OMQ

SOLUTIONS

1. ELECTRIC CHARGES AND FIELDS

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. By quantisation, charge q of a body is given by (where n is integer): [4]

1) $q=\frac{n}{2e}$ 2) $q=n\left(\frac{e}{3}\right)$ 3) $q=n\left(\frac{2e}{3}\right)$ **4) $q = ne$**

2. The value of permittivity of free space ε_0 is: [3]

1) $9\times10^9\ N\,m^2/C^2$ 2) $8.85\times10^{-12}\frac{Nm^2}{C^2}$ **3) $8.85\times10^{-12}\frac{C^2}{Nm^2}$** 4) $9\times10^9\frac{C^2}{Nm^2}$

3. If two bodies are rubbed and one of them acquires q_1 charge and another acquires q_2 charge, then the ratio $q_1 : q_2$ is: [3]

1) 1 : 2 2) 2 : 1 **3) –1 : 1** 4) 1 : 4

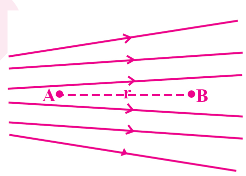
4. Two charges of equal magnitudes and at a distance r exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is [4]

1) F/8 2) F/4 3) 4F **4) F/16**

5. Two charges +2C and +6C are repelling each other with a force of 12N. If each charge is added with -2C, then the value of the force will be [4]

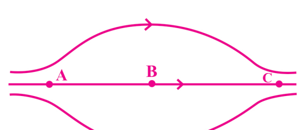
1) 4 (Attractive) 2) 4 (Repulsive) 3) 8 (Repulsive) **4) Zero**

6. Figure shows the electric lines of force emerging from a charged body. If the electric field at A and B are E_A and E_B respectively and the displacement between A and B is r, then [1]



1) $E_A > E_B$ 2) $E_A < E_B$ 3) $E_A = \frac{E_B}{r}$ 4) $E_A = \frac{E_B}{r^2}$

7. The figure shows some of the electric field lines corresponding to an electric field. The figure suggests [3]



1) $E_A > E_B > E_C$ 2) $E_A = E_B = E_C$ **3) $E_A = E_C > E_B$** 4) $E_A = E_C < E_B$

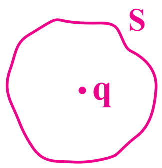
8. The Intensity of an electric field E due to a short dipole depends on distance r as: [2]

1) $E \propto \frac{1}{r^4}$ 2) $\mathbf{E \propto \frac{1}{r^3}}$ 3) $E \propto \frac{1}{r^2}$ 4) $E \propto \frac{1}{r}$

9. The angle between the electric dipole moment $\vec{p}$ and the direction of electric field strength due to it on the equatorial line is: [3]

1) 0° 2) 90° **3) 180°** 4) 60°

10. For the surface S shown in the figure (a closed surface) if the charge enclosed is q, then the net outward flux is: [1]



1) $\mathbf{\frac{q}{\varepsilon_0}}$ 2) $\frac{2q}{\varepsilon_0}$ 3) 0 4) $\frac{q}{2\varepsilon_0}$

II. FILL IN THE BLANKS(FIB)

1. When a glass rod is rubbed with silk, then the charge on glass rod becomes **positive**.
2. A simple apparatus to detect charge on a body is the **Gold – Leaf electroscope**.
3. The fact that the electric charge is always an integral multiple of **'e'** is termed as **quantization of charge**.
4. A soap bubble is given a negative charge then its radius **increases**.
5. The value of basic unit of charge is $\mathbf{1.6 \times 10^{-19} C}$.
6. The SI unit of electric field is **N/C (or) Volt/m**.
7. The direction of electric field lines of a isolated negative charge are **radially inward**.
8. The net force exerted on electric dipole placed in a uniform external electric field is **zero**.
9. The electrostatic field inside a charged conductor is **zero**.
10. The magnitude of torque on electric dipole of dipole moment P in a uniform external field E is $\mathbf{pE\sin\theta}$.
11. SI unit of volume charge density is $\mathbf{C / m^3}$.
12. SI unit of linear charge density is **C/m**.

III. ONE WORD ANSWER Q'S

1. What is the SI unit of electric charge?

A: SI unit of electric charge is **coulomb (C).**

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2. What is the nature of force between two like charges?

A: The nature of the force between two like charges is **repulsive.**

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3. How many number of electrons are in 1 coulomb charge?

A: Given that $q = 1C$, $e = 1.6 \times 10^{-19}$ C, $n = ?$

Formula: $q = ne \Rightarrow n = \frac{q}{e} \Rightarrow n = \frac{1}{1.6\times10^{-19}}$ = $\mathbf{0.625 \times 10^{19}}$ **electrons**

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4. What happens to the weight of a body when it is charged positively?

A: When a body is charged positively, its weight **decreases very slightly.** Because, some electrons are removed from the body.

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5. Give the expression for net force on charge q_1 due to system of charges q_2, q_3, q_4,... are located at r_{12}, r_{13},... distance from charge q_1.

A: The net force on q_1, due to charges q_2, q_3, q_4... is $F_{net} = F_{12} + F_{13} + F_{14} + \cdots$

$$\therefore F_{net} = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_2}{r_{12}^2} + \frac{q_1q_3}{r_{13}^2} + \frac{q_1q_4}{r_{14}^2} + \cdots\right)$$

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6. What is the direction of electric field due to a single positive charge?

A: The direction of electric field due to a single positive charge is **radially outward in all directions**.

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7. Define electric field intensity at a point.

A: **Electric field intensity** at a point is the force experienced by unit positive test charge placed at that point. **Formula:** $E = \frac{F}{q}$

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8. What is the SI unit of electric flux?

A: SI unit of electric flux is the **Volt-meter (V-m).** It is also equal to Nm^2/C.

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9. What is the SI unit of electric dipole moment?

A: SI unit of dipole moment is **coulomb -meter (C-m)**

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10. What is the total charge of electric dipole?

A: **Zero.** Total charge of an electric dipole is (+q) + (–q)=0

☞ Actual answers are kept in **bold font.**

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(4)** $q = ne$. The total charge of a body is always an integral multiple of the unit charge.

2. **(3)** ε_0 is derived from Coulomb's constant $K = 9 \times 10^9\ Nm^2 / C^2$

We know $K = \dfrac{1}{4\pi\varepsilon_0} \Rightarrow \varepsilon_0 = \dfrac{1}{4\pi K} = \dfrac{1}{4\pi \times 9 \times 10^9} = 8.85 \times 10^{-12} \dfrac{C^2}{Nm^2}$

3. **(3)** When two bodies are rubbed together, the bodies get equal and opposite charges so that $q_1 := -q_2$ $\quad\therefore$ Ratio $q_1 : q_2 = -1 : 1$

4. **(4)** From Coulomb's law $F \propto \dfrac{q_1 q_2}{r^2} \Rightarrow F = \dfrac{Kq_1q_2}{r^2}$.

Here charges are halved and distance is doubled

$$F^1 = \frac{K\left(\frac{q_1}{2}\right)\left(\frac{q_2}{2}\right)}{(2r)^2} = \frac{K}{16}\left[\frac{q_1q_2}{r^2}\right] = \frac{F}{16} \qquad \therefore F^1 = \frac{F}{16}$$

5. **(4)** From Coulomb's law $F \propto q_1 q_2$.

Given $q_1 = 2c$, $q_2 = 6c$. When each charge is added with $-2c$.

New charge $q_1^1 = +2c - 2c = 0$, $q_2^1 = 6c - 2c = 4c$ $\quad\therefore F' = 0\ (4c) = 0$

6. **(1)** The electric field lines are more concentrated at A than at B.

So that the magnitude of electric field at A is greater than at B. $\quad\therefore E_A > E_B$.

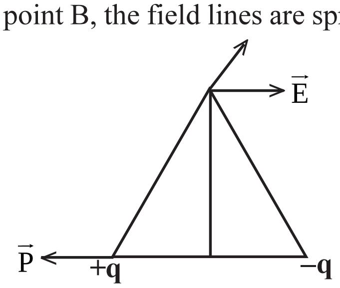
7. **(3)** When the electric lines are closer together, the field is stronger, when they are spread apart, the field is weaker.

At points A & C, the field lines are equally crowded. At point B, the field lines are spread out.

So, $E_A = E_C > E_B$

8. **(2)** $E_{axial} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2P}{r^3}$, $E_{eq} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{P}{r^3}$

In both the cases, $E \propto \dfrac{1}{r^3}$



9. **(3)** On the equatorial plane, the resultant electric field E always directed antiparallel to the direction of the dipole moment. When they are in opposite, $\theta = 180^\circ$.

10. **(1)** From Gauss's Law, the total electric flux ϕ through any closed surface is equal to $\dfrac{1}{\varepsilon_0}$ times q. $\quad\therefore \phi = \dfrac{q}{\varepsilon_0}$

FILL IN THE BLANKS (FIB)

1. When we rub glass with silk, electrons are transferred from glass to silk.
   Since glass loses electrons, it becomes positive.
2. A gold leaf electroscope consists of gold leaves. When a charged object touches the at the top, the charge spreads to the leaves. Since the like charges repel, the gold leaves get diverge,
3. The total charge is given by q = ne . This is the quanitzation of charge. Here n is an integer.
4. When we add positive or negative charges, the charges spread over the surface and repel each other. Due to this, the repulsion acts outwards. Then the bubble expand hence radius increases.
5. $e = 1.6\times10^{-19}$ C. This is the magnitude of the charge on a single electron.
6. The SI unit of electric field N/C or V/m $\left(\because E = \frac{F}{q} \Rightarrow \frac{N}{C}\right)$ or $\left(E = \frac{V}{d} \Rightarrow \frac{V}{m}\right)$
7. Isolated negative charge directs inward because negative charge attracts the positive.
8. In a uniform electric field, the force on the positive charge ($+E_q$) and negative charge ($-E_q$) are equal and opposite. So, they cancel each other.
9. In electrostatic equilibrium, charges resides only on the outer surface of the conductor,
   hence inside conductor is zero.
10. In vector form $\vec{\tau} = \vec{P}\times\vec{E} = PE\sin\theta$
11. Volume charge density $\rho = \frac{q}{v} \Rightarrow \frac{C}{m^3}$
12. Linear charge density $\lambda = \frac{q}{l} = \frac{C}{m}$

3. CURRENT ELECTRICITY

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. A wire of 50 cm long and 1 mm^2 in cross-section carries a current of 4 A when connected to a 2V battery. The resistivity of wire is [2]

1) $4 \times 10^{-6}\ \Omega m$ **2) $1 \times 10^{-6}\ \Omega m$** 3) $2 \times 10^{-7}\ \Omega m$ 4) $5 \times 10^{-7}\ \Omega m$

2. A charged particle having drift velocity of 7.5×10^{-4} m/s in an electric field of 3×10^{-10} V/m has a mobility in $m^2V^{-1}s^{-1}$ [2]

1) 2.25×10^{15} **2) 2.5×10^{6}** 3) 2.5×10^{-6} 4) 2.25×10^{-15}

3. Which of the following material has the largest resistivity? [3]

1) Silicon 2) Germanium **3) Glass** 4) Silver

4. As the temperature increases, the electrical resistance [3]

1) increases for both conductors and semiconductors
2) decreases for both conductors and semiconductors
3) increases for conductors but decreases for semiconductors
4) decreases for conductors but increases for semiconductors

5. An electric bulb is rated 60 W, 220 V. The resistance of the filament is close to[1]

1) 807 Ω 2) 870 Ω 3) 708 Ω 4) 780 Ω

6. The internal resistance of a 2.1 V cell which gives a current of 0.2 A through the resistance of 10 Ω is [4]

1) 0.8 Ω 2) 1.0 Ω 3) 0.2 Ω **4) 0.5 Ω**

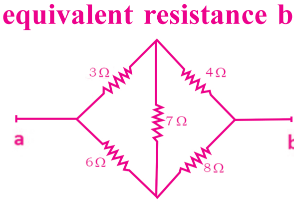
7. The internal resistance of a cell of emf 2V is 0.1 Ω . It is connected to a resistance of 3.9 Ω . The voltage across the cell will be [1]

1) 1.95 V 2) 1.9 V 3) 0.5 V 4) 2V

8. Kirchhoff's first and second rules of electrical circuits are consequences of [3]

1) conservation of energy and electric charge respectively
2) conservation of energy
3) conservation of electric charge and energy respectively
4) conservation of electric charge

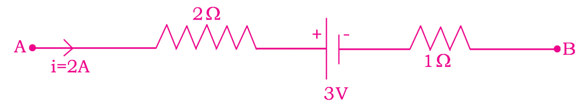
9. A bridge circuit is shown in figure . The equivalent resistance between points a and b is [4]



1) 21 Ω 2) 7 Ω

3) $\frac{252}{85}\Omega$ **4) $\frac{14}{3}\Omega$**

10. The potential difference ($V_A - V_B$) between the points A and B in Figure [4]



1) $-3V$ 2) $+3V$

3) $+6V$ **4) $+9V$**

II. FILL IN THE BLANKS(FIB)

1. The electric current in a conductor is due to the flow of **electrons**.
2. The electric current in an electrolytic solution is due to the flow of **ions**.
3. The average velocity that the electrons move in a conductor due to an applied electric field is called **drift velocity**.
4. The electromotive force (emf) is not a force, but it is **potential difference**.
5. The SI unit of resistivity is **Ωm** .
6. The SI unit of current density is **A/m^2** .
7. The reciprocal of resistivity is **conductivity**.
8. The current per unit area (i/A) is called **current density**.
9. In an open circuit, the potential difference between the ends of a battery is equal to its **electromotive force (emf)**.
10. Null point condition for a Wheatstone bridge arrangement for four resistances R_1, R_2, R_3, R_4 is $\frac{R_1}{R_2} = \frac{R_3}{R_4}$.

III. ONE WORD ANSWER Q'S

1. What is the SI unit of electric current?

A: SI unit of electric current is the **ampere (A).**

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2. What is the SI unit of Resistance?

A: SI unit of electric resistance is the **ohm (Ω).**

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3. What is current density?

A: **Current density (J)** is the amount of electric current (I) flowing per unit cross sectional area (A) of a conductor. **Formula:** $J = \frac{I}{A}$

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4. What is conductivity?

A: **Conductivity** is the ability of a material **to allow the flow of electric charge.**

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5. What is the sign of temperature coefficient of resistivity for metals?

A: The sign of the temperature coefficient of resistivity for metals is **positive**. Because the resistivity increases with temperature.

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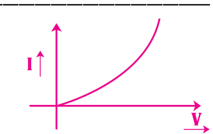
6. Draw the V-I graph for non-ohmic conductor (diode).



A: For a non-ohmic conductor, V-I graph is is a **non-linear curve.**

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7. Give the relation between emf and potential difference in open circuit.

A: In an open circuit, **EMF is equal to the potential difference** across the terminals (E = V).

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8. Give the relation between emf and potential difference in closed circuit.

A: In a closed circuit, the relationship between emf and terminal voltage is given by **V = E – Ir.** Here I is the current flow through the circuit and r is the internal resistance of the cell.

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9. What are the dimensions of Resistivity?

A: The dimensional formula of resistivity is $[ML^3T^{-3}A^{-2}]$

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10. Define the relaxation time of colliding electron.

A: **Relaxation time (τ)** is the average time interval between two successive collisions of free electrons with ions (impurities) when they drift through a conductor.

HINTS FOR MCQ & FIB

1. **(2)** Length l = 50cm = 0.5m; Area = $1mm^2 = 10^{-6}\ m^2$, Potential V = 2V; Current I= 4A

Resistance $R = \frac{V}{I} = \frac{2}{4} = 0.5\Omega$; Resistivity $\rho = \frac{RA}{l} = \frac{0.5\times10^{-6}}{0.5} = 10^{-6}\ \Omega m$

2.**(2)** Drift velocity $v_d = 7.5\times10^{-4} m/s$; Electric field $E = 3\times10^{-10} V/m$

Mobility $\mu = \frac{v_d}{E} = \frac{7.5\times10^{-4}}{3\times10^{-10}} = 2.5\times10^{6} m^2v^{-1}s^{-1}$

3.**(3)** Insulator have much higher resistivity than conductors & semi conductors.

4.**(3)** Conductors have positive temperature coefficient.
Here resistance increases with increase in temperature.
Semiconductors have negative temperature coefficient, hence resistance decreases.

5.**(1)** Power P = 60W, voltage V = 220V

Resistance $R = \frac{V^2}{P} = \frac{(220)(220)}{60} = 806.67\Omega = 807\Omega$

6.**(4)** Emf E =2.1V, Current I = 0.2 A, External resistance R = 10Ω

$E = I(R + r) \Rightarrow 2.1 = 0.2(10 + r) \Rightarrow 10 + r = 10.5 \Rightarrow r = 10.5–10=0.5\ \Omega$

7.**(1)** $I = \frac{E}{R+r} = \frac{2}{3.9+0.1} = 0.5A$

Potential difference across cell is V= E–Ir =2– (0.5×0.1)=2–0.05=1.95V

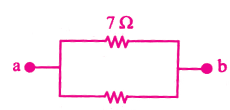
8.**(3)** Kirchhoff's first law states that the sum of currents entering a junction equals to sum of currents leaving it. It is based on the conservation of electric charge.

Kirchhoff's second law states that the algebraic sum of potential differences is zero.

It is based on the conservation of energy.

9.**(4)** Given circuit is a balanced wheatstone bridge. Here $\frac{3}{6} = \frac{4}{8} \Rightarrow \frac{R_1}{R_2} = \frac{R_3}{R_4}$

In the equivalent circuit the resistors 7Ω, 14Ω are parallel.



$\therefore \frac{1}{R_{ab}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{7} + \frac{1}{14} = \frac{2+1}{14} = \frac{3}{14}$ $\therefore R_{ab} = \frac{14}{3}\Omega$

10.**(4)** Given current I = 2A

Applying Kirchhoff's second law we have $V_A - IR_1 - 3 - IR_2 - V_B = 0$

$\Rightarrow V_A - [2\times2] - 3 - [2\times1] - V_B = 0 \Rightarrow V_A - V_B = 9V$

FILL IN THE BLANKS [FIB]

1. The current flow through the circuit is due to flow of free electrons.
2. The current flow through electrolytic solution is due to both positive & negative ions.
3. The electrons move in a conductor due to the application of electric field intensity with drift velocity.
4. The **potential difference** is the energy per unit charge which is equal to emf.
5. Resistivity $P = \frac{RA}{l} = \frac{\Omega m^2}{m} = \Omega m$
6. Current density $= \frac{I}{A} = \frac{A}{m^2} = Am^{-2}$
7. Conductivity is the reciprocal of resistivity.
8. Current density $J = \frac{I}{A}$
9. In an open circuit, the potential difference between the ends of a battery is equal to emf.
10. According to Wheatstone bridge principle, $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

5. MAGNETISM AND MATTER

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. **The magnetic field lines of the bar magnet looks similar to the magnetic field lines of ________** [3]
   1) a current carrying circular coil 2) a straight long current carrying wire
   3) a long solenoid 4) a plane current sheet
2. **A bar magnet of magnetic moment m is placed in a uniform magnetic field B . Its potential energy is zero when the angle between magnetic moment and magnetic field is ….** [2]
   1) 0^o **2) 90^o** 3) 180^o 4) 45^o
3. **Which of the following is not true for the magnetic field lines?** [1]
   1) The magnetic lines are open curves 2) The magnetic lines never intersect
   3) The direction of magnetic induction is tangential to the field line at a point
   4) The magnetic field is strong where the field lines are denser
4. **The magnetic field induction and magnetisation in a paramagnetic material are $\vec{B}$ and $\vec{M}$. Then the magnetic field intensity is ____________** [4]
   1) $\vec{H}=\mu_0(\vec{B}+\vec{M})$ 2) $\vec{H}=\frac{1}{\mu_0}(\vec{B}+\vec{M})$ 3) $\vec{H}=\frac{\vec{M}}{\mu_0}-\vec{B}$ **4) $\vec{H}=\frac{\vec{B}}{\mu_0}-\vec{M}$**
5. **The universal character of every material is** [1]
   1) diamagnetic 2) paramagnetic 3) ferromagnetic 4) ferrimagnetic
6. **Which of the following materials exhibits paramagnetic property?** [3]
   1) Iron 2) Cobalt **3) Aluminium** 4) Nickel
7. **A freely suspended magnet align in _________________ direction.** [3]
   1) South-West 2) East-West **3) North-South** 4) North-East
8. **Which one among the following materials exhibits higher magnetic susceptibility?** [1]
   1) Ferromagnetic 2) Paramagnetic
   3) Diamagnetic 4) Both Paramagnetic and Diamagnetic

II. FILL IN THE BLANKS(FIB)

1. The minimum potential energy of the bar magnet of magnetic moment m placed in a uniform magnetic field B is **–mB**.
2. The SI unit of magnetisation (M) is **ampere/metre**.
3. The SI unit of magnetic field intensity (H) is **ampere/metre**.
4. The magnetic material which tries move from strong field region to weak field region is known as **diamagnetic**.
5. The magnetic material whose susceptibility is positive but small is **paramagnetic**.
6. There is **repulsive** kind of force when the north poles of two magnets are brought close together.

7. A long magnet of length 2L and magnetic moment M and pole strength m units is broken into two pieces at the middle then magnetic moment of the piece is **less** than the original magnet.

8. The sign of susceptibility of the diamagnetic material is **negative**.

9. Domains are the characteristic feature of **ferro** magnetic materials

10. The net magnetic flux passing through any closed surface around bar magnet is **zero**.

III. ONE WORD ANSWER Q'S

1. What happens to magnetic moment of a magnet, if it is cut into two pieces along its length?

A: Magnetic moment becomes **half of the original (M'=M/2)**

Magnetic moment M = pole strength × length $\Rightarrow M = m2l$.

When the magnet is broken into two pieces, length becomes half. So, $M' = m\left[\frac{2l}{2}\right] = \frac{2lm}{2} = \frac{M}{2}$

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2. What is the magnetic field induction at a distance of r from the center of the bar magnet of magnetic moment m on its axis?

A: Along the axial line, for short magnet $\mathbf{B_{axial}} = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$. M = magnetic moment, r= distance

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3. What is the magnetic field induction at a distance of r from the center of the bar magnet of magnetic moment m on its bisector line (equatorial line)?

A: Along the equatorial line, for short magnet $\mathbf{B_{eq}} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$. M = magnetic moment, r = distance

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4. What is the analogy to permittivity ε_0 of free space in magnetic field?

A: **Permeability of free space (μ_0).** [$\mu_0 = 4\pi \times 10^{-7}$ H/m.]

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5. Write a relation between susceptibility and relative permeability.

A: $\mu_r = 1 + \chi$ is a relation between relative permeability (μ_r) and magnetic susceptibility (χ).

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6. Which law confirms that no mono magnetic poles exist?

A: **Gauss's law for magnetism i**s the law that confirms that no mono magnetic poles exist.

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7. What is magnetization of a sample?

A: Magnetisation M of a sample is the **net magnetic moment per unit volume.**

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8. How many atoms does a magnetic domain roughly contain?

A: **10^{11} to 10^{18} atoms** will be there in the magnetic domain of ferromagnetic material .

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9. Write down the relation between magnetic induction (B) and magnetic Intensity (H).

A: $B = \mu H$ (or) $B = \mu_0\mu_r H$

This is the relation between magnetic induction (B) and magnetic field intensity (H).

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(3)** **A long solenoid** produces a magnetic field that is similar to that of a bar magnet, with field lines forming continuous loops through the centre and spreading out of the poles.

2. **(2)** Potential energy $U = -MB\cos\theta = 0 \Rightarrow \cos\theta = 0 \Rightarrow \theta = 90^{\circ}$

3. **(1)** Magnetic lines always form closed loops. Hence open curves are not possible.

4. **(4)** The relation between B, H & M is $B = \mu_0(H + M)$

$$\Rightarrow H + M = \frac{B}{\mu_0} \qquad \therefore H = \frac{B}{\mu_0} - M$$

5. **(1)** **Diamagnetism is a fundamental property** present in all atoms and molecules. It arises fromthe orbital motion of atoms.

6.**(3)** Aluminium is paramagnetic. Iron, Nickel and cobalt are ferromagnetic.

7.**(3)** Due to earth's magnetic field, a suspended magnet always aligns, it self along geographic **north and south poles.**

8.**(1)** Ferromagnetic materials have very high and positive susceptibility (χ).

FILL IN THE BLANKS (FIB)

1. When the magnet is aligned parallel to the field, $\theta = 0^{\circ}$ or 180°
When $\theta = 180^{\circ}$, Potential energy $U = MB\cos\theta = MB\cos 180^{\circ} = MB(-1) = -MB$

2. SI Units of M =Ampere/ metre (or) A/m

3. SI Units of H =Ampere/ metre (or) A/m

4. Diamagnetic materials are repelled from strong field to weak field.

5. Paramagnetic materials have a small positive susceptibility .

6. Repulsive force exists when the north poles (like poles) are brought close together.

7. Magnetic moment M = pole strength $\times$ length $\Rightarrow M = m2l$. When the magnet is broken into two pieces at the middle, length becomes half. So, $M' = m\left[\frac{2l}{2}\right] = \frac{2lm}{2} = \frac{M}{2}$

8. For diamagnetic material, susceptibility is **negative.** Induced magnetic moment of these materials is opposite direction of applied field.

9. **Domains** are the characteristic feature of **ferromagnetic materials.**

10. The net magnet flux passing through any closed surface around bar magnet is **zero.** Based as Gauss's law for magnetism, the magnetic monopoles do not exists.

6. ELECTRO MAGNETIC INDUCTION

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. Faraday's law of electromagnetic induction states that the induced emf is proportional to: [1]

1) the rate of change of magnetic flux 2) the absolute value of the magnetic field
3) the distance between coils 4) the square of the current

2. Lenz's law is a consequence of which principle? [1]

1) Conservation of energy 2) Newton's first law
3) Coulomb's law 4) Ohm's law

3. A conducting loop is rotated in a uniform magnetic field. The induced emf will be maximum when the plane of the loop is: [1]

1) parallel to the magnetic field 2) perpendicular to the magnetic field
3) at 45° to the magnetic field 4) at any angle

4. The SI unit of self inductance is: [4]

1) Tesla 2) Weber 3) Ampere **4) Henry**

5. A coil of 500 turns and area of 0.01 m^2 is placed perpendicular to magnetic field. If the magnetic field changes uniformly from 0 to 0.5 T in 0.1 s, what is the average emf induced? [3]

1) 0.25 V 2) 2.5 V **3) 25 V** 4) 50 V

6. Mutual induction between two coils does not depend on: [4]

1) number of turns in both coils 2) cross sectional area of coils
3) magnetic permeability of medium between them **4) current flowing through the coils**

7. In electromagnetic induction, the direction of induced current is such that it opposes the cause of its production. This is known as: [2]

1) Kirchhoff's law **2) Lenz's law** 3) Ampere's law 4) Biot-Savart's law

8. A metal rod moves perpendicular to a uniform magnetic field. The emf induced is given by: [1]

1) $\varepsilon = B\,l\,v$ 2) $\varepsilon = B\,l\,/\,v$ 3) $\varepsilon = B\,l^2\,v$ 4) $\varepsilon = B\,v^2\,l$

9. A change in magnetic flux of 0.3 Wb in 0.1 s produces an average emf of: [2]

1) 0.03 V **2) 3 V** 3) 30 V 4) 300 V

10. If the flux linkage in a coil changes from 2 Wb to 8 Wb in 0.5 s, the average emf induced is: [2]

1) 10 V **2) 12 V** 3) 6 V 4) 4 V

11. The direction of induced current in a loop moving into a magnetic field is such that it:

1) enhances the magnetic field **2) opposes the relative motion** [2]
3) has no relation to the field 4) always flows clockwise

II. FILL IN THE BLANKS(FIB)

1. According to Faraday's law, the induced emf in a coil is directly proportional to the **rate of change** of the magnetic flux.
2. Lenz's law states that the direction of the induced current is such that it opposes the **change of magnetic flux** that causes it.
3. The SI unit of magnetic flux is **Weber**.
4. The back emf in an inductor is always in the direction opposite to the **original emf**.
5. The flux linkage through a coil of N-turns is proportional to the **current** passing through the coil.
6. Self-inductance depends on the geometry of the coil, the number of turns, and the **permeability** of the core material.
7. The average induced emf is equal to the change in magnetic flux linkage divided by the **time** during which the change takes place.
8. The direction of induced current is determined by **Lenz** law.

III. ONE WORD ANSWER Q'S

1. Which law states that the induced emf is proportional to the rate of change of magnetic flux?

A: **Faraday's law of induction.**

It states that the induced emf in a circuit is directly proportional to the time rate of change of magnetic flux through that circuit.

---

2. Which law states that the induced current opposes the change in flux that produces it?

A: **Lenz's law**

It states that the direction of an induced current is always such as to oppose the change that causes it.

---

3. Give the expression for the emf induced between the ends of a metal conductor moving perpendicular to a uniform magnetic field.

A: $\mathbf{E = B}l\mathbf{v}$. Here l is the length, v is the velocity, B is the uniform magnetic field

4. What will be the dimension of L/R, if L is inductance and R is resistance.

A: The dimension of **L/R is T**

Inductance L = $[ML^2T^{-2}I^{-2}]$; Resistance R = $[ML^2T^{-3}I^{-2}]$ $\therefore \frac{L}{R} = \frac{ML^2T^{-2}I^{-2}}{ML^2T^{-3}I^{-2}} = T$

---

5. Why induced emf is also called back emf?

A: According to Lenz's law, the induced emf **opposes the applied voltage.**

Hence it is called back emf.

---

6. What is the working principle of a transformer?

A: Transformer works on the principle of **mutual inductance.**

---

7. Why are resistance coils double wounded in opposite direction?

A: To **minimize/ avoid self inductance.**

---

8. What is the change in self inductance of solenoid if iron core is inserted into solenoid?

A: Inserting an iron core into a solenoid **increases its self inductance** L.

---

9. Write the expression for instantaneous value of emf in A.C generator.

A: Instantaneous emf induced in an AC generator is **E = NBAω sinωt**

Here N is the number of turns; B is the magnetic induction.

A is the area of the coil; ω is the angular velocity

---

10. What is the unit of mutual inductance?

A: SI unit of mutual inductance is **Henry** (H)

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1.**(1)** **From Faraday's second law** emf $e = -N\frac{d\phi}{dt} \Rightarrow e \propto \frac{d\phi}{dt}$ = Rate of change in flux.

2.**(1)** Lenz's Law is a consequence of Law of **conservation of energy.**

3.**(1)** Induced emf in a rotating loop is e=NBAsinθ whereθ is the angle between the normal to the loop and the magnetic field. The emf is maximum when sinθ=1⇒θ=90°. That means the normal to the loop is perpendicular to the field, so the **plane of the loop is parallel to the magnetic field.**

4.**(4)** Units of Self Induction : Henry.

5.**(3)** $N=500, A=0.01m^2=1\times10^{-2}m^2$, $\frac{dB}{dt}=\frac{0.5}{0.1}=5$ Emf $e = NA\frac{dB}{dt} = 500\times10^{-2}\times5 = 25N$

6.**(4)** Mutual inductance is a material property.
So, it does not depend on the current flowing through the coils.

7.**(2)** Lenz's law explains the negative sign in Faraday's law equation, indicating that the system maintain the status of the magnetic flux.

8.**(1)** When a conductor of length l moves with a velocity ν, perpendicular to magnetic field B then emf across the conductor is $\varepsilon = Bl\nu$

9.**(2)** Emf $e = \frac{d\phi}{dt} = \frac{0.3}{0.1} = 3V$ 10.**(2)** Emf $e = \frac{d\phi}{dt} = \frac{6}{0.5} = 12V$

11.**(2)** According to lenz's law, the induced current will create a magnetic force that acts in the opposite direction of the loops motion to resist the change in flux.

FILL IN THE BLANKS (FIB)

1. **From Faraday's second law** emf $e = -N\frac{d\phi}{dt} \Rightarrow e \propto \frac{d\phi}{dt}$ = Rate of change in flux.

2. If the magnetic flux increases, the induced current creates a field to decrease it.
If it decreases, the current tries to increase it. So induced current always opposes the change of magnetic field

3. SI units of Magnetic Flux is **Weber (Wb)**

4. Back emf is opposite to the **original emf.**

5. Magnetic flux is created by current. Flux linkage Nϕ=LI

6. Self inductance of Solenoid $L = \frac{\mu_0 N^2 A}{l}$

7. Emf $E = \frac{d\phi}{dt}$. induced emf is the result of change in flux by the **time duration** of that charge.

8. Faraday's law gives us the magnitude and then Lenz's law provides the direction.

7. ALTERNATING CURRENT

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

$1 \times 1 = 1$ Mark

1. The r.m.s. value of an alternating current of peak value 10 A is: [2]
   1) 5 A **2) 7.07 A** 3) 10 A 4) 14.14 A
2. The frequency of AC mains in India is: [2]
   1) 25 Hz **2) 50 Hz** 3) 100 Hz 4) 60 Hz
3. The power factor of a pure inductive circuit is: [2]
   1) 1 **2) 0** 3) –1 4) 0.5
4. In an AC circuit, the instantaneous current is given by $i = 10 \sin(100\pi t)$ A. The frequency of the alternating current is: [1]
   1) 50 Hz 2) 100 Hz 3) 25 Hz 4) 200 Hz
5. In a series LCR circuit at resonance, the current is: [2]
   1) minimum **2) maximum** 3) zero 4) infinite
6. The phase difference between current and voltage in a purely capacitive AC circuit is:
   1) 0° **2) I leads V by 90°** 3) I lags behind V by 90° 4) 180° [2]
7. The reactance of a capacitor decreases with: [2]
   1) decrease in capacitance **2) increase in frequency**
   3) both (1) and (2) 4) decrease in frequency
8. In a purely resistive AC circuit, the average power dissipated is given by: [1]
   1) VI 2) VI/2 3) VI cos ϕ 4) zero
9. The power factor of a series LCR circuit at resonance is: [3]
   1) 0 2) 0.5 **3) 1** 4) –1
10. A transformer is designed to: [1]
    1) increase or decrease AC voltage 2) convert AC into DC
    3) increase the frequency of AC 4) store electric charge

II. FILL IN THE BLANKS(FIB)

1. The r.m.s. value of an AC of peak value I_0 is $\underline{\mathbf{I_0 / \sqrt{2}}}$.
2. The phase difference between current and voltage in a purely resistive AC circuit is **0°**.
3. The power factor of a pure inductive or capacitive circuit is **0**.
4. In an LCR circuit at resonance, the impedance is equal to **resistance (R)**.
5. The average power consumed in a purely inductive circuit is **zero**.
6. The expression for the capacitive reactance $\underline{\mathbf{X_C = 1/\omega C \text{ or } 1/2\pi f C}}$.
7. The expression for the inductive reactance $\underline{\mathbf{X_L = \omega L \text{ or } 2\pi f L}}$.
8. In a purely capacitive circuit, the current **leads** the voltage by 90°.
9. In a transformer, the core is laminated to reduce **eddy current** losses.
10. The power factor of an AC circuit is given by $\underline{\mathbf{\cos\phi}}$.

III. ONE WORD ANSWER Q'S

1. What is the r.m.s value of an AC whose peak value is 141 V?

A: $V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{141}{1.414} = 99.7V \simeq \mathbf{100V}$ $\quad [\because \text{peak value } V_0 = 141V]$

---

2. What is the time period of AC mains in India?

A: The time period (T) of AC mains in India is **0.02 seconds.**

$\therefore$ Time period $T = \frac{1}{\text{frequency}} = \frac{1}{50} = 0.02s = 20$ milli seconds [$\because$ standard AC frequency in India is 50Hz.]

---

3. In which type of AC circuit is the phase difference between current and voltage zero?

A: In a **purely resistive AC circuit,** the phase difference between current and voltage is zero.

---

4. What is the condition for resonance in a series LCR circuit?

A: Condition for resonance: $\mathbf{X_L = X_C}$ i.e., Inductive reactance = Capacitive reactance.

---

5. At resonance, what is the value of the power factor in a series LCR circuit?

A: At resonance, the Power factor is **1.** Power factor $= \frac{R}{Z} = \frac{R}{R} = 1$ $\quad [\because Z = R]$

---

6. Give the expression for impedance of a series LCR circuit.

A: **Impedance** $\mathbf{Z = \sqrt{R^2 + (X_L - X_C)^2}}$

Here R is resistance, X_L is inductive reactance and X_C is capacitive reactance.

---

7. Which device is used to reduce AC without much loss of energy?

A: **Step down transformer** is the device used to reduce AC without much loss of energy.

---

8. Write the expression for power factor in an AC circuit.

A: Power factor $\cos\phi = \frac{R}{Z}$; R= Resistance, Z= Impedance, ϕ is phase angle.

---

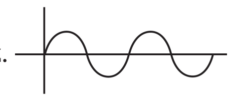
9. Name the type of current in which electrons flow in one direction only.

A: In **direct current (DC)**, the electrons flow in one direction.

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1.**(2)** $I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{10}{1.414} = 7.07A$

2.**(2)** The frequency of AC mains in India is 50Hz. 

3.**(2)** In a purely inductive circuit, the phase difference ϕ between current and voltage is 90º.
Power factor $\cos\phi = \cos 90^\circ = 0$.

4.**(1)** Comparing $i = 10 \sin 100\pi t$ with $i = i_0 \sin \omega t$, we have $\omega = 100\pi$

We know $\omega = 2\pi f$ $\therefore$ Frequency $f = \frac{\omega}{2\pi} = \frac{100\pi}{2\pi} = 50Hz$

5.**(2)** At resonance, $X_L = X_C$ then Z=R . So when impedance is at lowest value, then current is maximum.

6.**(2)** For pure capacitor $V = v_m \sin\omega t$, $I = I_m \sin(\omega t + 90^\circ)$ $\therefore$ Current I leads V by 90º

7.**(2)** Capacitive reactance $X_C = \frac{1}{2\pi fC} \Rightarrow X_C \propto \frac{1}{f}$ X_C decreases with increase in f.

8.**(1)** In a purely resistive circuit, average power dissipated is $P = VI \cos\phi$.
Power factor $\cos\phi = 1$ $\therefore P = VI \cos\phi = VI(1) = VI$

9.**(3)** At resonance, the phase difference between voltage and current is zero.

10.**(1)** Transformed works on the principle of mutual induction. Transformer is used to change the AC voltage levels i.e, step up and step down, keeping the frequency and power are same.

Fill in the Blanks (FIB)

1. $I_{rms} = \frac{I_0}{\sqrt{2}} = 0.707 I_0$

2. In a pure resistor $V = v_m \sin\omega t$, $I = I_m \sin(\omega t)$ $\therefore$ Phase difference is 0º

3. In pure inductive $\phi = 90^\circ$ $\therefore$ Power factor = $\cos\phi = \cos 90^\circ = 0$.

4. At resonance, $X_L = X_C$. Hence, Impedance Z = R

5. At pure inductor stores energy in its magnetic field during one half cycle and returns it all to the source in the next. The net energy and hence average energy consumed over a full cycle is zero.

6. Capacitive reactance $X_C = \frac{1}{\omega C} = \frac{1}{2\pi fC}$

7. Inductive reactance $X_L = \omega L = 2\pi fL$

8. For pure capacitor $V = v_m \sin\omega t$, $I = I_m \sin(\omega t + 90^\circ)$ $\therefore$ Current I **leads** V by 90º

9. In a transformer, the core is laminated to reduce **eddy current** losses.

10. The power factor of an AC circuit is given by **cosϕ**

8. ELECTROMAGNETIC WAVES

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. In 1885, the existence of electromagnetic waves was experimentally demonstrated by

1) Ampere 2) Maxwell 3) Gauss **4) Hertz** [4]

2. The speed of propagation of electromagnetic wave in free space is given by [3]

1) $C=\sqrt{\frac{\mu_0}{\varepsilon_0}}$ 2) $C=\sqrt{\frac{\varepsilon_0}{\mu_0}}$ **3)** $\mathbf{C=\sqrt{\frac{1}{\varepsilon_0 \mu_0}}}$ 4) $C=\sqrt{\varepsilon_0 \mu_0}$

3. In an electromagnetic wave travelling in free space, the amplitude of magnetic field is 6.0×10^{-4} T . The amplitude of its electric field is: [3]

1) 2×10^4 V/m 2) 1.5×10^{12} V/m **3) 1.8×10^5 V/m** 4) 0.3×10^4 V/m

4. A plane electromagnetic wave propagates along the + X direction in free space. The components of the electric field, and magnetic field, vectors associated with the wave in Cartesian frame are [3]

1) E_x, B_y 2) E_y, B_x **3) E_y, B_z** 4) E_z, B_y

5. Arrange the following in the ascending order of wavelength. [2]

A) Microwaves (λ_1) **C) Ultraviolet rays (λ_2)**

B) Infrared rays (λ_3) **D) X-rays (λ_4)**

Choose the most appropriate answer from the options given below.

1) $\lambda_4<\lambda_3<\lambda_2<\lambda_1$ **2) $\lambda_4<\lambda_2<\lambda_3<\lambda_1$**

3) $\lambda_3<\lambda_4<\lambda_3<\lambda_1$ 4) $\lambda_4<\lambda_3<\lambda_1<\lambda_2$

6. Which colour of the light has the longest wavelength? [3]

1) Green 2) Blue **3) Red** 4) Violet

7. Electromagnetic waves travel in a medium with speed of 1.5×10^8 m/s. The relative permeability of the medium is 2.0. The relative permittivity will be: [3]

1) 4 2) 1 **3) 2** 4) 5

8. If the frequency of an electromagnetic wave is 60 MHz and it travels in free space, the wavelength of the wave (m) is: [2]

1) 2.5 **2) 5** 3) 10 4) 2

9. The relative permittivity of distilled water is 81. The velocity of light in it will be: (Given $\mu_r = 1$) [3]

1) 4.33×10^7 m/s 2) 2.33×10^7 m/s **3) 3.33×10^7 m/s** 4) 5.33×10^7 m/s

10. Green House effect is due to [4]

1) absorption of Ultra-Violet radiation by Ozone layer
2) transmission of visible light by the atmosphere
3) good weather
4) reflection of infrared rays emitted by earth's atmosphere

11. Ozone Layer absorbs [2]

1) Visible light **2) UV radiation** 3) Infrared radiation 4) Microwaves

12. Which of the following rays are not electromagnetic waves [4]

1) Ultra violet rays 2) Visible light 3) X-rays **4) Alpha (α) rays**

13. Which of the following waves are also called the "Heat waves"? [3]

1) Visible light 2) X-rays **3) Infrared rays** 4) Radio waves

II. FILL IN THE BLANKS(FIB)

1. To remove the inconsistency in the Ampere's circuital law, Maxwell suggested the existence of **displacement** current.
2. The spectrum of electromagnetic waves stretching in order of increasing wavelength from **Gamma** rays to long **Radio** waves.
3. In the charging capacitor both conduction current and **displacement** current may be present.
4. Faraday's law of induction states that there is an induced emf equal to the rate of change of **magnetic flux**.
5. **Accelerated** charges radiate electromagnetic waves.
6. The wave vector 'K' direction describes the direction of **propagation** of the wave.
7. Jagadish Chandra Bose succeeded in producing electromagnetic waves of **shorter** wavelength.

III. ONE WORD ANSWER Q'S

1. What type of electric field generates magnetic field?

A: Magnetic field is generated by **changing electric field (or) non-uniform electric field.**

---

2. What is the name of the current carried by conductors due to flow of charges?

A: **Electric conduction current** is the current carried by conductors due to the flow of charges.

---

3. "There is an induced emf equal to the rate of change of magnetic flux." It is the statement of which law?

A: This statement refers to **Faraday's law of electromagnetic induction.**

---

4. In a material medium of permittivity (ε) and permeability (μ), what is the expression for the velocity of light in that medium?

A: Velocity of light $c = \frac{1}{\sqrt{\mu\varepsilon}}$

Here ε is the permittivity of medium and μ is the magnetic permeability

---

5. In cellular phones which band of radio waves are used to transmit voice communication?

A: Cellular phones use UHF band **(Ultra High Frequency)** .

The frequency range is 300 MHz to 3 GHz.

---

6. Earth surface absorbs the incoming visible radiation from the sun and what type of waves it re-radiate?

A: Earth re-radiates **long infrared waves.**

---

7. What type of rays can snakes detect in addition to visible rays?

A: Snakes can detect **infrared rays in** addition to visible rays.

---

8. When high energy electrons bombard a metal target, what type of waves are produced?

A: **X-rays** are produced when high energy electrons bombard a metal target.

---

9. Which type of electromagnetic waves are used in the treatment of cancer?

A: **Gamma rays** and **X-rays** are used in radiation therapy to destroy cancer cells.

---

10. What is the most important prediction from Maxwell's equations.

A: The **existence of electromagnetic waves** is the most important prediction from Maxwell's equations.

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1.**(4)** The existence of electromagnetic waves was experimentally demonstrated by **Hertz.**

2.**(3)** The speed of propagation of electromagnetic wave in free space is given by $C = \sqrt{\frac{1}{\varepsilon_0 \mu_0}}$

3.**(3)** $E_0 = CB_0 = (3 \times 10^8)\ (6 \times 10^{-4}) = 1.8 \times 10^5\ vm^{-1}$

4.**(3)** Electric field $\vec{E}$, magnetic field $\vec{B}$ and propagation direction $\vec{\upsilon}$ are all mutually perpendicular. If the wave moves in x direction, the field must exist in YZ planes.
In the given options we have $\mathbf{E_y, B_z}$

5.**(2)** High frequency waves have short wavelengths. The order from shortest to longest wave length is: X rays (λ_4) < Ultraviolet(λ_2) < infrared (λ_3) < Microwaves (λ_1)

6.**(3)** In the visible spectrum (VIBGYOR), Red has lowest frequency and longest wavelength (700nm),.

7.**(3)** Given $\upsilon = 1.5 \times 10^8$ m/s; $\mu_r = 2$ we know $c = 3 \times 10^8$ m/s; $\varepsilon_r = ?$
The speed of light in a medium is $\upsilon = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$;
$$\Rightarrow 1.5\times10^8 = \frac{3\times10^8}{\sqrt{2\times\varepsilon_r}} \Rightarrow \sqrt{2\times\varepsilon_r} = 2 \Rightarrow 2\varepsilon_r = 4 \Rightarrow \varepsilon_r = 2$$

8.**(2)** Given $f = 60MHz = 60 \times 10^6$ Hz, $c = 3 \times 10^8$ m/s; $\lambda = \frac{c}{f} = \frac{3\times10^8}{60\times60^6} = 5m$

9.**(3)** The velocity of light in a medium, $\upsilon = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$; $\varepsilon_r = 81, \mu_r = 1$
$$\upsilon = \frac{3\times10^8}{\sqrt{1\times81}} = \frac{3\times10^8}{9} = 0.33\times10^8 \qquad \therefore \upsilon = 3.33\times10^7\ m/s$$

10.**(4)** Green House effect is due to reflection of infrared rays emitted by earth's atmosphere.

11.**(2)** Ozone Layer absorbs harmful **UV radiation.**

12.**(4)** Alpha (α) rays are not electromagnetic waves.

13.**(3)** Infrared rays are called heat waves, because, they trigger the atoms and molecules in an object to vibrate, increasing its internal energy and temperature upon absorption.

Fill in the blanks

1. To remove the inconsistency in Ampere's circuital law, maxwell suggested the existence of **displacement current.**
2. The spectrum of electromagnetic waves stretching in order of increasing wave length from **gamma rays to long radio waves,**
3. In the charging capacitor both conduction current and **displacement current** may be present.
4. Faraday's law of induction states that there is an induced emf equal to the rate of change of **magnetic flux.**
5. Accelerating charges radiate EM waves as per Maxwell's theory.
6. The wave vector $\vec{K}$ describes the direction of propagation of wave.
7. Jagadish Chandra Bose succeeded in producing EM waves of **shorter** wavelength.

10.WAVE OPTICS

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. **If a plane wave passes through a convex lens, the geometrical shape of the wave front that emerges is** [3]

   1) plane 2) diverging spherical **3) converging spherical** 4) cylindrical

2. **What is the ratio of intensities of light sources, when the amplitudes of light waves from them has the ratio of $1:\sqrt{2}$** [3]

   1) 1 : 2 2) $\sqrt{2}$: 1 **3) 1 : 2** 4) 2 : 1

3. **When three lights of red, violet and green coloured are used successively in young double slit experiment, the fringe width will be maximum for .....** [1]

   1) Red 2) Violet 3) Green 4) Same for all

4. **In a wave, the path difference corresponding to a phase difference of ϕ is** [3]

   1) $\frac{2\pi}{\lambda}\phi$ 2) $\frac{\pi}{\lambda}\phi$ **3) $\frac{\lambda}{2\pi}\phi$** 4) $\frac{\lambda}{\pi}\phi$

5. **The phase difference between two points 'A' and 'B' on a wave front separated by distance λ is** [2]

   1) $\pi/4$ **2) 2π** 3) π 4) $\pi/2$

6. **Two waves having intensity in the ratio 25 : 4 produces interference, then the ratio of maximum to minimum intensity is** [3]

   1) 5 : 2 2) 7: 3 **3) 49 : 9** 4) 9 : 49

7. **The penetration of light into the region of geometrical shadow is called** [3]

   1) polarization 2) interference **3) diffraction** 4) Refraction

8. **Which one of the following phenomenon confirms that transverse nature of light?** [4]

   1) Interference 2) Diffraction 3) Dispersion **4) Polarization**

9. **Which of the following waves cannot be polarized?** [3]

   1) X- rays 2) Radio waves **3) Sound waves** 4) Light waves

10. **The angle between the axis of polarizer and analyser is 45°, the percentage of polarized light passing through analyser is** [2]

    1) 100 % **2) 50 %** 3) 25% 4) 75 %

II. FILL IN THE BLANKS(FIB)

1. A wave front is the continuous locus of all particles vibrating with **same phase**.
2. The secondary wave fronts emanating from a primary wave front are also called as **wavelets**.
3. According to the principle of super position, the resultant displacement is **vector sum** of displacements produced by each of the waves.
4. **Coherent** light sources should emit waves of same frequency and having constant phase difference.
5. In interference pattern, all bright and dark fringes are of **same** width.
6. For constructive interference, the path difference between two waves is equal to **$n\lambda$** .
7. The phenomenon of bending of light around the corners of obstacles is called **diffraction**.
8. Angular width of central maximum in diffraction of single slit is $\mathbf{\frac{2\lambda}{a} (or) 2\theta}$.
9. Due to **diffraction** phenomenon of light, colours on CD are formed.
10. When unpolarised light is passed through a polarizing sheet, the intensity of the transmitted light is **50 %** that of original intensity of light.

III. ONE WORD ANSWER Q'S

1. State Huygen's principle.

A: Every point on a wave front acts as a source of secondary spherical wavelets.

---

2. Which principle is used to find the position of a wave front after some time?

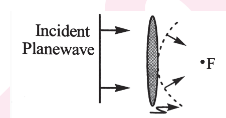
A: **Huygen's principle** is used to find the position of a wave front.

---

3. Sketch the wavefront corresponding to converging rays.

A: A **spherical wave front**

Concave in the direction of propagation.



Spherical wavefront of radius f

---

4. What is interference of light?

A: Interference is the phenomenon where two or more light waves overlap to form a resultant wave of greater, lower or the same amplitude.

---

5. What is the main condition to produce interference of light?

A: The primary condition is that the **light sources must be coherent.**

---

6. Why are coherent sources required to create interference of light?

A: To **maintain a stationary** and **permanent interference pattern.**

---

7. What sheets are used in sunglasses and window panels to control the intensity of light?

A: **Polaroid sheets** are used is sunglasses and window panels to control the intensity of light.

---

8. What should be the approximate slit size to observe the diffraction?

A: The slit size should be **comparable to the wave length** of the light used.

---

9. What do you mean by the polarisation of light?

A: Polarization is the process of restricting the vibrations of light to a single plane perpendicular to the direction of propagation.

---

10. A polariser and an analyser are so oriented that no light is transmitted. What is the angle between the axes of polariser and an analyser?

A: **Angle $\theta = 90^\circ$**

From Malus law $I = I_0 \cos^2 \theta$. When no light is trantimitted, $I = 0 \Rightarrow \cos\theta = 0 \Rightarrow \theta = 90^\circ$

HINTS FOR MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(3)** A convex lens converts a plane wavefront into a converging spherical wavefront by focusing the light rays to a point.
2. **(3)** Intensity $I \propto$ Amplitude A^2. Here $A_1 : A_2 = 1 : \sqrt{2}$ So, $\frac{I_1}{I_2} = \left[\frac{A_1}{A_2}\right]^2 = \left[\frac{1}{\sqrt{2}}\right]^2 = \frac{1}{2}$
3. **(1)** Fringe width $\beta = \frac{\lambda D}{d}$; So, $\beta \propto \lambda$

   Among the given colours **Red** has longest wavelength. $\therefore$ It produces the widest fringes.
4. **(3)** Phase difference $\phi = \frac{2\pi}{\lambda}(\Delta x)$ $\Rightarrow$Path difference $\Delta x = \frac{\lambda}{2\pi}\phi$
5. **(2)** In wave motion, a distance of one wave length AB corresponds to a phase difference of 2π.
6. **(3)** $I_1 : I_2 = 25 : 4$, $a_1 : a_2 = \sqrt{25} : \sqrt{4} = 5 : 2$; $\frac{I_{max}}{I_{min}} = \left[\frac{a_1 + a_2}{a_1 - a_2}\right]^2 = \left[\frac{5+2}{5-2}\right]^2 = \left[\frac{7}{3}\right]^2 = \frac{49}{9}$
7. **(3)** Diffraction is defined as the bending of waves around the corners of an obstacle or through an aperture into the region of geometrical shadow.
8. **(4)** Polarization can only occur with transverse waves because it involves restricting the vibrations to a single plane perpendicular to the direction of propagation.
9. **(3)** Sound waves are longitudinal waves, and longitudinal waves cannot be polarized.

   X-rays, radio, light waves are electromagnetic (transverse) waves, so they can be polarized.
10. **(2)** **Malus law:** $I = I_0 \cos^2\theta$, if $\theta = 45^\circ$ $I = I_0\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{2} = 50\%\ I_0$

1. A wave front is the continuous locus of all particles vibrating with **same phase**.
2. The secondary wave fronts emanating from a primary wave front are also called as **wavelets**.
3. According to the principle of super position, the resultant displacement is **vector sum** of displacements produced by each of the waves.
4. **Coherent** light sources should emit waves of same frequency and having constant phase difference.
5. In interference pattern, all bright and dark fringes are of **same** width.
6. For constructive interference, the path difference between two waves is equal to **$\underline{n\lambda}$**.
7. The phenomenon of bending of light around the corners of obstacles is called **diffraction**.
8. Angular width of central maximum in diffraction of single slit is 2λ/**a (or) 2θ**
9. Due to **diffraction** phenomenon of light, colours on CD are formed.
10. When unpolarised light is passed through a polarizing sheet, the intensity of the transmitted light is **50 %** that of original intensity of light.

12. ATOMS

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. The first model of an atom was proposed by [1]

   1) J.J.Thomson 2) Rutherford 3) Niels Bohr 4) Hans Geiger

2. Identify the source of α -particles in H.Geiger and E.Marsedeins experiment[4]

   1) ${}_{92}U^{235}$ 2) ${}_{92}U^{238}$ 3) ${}_{90}Pb^{231}$ **4) ${}_{83}Bi^{214}$**

3. The expression for kinetic energy (K) and electrostatic potential energy (U) of the electron in hydrogen atom are [4]

   1) $K = e^2 / 8\pi\varepsilon_0 r^2$ and $U = -e^2 / 4\pi\varepsilon_0 r^2$ 2) $K = e^2 / 4\pi\varepsilon_0 r$ and $U = -e^2 / 8\pi\varepsilon_0 r$

   3) $K = e^2 / 4\pi\varepsilon_0 r^2$ and $U = -e^2 / 8\pi\varepsilon_0 r^2$ **4) $K = e^2 / 8\pi\varepsilon_0 r$ and $U = -e^2 / 4\pi\varepsilon_0 r$**

4. According to second postulate of Bohr's model, which parameter is quantized for orbiting electron? [4]

   1) Energy 2) Charge 3) Mass **4) Angular momentum**

5. 1eV is equivalent to [3]

   1) 6.67×10^{-34} J 2) 1.6×10^{-27} J **3) 1.6×10^{-19} J** 4) 6.24×10^{-22}J

6. Identify the incorrect postulate of Niels Bohr's theory of atomic model. [4]

   1) Electron revolve in certain stable orbits without radiating energy

   2) Energy is only emitted or absorbed when electron jumps between orbits

   3) The angular momentum of the revolving electron is quantized

   4) The energy of emitted/absorbed photon is $h\upsilon = E_f + E_i$

7. The total energy of an electron in the stationary states of the hydrogen atom is[2]

   1) $E_n = -\frac{13.6}{n}eV$ **2) $E_n = -\frac{13.6}{n^2}eV$** 3) $E_n = \frac{13.6}{n}eV$ 4) $E_n = \frac{13.6}{n^2}eV$

8. Bohr's atomic model is not valid for [4]

   1) hydrogen atom 2) singly ionized helium atom (He^+)

   3) deuterium atom **4) singly ionized neon atom (Ne^+)**

9. If an electron is revolving in the n^{th} orbit of hydrogen atom, then its velocity in the n^{th} orbit is [2]

   1) proportional to n **2) inversely proportional to n**

   3) proportional to n^2 4) inversely proportional to n^2

10. The angular momentum of an electron revolving in n^{th} orbit is given by [1]

   1) $mvr = nh/2\pi$ 2) $mvr = n^2h/2\pi$ 3) $mvr = h\,\pi\,n^3$ 4) $mvr = n^2h^2/2\pi$

11. The ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom is [**2**]

1) 1 : 1 **2) 1 : –1** 3) 2 : –1 4) 1 : –2

12. The ground state energy of hydrogen atom is –13.6eV. When its electron is excited to first excited state, it's excitation energy is [**4**]

1) 0 eV 2) –13.6 eV 3) 3.4 eV **4) 10.2 eV**

13. According to Bohr atomic model, in which of the following transition will the frequency be maximum? [**2**]

1) n = 4 to n = 3 **2) n = 2 to n = 1** 3) n = 5 to n = 4 4) n = 3 to n = 2

II. FILL IN THE BLANKS(FIB)

1. If F_e, F_c denotes the electrostatic force of attraction, centripetal force respectively, then the relation between F_e and F_c for a dynamically state orbit in a hydrogen atom is $\underline{\mathbf{F_e = F_c}}$.
2. A He^+ ion is in its first excited state, its ionization energy is **13.6 eV**
3. Energy required for the electron excitation in Li^{++} from the first to the third Bohr's orbit is **108.8 eV**.
4. The change in angular momentum of an electron when it jumps from 4th orbit to 5th orbit in hydrogen atom is $\underline{\mathbf{h / 2\pi}}$.
5. The wavelength of the photon emitted by a hydrogen atom when an electron makes transition from n = 2 to n = 1 state is **121.8 nm**.
6. The de-Broglie wavelength of electron revolving in its second excited state (having radius 4.65Å) is **9.7** Å.
7. The process of raising or transferring the electron from lower energy state to higher energy state is called **excitation**.
8. The process of raising the atom from the normal state to the ionized state is called **ionization**.
9. The total energy of an electron in an atom in an orbit is –3.4 eV, then its potential energy is **-6.8 eV**.
10. The energy of the ground electronic state of hydrogen atom is –13.6 eV. The energy of the first excited state will be **-3.4 eV**.
11. The value of impact parameter (b) for head-on collision is **zero**.
12. 1 fermi is equal to $\underline{\mathbf{10^{-15}}}$ meter.

III. ONE WORD ANSWER Q'S

1. What is the net charge of an atom, based on plum pudding model?

A: According to **J.J.Thomson's** plum pudding model, the net charge of **an atom is zero .**

---

2. What kind of charge is spread throughout the atom in Thomson's model?

A: In Thomson's model, **positive charge** is spread throughout the atom.

---

3. Which metal foil is used in the Rutherford α - scattering experiment?

A: **Gold foil** is used in Rutherford α -scattering experiment

---

4. What is the SI unit of the impact parameter?

A: The SI unit of impact parameter is **metre (m).**

---

5. What type of energy arises due to attraction between electron and nucleus?

A: **Electrostatic potential energy** arises due to the attraction between electron & nucleus.

---

6. What is the value of Planck's constant in J sec ?

A: The value of Planck's constant is h= $\mathbf{6.63 \times 10^{-34}}$ **Js**

---

7. The energy of a hydrogen atom in the ground state is –13.6eV. What will be the energy of He^+ ion in the first excited state?

A: For He^+ ion we have Z=2 and for the first excited state n=2

Energy $E_n = \dfrac{-13.6Z^2}{n^2} \Rightarrow E_2 = \dfrac{-13.6(2)^2}{(2)^2} = -13.6\text{eV}.$

---

8. An electron in a hydrogen atom revolving in its second excited state having the radius of 4.65Å. What is its de-Broglie wavelength?

A: According to Bohr's postulate, $2\pi r = n\lambda \Rightarrow \lambda = \dfrac{2\pi r}{n} = \dfrac{2\times 3.14\times 4.65}{3} = 9.734\text{Å}$

---

9. Express the energy of a photon of wavelength 620nm in terms of eV.

A: Given $\lambda = 620\text{nm} = 6200\text{Å}$

Energy, $E = \dfrac{12400}{\lambda(\text{Å})} = \dfrac{12400}{6200} = 2\text{eV}$

10. What is the ratio of wavelengths of photons having energies E and 3E?

A: Energy $E = \frac{hc}{\lambda} \Rightarrow E \propto \frac{1}{\lambda} \Rightarrow \lambda \propto \frac{1}{E}$ $\therefore \frac{\lambda_1}{\lambda_2} = \frac{E_2}{E_1} = \frac{3E}{E} = \frac{3}{1}$ $\therefore \boldsymbol{\lambda_1 : \lambda_2 = 3 : 1}$

---

11. Write the formula for the energy of an electron in the n^{th} orbit for hydrogen atom.

A: Energy of an electron in the n^{th} orbit for hydrogen atom is $\mathbf{E_n = \frac{-13.6}{n^2} eV}$ Here n =1, 2, 3, ...

---

12. What is the path of an electron around the nucleus as per Rutherford's atomic model?

A: According to Rutherford's atomic model, the path of an electron around the nucleus is a **circular orbit.**

HINTS FOR MCQ & FIB

1.**(1)** The first model of an atom was proposed by **J.J.Thomson**

2.**(4)** In the gold foil experiment, a radioactive source of Bismuth was used inside a lead cavity to emit a stream of high energy alpha particles.

3.(4) $\mathbf{K = e^2 / 8\pi\varepsilon_0 r}$ **and** $\mathbf{U = -e^2 / 4\pi\varepsilon_0 r}$

4.**(4)** From Bohr's second postulate angular momentum of orbiting electron is quantized.

5.**(3)** 1 eV = 1.6×10^{-19} Joule.

6.**(4)** Then energy $h\nu = E_f + E_i$ is incorrect. But, $h\nu = E_i - E_f$ is correct.

7.**(2)** $E_n = \frac{13.6Z^2}{n^2}eV = \frac{13.6}{n^2}eV$ For hydrogen Z=1

8.**(4)** Bohr's model fails on multiple electron systems. Atomic number of Ne is 10 . Hence singly ionized (Ne^+) has 9 electrons. So, Bohr's model does not apply to it.

9.**(2)** According to Bohr's theory, the velocity of an electron in the n^{th} orbit $v_n \propto \frac{Z}{n}$, for hydrogen, $Z = 1$. So, $v \propto \frac{1}{n}$

10.**(1)** According to Bohr's second postulate $mvr = \frac{nh}{2\pi}$

11.**(2)** In a Bohr's orbit, Total energy E = – KE. Hence KE:E=1:–1

12.**(4)** Ground state energy $E_1 = -13.6eV$. ; First excited state energy $E_2 = \frac{-13.6}{2^2} = -3.4eV$

Excitation energy required $E_2 - E_1 = -3.4 - (-13.6) = 10.2eV$ or

13.**(2)** Energies of hydrogen levels are, $E_1 = -13.6ev,\ E_2 = -3.4eV,\ E_3 = -1.51eV, E_4 = -0.85eV$
The transition from n = 2 to n = 1 has an energy difference of 10.2 eV which is maximum

or Frequency $\nu = k\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = k\left(\frac{n_2^2 - n_1^2}{n_1^2 n_2^2}\right)$

Among the given options for n_1=1 and n_2=2 we have $\nu = k\left(\frac{2^2 - 1^2}{(1\times 2)^2}\right) = \frac{3}{4}k$ which is max.

FILL IN THE BLANKS

1. For electron to revolve in a stable circular orbit the inward electrostatic force of attraction (F_e) outwards centripetal force(F_c) required. $F_e = F_c$

2. Energy $E_n = \frac{-13.6Z^2}{n^2} \Rightarrow E_2 = \frac{-13.6(2)^2}{2^2} = -13.6eV$ For He, n = 2, Z = 2

3. Atomic number of Lithium is Z= 3. ; $E_n = \frac{-13.6Z^2}{n^2} = \frac{-13.6(3)}{n^2} = \frac{-122.4}{n^2}$;

   For 1st orbit $E_1 = \frac{-122.4}{1^2} = -122.4eV$; For 3rd orbit, $E_3 = \frac{-122.4}{3^2} = \frac{-122.4}{9} = -13.6eV$

   $\therefore \Delta E = E_3 - E_1 = -13.6 - (-122.4) = -13.6 + 122.4 = 108.8eV$

4. Angular momentum (L) of an electron in the n^{th} orbit is $L = \frac{nh}{2\pi}$

   The change in angular momentum from 4^{th} to 5^{th} orbit is $\Delta L = \frac{5h}{2\pi} - \frac{4h}{2\pi} = \frac{h}{2\pi}$

   Also $\frac{h}{2\pi} = \frac{6.63\times10^{-34}}{2\times3.14} = 1.055\times10^{-34}J$

5. We know $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{1}{\lambda} = 1.097\times10^7\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = 1.097\times10^7\left(\frac{3}{4}\right)$

   Hence, we get $\lambda = 121.8\,nm$

6. Given n = 3, r = 4.65Å We know $2\pi r = n\lambda \Rightarrow 2 \times \pi \times 4.65 = 3\lambda$

   $\therefore \lambda = \frac{9.3\pi}{3} = 3.1\times3.14 = 9.74\,Å$

7. The process of raising or transferring the electron from lower energy state to higher energy state is called **excitation**.

8. The process of raising the atom from the normal state to the ionized state is called **ionization**.

9. Given E= –3.4 eV $\therefore U = 2E = 2\times-3.4eV = -6.8eV$

10. The energy of the ground electronic state of hydrogen atom is –13.6 eV. The energy of the first excited state will be **-3.4 eV**.

11. The value of impact parameter (b) for head-on collision is **zero**.

12. 1 fermi = $\mathbf{10^{-15}}$ meter.

14. SEMICONDUCTOR ELECTRONICS: MATERIALS, DEVICES AND SIMPLE CIRCUITS

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. **Following is an example of a compound semiconductor** [4]
   1) Al_2O_3 2) SiO_2 3) H_2O **4) GaAs**

2. **Which of the following is used as pentavalent impurities for doping process?** [1]
   1) Arsenic 2) Boron 3) Indium 4) Aluminium

3. **For an n-type semiconductor n_e = number of conduction electrons and n_h = number of holes, then ____________.** [2]
   1) $n_e = n_h$ **2) $n_e > n_h$** 3) $n_e < n_h$ 4) $n_e = (n_h/2)$

4. **The energy band gaps of silicon and germanium are** [3]
   1) 0.7eV, 1.1eV 2) 1eV, 0.7eV **3) 1.1eV,0.7eV** 4) 2eV, 1.5eV

5. **On the basis of electrical conductivity, which one of the following material has the smallest resistivity?** [4]
   1) Germanium 2) Silicon 3) Glass **4) Silver**

6. **In case of full wave rectification, if the input frequency is 60 Hz, then the output frequency would be** [2]
   1) 60 Hz **2) 120 Hz** 3) 100 Hz 4) 150 Hz

7. **The electron concentration in an n-type semiconductor is the same as hole concentration in a p-type semiconductor. An external field (electric) is applied across each of them. Compare the currents in them.** [4]
   1) No current will flow in p-type, current will only flow in n-type
   2) Current in n-type = Current in p-type
   3) Current in p-type > Current in n-type
   4) Current in n-type > Current in p-type

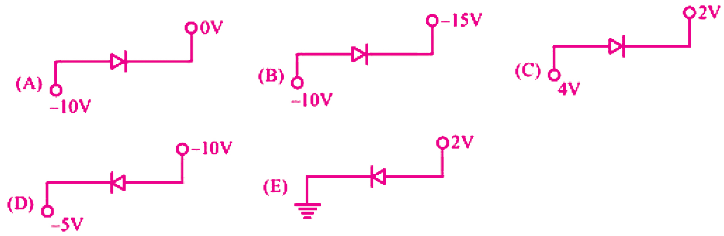
8. **For a p-n junction diode, the current in reverse bias is in the order of** [3]
   1) Few mA 2) Few amperes **3) Few μA** 4) Few kilo amperes

9. **The increase in the width of the depletion region in a p-n junction diode is due to**
   1) reverse bias only 2) both forward bias and reverse bias [1]
   3) high doping concentrations 4) forward bias only

10. **A Ge specimen is doped with aluminium. The concentration of acceptor atoms is 10^{21} atoms/m^3. Given that the intrinsic concentration of electrons in the specimen is $10^{19}/m^3$. The new electron concentration is** [1]
    1) $10^{17}/m^3$ 2) $10^{15}/m^3$ 3) $10^4/m^3$ 4) $10^2/m^3$

11. Which of the following circuits represents a forward biased diode? [**4**]

Choose the correct answer from the options given below:



1) (C) and (E) only 2) (A) and (D) only 3) (B), (D) and (E) only **4)(B),(C) and (E) only**

II. FILL IN THE BLANKS(FIB)

1. In a vacuum tube, the electrons are supplied by a **cathode**.

2. In vacuum tubes, electrons flow from the cathode to the anode in **only one** direction.

3. The conduction in a semiconductor possible due to motion of **electrons** in the conduction band and **holes** in the valence band.

4. The gap between the top of the valence band and bottom of the conduction band is called the **energy band gap/forbidden energy gap**.

5. The semiconductor elements Ge and Si crystal structure is almost similar to **diamond cubic crystal** structure.

6. In intrinsic semiconductors, the number of free electrons(n_e) = number of holes (n_h) = n_i where n_i is called **intrinsic carrier concentration**.

7. The pentavalent dopant donates one extra electron for conduction and hence this impurity is called **donor**.

8. In an n-type Si semiconductor, the donor energy level E_D is slightly **below** the bottom of the conduction band (E_C).

9. At Thermal equilibrium the electron and hole Concentration in an intrinsic semiconductor is **equal**.

10. In the p-n junction diode symbol, the direction of arrow indicates **direction of conventional current**.

III. ONE WORD ANSWER Q'S

1. At what temperature the intrinsic semiconductor will behave like an insulator?

A: **At absolute zero temperature (0 K)** intrinsic semi conductor behaves like an insulator

---

2. What is the ratio of number of holes and the number of conduction electrons in an intrinsic semiconductor?

A: The ratio of the number of holes (n_h) to the number of conduction electrons (n_e) in an intrinsic semiconductor is **1:1.**

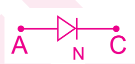
---

3. What is the overall charge of the p-type semiconductor crystal?

A: The overall charge of p-type semi conductor crystal is electrically **neutral (zero).**

---

4. Draw the circuit symbol of the p-n junction diode.

A: **Circuit symbol of the p-n junction diode:** 

p-n junction diode: 

---

5. For a p-n junction diode, built in potential = V_0 and applied voltage is V ($V > V_0$) and diode is in forward bias then what is the height of effective barrier?

A: The **effective barrier height = $V_0 - V$.**

The effective barrier height (potential) of a forward biased diode is reduced by the applied voltage (V) from initial voltage (V_0).

---

6. What is the forbidden energy gap in Ge semiconductor crystal in terms of Joules?

A: **Forbidden energy gap in Ge** at room temperature $Eg = 0.72 \times 1.6 \times 10^{-19}$ J $= \mathbf{1.15 \times 10^{-19}}$ **J**

---

7. What is the name of the current due to motion of charge carriers when external electric field is applied.

A: The current produced by the motion of charge carries under the influence of an external electric field is known as **drift current.**

8. At thermal equilibrium condition what will be the product of number of electrons and number of holes in any semiconductor material?

A: **At thermal equilibrium,** the product of the concentration of electrons (n_e) and the concentration of holes (n_h) in any semi conductor material is given by $n_e n_h = n_i^2$.

Here n_i is the intrinsic carrier concentration .

This is known as the "Law of mass Action".

---

9. What is the energy band which includes the energy levels of the valence electrons?

A: The **valence band** is the energy band includes the energy levels of the valence electrons.

It is the highest occupied energy band in a material.

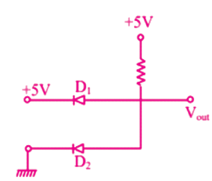
---

10. What is the name of the process "adding impurities to the intrinsic semiconductor to make extrinsic semiconductor"?

A: **Doping** is the process of adding impurities to an intrinsic semiconductor to make extrinsic semi conductor.

---

11. The output voltage in the following circuit is (Consider diodes are ideal)



A: Output voltage is equal to zero.

Reason: The diode D_2 conducts and acts as a short circuit to ground.

---

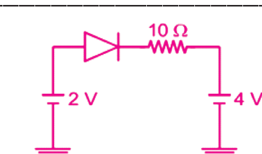
12. What is the output frequency of a half-wave rectifier if the input voltage frequency is 50 Hz?

A: If the input is 50Hz, out is also **50Hz.**

Reason: The output frequency of a rectifier is equal to input voltage frequency.

---

13. What is the current through an ideal p-n junction diode shown in the following figure.



A: Current through the diode is **i = 0 A.**

Reason: For an ideal P-N junction diode in reverse bias, the resistance is considered infinite and hence no current flows through it.

---

14. A semiconductor is known to have an electron concentration of 8×10^{13} /cm^3 and a hole concentration 5×10^2 /cm^3. What type of the semiconductor is it?

A: It is an **n-type semiconductor** because $n_e > n_h$.

Electron concentration $n_e = 8 \times 10^{13}$ /cm^3 ; Hole concentration $n_h = 5 \times 10^2$ /cm^3.

Here the electron concentration is much higher than the hole concentration.

HINTS FOR MCQ & FIB

1.**(4)** Gallium Arsenide (Ga As) is classified as a compound semiconductor

2.**(1)** Arsenic is used as a Pentavalent depend because, it contributes a base electron to the semi conductor lattice, creating an n-type material with high increased electrical conductivity.

3.**(2)** For n-type semiconductor, $n_e > n_r$, because the material is intentionally doped with pentavalent impurities.

4.**(3)** Silicon and Germanium have different atomic sizes, nuclear charges and crystal binding forces. Because of this it takes 1.1ev of energy the break a covalent bond in Silicon, compared to only 0.7ev in Germanium.

5.**(4)** Silver has lowest resistivity $1.59 \times 10^{-8}\Omega$. It is due to its unique atomic structure how electronegativity, high concentration of free electrons .

6.**(2)** In a full wave rectifier the input frequency n= 60 Hz then its output frequency is 2n= 120 Hz

7.**(4)** $I_n > I_p$. At equal charge carrier concentration, current in entire (mobility of electrons) is higher than current in p-type (mobility of holes)

8.**(3)** In a p-n junction diode, the reverse bias current is extremely small in the order of μA for Ge

9.**(1)** The increase in the width of the depletion region in a p-n junction diode is due to reverse bias only

10.**(1)** When concentration of electron is n, hole is p and inter intrinsic carrier is n_i then $nP = n_i^2$

$$\therefore n = \frac{n_i^2}{P} = \frac{(10^{19})^2}{10^2} = \frac{10^{38}}{10^{21}} = 10^{17}\,m^{-3}$$

11.**(4)** A diode in forward biased, $V_{anode} > V_{cathode}$. Among the given (B)(C) (E) are correct.

Fill in the Blanks

1. In a vacuum tube, the electrons are supplied by a **cathode**.

2. In vacuum tubes, electrons flow from the cathode to the anode in **only one** direction.

3. The conduction in a semiconductor possible due to motion of **electrons** in the conduction band and **holes** in the valence band.

4. The gap between the top of the valence band and bottom of the conduction band is called the **energy band gap/forbidden energy gap**.

5. The semiconductor elements Ge and Si crystal structure is almost similar to **diamond cubic crystal** structure.

6. In intrinsic semiconductors, the number of free electrons(n_e) = number of holes (n_h) = n_i where n_i is called **intrinsic carrier concentration**.

7. The pentavalent dopant donates one extra electron for conduction and hence this impurity is called **donor**.

8. In an n-type Si semiconductor, the donor energy level E_D is slightly **below** the bottom of the conduction band (E_C).

9. At Thermal equilibrium the electron and hole Concentration in an intrinsic semiconductor is **equal**.

10. In the p-n junction diode symbol, the direction of arrow indicates **direction of conventional current**.