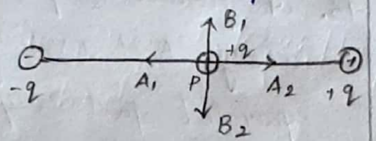
1. Two identical point charges of magnitude $-q$ are fixed as shown in figure below. A 3rd charge $+q$ is placed midway between the two charges at the point P. Suppose this charge $+q$ is placed small distance from the point P in the direction indicated by the arrows, in which direction will $+q$ be stable with respect to displacement?



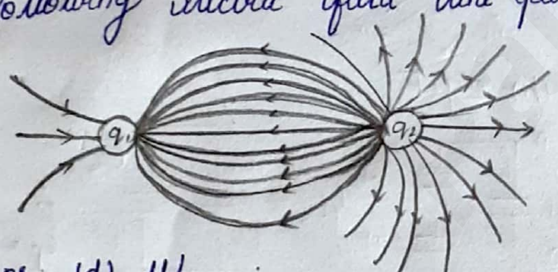
Ans : (b) B_1 and B_2

When $+q$ is moved along B_1 and B_2, $+q$ will be stable.

2. Which charge configuration produces an uniform electric field?

Ans : (c) uniformly charged infinite plane

3. What is the ratio of charge $\left|\frac{q_1}{q_2}\right|$ for following electric field line pattern.



Ans : (d) $11/25$

q_1 - negative charge, q_2 - positive charge. The number of line from q_2 to q_1 is 11 and number of lines in q_2 is 25. $\Rightarrow \left|\frac{q_1}{q_2}\right| = 11/25$.

4. An electric dipole is placed at an alignment angle of $30°$ with an electric field of 2×10^5 NC^{-1}. It experiences a torque equal to 8 Nm. The charge on the dipole if the dipole length is 1 cm is

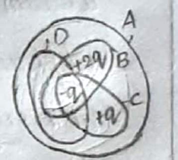
Ans : (b) 8 mC.

$$\tau = Eq\,2d \sin\theta$$

$$q = \frac{\tau}{E.2d\sin\theta} \Rightarrow q = \frac{8}{2\times10^5\times10^{-2}\times\sin 30°}$$

$$q = \frac{8}{2\times10^5\times10^{-2}\times 1/2} \Rightarrow q = 8\times10^{-3}\ C.$$

5. Four Gaussian surfaces are given below with charges inside each gaussian surface. Rank the electric flux through each Gaussian surface in increasing order.



Ans : (a) $D < C < B < A$

Electric flux at $A = 2q/\varepsilon_0$

Electric flux at $B = q/\varepsilon_0$

Electric flux at $C = 0/\varepsilon_0 = 0$

Electric flux at $D = -q/\varepsilon_0$

6. The total electric flux for the following closed surface which is kept inside water

Ans : (b) $\frac{q}{40\varepsilon_0}$

$$\phi = \frac{q}{\varepsilon_r\varepsilon_0} \Rightarrow \phi = \frac{2q}{80\varepsilon_0} \Rightarrow \frac{q}{40\varepsilon_0}$$

$\because$ here $q = 2q$, ε_r of Water $= 80$.

7. Two identical conducting balls having positive charge q_1 and q_2 are separated by a center to center distance r. If they are made to touch each other and then separated to the same distance, the force between them will be

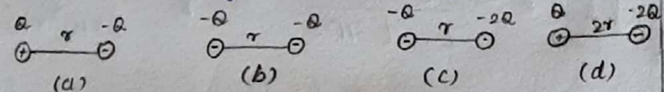
Ans: (c) more than before.

$F \propto q_1 q_2$, After touching $F' \propto q^2$

Naturally, $q^2 > q_1 q_2$

$\therefore F' > F$.

8. Rank the electrostatic potential energies for the following in increasing order



Ans: (a) $1 = 4 < 2 < 3$

$U_1 \propto -\frac{Q^2}{r}$; $U_2 \propto \frac{Q^2}{r}$; $U_3 \propto \frac{2Q^2}{r}$;

$U_4 \propto -\frac{2Q^2}{2r} \propto -\frac{Q^2}{r}$

9. An electric field $\vec{E} = 10x\hat{i}$ exists in a certain region of space. Then the potential difference $V = V_0 - V_A$. when V_0 is the potential at the origin and V_A is potential at $x = 2m$ is

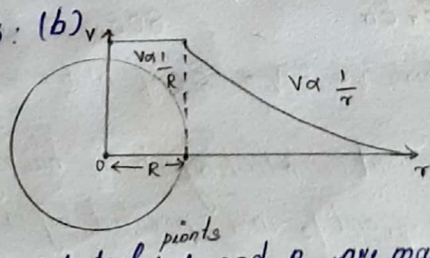
Ans: (c) +20 J

$V = V_0 - V_A = -\int_{V_A}^{V_0} \vec{E}.dx = -\int_2^0 10x.dx$

$V = -10\left[\frac{x^2}{2}\right]_2^0 = -5[0-4] = +20V$

10. A thin conducting spherical shell of radius R has a charge Q which is uniformly distributed on it surface. The correct plot for electrostatic potential due to spherical shell is

Ans: (b)



11. Two ~~potential~~ points A and B are maintained a potential of 7V and -4V respectively. The work done in moving 50 electrons from A to B is

Ans: 8.80×10^{-17} J.

$q = ne = -50 \times 1.6 \times 10^{-19}$

$\Delta V = V_B - V_A = -4 - 7 = -11V$

$W = q\Delta V = -50 \times 1.6 \times 10^{-19} \times -11 = 880 \times 10^{-19}$ C.

12. If voltage applied on a capacitance is increased from V to 2V, choose the correct conclusion.

Ans: (c) C remains same, Q doubled

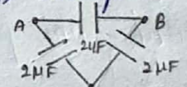
If V is doubled then Q also doubled but $\therefore C = Q/V = 2Q/2V = Q/V$, C remains same.

13. A parallel plate capacitor stores a charge Q at a voltage V. Suppose the area of parallel plate capacitor and the distance btw -een the plates are each doubled then which is the quantity that will change?

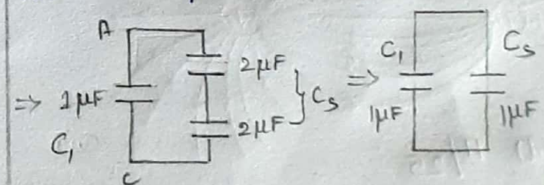
Ans: (d) Energy density.

If A and d are doubled then C, V remains same but energy density varies.

14. Three capacitor are connected in triangle as shown in figure. The equivalent capacitance between the point A and C is



Ans: (b) 2 μF



$\therefore C_p = C_1 + C_s = 1 + 1 = 2$

$C_s = \frac{1}{2} + \frac{1}{2} = 1\mu F$

15. Two metallic sphere of radius 1cm and 3cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is

Ans: (a) 3×10^{-2} C.

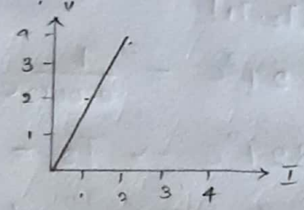
here, $V_1 = V_2$ $\therefore \frac{q_1}{r_1} = \frac{q_2}{r_2} = \frac{Q}{r_1 + r_2} = \frac{q_1 + q_2}{r_1 + r_2}$

$\Rightarrow q_2 = \left(\frac{q_1 + q_2}{r_1 + r_2}\right) r_2 = \left(\frac{3 \times 10^{-2}}{4 \times 10^{-2}}\right) \times 4 \times 10^{-2}$

$\Rightarrow q_2 = 3 \times 10^{-2}$ C.

UNIT - 2

1. The following graph shows current versus voltage value of some unknown conductor. What is the resistance of this conductor?

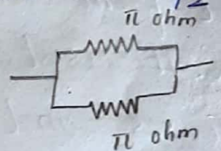


Ans : (a) 2 ohm.

$R = \Delta V / \Delta I = 4/2 = 2 \text{ ohm}$.

2. A wire of resitance 2 ohms per meter is bent to form a circle of radius 1m. The equivalent resistance between its two diametrically opposite piont A and B as shown in figure is

Ans: (b) $\pi/2\ \Omega$



$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{\pi} + \frac{1}{\pi}$

$\Rightarrow R_p = \pi/2$ ohm.

3. A toaster operating at 240V has a resistance of 120 ohm. The power is

Ans: (c) 480 W

$P = V^2/R = \frac{240 \times 240}{120} = 480\ W$

4. A carbon resistor of (47 ± 4.7)k ohm to be marked with rings of different colours for its identification. The colour code sequence will be

Ans : (b) yellow - violet - Orange - Silver

$R = 47 \times 10^3 \pm 10\% \rightarrow$ Silver.

(4 → yellow, 7 → violet, 10^3 → Orange)

5. What is the value of resistance of the following resistor?

Ans : (a) 100 k Ω

brown ↓ 1, black ↓ 0, yellow ↓ 10^4

$\Rightarrow 10 \times 10^4\ \Omega = 100\ k\Omega$.

6. Two wires A and B with circular cross section made up of same material with equal lengths. Suppose $R_A = 3R_B$, then what is the ratio of radius of wire A to that of B?

Ans: (c) $\frac{1}{\sqrt{3}}$

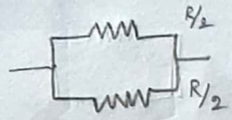
$R \propto \frac{1}{A} \propto \frac{1}{r^2} \Rightarrow \frac{R_A}{R_B} = \frac{r_B^2}{r_A^2} \Rightarrow \frac{r_B^2}{r_A^2} = \frac{3R_B}{R_B}$

$\Rightarrow \frac{r_B^2}{r_A^2} = 3 \Rightarrow \frac{r_A^2}{r_B^2} = \frac{1}{3} \Rightarrow \frac{r_A}{r_B} = \frac{1}{\sqrt{3}}$.

7. A wire connected to a power supply of 230V has power dissipation P_1. Suppose the wire is cut into two equal pieces and connected parallel to same power supply. In this case power dissipation is P_2. The ratio $\frac{P_2}{P_1}$ is

Ans: (d) 4.

$P_1 \propto \frac{1}{R}$,



$R/4 = R'$

$\Rightarrow P_2 \propto \frac{1}{R'} \quad \therefore \frac{P_2}{P_1} = \frac{R}{R'} = \frac{R}{(R/4)} = 4$

8. In India electricity supplied for domestic use at 220V. It is supplied at 110V in USA. If the resistance of a 60W bulb for use in India is R, the resistance of a 60W bulb for use in USA will be

Ans : (c) $R/4$

$\frac{V_1^2}{R_1} = \frac{V_2^2}{R_2} \Rightarrow R_2 = \left(\frac{V_1^2}{V_2^2}\right) R_1$

$\Rightarrow R_2 = \left(\frac{110 \times 110}{220 \times 220}\right) R_1 \Rightarrow R_2 = R_1/4$

9. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW are connected. The voltage of electric mains is 220 V. The minimum capacity of the main fuse of building will be

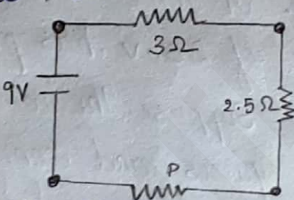
Ans: (d) 12 A.

$P_{tot} = (15 \times 40) + (5 \times 100) + (5 \times 80) + (1 \times 1000) \Rightarrow P = 600 + 500 + 400 + 1000$

$\Rightarrow P = 2500\ W \therefore I = P/V = 2500/220$

$\Rightarrow I = 11.36 \simeq 12\ A$

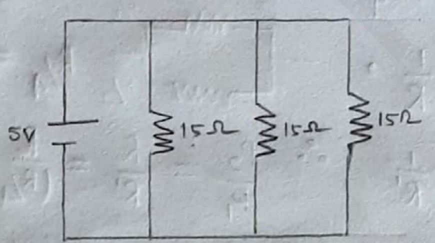
10. There is a current of 1.0 A in the circuit shown below. What is the resistance of P?



Ans: (c) 3.5 Ω

$9 = P + 2.5 + 3 \Rightarrow P = 3.5\ \Omega$

11. What is the current out of battery?



Ans: 1 A

$I = \frac{V}{R_{eff}}$ $\because R_{eff} = \frac{R}{n} = \frac{15}{3} = 5$ ohm

$I = 5/5 = 1\ A.$

12. The temperature coefficient of resistance of wire is 0.00125 per °C. At 300 K, its resistance is 1 Ω. The resistance of a wire will be 2 Ω at

Ans: (d) 1127 K.

$\alpha = \frac{R_2 - R_1}{R_1 (T_2 - T_1)}$

$\alpha = \frac{2-1}{1(T_2 - T_1)} \Rightarrow T_2 - T_1 = \frac{1}{\alpha}$

$\Rightarrow T_2 - 27^\circ C = \frac{1}{0.00125} \Rightarrow T_2 - 27 = 800$

$\Rightarrow T_2 = 827^\circ C \Rightarrow T_2 = 1100\ K.$

13. The internal resistance of a 2.1 V cell which gives current of 0.2 A through a resistance of 10 Ω is

Ans: (b) 0.5 ohm

$r = \frac{\mathcal{E} - V}{I}$ $\because V = IR \Rightarrow V = 0.2 \times 10 = 2V$

$r = \frac{2.1 - 2}{0.2} \Rightarrow r = \frac{0.1}{0.2} = 0.5$ ohm

14. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

Ans: (d) copper decreases and germanium increases.

$\because$ If temperature decreases, the resistance of conductor decreases while the resistance of semi-conductor increases.

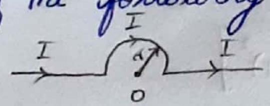
15. In Joule's law of heating, when I and t are constant, if the H is taken along y axis and I^2 along x axis, the graph is

Ans: (a) straight line.

$H \alpha I^2$.

UNIT - 3

1. The magnetic field at a centre O of the following current loop is

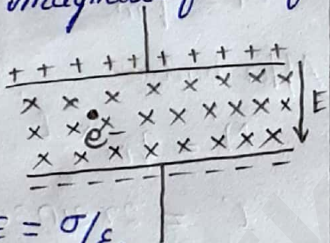


Ans : (a) $\frac{\mu_0 I}{4r}$ ⊗

$B = \int dB = \int_0^{\pi r} \frac{\mu_0 I}{4\pi} \cdot \frac{I\,dl}{r^2}$

$\Rightarrow B = \frac{\mu_0 I}{4\pi r^2} \cdot [l]_0^{\pi r} = \frac{\mu_0 I}{4r}$ ⊗

2. An electron moves straight inside a charged parallel plates capacitor of uniform charge density σ. The time taken by the electron to cross the parallel plate capacitor when the plates of the capacitor are kept under constant magnetic field of induction $\vec{B}$ is



Ans : (d) $\varepsilon_0 \frac{lB}{\sigma}$

$v = E/B \quad \because E = \sigma/\varepsilon_0$

$l/t = \frac{\sigma}{\varepsilon_0 B} \Rightarrow t = \varepsilon_0 \frac{lB}{\sigma}$

3. The force experienced by a particle having mass m and charge q accelerated through a potential difference V when it is kept under perpendicular magnetic field $\vec{B}$ is :

Ans : (c) $\sqrt{\frac{2q^3B^2V}{m}}$

$\frac{1}{2}mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}}$

$F = Bqv = Bq\sqrt{\frac{2qV}{m}}$

$F = \sqrt{\frac{2q^3B^2V}{m}}$

4. A circular coil of radius 5 cm and has 50 turns carries a current of 3 ampere. The magnetic dipole moment of coil is :

Ans : (b) 1.2 amp - m^2 $\quad \because A = \pi r^2$

$M = NiA = 50 \times 3 \times 3.14 \times (5 \times 10^{-2})^2$

$M = 1.17 \simeq 1.2$ A-m^2

5. A thin insulated wire forms a plane spiral of N = 100 tight turns carrying a current I = 8 mA. The radii of inside and outside turns are equal to a = 50 mm and b = 100 mm respectively. The magnetic induction at the centre of spiral is :

Ans : (b) 7 μT

$B = \frac{\mu_0 NI}{2(b-a)} \ln(b/a) = \frac{4\pi \times 10^{-7} \times 8 \times 10^{-3} \times 10^2}{2(100-50) \times 10^{-3}} \ln\left(\frac{100}{50}\right)$

$B = 4 \times 3.14 \times 10^{-7} \times 8 \times 2.303 \log 2$

$B = 69.65 \times 10^{-7} \simeq 7\ \mu T \qquad \because \log 2 = 0.3010$

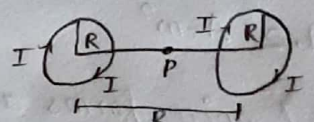
6. Three wires of equal length are bent in the form of loops. One of the loops is circle, another is a semicircle and the third one is a square. They are placed in a uniform magnetic field and same electric current is passed through them. Which will experience greater torque.

Ans : (a) Circle

$A_{circle} > A_{square} > A_{semi\text{-}circle}$

$\therefore \tau_{circle} > \tau_{square} > \tau_{semi\text{-}circle}$

7. Two identical coils, each with N turns and radius R are placed coaxially at a distance R as shown in figure. If I is the current passing through the loops of in the same direction, then magnetic field at a point P which is at a distance R/2 between two coil is:



Ans: (b) $\frac{8 N \mu_0 I}{5^{3/2} R}$

$B_1 = \cancel{\frac{4n \mu_0 I}{5^{3/2} R}} \quad \frac{n \mu_0 I R^2}{2(R^2+x^2)^{3/2}} \qquad \because x = R/2$

$B_1 = \frac{n\mu_0 I R^2}{2\left(R^2 + R^2/4\right)^{3/2}} = \frac{n\mu_0 I R^2}{2\left(\frac{5R^2}{4}\right)^{3/2}}$

$B_1 = \frac{n\mu_0 I R^2}{\frac{5^{3/2}}{4}\left(R^3\right)} = \frac{4n\mu_0 I}{5^{3/2} R} = B_2$

$B_T = B_1 + B_2 = \frac{8n\mu_0 I}{5^{3/2} R}$.

8. A wire of length l carries a current I along the y direction and magnitic field is given by $\vec{B} = \frac{B}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$ T. The magnitude of Lorentz force acting on wire is:

Ans: (a) $\sqrt{\frac{2}{\sqrt{3}}}\ BIl$.

$\vec{F} = I\vec{l} \times \vec{B}$

$\vec{F} = I\, l\hat{j} \times \frac{B}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$

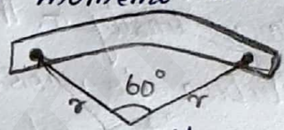
$\vec{F} = \frac{IlB}{\sqrt{3}}\left[(\hat{j}\times\hat{i}) + (\hat{j}\times\hat{j}) + (\hat{j}\times\hat{k})\right]$

$\vec{F} = \frac{IlB}{\sqrt{3}}\left[\hat{k} + 0 + (-\hat{i})\right]$

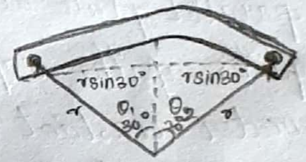
$\vec{F} = \frac{IlB}{\sqrt{3}}\left[1^2 + (-1)^2\right]$

$\vec{F} = \frac{IlB}{\sqrt{3}}\sqrt{2} = \sqrt{\frac{2}{3}}\ IlB$.

9. A bar magnet of length l and magnetic moment M is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be:



Ans: (b) $3/\pi\ M$



$M = q_m \times l$

After bent

$M' = q_m \times l'$

$l' = 2r\sin 30 = \frac{1}{2} \times 2r = r$.

$l/r = \pi/6 \qquad \therefore r = 3l/\pi$

$M' = q_m \times \frac{3l}{\pi} = 3/\pi\ M$

10. A non conducting charged ring of charge q, mass m and radius r is rotated with constant angular speed ω. Find the ratio of its magnetic moment with angular ~~velocity~~ momentum is:

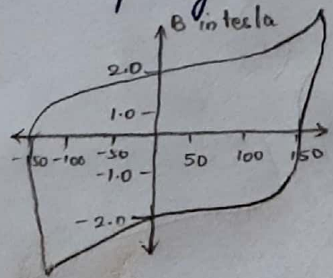
Ans: $q/2m$ $\qquad \because L = m\omega r^2$

$\mu_l = i \cdot A = \frac{q}{T}\cdot \pi r^2 \qquad \because T = \frac{2\pi}{\omega}$

$\mu_l = \frac{q\omega\pi r^2}{2\pi} = \frac{1}{2} q r^2 \omega$

$\frac{\mu_l}{L} = \frac{\frac{1}{2} q r^2 \omega}{m r^2 \omega} = \frac{1}{2}\frac{q}{m} = \frac{q}{2m}$

11. The BH curve for a ferromagnetic material is shown in figure. The material is placed inside a long solenoid which contain 1000 turns/cm. The current that should be passed in the solenoid to demagnetize the ferro magnet completely :



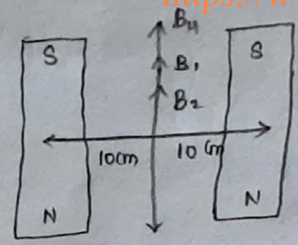
Ans : (C) 1. 5 mA

$\mu = nI \Rightarrow I = \mu/n = \frac{150}{1000 \times 10^{-2}}$

$\mu = \frac{150}{100} \times 10^{-3} = 1.5\,mA.$

12. Two short bar magnets have magnetic moment $1.20\,Am^2$ and $1.00\,Am^2$ respectively. They are kept on a horizontal table parallel to each other with their north poles pointing towards the south. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of resultant horizontal magnetic induction at mid-point O of line joining their centre is (Horizontal magnetic induction is 3.6×10^{-5} $Wb\,m^{-2}$)

Ans : (c) 2.56×10^{-4} T.



$B = B_1 + B_2 + B_H$

$B = \frac{\mu_0}{4\pi} \cdot \frac{H_1}{r^3} + \frac{\mu_0}{4\pi} \cdot \frac{H_2}{r^3} + B_H$

$B = \frac{\mu_0}{4\pi r^3} [H_1 + H_2] + B_H$

$B = \frac{10^{-7}}{(10^{-1})^3} [1.2 + 1] + 3.6 \times 10^{-5}$

$B = 2.2 \times 10^{-4} + 3.6 \times 10^{-5}$

$B = 2.56 \times 10^{-4}\,T.$

13. The vertical component of Earth's magnetic field at a piont is equal to horizontal component. What is the value of angle of dip at this piont ?

Ans : (b) 45°.

$B_V = B_H \quad \because \tan\theta = \frac{B_V}{B_H} = 1 \Rightarrow \theta = 45^\circ$

14. A flat dielectric disc of radius R carries an excess charge on its surface. The surface charge density is σ. The disc rotates about an axis perpendicular to its plane passing through centre with angular velocity ω. Find the magnitude of torque on disc if it is placed in an uniform magnetic field whose strength is B which is directed perpendicular to the axis of rotation :

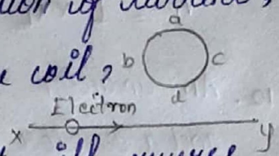
Ans : (d) $\frac{1}{4}\sigma\omega\pi BR^4$ $\quad \tau = HB$

$H = \frac{q}{4}\omega R^2 = \frac{\sigma A}{4}\omega R^2 = \frac{\sigma\pi R^2 \omega R^2}{4}$

$H = \frac{1}{4}\sigma\omega R^4\pi \Rightarrow \tau = \frac{1}{4}\sigma\omega\pi BR^4.$

UNIT - 4

1\. An electron moves on a straight line path xy as shown in figure. The coil abcd is adjacent to path of electron. What will be the direction of current, if any, induced in the coil?



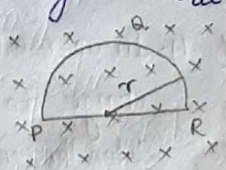
Ans: (a) The current will reverse its direction as the electron goes past the coil.

Electron moves towards the path, magnetic flux increases. The current flows in the direction abcd.

When electron moves away, magnetic flux decreases. The current flow in direction adcb.

2\. A thin semi-circular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed v, is

Ans: (d) $2rBv$ and R is at higher potential



$$\mathcal{E} = Blv = B2rv$$

R at higher potential.

3\. The flux linked with a coil at any instant t is given by $\Phi_B = 10t^2 - 50t + 250$. The induced emf at t = 3 is:

Ans: (b) $-10V$

$$\mathcal{E} = -\frac{d\Phi_B}{dt} = -[20t - 50] \quad t=3$$

$$\mathcal{E} = -10V.$$

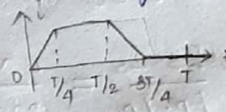
4\. When the current changes from +2A to -2A in 0.05 s, an emf of 8 V is induced in a coil. The co-efficient of self-induction of the coil is:

Ans: (d) 0.1 H

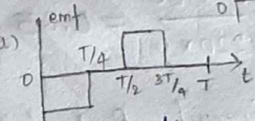
$$\mathcal{E} = -L\left(\frac{di}{dt}\right) \Rightarrow L = -\mathcal{E}/(di/dt)$$

$$L = \frac{8}{(4/0.05)} = 0.1\ H$$

5\. The current i flowing in a coil varies with time as shown in figure. The variation of induced emf with time would be:



Ans: (a)



(1) $0 \to T/4$; $\frac{di}{dt}$ = changes (+ve) ; $\mathcal{E}$ = negative

(2) $T/4 \to T/2$; $\frac{di}{dt} = 0$; $\mathcal{E} = 0$

(3) $T/2 \to 3T/4$; $\frac{di}{dt}$ = changes (-ve) ; $\mathcal{E}$ = positive

(4) $3T/4 \to T$; $di/dt = 0$; $\mathcal{E} = 0$

6\. A circular coil with a cross-sectional area of 4 cm^2 has 10 turns. It is placed at the centre of a long solenoid that has 15 turns/cm and a cross-sectional area 10 cm^2. The axis of the coil coincides with the axis of the solenoid. What is their mutual inductance?

Ans: (a) 7.54 μH.

$$M = \frac{\mu_0 N_1 N_2 A_2}{l_1} = \mu_0 n_1 N_2 A_2$$

$$M = 4\pi \times 10^{-7} \times \frac{15}{10^{-2}} \times 10 \times 4 \times 10^{-4}$$

$$M = 7.54 \times 10^{-6} = 7.54\ \mu H$$

7\. In a transformer, the number of turns in the primary and secondary are 410 and 1230 respectively. If the current in primary is 6A, then that in the secondary coil is:

Ans : (a) 2 A

$\frac{I_S}{I_P} = \frac{N_P}{N_S} \Rightarrow I_S = \frac{N_P}{N_S}(I_P)$

$\Rightarrow I_S = \frac{410}{1230} \times 6 \Rightarrow I_S = 2\,A$

8. A step down transformer reduces the supply voltage from 220 V to 11 V and increases the current from 6A to 100A. Then its efficiency is:

Ans: (b) 0.83

$\eta = \frac{E_S \cdot I_S}{E_P \cdot I_P} = \frac{11 \times 100}{220 \times 6} = 0.83$

9. In an electrical circuit, R, L, C and AC voltage source are all connected in series. When L is removed from the circuit, the phase difference between the voltage and current in the circuit is $\pi/3$. Instead, if C is removed from the circuit, the phase difference is again $\pi/3$. The power factor of the circuit is:

Ans : (c) 1

here, $X_L = X_C \Rightarrow Z = R$

$\cos\phi = R/Z = 1$

10. In a series RL circuit, the resistance and inductive reactant are same. Then the phase difference between the voltage and current in the circuit is:

Ans : (a) $\pi/4$

$R = X_L \quad \therefore \tan\phi = \frac{X_L}{R} = 1$

$\Rightarrow \phi = \tan^{-1}(1) \Rightarrow \phi = \pi/4$

11. In a series resonant RLC circuit, the voltage across 100Ω resistor is 40V. The resonant frequency ω is 250 rad/s. If the value of C is 4 μF, then voltage across L is:

Ans : 400V

$X_L = X_C = \frac{1}{C\omega_r} = \frac{1}{4 \times 10^{-6} \times 250} = 10^3\,\Omega$

$I = V/R = 40/100 = 0.4\,A$

$V_L = I \times X_L = 0.4 \times 10^3 = 400\,V$.

12. An inductor 20mH, a capacitor 50μF and a resistor 40Ω are connected in series across a source of emf $V = 10\sin 340t$. The power loss in AC circuit is:

Ans : (c) 0.46 W

$X_L = \omega L = 20 \times 10^{-3} \times 340 = 6.8\,\Omega$

$X_C = \frac{1}{C\omega} = \frac{1}{50 \times 10^{-6} \times 340} = 58.8\,\Omega$

$X_L - X_C = 52\,\Omega \quad \therefore Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{40^2 + 5^2} \Rightarrow Z = 65.6\,\Omega$

$P = I_{rms}^2 \cdot R = \left[\frac{E_{rms}}{2}\right]^2 \cdot R = \left[\frac{7.07}{65.6}\right] \times 40$

$P = 0.46\,W$

13. The instantaneous value of alternating current and voltage in a circuit are:

$i = \frac{1}{\sqrt{2}}\sin(100\pi t)$ A and $v = \frac{1}{\sqrt{2}}\sin(100\pi t + \pi/3)$ V

The average power is:

Ans : (d) 1/8

$P_{av} = \frac{I_0 E_0}{2} \times \cos\phi = \frac{1}{2} \times \frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} \times \cos\pi/3 = 1/8$

14. In an oscillating LC circuit, the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic field is

Ans: (c) $Q/\sqrt{2}$

$U' = 1/2 \quad \therefore \frac{Q'^2}{2C} = 1/2 \cdot \frac{Q^2}{2C} \Rightarrow Q'^2 = Q^2/2$

$\Rightarrow Q' = Q/\sqrt{2}$.

15. $\frac{20}{\pi^2}$ H inductor is connected to a capacitor of capacitance C. The value of C in order to impart maximum power at 50 Hz is: Ans : (d) 5μF

$X_L = X_C \Rightarrow C = \frac{1}{L\omega_r^2} = \frac{\pi^2}{20 \times 4\pi^2 \times 2500} = 5\mu F$

UNIT - 5

1. The dimension of $\frac{1}{\mu_0 \varepsilon_0}$ is :

Ans : (b) $[L^2 T^{-2}]$

μ_0 dimension $[MLT^{-2}A^{-2}]$

ε_0 dimension $[M^{-1}L^{-3}T^4A^2]$

$\therefore \frac{1}{\mu_0 \varepsilon_0} = \frac{1}{[L^{-2}T^2]} = [L^2T^{-2}]$

2. If the amplitude of magnetic field is 3×10^{-6} T, then amplitude of electric field for a electromagnetic waves:

Ans : (d) 900 Vm^{-1}

$C = E_0 / B_0 \Rightarrow E_0 = CB_0$

$E = 3 \times 10^8 \times 3 \times 10^{-6} = 9 \times 10^2 \ Vm^{-1}$

3. Which of the following electromagnetic radiation is used for viewing object through fog?

(d) infrared rays.

4. Which of the following are false for electromagnetic waves?

Ans : (c) longitudinal.

5. Consider an oscillator which has a charged particle and oscillates about its mean position with a frequency of 300 MHz. The wave length of electromagnetic waves produced by this oscillator is :

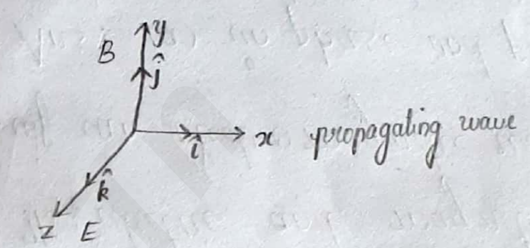
Ans : (a) 1m

$C = \lambda \nu \Rightarrow \lambda = C/\nu = \frac{3 \times 10^8}{300 \times 10^6}$

$\Rightarrow C = 1m$

6. The electric and the magnetic field, associated with an electro magnetic wave, propogating along x axis can be represented by :

Ans : (b) $\vec{E} = E_0 \hat{k}$ and $\vec{B} = B_0 \hat{j}$



7. In an electromagnetic wave in free space the rms value of the electric field is 3 Vm^{-1}. The peak value of magnetic field is :

Ans : (a) 1.414×10^{-8} T

$C = E_{rms} / B_{rms} \Rightarrow B_{rms} = E_{rms}/c$

$B_0 = \sqrt{2} \cdot B_{rms} \Rightarrow B_0 = \sqrt{2} \cdot \frac{E_{rms}}{c}$

$\Rightarrow B_0 = 1.414 \cdot \left(\frac{3}{3 \times 10^8}\right) = 1.414 \times 10^{-8}$ T

8. During the propagation of electromagnetic waves in a medium.

Ans : (c) electric energy density is equal to magnetic energy density

9. If the magnetic monopole exists, then which of Maxwell's equation to be modified?

Ans: (b) $\oint \vec{E} \cdot d\vec{A} = 0$

10. A radiation of energy to be E modified falls normally on a perfectly reflecting surface. The momentum transferred to the surface is:

Ans: (b) $2E/c$

$E = h\nu = h \cdot c/\lambda = P \cdot c$

$\Rightarrow P = E/c$

Initial momentum $P_i = E/c$

Final momentum $P_f = -E/c$

$\Delta p = -2E/c$

The momentum transfered to surface $= |\Delta p| = 2E/c$.

11. Which of the following is an electromagnetic wave?

Ans: (c) γ-rays.

12. Which of them is used to produce a propagating electro-magnetic waves?

Ans: (a) an accelerating charge.

13. Let $E = E_0 \sin(10^6 x - \omega t)$ be the electric field of plane electro magnetic wave, the value of ω is:

Ans: 3×10^{14} rad s^{-1}

$E = E_0 \sin(10^6 x - \omega t)$

$E = E_0 \sin(kx - \omega t)$

$k = 10^6 \quad \because k = \omega/c$

$\Rightarrow kC = \omega \Rightarrow \omega = 10^6 \times 3 \times 10^8$

$\Rightarrow \omega = 3 \times 10^{14}$ rad s^{-1}.

14. Which of the following is not true for electromagnetic waves?

Ans: (d) In Vaccum, it travels with different speeds which depends on their frequency.

$\because$ In vaccum, speed remains constant.

15. The electric and magnetic field of an electromagnetic wave are:

Ans: (a) in phase and perpendicular to each others.