Adhikaansh Academy
Revision Test -08
Physics: Moving Charge & Magnetism
Class : XII

Roll No. :
Date : 22.07.23

Time - 1hr
MM - 25

1. A current carrying loop is free to turn in a uniform magnetic field B. Under what conditions, will the torque acting on it be (i) minimum and (ii) maximum? 1

Ans : t = MB sin θ
(i) Torque is minimum when the area vector of the loop and the magnetic field vector are in the same direction, i.e. $\vec{A} \| \vec{B}$.
(ii) Torque is maximum when $\vec{A} \perp \vec{B}$.

2. Write two factors by which voltage sensitivity of a galvanometer can be increased. 1

Ans : As we know that $V_s = \left(\frac{NAB}{k}\right)\frac{1}{R}$

Thus, (i) Resistance should be less.
(ii) Torsional constant should be less.

3. An ammeter and a milliammeter are converted from the same galvanometer. Out of the two, which current measuring instrument has higher resistance? 1

Ans : The higher is the range, the lower will be the value of shunt, so a milliammeter will be having higher resistance.

4. What is the advantage of using radial magnetic field in a moving coil galvanometer? 1

Ans : (i) Maximum torque is experienced.
(ii) Current is directly proportional to the deflection.
(iii) The plane of the coil is parallel to the direction of magnetic field.

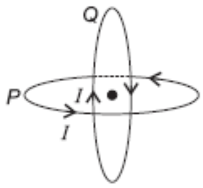
5. Under what conditions will the force exerted by the magnetic field on a charged particle be (i) maximum and (ii) minimum? 1

Ans : (i) When a charged particle is moving perpendicular to the magnetic field.
(ii) When a charged particle is moving parallel or anti-parallel to the magnetic field.

6. Which one of the following will experience maximum force, when projected with the same velocity ‘v’ perpendicular to the magnetic field ‘B’: (i) α-particle, and (ii) β-particle? 1

Ans : As $F = qvB$, α-particle will experience more force.

7. Two identical circular wires P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils. 2



Ans : Magnetic field at the centre of a circular loop of radius R carrying current I is given by

$$B = \frac{\mu_0 I}{2R}$$

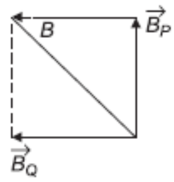
Here $B_P = \frac{\mu_0 I}{2R}$ [directed vertically upward]

$$B_Q = \frac{\mu_0 I}{2R}$$

[directed along horizontal direction say left]

Resultant magnetic field, $B = \sqrt{B_P^2 + B_Q^2} = \sqrt{2}B_P$

i.e. $B = \sqrt{2}\left(\frac{\mu_0 I}{2R}\right)$; $B = \frac{\mu_0 I}{\sqrt{2}R}$



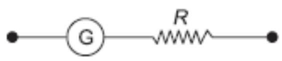
$\because$ $\tan\beta = \frac{B_P}{B_Q} = 1$

$\therefore$ $\beta = 45°$

The resultant magnetic field is $\frac{\mu_0 I}{\sqrt{2}R}$ making an angle of 45° with the horizontal.

8. How is a moving coil galvanometer converted into a voltmeter? Explain, giving the necessary circuit diagram and the required mathematical relation used. 2

Ans : A galvanometer is a low resistance device and is very sensitive. It gives a large deflection even when a very weak current is passed through it. To measure large potential, a suitable high resistance R is connected in series with it. The value of this resistance R depends upon the voltage to be measured.



Let I_g – maximum safe current,
V_g = Range of conversion, G = Resistance of galvanometer and R = Required resistance.

Total resistance = $R + G$

$\therefore$ Current = $\frac{V}{R+G}$

This current must be equal to I_g.

$\therefore$ $I_g = \frac{V}{R+G} \Rightarrow R + G = \frac{V}{I_g}$

or $R = \frac{V}{I_g} - G$

which is the required resistance.

9. Define the current sensitivity of a moving coil galvanometer. “Increasing the current sensitivity may not necessarily increase the voltage sensitivity.” Justify this statement. 2

Ans : Current Sensitivity: It is defined as the deflection produced in a coil per unit current passed through it.

$$I_s = \frac{\alpha}{I} = \frac{NBA}{k}$$

$\because$ If $N \rightarrow 2N$, then $l \rightarrow 2l$ and $R \rightarrow 2R \Rightarrow I_s' = \frac{BA(2N)}{k} = 2I_s$

But voltage sensitivity $= V_s' = \frac{BA(2N)}{k(2R)} = \frac{BAN}{kR} = V_s$

i.e. if the current sensitivity is doubled, say by doubling the number of turns, then the voltage sensitivity may not be increased because it will increase the resistance of the galvanometer and the voltage sensitivity may remain the same.

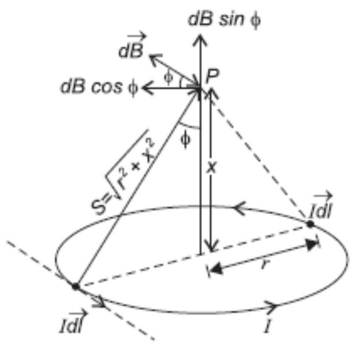
10. (a) Using Biot–Savart's law, derive the expression for the magnetic field in the vector form at a point on the axis of a circular current loop. 5

(b) What does a toroid consist of? Find out the expression for the magnetic field inside a toroid for *N* turns of the coil having the average radius *r* and carrying a current *I*. Show that the magnetic field in the open space inside and exterior to the tortoid is zero.

Ans : (*a*) Consider a circular current carrying conductor of radius r.
According to the Biot-Savart law, the magnetic field at P due to current element $I\vec{dl}$ is given by

$$|\vec{dB}| = \frac{\mu_0}{4\pi}\frac{Idl \sin 90°}{S^2}$$

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{S^2} = \frac{\mu_0}{4\pi}\frac{Idl}{(r^2+x^2)} \left(\because S = \sqrt{r^2+x^2}\right)$$



The direction of $\vec{dB}$ is perpendicular to the plane containing $\vec{S}$ and $\vec{dl}$. We resolve $\vec{dB}$ into rectangular components $dB \cos \phi$ and $dB \sin \phi$. We see that $\cos \phi$ components get cancelled by the corresponding component of magnetic field at P produced by the current element diamatrically opposite to the previous one. It is only $dB \sin \phi$ that is added up for magnetic field of every current element on the loop.

Thus, total magnetic field is given by

$$B = \int dB \sin \phi = \int \frac{\mu_0 Idl \sin \phi}{4\pi(r^2+x^2)} \qquad \left[\because \sin \phi = \frac{r}{\sqrt{x^2+r^2}}\right]$$

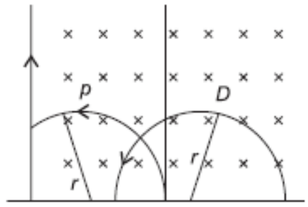
$$B = \frac{\mu_0 I}{4\pi(r^2+x^2)}\frac{r}{(x^2+r^2)^{1/2}}.2\pi r = \frac{\mu_0 I r^2}{2(r^2+x^2)^{3/2}}$$

(*b*) Toroid is a hollow circular ring on which a large number of turns of a wire are closely wound. (**Only qualitative treatment**)

11. (a) Derive the expression for the torque on a rectangular current carrying loop suspended in a uniform magnetic field. 5
(b) A proton and a deuteron having equal momenta enter in a region of uniform magnetic field at right angle to the direction of the field. Depict their trajectories in the field.

Ans : (a) Refer to Ans. 50.

(b) A deuteron is composed of a proton and a neutron.



$$evB = \frac{mv^2}{r} \quad (\because \theta = 90)$$

$$\therefore r = \frac{p}{qB} \text{ where } p = \text{momentum}$$

Hence, both the particles will trace a circular path of same radius.

12. A circular coil of radius 4 cm and of 20 turns carries a current of 3 amperes. It is placed in a magnetic field of intensity of 0.5 weber/m^2. The magnetic dipole moment of the coil is 1

(a) 0.15 ampere–m^2 (b) 0.3 ampere–m^2

(c) 0.45 ampere–m^2 (d) 0.6 ampere–m^2

Ans : (b)

13. The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA. It is converted into voltmeter that can read upto 50 V. The resistance to be connected in the series with the galvanometer is 1

(a) 2010 Ω (b) 4050 Ω

(c) 5040 Ω (d) 4960 Ω

Ans : (d) $R = \frac{V}{I_g} - G = \frac{50}{10 \times 10^{-3}} - 40 = 4960\ \Omega$

14. In a circular coil of radius r, the magnetic field at the centre is proportional to 1

(a) r^2 (b) r

(c) $\frac{1}{r}$ (d) $\frac{1}{r^2}$

Ans : (c) Since $B = \frac{\mu_0 NI}{2r}$, i.e. $B \propto \frac{1}{r}$.