CBSE Test Paper-02

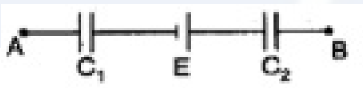
Class - 12 Physics (Moving Charges and Magnetism)

1. If only 2% of the current is to pass through a galvanometer of resistance G, then resistance of shunt will be
   a. 50 G
   b. 49 G
   c. $\frac{G}{50}$
   d. $\frac{G}{49}$
2. A proton (charge + e coul) enters a magnetic field of strength B (Tesla) with speed v, parallel to the direction of magnetic lines of force. The force on the proton is
   a. evB/2
   b. α
   c. zero
   d. evB
3. The magnetic induction in air at point 1 cm away from a long wire that carries a current of 1 A, will be
   a. $1 \times 10^{-5}\ T$
   b. $2 \times 10^{-5}\ T$
   c. $4 \times 10^{-5}\ T$
   d. $3 \times 10^{-5}\ T$
4. A galvanometer having 30 divisions has a current sensitivity of $20 \mu\mathrm{A}/\mathrm{div}$. It has a resistance of 25 ohm. How will you convert it into an ammeter measuring upto 1 ampere. Find the shunt to be used
   a. 0.30 Ω
   b. 0.15 Ω
   c. 0.015 Ω
   d. 0.030 Ω
5. The magnetic field of given length of wire for single turn coil at its centre is B, then its value for two turns coil for the same wire is:
   a. 2 B
   b. B/4

c. 4B

d. B/2

6. An electron moving with a velocity of 107 m/s enters a uniform magnetic field of 1 T along a direction parallel to the field. What would be its trajectory?
7. Magnetic lines of force are endless?
8. Give two factors by which the current sensitivity/voltage sensitivity of a moving coil galvanometer can be increased.
9. What is the nature of magnetic field in a moving coil galvanometer?
10. The wires which connect the battery of an automobile to its starting motor carry a current of 300 A (for a short time). What is the force per unit length between the wires if they are 70 cm long and 1.5 cm apart? Is the force attractive or repulsive?
11. A charge 2Q is spread uniformly over an insulated ring of radius R/2. What is the magnetic moment of the ring if it is rotated with an angular velocity ω with respect to normal axis?
12. Charges of magnitudes 2q and -q are located at points (a, 0, 0) and (4a, 0, 0). Find the ratio of the flux of electric field due to these charges through concentric spheres of radii 2a and 8a centered at the origin.
13. A circuit has a section AB as shown in figure. The emf of the source equals E = 10 V, the capacitor capacitances are equal to $C_1 = 1.0\mu F$ and $C_2 = 2.0\mu F$ and the potential difference V_A - V_B = 5.0V. Find the voltage across each capacitor.



14. A circular coil of 200 turns, radius 5 cm carries a current of 2.5 A. It is suspended vertically in a uniform horizontal magnetic field of 0.25 T, with the plane of the coil making an angle of 60° with the field lines. Calculate the magnitude of the torque that must be applied on it to prevent it from turning.
15. What is the relationship between the current and the magnetic moment of a current carrying circular loop? Use the expression to derive the relation between the magnetic moment of an electron moving in a circle and its related angular momentum?

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Answers

1. d. $\frac{G}{49}$

   Explanation: If I_g is the current through the galvanometer of resistance G and I is the total current through it, $I_g G = (I - I_g) S$,
   where S is the shunt resistance $S = \frac{I_g}{I - I_g} G$.
   since $I_g = \frac{2}{100} I = 0.02I$
   $\therefore$ S = $\frac{I_g}{I - I_g} G = \frac{0.02I}{I - 0.02I} G = \frac{2}{98} G = \frac{G}{49}$

2. c. zero

   Explanation: Lorentz force is given by $F = Bqv \sin\theta$
   When the proton enters the magnetic field parallel to the direction of the lines of force, $\theta = 0$.
   Therefore F = 0

3. b. $2 \times 10^{-5}\, T$

   Explanation: $B = \frac{\mu_0 I}{2\pi r}$
   $= \frac{4\pi \times 10^{-7} \times 1}{2\pi \times 1 \times 10^{-2}}$
   $= 2 \times 10^{-5} T$

4. c. 0.015

   Explanation: The value of each division is 20μA. The range of the galvanometer $I_g = 20 \times 30 = 600 \mu A$ To convert it into an ammeter of range I =1A, a shunt S is connected in parallel to it.

5. c. 4B

   Explanation: Magnetic field due to coil is directly proportional to no. Of turns and inversely proportional to radius. As radius become half and no. Of turns gets double. So magnetic field gets 4 times.

6. Straight line as $F = qvB\ \sin\theta$ here $\theta = 0$

7. This is because magnetic lines of force are continuous closed loops and mono pole is not possible.

8. i. Increasing the number of turns in the galvanometer coil.
   ii. Decreasing the torsion constant of the suspension fibre.

9. It is radial in nature.

10. Given, I_1 = 300 A, I_2 = 300A, r = 1.5 cm

    $= 1.5 \times 10^{-2}m$

    By using formula $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$

    Or force per unit length $= \frac{F}{1} = \frac{4\pi \times 10^{-7} \times 300 \times 300}{2\pi \times 0.015}$

    = 1.2 Nm^{-1}

    The total force between the wires is

    F = fl

    $= 1.2 \times 0.70N = 0.84N$

    The force is repulsive since the current will flow in opposite direction in the two wires connecting the battery to the starting motor.

11. Charge on the element of length dl of the ring is $d_q = \lambda \cdot dl$

    $dq = \frac{2Q}{2\pi(R/2)}dl = \frac{2Q}{\pi R}dl$

    Current due to circular motion of this charge is

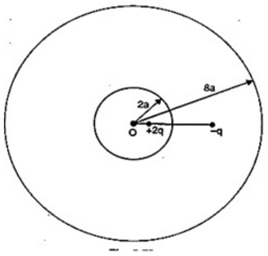
    $dI = dq \times v = \frac{2Q}{\pi R}dl \times \frac{\omega}{2\pi}(\because \omega = 2\pi v)$

    Magnetic moment due to current dl

    $dM = dI \times \pi\left(\frac{R}{2}\right)^2 = \frac{2Q}{\pi R}dl \times \frac{\omega}{2\pi} \times \pi\left(\frac{R}{2}\right)^2$

    or $M = \frac{Q\omega R}{4\pi}\int dl = \frac{Q\omega R}{4\pi} \cdot 2\pi R = \frac{1}{2}Q\omega R^2$

12. The locations of the charges are shown in the figure.



    The electric flux through the sphere of radius 2a,

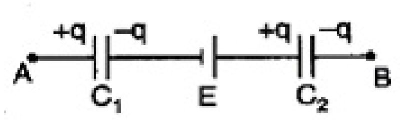
    $\phi_1 = \frac{1}{\varepsilon_0}(2q)$

    The electric flux through the sphere of radius 8a

    $\phi_2 = \frac{1}{\varepsilon_0}(2q - q) = \frac{1}{\varepsilon_0}(q)$

$\therefore \frac{\phi_1}{\phi_2} = \frac{2}{1}$

13. Let the charge distribution be as shown in figure.



$\therefore V_A - V_B = \frac{q}{C_1} - E + \frac{q}{C_2}$

or $(V_A - V_B) + E = q\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$

$= \frac{q(C_2+C_1)}{C_1C_2}$

$q = \frac{[(V_A-V_B)+E]C_1C_2}{C_1+C_2}$

Voltage across C_1 is $V_1 = \frac{q}{C_1} = \frac{[(V_A-V_B]+E]C_2}{C_1+C_2}$

$= \frac{(5+10)2.0}{1.0+2.0}$ = 10 volt

Voltage across C_2 is V_2

$\frac{q}{C_2} = \frac{[(V_A-V_B)+E]C_1}{C_1+C_2}$

$= \frac{(5+10)1.0}{1.0\times2.0} = 5volt$

14. Given, N = 200, r = 5 $\times$ 10^{-2}m

Area of coil, $A = \pi r^2$

$= \frac{22}{7} \times 5 \times 10^{-2} \times 5 \times 10^{-2}$

$= 7.857 \times 10^{-3} m^2$

I = 2.5 A, B = 0.25 T, $\theta = 60^\circ$

Since, $\tau = NBIA\cos\theta$

Where θ is the angle between the plane of the coil and the direction of the magnetic field.

Now, $\tau = 200 \times 0.25 \times 2.5 \times 7.857 \times 10^{-3} \times \cos 60^\circ Nm$

= 0.49 Nm

An opposite and equal torque is required in order to prevent the coil from turning. Thus, the magnitude of the applied torque should be 0.49 m.

15. Let us assume that an electron of mass m_e and charge e revolves in a circular orbit of radius r around the positive nucleus in anti-clockwise direction.

The angular momentum of the electron due to its orbital motion is given by

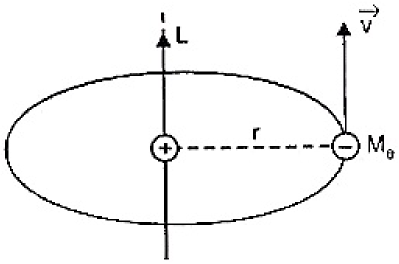
L = $m_e$vr ...(i)

Let the period of orbital motion of the electron is T. Then, the electron crosses any point on its orbit after every T seconds.

Therefore, orbital motion of electron is equivalent to a current.

$I = e \cdot \left(\frac{1}{T}\right)$

The period of revolution of the electron is given by



$T = \frac{2\pi r}{v}$

$\therefore I = e\left(\frac{1}{2\pi r/v}\right) = \frac{ev}{2\pi r}$

The area of the electron orbit, $A = \pi r^2$

The magnetic dipole moment of the atom is M = IA

$M = \frac{ev}{2\pi r} \times \pi r^2 = \frac{evr}{2}$ ....(ii)

$\therefore$Using the equation (i) we have

$M = \left(\frac{e}{2m_e}\right) L$ [From i]

In vector rotation

$\overrightarrow{M} = -\left(\frac{e}{2m_e}\right)\overrightarrow{L}$

which tells that the magnetic dipole moment vector is directed in a direction opposite to that of angular momentum vector.