J_2 and length $AJ_2 = l_2$. Hence

$E_2 = kl_2$ ---------------------------------- (2)

Dividing (1) by (2) we get the ratio of e.m.f.s $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

(iii)At the balancing point no current drawn from the cell and cell is in open circuit condition. voltmeter has some resistance when connected across cell. some current is drawn as a result emf of cell decreases. hence emf of the cell cannot be measured by the voltmeter.

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UNIT III Magnetic effect of current & magnetism

MCQ(1 Mark)

1. What is the angle of dip at a place where the horizontal component of earth's magnetic field is equal to the vertical component?
(a) 0°
(b) 30°
(c) 45°
(d) 90°

2. The force between two parallel wire 2×10^{-7} Nm^{-1}, placed 1 m apart to each other in vacuum. The electric current flowing through the wires is:
(a) 1 A
(b) zero
(c) 5×10^{6} A
(d) 2×10^{-7}

3. A wire of length I has a magnetic moment M. It is then bent into a semi-circular arc. The magnetic moment is :
(a) M
(b) M.I.
(c) 2M/п
(d) Mп

4. The radius of curvature of the path of charged particle in a uniform magnetic file is directly proportional to the
(a) charge on fie particle
(b) Momentum of particle
(c) energy of particle
(d) Strength of field

5. The magnetic field at the centre of a current carrying circular loop is B. If the radius of the loop is doubled keeping the current unchanged, the magnetic field at the centre of loop will become:
(a) B/2
(b) B/4
(c) 2B
(d) 4B

6. The dimensional representation of magnetic flux density is :
(a) $[MLT^{-2}]$
(b) $[MLT^{-2}A^{-1}]$
(c) $[MLT^{-2}A^{-2}]$
(d) $[MT^{-2}A^{-1}]$

7. A magnetic bar of M magnetic moment is placed m the field of magnetic strength B, the torque acting on it is :
(a) $\vec{M} . \vec{B}$
(b) $-\vec{M} . \vec{B}$
(c) $\vec{M} \times \vec{B}$.
(d) $\vec{B} \times \vec{M}$

8. The magnetic lines of force inside a bar magnet:
(a) do not exist

(b) depends on area of cross-section of bar magnet
(c) are from N-pole to S-pole of the magnet
(d) are from S-pole to N-pole of the magnet.

9. The sensitivity of a tangent galvanometer can be increased by increasing:
(a) the radius of the coil
(b) the external magnetic field
(c) the number of turns of the coil
(d) all the above

10. The permeability of a paramagnetic substance is:
(a) very large
(b) small but more than unity
(c) less than unity
(d) negative

ASSERTION REASON TYPE

1. Assertion : Gauss's law of magnetism is different from that for electrostatics.
   Reason : Isolated magnetic poles are not known to exist.

2. **Assertion:** A current-carrying conductor experiences a force in a magnetic field.

   Reason: The force acting on a current-carrying conductor in a magnetic field is due to interaction between magnetic field produced by the current-carrying conductor and external magnetic field in which the conductor is placed.

3. **Assertion:** Lenz's law is consequence of law of conservation of energy.

   Reason: In every condition of electromagnetic induction, induced current and induced emf oppose those factors which are responsible for its production.

4. **Assertion:** Magnetic field lines do not intersect each other. **Reason:** There cannot to two direction of the magnetic field at a point.

5. Assertion: The poles of magnet cannot be separated by breaking into two pieces. Reason: The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.

2 MARKS Questions

1. **Define angle of dip. Deduce the relation connecting angle of dip and horizontal component of earth's total magnetic field with the horizontal direction.**

2. **State two factors by which voltage sensitivity of a moving coil galvanometer can be increased?**
3. **Give one difference each between diamagnetic and ferromagnetic substances. Give one example of each?**

4. **Write the expression for the force acting on a charged particle of charge q moving with velocity is in the presence of magnetic field B. Show that in the presence of this force. (a) The K.E. of the particle does not change.(b) Its instantaneous power is zero.**

5. State Gauss's law for magnetism. Also write its physical significance.

Case Study Type Questions

(A)

A charge q moving with a velocity v in presence of both electric and magnetic fields experience a force F=q [E+vxB]. If electric and magnetic fields are perpendicular to each other and also perpendicular to the velocity of the particle, the electric and magnetic forces are in opposite directions. If we adjust the value of electric and magnetic field such that magnitude of the two forces are equal. The total force on the charge is zero and the charge will move in the fields un deflected.

1.What will be the value of velocity of the charge particle, when it moves un deflected defeated in a region where the electric field is perpendicular to the magnetic field and the charge particle enters at right angles to the fields.

(a) v = E/B (b) v = B/E (c) v = EB (d) v = EB/q

2. Proton, neutron, alpha particle and electron enter a region of uniform magnetic field with same velocities. The magnetic field is perpendicular to the velocity. Which particle will experience maximum force?

(a) proton (b) electron (c) alpha particle (d) neutron

3. A charge particle moving with a constant velocity passing through a space without any change in the velocity. Which can be true about the region?

(a) E = 0, B = 0
(b)E non zero, B#0
(c)E=0, B#0
(d) All of these

4. Proton, electron and deuteron enter a region of uniform magnetic field with same electric potential-difference at right angles to the field. Which one has a more curved trajectory?
(a) Proton
(b) Electron
(c) Deuteron
(d) All

(B)

The galvanometer is a device used to detect the current flowing in a circuit or a small potential difference applied to it consists of a coil with many turns, free to rotate about a fixed axis, in a uniform radial magnetic field formed by using concave pole pieces of a magnet. When a current flow through the coil, a torque acts on it

1.What is the principle of moving coil galvanometer?

(a) Torque acting on a current carrying coil placed in a uniform magnetic field.

(b) Torque acting on a current carrying coil placed in a non-uniform magnetic field.

(c) Potential difference developed in the current carrying coil.

(d) None of these.

2. If the field is radial, then the angle between magnetic moment of galvanometer coil and the magnetic field will be

(a) 0° (b) 30° (c) 60° (a)90°

3. Why pole pieces are made concave in the moving coil galvanometer? (a) to make the magnetic field radial.

(b) to make the magnetic field uniform.

(c) to make the magnetic held non-uniform.

(d) none of these.

4. What is the function of radial field in the moving coil garyanometer?

(a) to make the torque acting on the coil maximum.

(b) to make the magnetic Held strong.

(c) to make the current scale linear.

(d) all the above.

5. If the rectangular coil used in the moving coil galvanometer is made circular, then what will be the effect on the maximum torque acting on the coil in magnetic field for the same area of the coil?

(a) remains the same

(b) becomes less in circular

(c) becomes greater in circular coil

(d) depends on the orientation of the coil

5 MARKS QUESTIONS

1. A steady current I1 flows through a long straight wire. Another wire carrying steady current I_2 in the same direction is kept close and parallel to the first wire. Show with the help of a diagram, how the magnetic field due to the current I_r exert a magnetic force on the second wire. Deduce the expression for this force.

2. Draw a labelled diagram of a moving coil galvanometer and explain its working. What is the function of radial magnetic field inside the coil? Define current sensitivity and voltage sensitivity of galvanometer. Increasing the current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer, justify your answer.

ANSWER KEY

MCQs (1 Marks)

Q.No.	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	C	B	A	D	C	D	D	B

Assertion Reason (1 Mark)

Q.No.	1	2	3	4	5
Ans.	A	A	B	A	B

2 Marks questions

1.Ans. Angle of dip is also known as the magnetic dip and is defined as *the angle that is made by the earth's magnetic field lines with the horizontal.*

The angle of dip varies from point to point by providing the information related to the movement of the earth's magnetic field. The angle of dip is 0° when the dip needle rests horizontally while the angle of dip is 90° when the dip needle rests vertically. Horizontal component And Vertical component (v)

tanδ=Bv/BH sinδ=Bv/B cosδ=BH/B sin2δ+cos2δ=B2HB2+B2vB2 1=B2HB2+B2vB2 B=B2H−−−√+B2v

2.Ans.

Voltage Sensitivity = φ/V = (NAB/KR)

Therefore, in order to increase the voltage-sensitivity of the galvanometer,

1. We can increase the area of the coil

2. We can decrease the torsion-constant of the galvanometer.

3.Ans. The material is **Diamagnetic** if the value of χ is small and negative, Paramagnetic if the value of χ is small and positive and **Ferromagnetic** if the value is large and positive.

Example of paramagnetic material: NaCl,benzene
Example of ferromagnetic material: Iron,cobalt

4. Force acting on a charge 'q' moving with a velocity v in the presence of both electric field E and magnetic field B.

$$F=qE+q(v\times B)$$

(a) Here magnitude of velocity and mass of charged particle remain same therefore kinetic energy of charged particle does not change.

(b) P=F.V=FV cosΦ , Here F perpendicular V ,therefore cosΦ =0
Since instantaneous power is zero

5.
Integral equation

The Gauss's law for magnetic fields in integral form is given by:

$$\Phi = \oint B.dA=0$$

Φ is the magnetic flux

The equation states that there is no net magnetic flux bb (which can be thought of as the number of magnetic field lines through an area) that passes through an arbitrary closed surface SS. This means the number of magnetic field lines that enter and exit through this closed surface SS is the same. This is explained by the concept of a magnet that has a north and a south pole, where the strength of the north pole is equal to the strength of the south pole

Case Study type questions

A.
1.(a)
2.(c) Alpha particle
3.(b) E & B nonzero
4.(b) Electron having less mass has less radius and hence more curved trajectory

B.
(1) a
(2) b
(3) a
(4) d

5 Marks questions

1.Ans. The force between two long straight and parallel conductors separated by a distance *r* can be found by applying what we have developed in preceding sections. Figure 1 shows the wires, their currents, the fields they create, and the subsequent forces they exert on one another. Let us consider the field produced by wire 1 and the force it exerts on wire 2 (call the force F_2). The field due to I_1 at a distance *r* is given to be

B1=μ0I12πrB1=μ0I12πr.

(b) A view from above of the two wires shown in (a), with one magnetic field line shown for each wire. RHR-1 shows that the force between the parallel conductors is attractive when the currents are in the same direction. A similar analysis shows that the force is repulsive between currents in opposite directions.

This field is uniform along wire 2 and perpendicular to it, and so the force F_2 it exerts on wire 2 is given by $F = IlBSin\theta = IlbSin\theta \; With \; Sin\theta = 1$

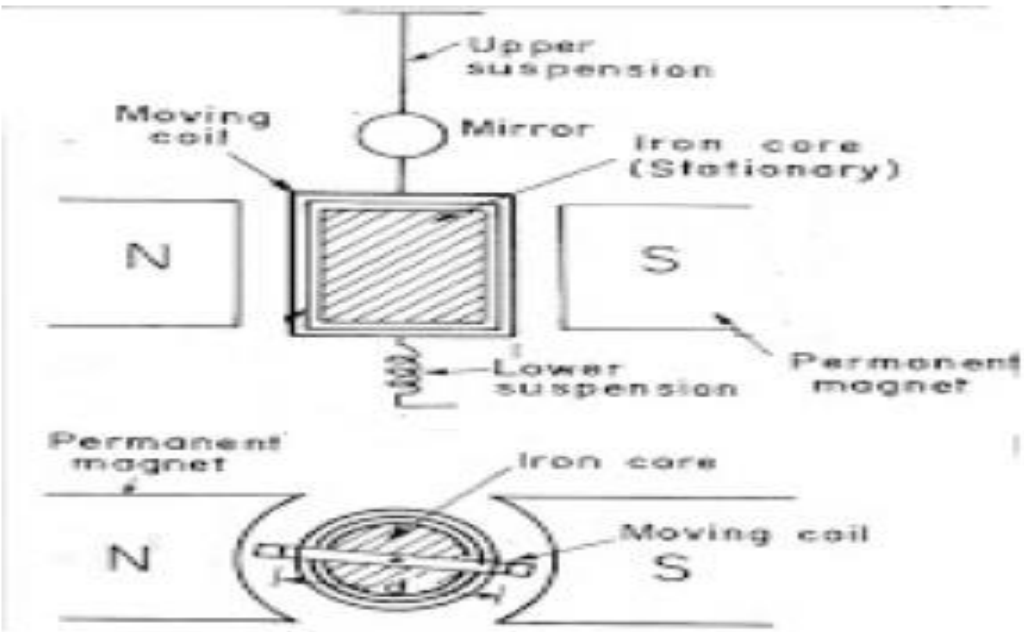
$$F_2=I_{2l}B_1F_2=I_2lB_1.$$

By Newton’s third law, the forces on the wires are equal in magnitude, and so we just write *F* for the magnitude of F_2. (Note that $F_1=-F_2$.) Since the wires are very long, it is convenient to think in terms of *F*/*l*, the force per unit length. Substituting the expression for B_1 into the last equation and rFearranging terms gives

$$\frac{F}{l} = \mu_0 I_1 I_2 \ 2\ пr.$$

2. Principle of Moving Coil GalLvanometer

Torque acts on a current-carrying coil suspended in the uniform magnetic field. Due to this, the coil rotates. Hence, the deflection in the coil of a moving coil galvanometer is directly proportional to the current flowing in the coil.



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The Moving Coil Galvanometer

Construction of Moving Coil Galvanometer

It consists of a rectangular coil of a large number of turns of thinly insulated copper wire wound over a light metallic frame. The coil is suspended between the pole pieces of a horseshoe magnet by a fine phosphor – bronze strip from a movable torsion head. The lower end of the coil is connected to a hairspring of phosphor bronze having only a few turns.

The other end of the spring is connected to a binding screw. A soft iron cylinder is placed symmetrically inside the coil. The hemispherical magnetic poles produce a radial magnetic field in which the plane of the coil is parallel to the magnetic field in all its positions. A small plane mirror attached to the suspension wire is used along with a lamp and scale arrangement to measure the deflection of the coil.

Working of Moving Coil Galvanometer

Let PQRS be a single turn of the coil. A current I flows through the coil. In a radial magnetic field, the plane of the coil is always parallel to the magnetic field. Hence the sides QR and SP are always parallel to the field. So, they do not experience any force. The sides PQ and RS are always perpendicular to the field.

PQ = RS = *l*, length of the coil and PS = QR = b, breadth of the coil. Force on PQ, F = BI (PQ) = BI*l*. According to Fleming's left-hand rule, this force is normal to the plane of the coil and acts outwards.

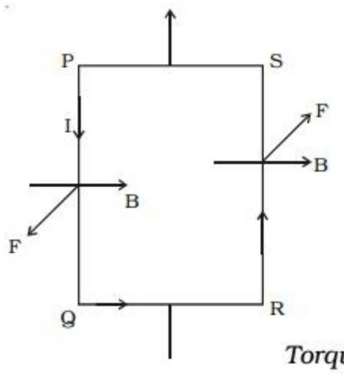


Fig 3.28

Torque on the coil

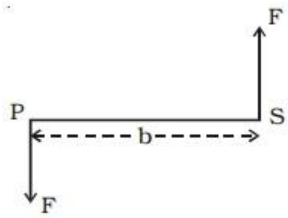


Fig 3.29

Force on RS, F = BI (RS) = BI*l*. This force is normal to the plane of the coil and acts inwards. These two equal, oppositely directed parallel forces having different lines of action constitute a couple and deflect the coil. If there are *n* turns in the coil, the moment of the deflecting couple = *n* BI*l* – b

Hence the moment of the deflecting couple = *n*BIA

The suspension wire twists when the coil deflects. On account of elasticity, a restoring couple is set up in the wire. This couple is proportional to the twist. If θ is the angular twist, then, the moment of the restoring couple = Cθ, where C is the restoring couple per unit twist.
At equilibrium, deflecting couple = restoring couple nBIA = Cθ

Hence we can write, nBIA = Cθ

I = (C / nBA) × θ where C is the torsional constant of the spring; i.e. the restoring torque per unit twist. A pointer attached to the spring indicates the deflection θ on the scale.

Now, increasing the number of turns N of the coil will result in the same increase in the resistance of the coil R as R∝l and surface-area of coil is kept constant.

Therefore, increasing number of turns N of the coil DOES NOT AFFECT the voltage-sensitivity of the galvanometer.

UNIT IV Electromagnetic induction & Alternating Current

MCQ (1 Marks)

1. The magnetic flux linked with a coil of N turns of area of cross section A held with its plane parallel to the field B is
(a) $\frac{NAB}{2}$ (b) NAB (c) $\frac{NAB}{4}$ (d) zero

2. Faraday's laws are consequence of the conservation of
(a) charge
(b) energy
(c) magnetic field
(d) both (b) and (c)

3. Direction of current induced in a wire moving in a magnetic field is found using
(a) Fleming's left hand rule
(b) Fleming's right hand rule
(c) Ampere's rule
(d) Right hand clasp rule
4. Lenz's law is a consequence of the law of conservation of
(a) charge
(b) energy
(c) induced emf
(d) induced current

5. A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, the current will
(a) increase
(b) decrease
(c) remain same
(d) first increase then decrease

6. The average value of power of AC over a complete cycle is:
(a) I_0
(b) I02
(c) I0√2
(d) zero

7.Power factor of an ac circuit is a measure of:
(a) virtual power
(b) power lost in the circuit
(c) mean power
(d) all the above

8.The dimensional formula of L/R is similar to that of:
(a) frequency
(b) time
(c) length
(d) none of these

9.Which of the following has dimensions different from the rest?
(a) L/R
(b) 1/RC
(c) LC−−−√
(d) RC

10.The dimensional formula of impedance is;
(a) $[ML^2T^{-2}A^{-2}]$
(b) $[ML^2T^{-3}A^{-2}]$
(c) $[ML^2T^{-2}A^{-1}]$
(d) $[ML^2T^{-2}A^{-3}]$

ASSERTION REASON(1Marks)

1. Assertion : The induced emf and current will be same in two identical loops of copper and aluminum, when rotated with same speed in the same magnetic field.
   Reason : Mutual induction does not depend on the orientation of the coils.

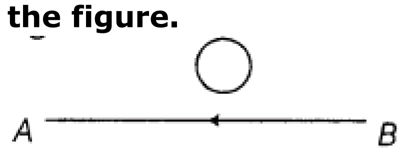
2. **Assertion:** Electric field produced by a variable magnetic field can't exert a force on a charged particle.
   Reason: This electric field is non-conservative in nature

3. Assertion : An alternating current does not show any magnetic effect.
   Reason : Alternating current varies with time.
4. Assertion : The dc and ac both can be measured by a hot wire instrument.
   Reason : The hot wire instrument is based on the principle of magnetic effect of current.

5. Assertion: Transformers are used only in alternating current source not in direct current.
   Reason: Only a.c. can be stepped up or down by means of transformer.

2 Marks Questions

1. **The electric current flowing in a wire in the direction from B to A Find out the direction of the induced current in the metallic loop kept the wire as shown in the figure.**



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2. **State Lenz's law. A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends? Justify your answer.**
3. **State the Faraday's law of electromagnetic induction.**
4. **Why is the use of AC voltage preferred over DC voltage? Give two reasons.**
5. Obtain the resonant frequency ωr of a series LCR circuit with L = 2.0H, C = 32 μF and R = 10 Ω. What is the Q-*value* of this circuit?

3 Marks questions

1. **Explain principle and working of AC generator.**
2. Define LC oscillations. Obtain frequency of LC oscillation. State energy losses in LC oscillations.
3. What is magnetic potential energy stored per unit volume of solenoid. Obtain its expression.

Case Study Type Questions

(A)

The magnetic field lines of the earth resemble that of a hypothetical magnetic dipole located at the centre of the earth. The axis of the dipole does not coincide with the axis of rotation of the ea. but is presently tilted by approximately 11.3° with respect to the later. If the magnetic needle is perfectly balanced about a horizontal axis so that it can swing in a plane of the magnetic meridian, the needle would make an angle with the horizontal. This is known as the angle of dip (also known as inclination).

1.What is the angle of dip at the equator?

(a) 0°

(b) 45°

(c) 60°

(d) 90°

2. At the poles, the dip needle will

(a) stay horizontal

(b) stay vertical

(c) stays at 45° angle with the horizon.

(d) does not remain steady in any fixed position

3.The angle of dip will be when the vertical component of the ea.'s magnetic field is equal to the horizontal component of the earth's magnetic field will be

(a) 30°

(b)45°

(c)50 WM'

(d) 0°

4. Which of the following independent quantities is not used to specify the

magnetic field?

(a) Magnetic declination (B)

(b) Angle of dip (6)

(c) Horizontal component of ea.'s magnetic field (B.)

(d) Vertical component of ea.'s magnetic field (Bs)

(B)

An inductor is simply a coil or a solenoid that has a fixed inductance. It is refer. to as a c.ke. The usual arcuit notation for an inductor is as shown.
Let a current i flows through the inductor from A to B. W.never elect. current changes through iL a back ernf is genera.. If the resistance of inductor is assumed to be zero (ideal inductor) then induced emf in it is given by e=VB-VA. - L di / dt
Thus, potential drops across an inductor as we movein the direction of current. But potential also drops across a pure resistor when we move in the direction of the current. The main differen. between a resistor and an inductor is that while a resistor opposes the current through it, an inductor opposes the change in current through it. Now answer the following questions.

(1) How does inductor behave when
(a) a steady current flow through it?
(b) a steadily increasing, current flows through it?
(c) a steadily decreasing current flows through it?
(d) Name the phenomenon in which change in current in a coil induc. EMF in coil itsetf?

5 Marks Questions

1. (a) State the condition under which the phenomenon of resonance Anti occurs in a series LCR circuit. Plot a graph showing the variation of current with frequency of a.c. sources in a series LCR circuit.

(b) Show that in a series LCR circuit connected to an a.c. source exhibits resonance at its natural frequency equal to $1/2\pi\sqrt{LC}$.

2.Explain principal and working of transformer. A transformer has a primary coil and a secondary coil with the number of loops are 500 and 5000. Input voltage is 220 V. What is the output voltage?

ANSWER KEY

MCQs(1Marks)

Q.No.	1	2	3	4	5	6	7	8	9	10
Ans.	D	B	B	B	B	D	B	B	B	B

Assertion Reason type

Q.No.	1	2	3	4	5

Ans.	D	C	A	C	B

2 Marks questions

1. Anticlockwise
2. According to Lenz's law ,an induced electric current flows in a direction such that the current opposes the change that induced it.
   Yes emf is induced in metallic rod because length of metallic rod is perpendicular to the magnetic field of earth.
3. First law: Whenever a conductor is placed in a varying magnetic field, an electromotive force is induced. If the conductor circuit is closed, a current is induced which is called induced current. Second law: The induced emf in a coil is equal to the rate of change of flux linkage. The flux is the product of the number of turns in the coil and the flux associated with the coil.

4. The use of AC voltage is preferred over DC voltage because of(i) the loss of energy in transmitting the AC voltage over long distances with the help of step-up transformers is negligible as compared to DC voltage.

   (ii) AC voltage can be stepped up and stepped down as per the requirement by using a transformer. R=10 unit,C=32 microfarad,L=2H,Putting values in last formula given below
5. We will get quality factor (solve) Q=25 unitless.

$$\text{Q-factor} = \frac{I_m X_L}{I_m R} = \frac{X_L}{R}$$

$$\text{Q-factor} = \frac{\omega_r L}{R} \qquad (4.59)$$

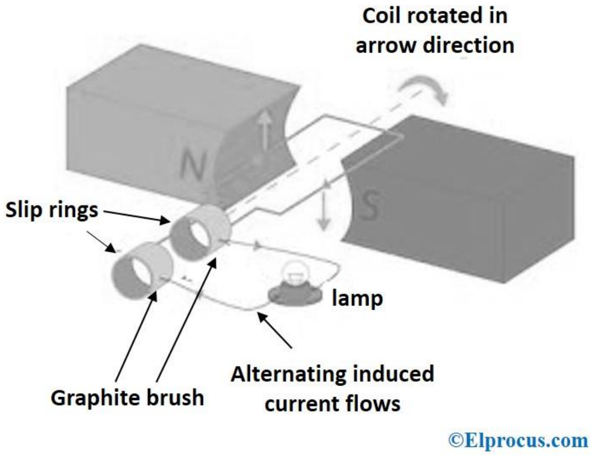
$$\text{Q-factor} = \frac{L}{R\sqrt{LC}} \qquad \text{since } \omega_r = \frac{1}{\sqrt{LC}}$$

$$\text{Q-factor} = \frac{1}{R}\sqrt{\frac{L}{C}} \qquad (4.60)$$

3 Marks questions

1. Ans. Working Principle: **AC generator working principle** is, these are commonly referred to as alternators which work on the principle of Faraday's Law of Electromagnetic Induction. The movement of a conductor in a uniform

magnetic field changes the magnetic flux linked with the coil, thus inducing an



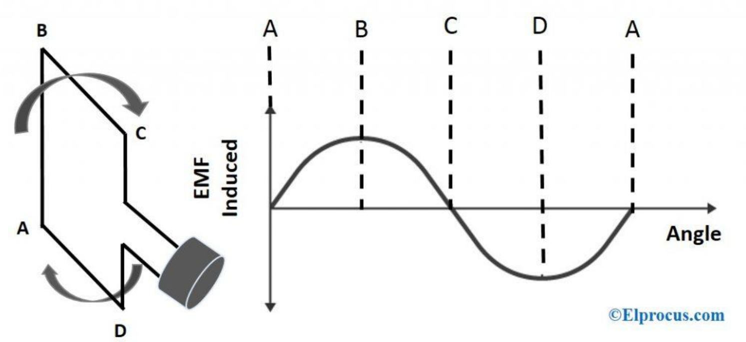
emf.

Simple AC Generator

The **parts of the AC generator** consist of a coil, slip rings, brushes, and a strong magnetic field as its main components.

Working of AC Generator

The coil is rotated in the magnetic field to produce a strong magnetic field. As coil on one side moves up through the magnetic field, an emf is induced in one direction. As the rotation of the coil continues and this side of a coil moves down and another side of the coil moves up, an emf is induced in the reverse direction. Fleming's right-hand rule is used to determine the direction of the induced emf. This process repeats for every cycle and the emf produced is of alternating type.



Different Positions of a Coil

The output of an AC generator is shown above with a graph.

- A – When the coil is at 0 degrees, the coil moves parallel to the direction of the magnetic field and hence induces no emf.
- B – When the coil is at 90 degrees, the coil moves at 90° to the magnetic field and hence induces maximum emf.
- C – When the coil is at 180 degrees, the coil again moves parallel to the magnetic field and hence induces no emf.
- D – When the coil is at 270 degrees, the coil again moves at 90° to the magnetic field and hence induces maximum emf. Here, the induced emf is opposite to that of B.
- A – When the coil is at 360 degrees, the coil has completed one rotation and it moves parallel to the magnetic field and induces zero emf.

Consider a coil of rectangular shape with 'N' turns that rotates in a uniform magnetic field 'B' of an angular velocity 'ω'. The angle between the magnetic field 'B' and normal to the coil at any time 't' is given by, $\boldsymbol{\theta = \omega t}$.

In this position, the magnetic flux is perpendicular to the plane of a coil and is given by B Cos ωt.

The magnetic flux linked with a coil of N turns is ϕ = B Cos ωt A, where A is the area of a coil.

The induced emf in the coil is given by Faraday's Laws of Electromagnetic Induction, which is

$$\varepsilon = -\frac{d\emptyset}{dt} = -\frac{d}{dt}(\mathrm{NBA\ Cos\ \omega t}) = NAB\sin\omega t \text{-----}(1)$$

When the coil rotates through 90°, the value of sine becomes 1 and the emf induced will be maximum, the above equation (i) reduces to,

$$\varepsilon \quad = \mathrm{N}\, B_m\, \mathrm{A}\, \omega = \mathrm{N\ Bm\ A\ 2\pi f} \text{ --------------}\mathbf{(ii)}$$

Where B_m refers to the maximum flux density in **Wb/m^2**
'A' refers to the area of a coil in m^2

'f' = frequency of rotation of a coil in rev/second.

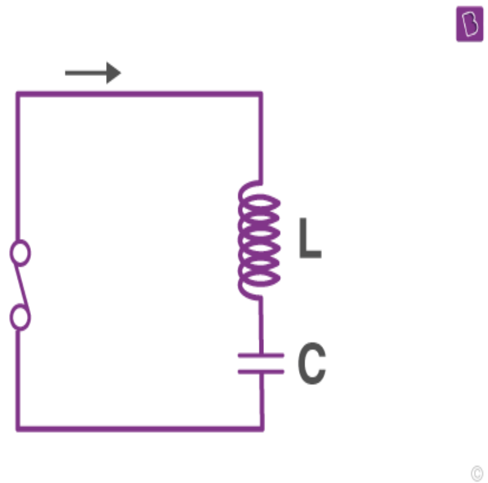
Substitute (ii) in (i),

$$\varepsilon = \varepsilon_o \sin\omega t$$

Induced alternating current is given by, **I = ε/R = ε0 sin ωt/ R**

2. LC oscillations- The electric current and the charge on the capacitor in the circuit undergo electrical LC oscillations when a charged capacitor is connected to an inductor. The electrical energy stored in the capacitor is its initial charge which is named as qm
It is represented by,

UE =12q2mC
The inductor contains zero energy. Charge varies sinusoidally with respect to time.



When the switch is turned on, the current in the circuit starts increases and the charge on the capacitor keeps decreasing. The current induced in the circuit produces a magnetic field in the inductor. When the current increase to its maximum level Im the magnetic energy in the circuit is represented as:
UB = 12LI2m

The magnetic field starts decreasing with time as there is no further change in current through the inductor. The current is induced in the circuit as a result of a decreasing magnetic field. With reverse polarization, the current starts charging the capacitor. This process is repeated and again, once the capacitor in the circuit is fully charged with regard to its previous states. Due to this reason energy in the whole system oscillates between the capacitor and the inductor.

On applying Kirchhoff’s law to the circuit we conclude that the charge oscillates with a natural frequency.

$\omega0 = 1LC\surd$

However, practically this whole process is not possible and is never achieved. The reason for the discrepancy is some loss of energy due to resistance in the circuit and also due to radiations in the form of electromagnetic waves.

$$W = \frac{1}{2} LI^2$$

$$\text{Energy density} \quad (u) = \frac{\text{total energy stored}}{\text{volume}}$$

$$u = \frac{\left(\frac{1}{2}\right)LI^2}{Al} = \frac{\frac{1}{2}(LI)\,I}{Al}$$

$$\text{Flux} = NBA = LI$$

$$\text{and} \quad B = \frac{\mu_0 NI}{l} \Rightarrow I = \frac{Bl}{\mu_0 N}$$

$$\therefore \quad u = \frac{\frac{1}{2}(NBA).\frac{Bl}{\mu_0 N}}{Al} = \frac{B^2}{2\mu_0}$$

4 .Magnetic energy density per unit volume in solenoid or inductor can be derived as

Case study type questions

(A)

Question no.	1	2	3	4
Ans.	a	b	B	a

(B)

ANS: (i) (a) As electric current is steady therefore di / dt = 0; :: induced emf e = 0 and the inductor behaves as short circuit.

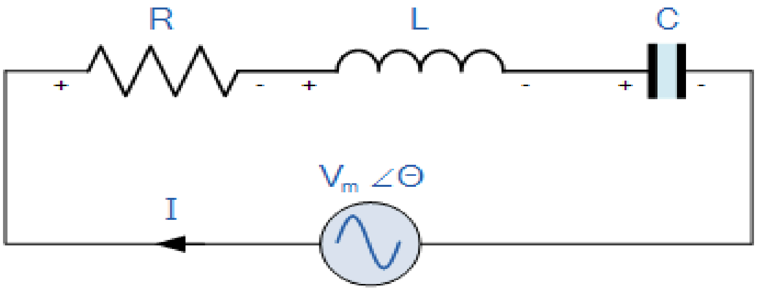
(b) in the expression e= - L di / dt as di kit is positive EMF is negative. that is Ve < VA That is back EMF is genreted that opposses the increase in current.

(c) di / dt is negative, therefore EMF is positive. that is Ve > VA. Forward EMF is generated that opposses fall in current. (d) Self induction.

5 Marks questions

1. *Series Resonance* circuits are one of the most important circuits used electrical and electronic circuits. They can be found in various forms such as in AC mains filters, noise filters and also in radio and television tuning circuits producing a very selective tuning circuit for the receiving of the different frequency channels. Consider the simple series RLC circuit below.

Series RLC Circuit



Firstly, let us define what we already know about series RLC circuits.

- Inductive reactance : $X_L = 2\pi f L = \omega L$
- Capacitive reactance : $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{\omega C}$
- When $X_L > X_C$ the circuit is Inductive
- When $X_C > X_L$ the circuit is Capacitive
- Total circuit reactance = $X_T = X_L - X_C$ or $X_C - X_L$
- Total circuit impedance = $Z = \sqrt{R^2 + X_T^2} = R + jX$

From the above equation for inductive reactance, if either the Frequency or the **Inductance** is increased the overall inductive reactance value of the inductor would also increase. As the frequency approaches infinity the inductors reactance would also increase towards infinity with the circuit element acting like an open circuit.

$$X_L = X_C \quad \Rightarrow \quad 2\pi f L = \frac{1}{2\pi f C}$$

$$f^2 = \frac{1}{2\pi L \times 2\pi C} = \frac{1}{4\pi^2 LC}$$

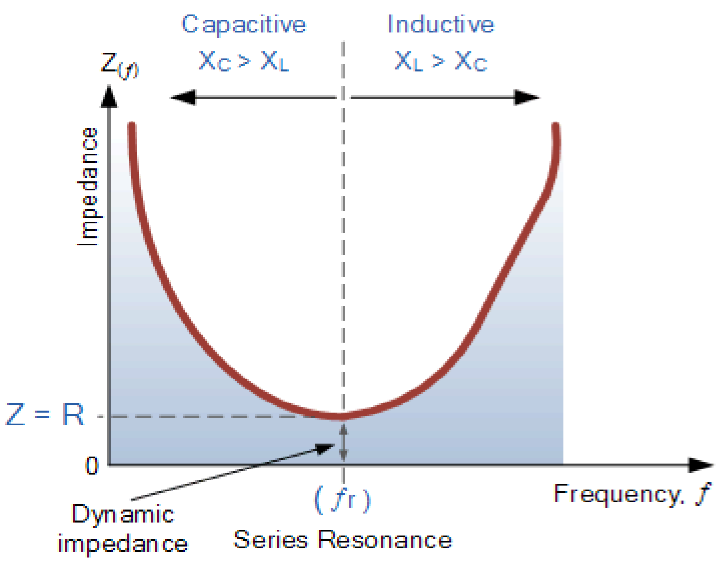
$$f = \sqrt{\frac{1}{4\pi^2 LC}}$$

1. $$\therefore \; f_r = \frac{1}{2\pi\sqrt{LC}} \text{ (Hz)} \quad \text{or} \quad \omega_r = \frac{1}{\sqrt{LC}} \text{ (rads)}$$

We can see then that at resonance, the two reactances cancel each other out thereby making a series LC combination act as a short circuit with the only opposition to current flow in a series resonance circuit being the resistance, R. In complex form, the resonant frequency is the frequency at which the total impedance of a series RLC circuit becomes purely *"real"*, that is no imaginary impedance's exist. This is because at resonance they are cancelled out. So the total impedance of the series circuit becomes just the value of the resistance and therefore: Z = R.

Then at resonance the impedance of the series circuit is at its minimum value and equal only to the resistance, R of the circuit. The circuit impedance at resonance is called the "dynamic impedance" of the circuit and depending upon the frequency, X_C (typically at high frequencies) or X_L (typically at low frequencies) will dominate either side of resonance as shown below.

Impedance in a Series Resonance Circuit



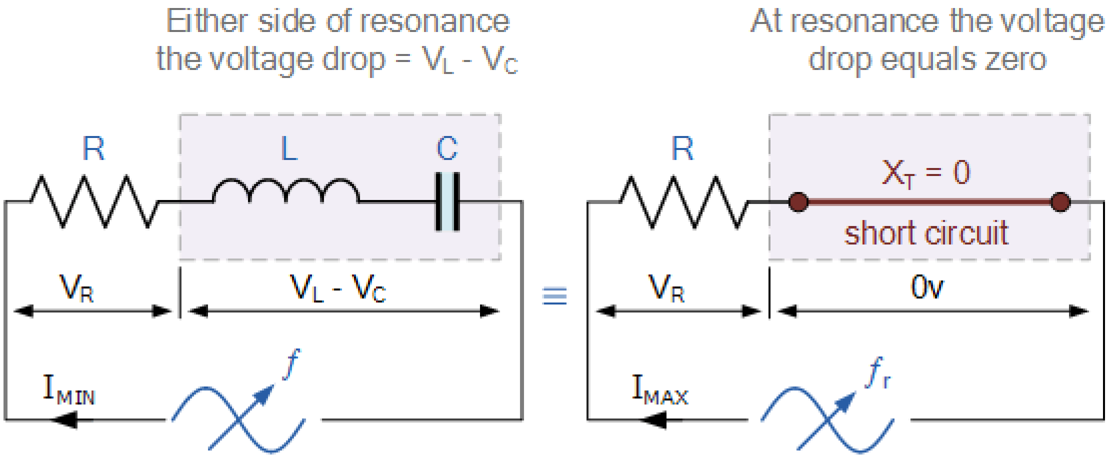
Note that when the capacitive reactance dominates the circuit the impedance curve has a hyperbolic shape to itself, but when the inductive reactance dominates the circuit the curve is non-symmetrical due to the linear response of X_L.

You may also note that if the circuits impedance is at its minimum at resonance then consequently, the circuits admittance must be at its maximum and one of the characteristics of a series resonance circuit is that admittance is very high. But this can be a bad thing because a very low value of resistance at resonance means that the resulting current flowing through the circuit may be dangerously high.

We recall from the previous tutorial about series RLC circuits that the voltage across a series combination is the phasor sum of V_R, V_L and V_C. Then if at resonance the two reactances are equal and cancelling, the two voltages representing V_L and V_C must also be opposite and equal in value thereby cancelling each other out because with pure components the phasor voltages are drawn at +90° and -90° respectively.

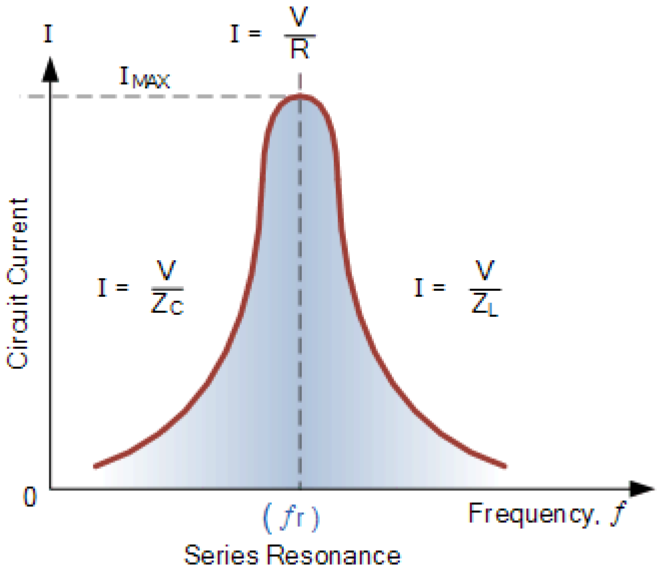
Then in a **series resonance** circuit as $V_L = -V_C$ the resulting reactive voltages are zero and all the supply voltage is dropped across the resistor. Therefore, $V_R = V_{supply}$ and it is for this reason that series resonance circuits are known as voltage resonance circuits, (as opposed to parallel resonance circuits which are current resonance circuits).

Series RLC Circuit at Resonance



Since the current flowing through a series resonance circuit is the product of voltage divided by impedance, at resonance the impedance, Z is at its minimum value, (=R). Therefore, the circuit current at this frequency will be at its maximum value of V/R as shown below.

Series Circuit Current at Resonance



The frequency response curve of a series resonance circuit shows that the magnitude of the current is a function of frequency and plotting this onto a graph shows us that the response starts at near to zero, reaches maximum value at the resonance frequency when $I_{MAX} = I_R$

2. A **transformer** is defined as a passive electrical device that transfers electrical energy from one circuit to another through the process of electromagnetic induction. It is most commonly used to increase ('step up') or decrease ('step down') voltage levels between circuits.

Working Principle of Transformer

The **working principle of a transformer** is very simple. Mutual induction between two or more windings (also known as coils) allows for electrical energy to be transferred between circuits. This principle is explained in further detail below.

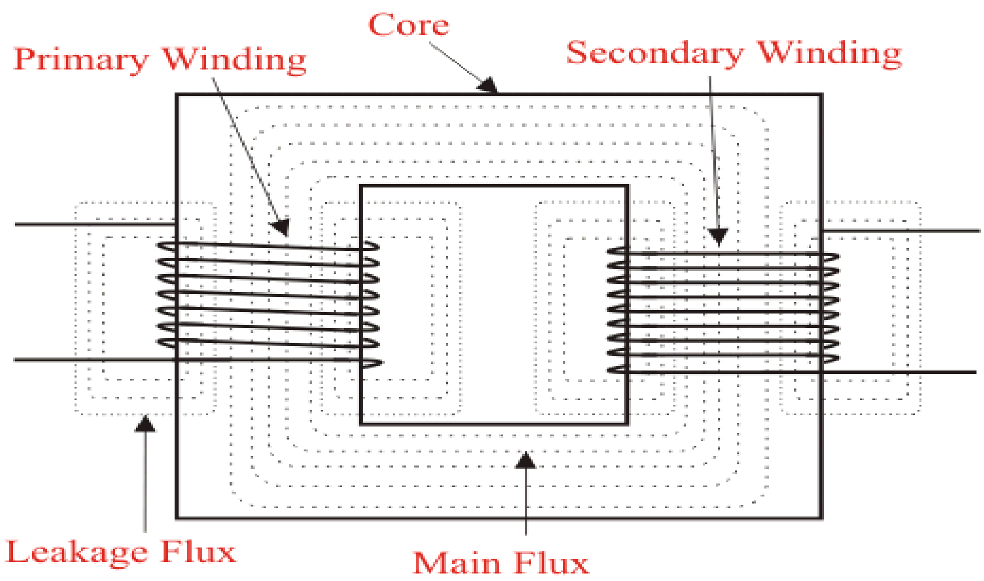
Transformer Theory

Say you have one winding (also known as a coil) which is supplied by an alternating electrical source. The alternating current through the winding produces a continually changing and alternating flux that surrounds the winding.

If another winding is brought close to this winding, some portion of this alternating flux will link with the second winding. As this flux is continually changing in its amplitude and direction, there must be a changing flux linkage in the second winding or coil.

According to Faraday's law of electromagnetic induction, there will be an EMF induced in the second winding. If the circuit of this secondary winding is closed, then a current will flow through it. This is the basic **working principle of a transformer**.

- The rate of change of flux linkage depends upon the amount of linked flux with the second winding. So ideally almost all of the flux of primary winding should link to the secondary winding. This is effectively and efficiently done by using a core type transformer. This provides a low reluctance path common to both of the windings.



- The purpose of the transformer core is to provide a low reluctance path, through which the maximum amount of flux produced by the primary winding is passed through and linked with the secondary winding.
- The current that initially passes through the transformer when
  Primary coil (NP) = 500 loops Secondary coil (Ns) = 5000 loops Primary voltage (VP) = 220 Volt

Wanted : Secondary voltage (VS)

Solution :

Vs / Ns = Vp / Np

Vs / 5000 = 220 / 500

Vs / 5000 = 0.44

Vs = (0.44)(5000)

V_s = 2200 Volt

UNIT –V ELECTROMANETIC WAVES

(MCQ 1-Mark)

Q.1 What is meant by transverse nature of electromagnetic waves?

Ans. Transverse nature means, $\vec{E}$ and $\vec{B}$ are perpendicular to each other as well as perpendicular to the direction of propagation of the wave.

Q.2 In which directions do the electric and magnetic field vectors oscillate in an electromagnetic wave propagation along the X-axis?

Ans. $\vec{E}$ (electric field)along Y-axis and $\vec{B}$ (magnetic field) along Z-axis.

[Alternatively $\vec{E}$ (electric field)along Z -axis and $\vec{B}$ (magnetic field) along Y -axis]

Q.3 Which constituent radiations of electromagnetic spectrum is used- (any one)

(i) In Radar (Ans.-Microwaves)

(ii)In photographs of internal parts of human body /diagnostic tool in medicine (Ans.-X-rays)

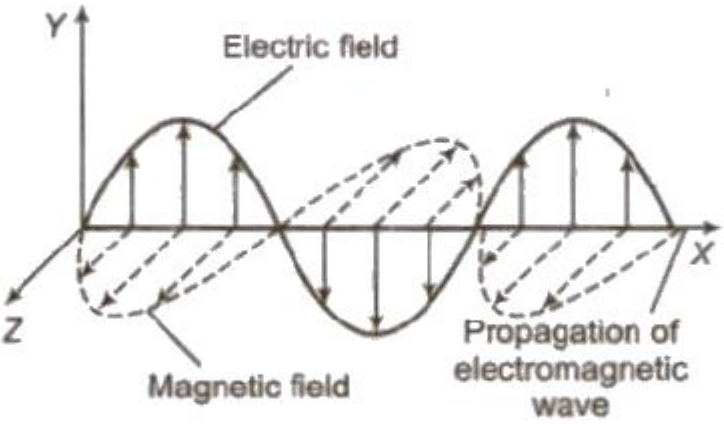
(iii) For used to destroy the cancer cells /treatment of cancer. (Ans. γ- rays)

(iv) Used for water purification /are absorbed by the ozone layer in atmosphere from the sunlight. (Ans. UV- rays)

(VSA- 2Marks)

Q.1Draw a sketch of linearly polarized electro-magnetic waves propagating in the Z-axis direction. Indicate the directions of the oscillating electric and magnetic fields. Write four characteristics of e-m waves.

Ans.



Properties of EM Waves

(I) These waves are transverse in nature.
(ii) These waves propagate through space with speed of light, i.e., 3×10^8 m / s.
(iii) The speed of electromagnetic wave,
$c = 1 / \sqrt{\mu_o \varepsilon_o}$
where, μ_o is permeability and ε_o is permittivity of free space,
$\therefore c = E_o / B_o$
where E_o and B_o are maximum values of electric and magnetic field vectors
(iv)The electric vector is responsible for the optical effects of an electromagnetic wave.

Q.3Suppose the electric field part of an electromagnetic wave is given by
E = (3.1 N/C) cos [(1.8 rad/m) y + (5.4 X10^6 rad/s) t] i

(i) What is the direction of propagation? (ii) what is the wavelength λ? (iii) what is the frequency ν? (iv) what is the amplitude of the magnetic field part of the wave?

Ans. (i) - j (ii) λ = 3.5 m (iii) ν = 8.6 X 10^6 HZ (iv) B = 10^{-11} cos [(1.8 rad/m) y + (5.4 X10^6 rad/s) t]

ASSERTION- REASON TYPE QUESTION

Directions: Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct; reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct; reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct; reason is incorrect

(d) Assertion is incorrect, reason is correct.

Q.1 Assertion: The electromagnetic wave is transverse in nature.

Reason: Electromagnetic wave propagates parallel to the direction of electric and magnetic fields.

Ans. (c) This electromagnetic wave contains sinusoidally time varying electric and magnetic field which act perpendicular to each other as well as at right angle to the direction of propagation of waves, so electromagnetic waves are transverse in nature. Electromagnetic wave propagates in the perpendicular direction to both fields.

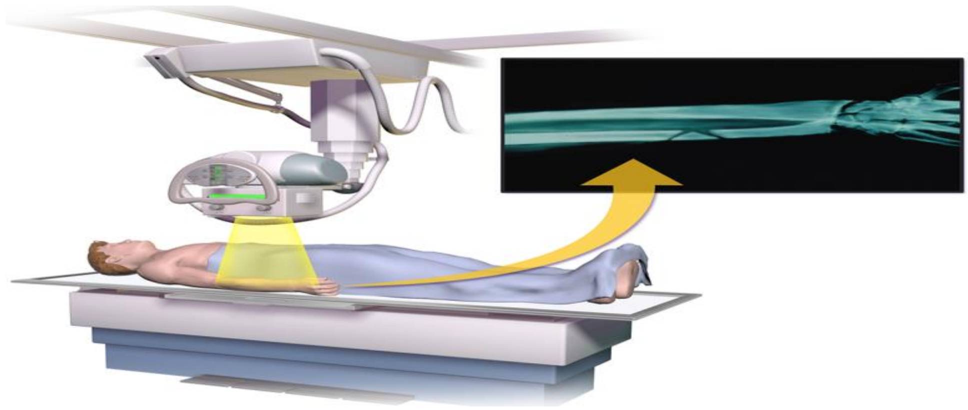
Q.2 Assertion: Infrared radiation plays an important role in maintaining the average temperature of earth.

Reason: Infrared radiations are sometimes referred to as heat waves

Ans. (b) Infrared radiation help to maintain the earth warmth through the greenhouse effect. Incoming visible light which passes relatively easily through the atmosphere is absorbed by the earth's surface and re-radiated as infrared radiation. The radiation is trapped by greenhouse gases such as carbon dioxide and water vapour and they heat up and heat their surroundings.

CASE STUDY BASED PROBLEMS

X- Rays:- X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body. Medical x-rays are used to generate images of tissues and structures inside the body



Q.1 What is the most common method of preparation of X -rays ?

(a)magnetron valve (b) vibration of atoms and molecules

(c) bombardment of metal by high energy electrons (d) radioactive decay of nucleus.

Ans.(c)

Q.2 which of the following set of instrument /equipment can detect X- rays

(a) Photocells, photographic film (b) Thermopiles, bolometer

(c) Photographic film, Geiger tube (d) Geiger tube, human eye

Ans.(c)

Q.3 where do X rays fall on the electromagnetic spectrum?

(a) Between UV region and infrared region (b) Between gamma rays and UV region

(c) Between infrared and microwaves (d) Between microwaves and radio waves

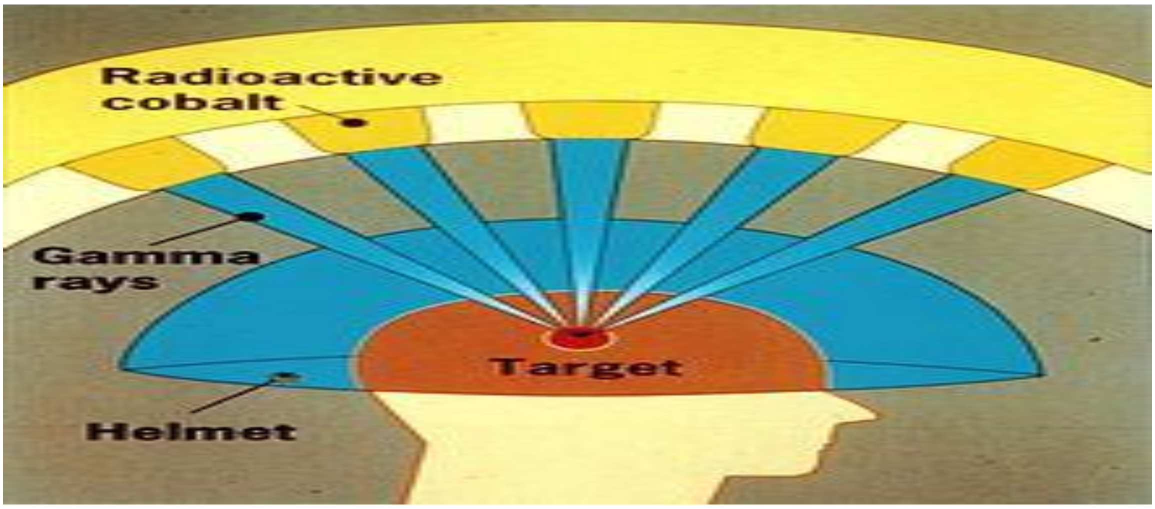
Ans.(b)

Q.4 what is the use of rays lying beyond X ray region in electromagnetic spectrum

(a) used to kill microbes (b) used to detect heat loss in insulated systems

(c) used in standard broadcast radio and television (d) used In oncology, to kill cancerous cells . Ans.(d)

Q (2) GAMMA RAYS IN TREATMENT OF CANCER Gamma rays are used in radiotherapy to Treat cancer. They are used to spot tumors. they kill the living cells and damage malignant tumor.



Q. (1) what is the source of gamma rays?

(a) radioactive decay of nucleus (b) accelerated motion of charges in conducting wire

(c) hot bodies and molecule (d) klystron valve

Ans.(a)

Q. (2) how is wavelength of gamma rays

(a) low (b) high (c) infinite (d) zero

Ans.(b)

Q. (3) choose the one with correct radiation order?

(a) alpha>beta>gamma (b) beta>alpha>gamma (c) gamma>beta>alpha (d) gamma>alpha>beta

Ans.(c)

Q.(4) what is other use of gamma rays?

(a) used to change white topaz to blue topaz (b) used in aircraft navigation (c) used in kill microbes (d) checking fractures of bone

Ans.(a)

UNIT 6 and 7(Optics and Dual Nature of radiation and matter)

Minimum learning program

MCQ

Q.1 Total internal reflection can take place only if

(a) light goes from optically rarer medium (smaller refractive index) to optically denser medium
(b) light goes from optically denser medium to rarer medium
(c) the refractive indices of the two media are close to different
(d) the refractive indices of the two media are widely Different
Ans (b)

Q.2 When light is refracted into a denser medium-

(a) its wavelength and frequency both increase
(b) its wavelength increases but frequency remains unchanged
(c) its wavelength decreases but frequency remains unchanged
(d) its wavelength and frequency both decrease
Ans (c)

Q.3 When the incidence angle is equal to the angle of emergence of light from the prism the refracted ray inside the prism-

(a) becomes parallel to the right face of prism
(b) becomes perpendicular to the base of prism
(c) becomes parallel to the base of prism
(d) becomes perpendicular to the left face of prism

Q.4 If the focal length of objective lens is increased then magnifying power of :

(a) microscope will increase but that of telescope decrease.
(b) microscope and telescope both will increase.
(c) microscope and telescope both will decrease
(d) microscope will decrease but that of telescope increase.
Ans (d)

Q.5 Which of the following statements is/are correct about a convex lens?
I. Convex lens is converging for light for all wavelengths.
II. For virtual object, the image is also virtual.
III. For real object, the image is always real.

(a) I and II (b) II and III (c) I and III (d) Only I
Ans (d)

Q.6 If two sources are coherent, then the phase difference between the waves produced by them at any point

(a) will change with time and we will have stable positions of maxima and minima.
(b) will not change with time and we have unstable positions of maxima and minima.
(c) will not change with time and we will have stable positions of maxima and minima.
(d) will change with time and we will have unstable positions of maxima and minima.
Ans (c)

Q.7 If Young's double slit experiment is performed in water keeping the rest of the set-up same, the fringes will

(a) increase in width (b) decrease in width
(c) remain unchanged (d) not be formed
Ans (b)

Q.8 If the width of the slit in single slit diffrection experiment is doubled, then the central maximum of diffraction pattern becomes

(a) broader and brighter (b) sharper and brighter
(c) sharper and fainter (d) broader and fainter.

Ans (b)

Q.9 The work-function of a metal is

(a) the minimum current required to take out electron from the metal surface
(b) the maximum frequency required to take out electron from the metal surface
(c) the minimum amount of energy required to take out the electron from the metal surface
(d) None of these

Ans (c)

Q.10 The stopping potential is directly related to

(a) the work function of the metal (b) intensity of incident radiation
(c) the saturation current for the given frequency (d) the kinetic energy gained by the photoelectrons

Ans (d)

ASSERTION - REASON TYPE QUESTIONS

Directions: Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

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(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

Q.11 Assertion: If the rays are diverging after emerging from a lens; the lens must be concave.

Reason: The convex lens can give diverging rays.

Answer- (c)

Q.12 Assertion: The optical instruments are used to increase the size of the image of the object.

Reason: The optical instruments are used to increase the visual angle.

Answer- (a)

Q.13 Assertion: White light falls on a double slit with one slit is covered by a green filter. The bright fringes observed are of green colour.

Reason: The fringes observed are coloured.

Answer- (c)

Q.14 Assertion: In Young's double slit experiment if wavelength of incident monochromatic light is just doubled, number of bright fringe on the screen will increase.

Reason: Maximum number of bright fringe on the screen is inversely proportional to the wavelength of light used

Answer- (d)

Q.15 Assertion: Diffraction takes place for all types of waves mechanical or non-mechanical, transverse or longitudinal.

Reason: Diffraction's effect are perceptible only if wavelength of wave is comparable to dimensions of diffracting device.

Answer- (b)

Questions 16 and 17 are <u>Case Study based questions</u> and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark

Q.16 Mirage an optical phenomenon, especially in the desert or at sea, by which the image of some object appears displaced above, below, or to one side of its true position as a result of spatial variations of the index of refraction of air.

1. Mirage is a phenomenon due to

(a) refraction of light (b) reflection of light
(c) total internal reflection of light (d) diffraction of light.

Ans-(c)

2. Critical angle of glass is θ_1 and that of water is θ_2. The critical angle for water and glass surface would be ($\mu_g = 3/2$, $\mu_w = 4/3$).

(a) less than θ_2 (b) between θ_1 and θ_2
(c) greater than θ_2 (d) less than θ_1

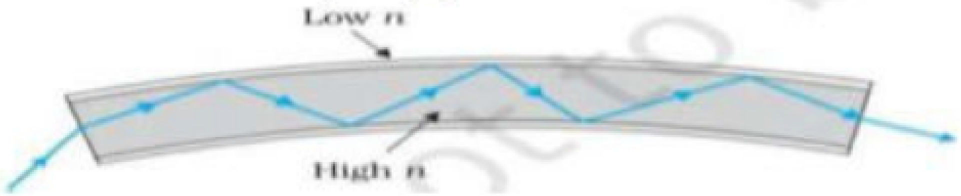
Ans-(c)

3. If the critical angle for total internal reflection from a medium to vacuum is 30o, the velocity of light in the medium is

(a) 3×10^8 m/s (b) 1.5×10^8 m/s
(c) 0.5×10^8 m/s (d) 0.2×10^8 m/s

Ans- (b)

Q.17 optical fibres are extensively used for transmitting audio and video signals through long distances. Optical fibres are fabricated with high quality composite glass/quartz fibres. Each fibre consists of a core and cladding. The refractive index of the material of the core is higher than that of the cladding. When a signal in the form of light is directed at one end of the fibre at a suitable angle, it undergoes repeated total internal reflections along the length of the fibre and finally comes out at the other end. Optical fibres are fabricated such that light reflected at one side of inner surface strikes the other at an angle larger than the critical angle. Even if the fibre is bent, light can easily travel along its length. Thus, an optical fibre can be used to act as an optical pipe.



(1) On which phenomena optical fibers works?

(a) Diffraction (b) Polarization
(c) dispersion of light (d) total internal reflection

Ans- (d)

(2) Which property of light remains same when it passes through optical fiber?

(a) Intensity of light (b) wavelength of light
(c) speed of light (d) frequency of light

Ans- (a)

(3) The outer concentric shell in fiber optic is called:

(a) cladding (b) core
(c) coat (d) mantle

Ans- (b)

(4) What is the relation between critical angle and refractive index?

(a) μ= SinC (b) μ=1/SinC
(c) μ= CosC (d) μ= 1/CosC

Ans-(b)

2 Marks questions

Q.18 State laws of refraction.

Ans- I law: the incident ray, the refracted ray and the normal drawn at the point of incidence all lie in the same plane

II law: the ratio of the sine of the angle of the incidence to the sine of the angle of refraction is constant for a given pair of media and given wavelength (color) of light.

Q.19 Mention a few illustrations of total internal reflection

Ans-Mirage, sparkling of diamond, total internal reflecting prisms, optical fibers

Q.20 State Huygens' principle.

Ans- Each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are called as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a later time.

Q.21 What is diffraction of light? Give an example.

Ans- The phenomenon of bending of light waves around the edges (or corners) of the obstacles and entering into the expected geometrical shadow of the obstacle is called diffraction of light.

Example: Colours observed when a CD (Compact Disc) is viewed is due to diffraction of light.

Q.22 Give the relationship between the accelerating potential and the de-Broglie wavelength associated with a charged particle.

Ans-de-Broglie wavelength associated with a charged particle is given by $\lambda = h/\sqrt{2mqV}$

Where q=charge of the particle

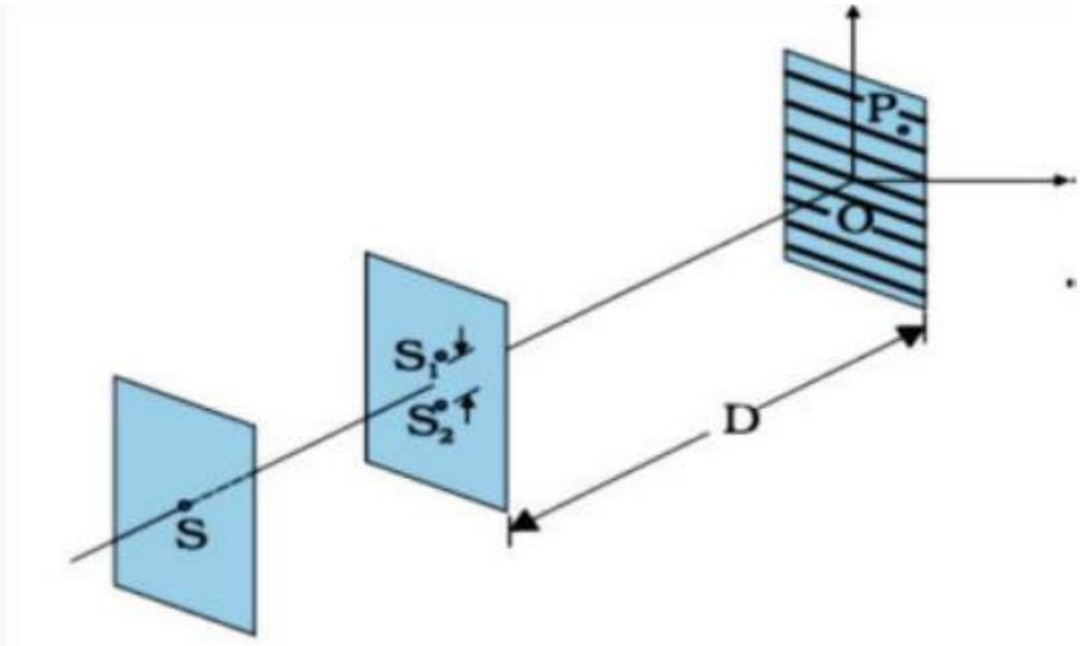
V=potential through particle is accelerated m=mass of the particle

3 Marks questions

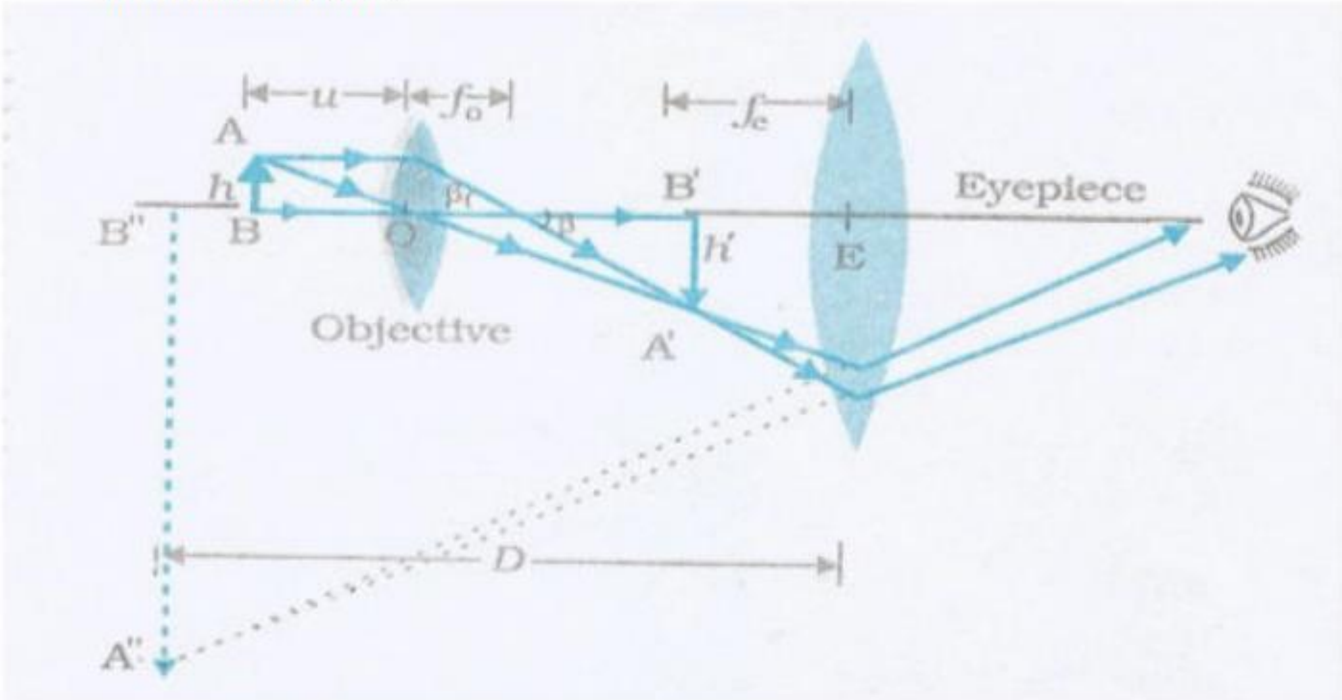
Q.23 Briefly describe Young's experiment with the help of a schematic diagram.

Ans- Young's experiment : Description with a schematic diagram

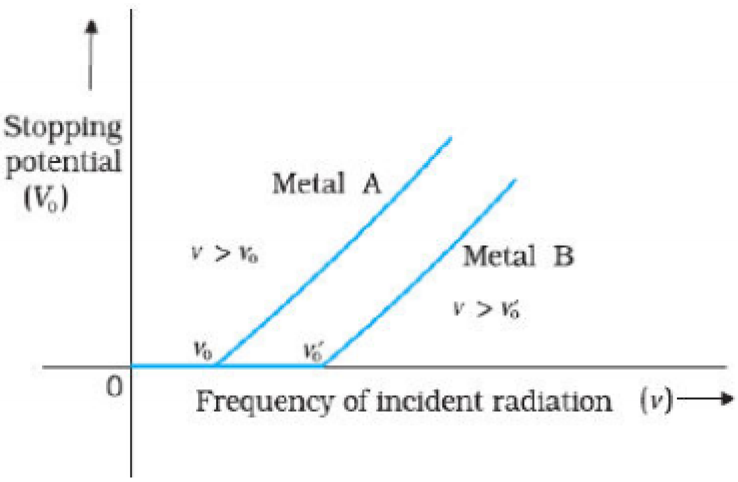
S represents a pin hole illuminated by sunlight. The spherical wave front from S is incident on two pin holes S1 and S2 which are very close to each other and equidistant from S. Then the pin holes S1 and S2 act as two coherent sources of light of same intensity. The two sets of spherical wave fronts coming out of S1 and S2 interfere with each other in such a way as to produce a symmetrical pattern of varying intensity on the screen placed at a suitable distance D.



Q.24 Draw ray diagram showing the image formation in a compound microscope and label the parts.



Q.25 Represent the variation of stopping potential with frequency of incident light graphically.

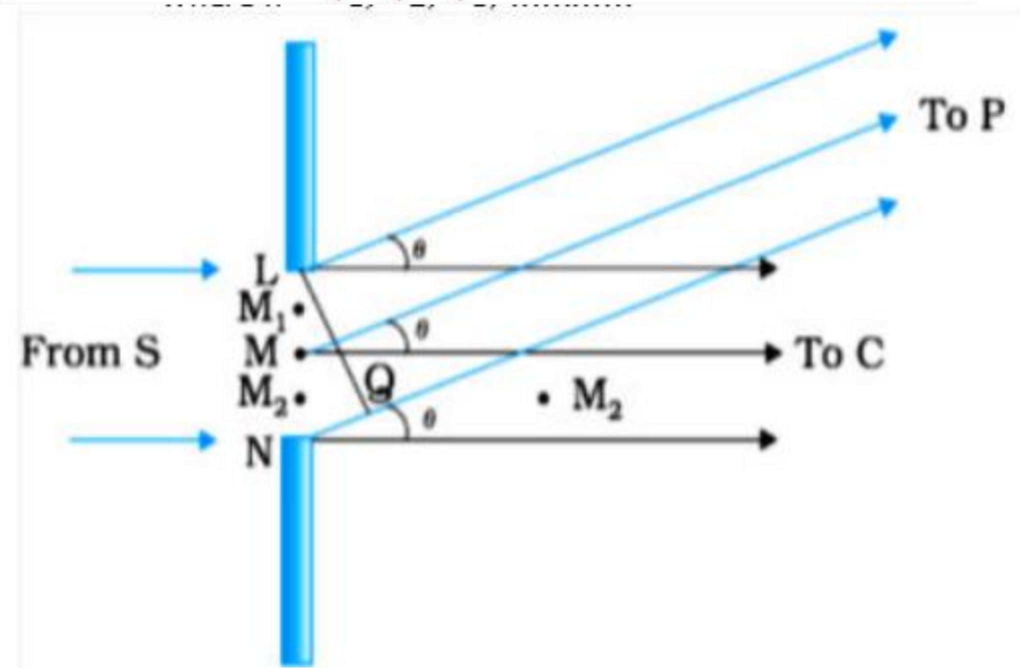


5 Marks questions

Q.26 Explain the phenomenon of diffraction of light due to a single slit and mention of the conditions for diffraction minima and maxima.

Answer - Diffraction of light at single slit:

- When single narrow slit illuminated by a monochromatic light source, a broad pattern with a central bright region is seen. On both sides, there are alternate dark and bright regions; the intensity becomes weaker away from the centre.
- A parallel beam of light falling normally on a single slit LN of width *a*. The diffracted light goes on to meet a screen. The midpoint of the slit is M. A straight line through M perpendicular to the slit plane meets the screen at C.
- The straight lines joining P to the different points L, M, N, etc., can be treated as parallel, making an angle θ with the normal MC. This is to divide the slit into smaller parts, and add their contributions at P with the proper phase differences.
- Different parts of the wavefront at the slit are treated as secondary sources. Because the incoming
- wavefront is parallel to the plane of the slit, these sources are in phase.
- The path difference between the two edges of the slit N and P is NP − LP = NQ = $a \sin\theta \approx a\theta$
- At the central point C on the screen, the angle θ is zero. The path difference is zero and hence all the
- parts of the slit contribute in phase. This gives maximum intensity at C, the central maximum.
- Secondary maxima is formed at $\theta = \frac{(2n+1)\lambda}{2a}$
- where n = ±1, ±2, ±3, ...
- Minima (zero intensity) is formed at $\theta = \frac{n\lambda}{a}$
- Where n = ±1, ±2, ±3, ...



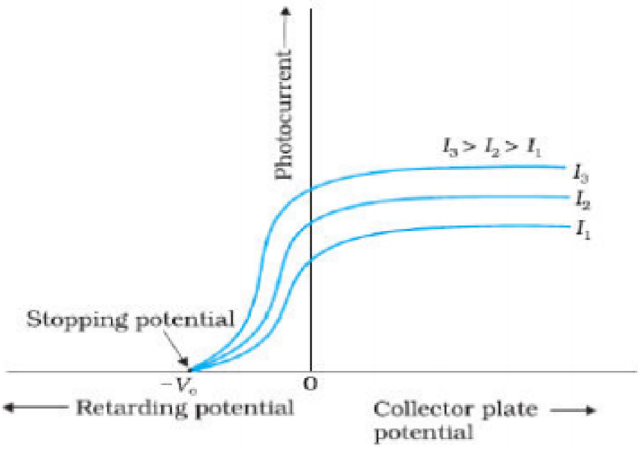
Q.27 Explain the effect of photoelectric current with collector plate potential.

Ans- Photoelectric current increases with increase in accelerating (positive) potential. At some stage, for a certain positive potential of plate A, the photoelectric current becomes maximum or saturates. If potential of plate A is further increased, the photocurrent remains same. This maximum value of the photoelectric current is called *saturation* current.

When the potential of the collector plate is made more and more negative (retarding) with respect to the plate emitter, the electrons are repelled and only the most energetic electrons reach the collector.

The photocurrent decreases rapidly until it drops to zero at a certain sharply defined, critical value of the negative potential *V0* .

For a particular frequency of incident radiation, the minimum negative (retarding) potential V0 given to the collector plate for which the photoelectrons are completely stopped from reaching collector or photocurrent becomes zero is called the cut-off or stopping potential.



UNIT-8 Atoms and Nuclei

Chapter -12 Atom

Q.1 Which of the following series in the spectrum of hydrogen atom lies in the visible region of the electromagnetic spectrum?

(a) Paschen series (b) Balmer series (c) Lyman series (d) Brackett series

Ans. (b) Balmer series

Q.2 Bohr's atom model is the modification of Rutherford's atom model by the application of

(a) Newton's theory (b) Huygens's theory (c) Maxwell's theory (d) Planck's quantum theory

Ans. (d) Planck's quantum theory

Chapter -13 Nuclei

Q.3 Nuclear forces exists between

(a) neutron - neutron (b) proton - proton (c) neutron - proton (d) all of these

Ans. (d) all of these

Q.4 Fusion reactions take place at high temperature because

(a) atoms are ionised at high temperature. (b) molecules break up at high temperature.

(c) nuclei break up at high temperature. (d) kinetic energy is high enough to overcome repulsion between nuclei.

Ans.(d) kinetic energy is high enough to overcome repulsion between nuclei.

ASSERTION- REASON TYPE QUESTIONS

Directions: Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.
(a) Assertion is correct; reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct; reason is correct; reason is not a correct explanation for assertion.

(c) Assertion is correct, reason is incorrect.

(d) Assertion is incorrect, reason is correct.

Chapter -12 Atom

Q.1 Assertion: The force of repulsion between atomic nucleus and α-particle varies with distance according to inverse square law.

Reason: Rutherford did α-particle scattering experiment.

Ans. (b) Rutherford confirmed that the repulsive force of α-particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the centre and not distributed throughout the atom.

Q.2 Assertion: Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate.

Reason: According to classical physics all moving electrons radiate.

Ans. (b) Bohr postulated that electrons in stationary orbits around the nucleus do not radiate. This is the one of Bohr's postulate, according to this the moving electrons radiates only when they go from one orbit to the next lower orbit.

CASE STUDY BASED PROBLEMS

Bohr's Atomic Model: -To study about atom various scientists perform various experiments and suggest various models of an atom with some explanation. For example, Thomson gives the "plum pudding" model in which he said the atom consists of a positive material known as "pudding" with some negative materials ("plums") distributed throughout. Later, famous scientist, Rutherford gives Rutherford's model of the atom after performing an Alpha Particle scattering experiment. This model is a modification of the earlier Rutherford Model. According to this model, an atom consists of a small, positively-charged nucleus and negatively-charged electrons orbiting around it in an orbital. These orbital can have different sizes, energy, etc. And the energy of the orbit is also related to its size, I.e The lowest energy is found in the smallest orbit. So if the electron is orbiting in nth orbit then we will study about its Velocity in nth orbital, Radius of nth orbital, Energy of electron in nth orbit, etc. Energy is also emitted due to the transition of electrons from one orbit to another orbit. This energy is emitted in the form of photons with different wavelengths. This wavelength is given by the Rydberg formula. When electrons make transitions between two energy levels in an atom various spectral lines are obtained. The emission spectrum of the hydrogen atom has been divided into various spectral series like Lyman series, Balmer series, Paschen series Etc.

Q1. The formula which gives the wavelength of emitted photon when electron jumps from higher energy state to lower was given by

(a) Balmer (b) Paschen (c) Lymen (d) Rydberg

Q2. What is true about Bohr's atomic Model

(a)His model was unique totally different from other (b) His model is a modification of Rutherford atomic model.
(c) His model is a modification of Thomson atomic model. (d) None of the above

Q3. Bohr's atomic model is applicable for

(a) All types of atoms (b) Only for hydrogen atom (c) For hydrogen like atoms (d) For H2 gas.

Q4. The cause of rejection of Rutherford atomic model was

(a) It was totally wrong (b) It could not justify its stability

(c) Rutherford was unable to explain it (d) None of the above.

Answer: Q1 – d; Q2 – b; Q3 – c; Q4 – b

Chapter -13 Nuclei

Q.1 Assertion: It is not possible to use ^{35}Cl as the fuel for fusion energy.

Reason: The binding energy of ^{35}Cl is too small.

Ans. (c) Assertion is correct, reason is incorrect.

Q.2 Assertion: Density of all the nuclei is same.

Reason: Radius of nucleus is directly proportional to the cube root of mass number.

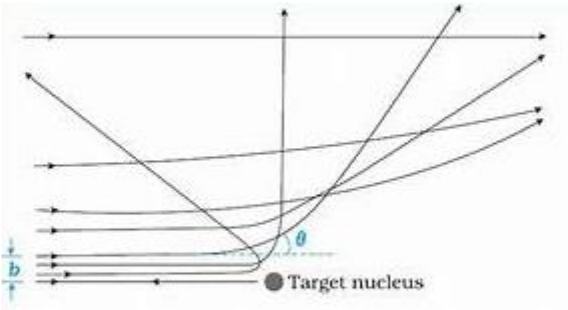
Ans. (d) In case of hydrogen atom mass number and atomic number are equal.

Chapter -12. Atom (2-marks /3 marks Questions)

Q.1 What is the impact parameter? write its significance.

Ans. Impact parameter:-It is the perpendicular distance of the initial velocity vector of the α-particle from the nucleus.

Significance: -   It gives estimate size of nucleus.



Q.2 Write the relation between mass number and radius of nucleus? What is the nuclear radius of ^{125} Fe, if that of ^{27}Al is 3.6 Fermi?

Ans. The radius of a nucleus (R) is proportional to the cube root of its mass number (A). The approximate law is $R\ \alpha\ A^{\frac{1}{3}}$ **.**

$$R\ \alpha\ A^{\frac{1}{3}} \quad => \frac{R_1}{R_2} = (\frac{A}{A})^{\frac{1}{3}} = \left(\frac{125}{27}\right)^{\frac{1}{3}} = \frac{5}{3}$$

$$=> \quad R_1 = R_2 \times \frac{5}{3} \ \mathbf{=3.6} \times \frac{5}{3} \ \mathbf{=6\ Fermi}$$

Chapter -13 Nuclei (2-marks /3 marks Questions)

Q.1 What are nuclear forces? State any two characteristic properties of nuclear forces.

Ans. Nuclear forces: - Very short range strongest attractive forces, which firmly hold the nucleons together inside a nucleus are called nuclear forces.

Properties-(i) Very short range strongest attractive forces. (ii)Charge independent.

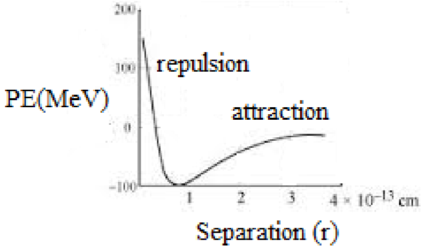
(iii) Non-central forces (iv) Do not obeys inverse square law.

Q.2 Draw a plot of potential energy of a pair of nucleons as a function

(i) Write two important conclusions that can be drawn from the graph.

(ii)What is the significance of negative potential energy in the graph drawn?

Ans. Graph



(i) Conclusion-(a) For $r<r_o$, potential energy, increases rapidly with decreasing in r. This indicates strong repulsion between the nucleons.

(b) For $r>r_o$, potential energy, is negative which falls to zero for a separation more than a few Fermi. It indicates attractive force between the nucleons.

(ii) Negative potential energy shows that binding force between the nucleons is strong.

UNIT-9

Chapter 14 (Electronic -Devices)

Q.1 For which reason, GaAs is most commonly used in making a solar cell.

(a) Suitable band gap and high optical absorption Coefficient.
(b) Suitable band gap and low optical absorption Coefficient.
(c) High band gap and high optical absorption Coefficient.
(d) Low band gap and low optical absorption Coefficient.

Ans.(a) Suitable band gap and high optical absorption Coefficient.
Q.2 What is the net charge in an n-type semi-conductor?

(a) Zero (b) 1C (c) 100C (d) None of these

Ans. Zero

Q.3 State the factors which control:
(i) Wavelength of light and
(ii) Intensity of light emitting by an LED

Ans: (i) Nature of semiconductor used in LED
(iii) Forward bias applied to LED.

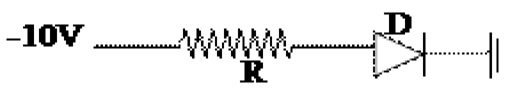
Q.4 half-wave rectification, what is the output frequency if the input frequency is 50Hz? What is the output frequency of a full- wave rectifier for the same input frequency?

Ans. Output frequency of a half wave rectifier = Input frequency = 50 Hz Output frequency of a full wave rectifier = 2x input frequency = 2 x 50 = 100 Hz.

Q.5 What type of impurity is added to obtain n-type semiconductor?

Ans. Pentavalent atoms like Arsenic (As).

Q.6 In the given diagram, is the diode D is in which biased?



Ans. Reverse biased
Q.7 In a semiconductor diode, the barrier potential offers opposition to

(a) holes in P-region only (b) free electrons in N-region only

(c) majority carriers in both regions (d) majority as well as minority carriers in both regions

Ans. (c) majority carriers in both regions

ASSERTION- REASON TYPE QUESTIONS

Directions: Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.
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(b) Assertion is correct; reason is correct; reason is not a correct explanation for assertion.

(c) Assertion is correct, reason is incorrect.

(d) Assertion is incorrect, reason is correct.

Q.1 Assertion: If the temperature of a semiconductor is increased then its resistance decreases.

Reason: The energy gap between conduction band and valence band is very small.

Ans. (a) In semiconductors the energy gap between conduction band and valence band is small (|1 eV). Due to temperature rise, electron in the valence band gain thermal energy and may jumpy across the small energy gap, (to the conduction band). Thus conductivity increases and hence resistance decreases.

Q.2 Assertion: A p-n junction with reverse bias can be used as a photo-diode to measure light intensity.
Reason: In a reverse bias condition the current is small but it is more sensitive to changes in incident light intensity

Ans. (a) Assertion is correct; reason is correct; reason is a correct explanation for assertion.

Q.3 Assertion: When two semiconductors of p and n type are brought in contact, they form p-n junction which act like a rectifier.

Reason: A rectifier is used to convent alternating current into direct current

Ans. (b) Study of junction diode characteristics shows that the junction diode offers a low resistance path, when forward biased and high resistance path when reverse biased. This feature of the junction diode enables it to be used as a rectifier.

Q.4 Assertion: The diffusion current in a p-n junction is from the p-side to the n-side.
Reason: The diffusion current in a p-n junction is greater than the drift current when the junction is in forward biased.

Ans. (b) Diffusion current is due to the migration of holes and electrons into opposite regions, so it will be from p-side to n-side. Also in forward bias it will increases.

Q.5. Assertion: The drift current in a p-n junction is from the n-side to the p-side.
Reason: It is due to free electrons only.

Ans. (a) Assertion is correct; reason is correct; reason is a correct explanation for assertion.

2-MARKS QUESTIONS

Q.1 Define the terms depletion layer and Potential barrier.

Ans. **Potential barrier**-The loss of electrons from the n-region and the gain of electron by the p-region cause a difference of potential across the junction of the two regions. Since this potential tends to prevent the movement of electron from the n region into the p region, it is often called a *barrier potential*.

Depletion region- The space-charge region on either side of the junction which is free of electrons and holes is known as *depletion region.*
(i) Thickness of depletion region decreases when diode is forward biased.
(ii) Thickness of depletion region increases when diode is reverse biased

Q.2 For an extrinsic semiconductor, indicate on the energy band diagram the donor and acceptor levels?

Ans.

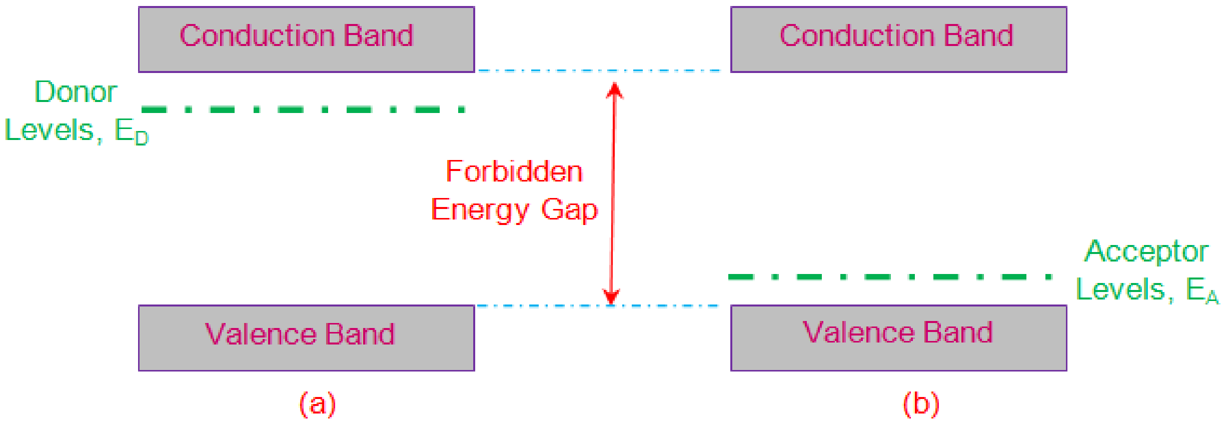


Figure 2 Energy Band Diagram of (a) *n*-type Extrinsic Semiconductor
(b) *p*-type Extrinsic Semiconductor

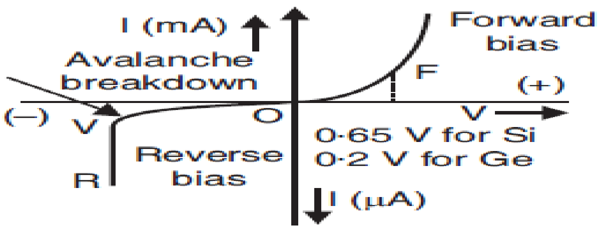
Q. 3 Why is a semiconductor damaged by a strong current?

Ans: (i)When we pass a strong current through a semiconductor, it gets heated.

(ii) Due to excessive heat, the covalent bonds are broken and crystal breakdown occurs. This makes the semiconductor useless.

Q. (4) Draw *V-I* characteristics of a *p-n* junction diode in (a) forward bias and (b) reverse bias.

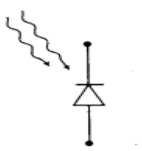
Ans.



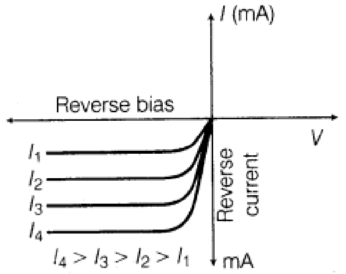
V-I Characteristics

Q.5 Draw the symbol and characteristics curve of (i) photodiode and (ii) solar cell

Ans. (i) Photo diode -A photodiode is a special type of junction diode used for detecting optical signals. It is a reverse biased p-n junction made from a photosensitive material. Its symbol is



Its V-I characteristics of photodiode are shown below:

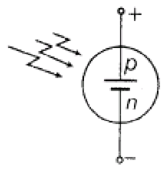


We observe from the figure that current in photodiode changes with the change in light intensity (I) when reverse bias is applied.

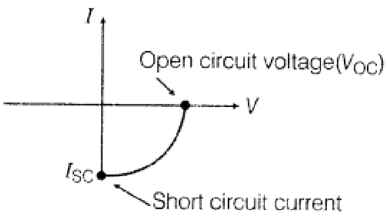
(ii) solar cell

(*iii*) **Solar Cell** Solar cell is a *p-n* junction diode which converts solar energy into electrical energy.

Its symbol is



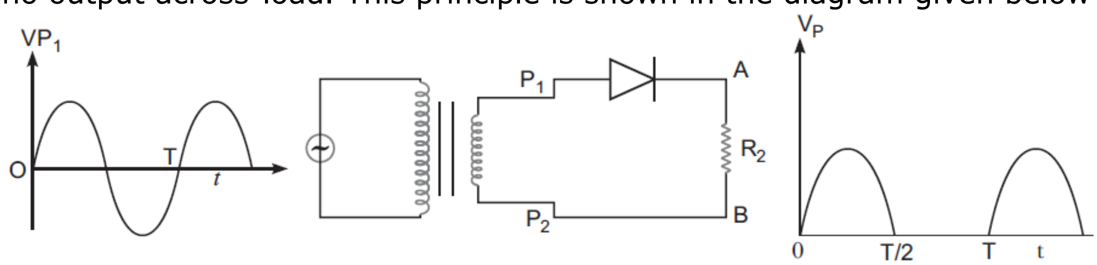
V-I characteristics of solar cell are shown below:



(3-MARKS QUESTIONS)

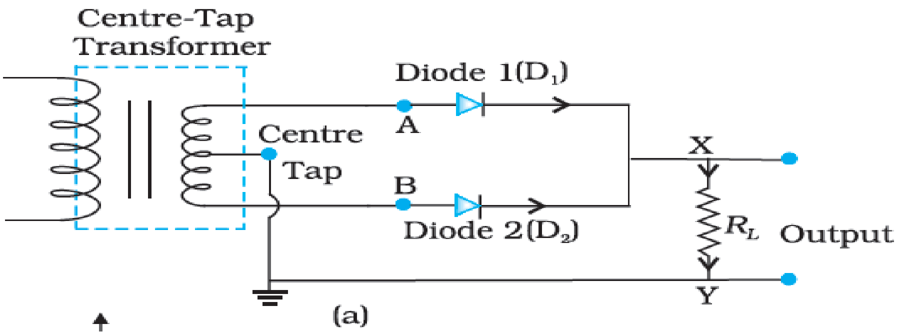
Q.1 With the help of a circuit diagram and input and output waveform explain working of half wave Rectifier.

Ans. Working: During the positive half cycle of the input a.c. The p-n junction is forward biased i.e the forward current flows from p to n, the diode offers a low resistance path to the current. Thus we get output across-load i.e. a.c input will be obtained as d.c output During the negative half cycle of the input a.c. The p-n junction is reversed biased i.e the reverse current flows from n to p, the diode offers a high resistance path to the current. Thus we get no output across-load. This principle is shown in the diagram given below

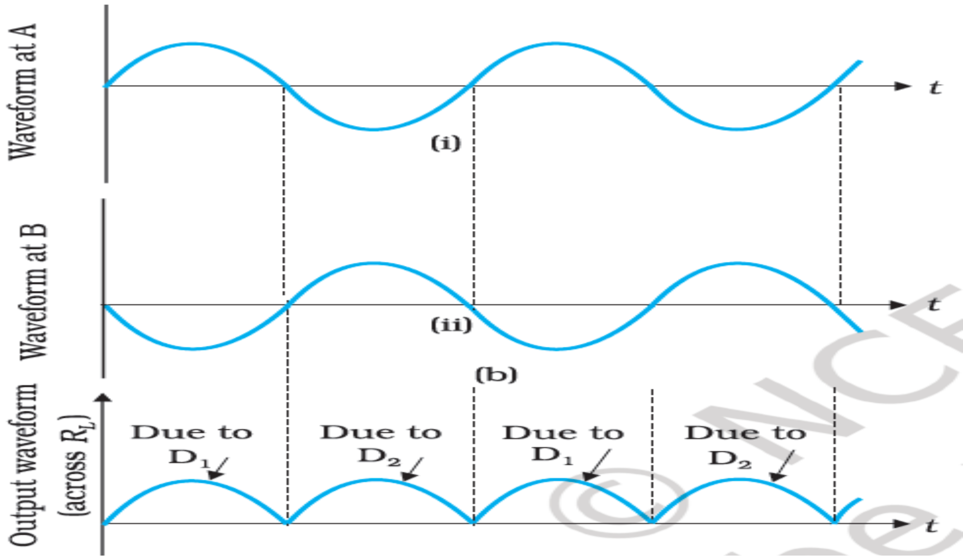


Q.2 With the help of a circuit diagram, explain the working of a junction diode as a full wave rectifier. Draw its input and output waveforms. Which characteristic property makes the junction diode suitable for rectification?

Ans.

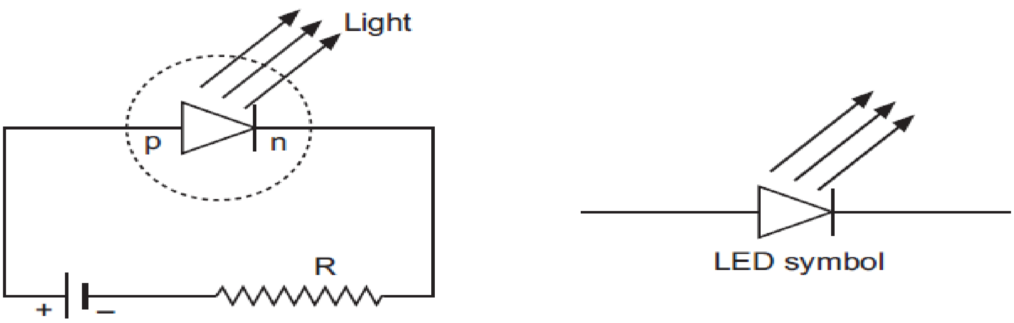


Working: The diode D1 is forward biased during one half cycle and current flows through the resistor, but diode D2 is reverse biased and no current flows through it. During the other half of the signal, D1 gets reverse biased and no current passes through it, D2 gets forward biased and current flows through it. In both half cycles current, through the resistor, flows in the same direction.



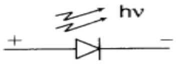
Q.3 What is a light emitting diode (LED)? Mention two important advantages of LEDs over conventional lamps.

Ans.

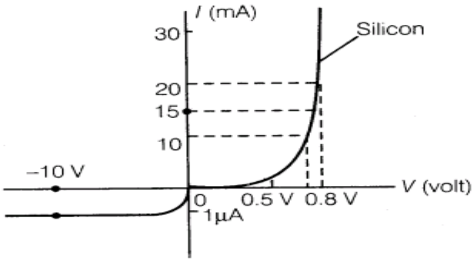


A light emitting diode is simply a forward biased *p-n* junction which emits spontaneous light radiation. When forward bias is applied, the electron and holes at the junction recombine and energy released is emitted in the form of light. For visible radiation phosphorus doped GaAs is commonly used.
The advantages of LEDs are:

(*i*) Low operational voltage and less power.
(*ii*) Fast action with no warm up time.
(*iii*) Emitted light is nearly monochromatic radiation.
(*iv*) They have long life.

Its symbol is 

V-I characteristics of LED are shown below:



CASE STUDY BASED PROBLEMS

Q. Zener diode: Zener diode is a specially designed p-n junction diode in which both p- side and n- side of p-n junction are heavily doped. The zener diode is designed specially to operate in the reverse break down voltage region continuously without being damaged. Zener diode is used to remove the fluctuations from given voltage and thereby provides a voltage of constant magnitude (i.e. zener diode is used as voltage regulator).

Q (1). Zener diode is mostly used as

a. Half wave rectifier b. Full wave rectifier c. Voltage regulator d. LED

Q (2). Zener diode is designed to specially work in which region without getting damaged?
a. Active region b. Break down region c. Forward Biased d. Reverse biased

Q (3). The depletion region of the zener diode is
a. Thick b. Normal c. Very thin d. Very thick

Q (4). What is the level of doping in zener diode?
a. Lightly dopped b. Heavily dopped c. Moderately dopped d. No dopping

Answers: -Q.1 (c) Q.2 (b) Q.3 (c) Q.4 (d)

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