Saitech Informatics

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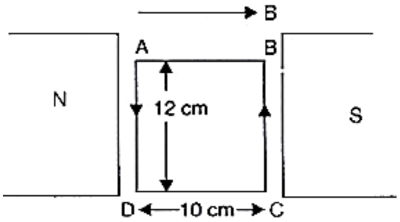
MOVING CHARGES AND MAGNETISM

Class 12 - Physics

Time Allowed: 1 hour and 30 minutes **Maximum Marks: 45**

1. State Oersted's observation. **[1]**
2. An electron moving with a velocity of 10^7 ms^{-1} enters a uniform magnetic field of 1 T, along a direction parallel to the field. What would be its trajectory in this field? **[1]**
3. A current-carrying conductor does not tend to deflect in a magnetic field. What conclusion can be drawn from it? **[1]**
4. Under what condition is the force acting on a charge moving through a uniform magnetic field minimum? **[1]**
5. What is the nature of the magnetic field associated with the current in a straight conductor? **[1]**
6. The magnetic field at the centre of a 50 cm long solenoid is 4.0×10^{-2} T when a current of 8.0 A flows through it. What is the number of turns in the solenoid? Take $\pi = 3.14$ **[1]**
7. A 50 turn coil as shown in the figure below carries of 2 A in a magnetic field B = 0.25 Wb m^{-2}. Find the torque acting on the coil. In what direction will it rotate? **[1]**



8. The magnetic induction at a point P which is at a distance of 4 cm from a long current-carrying wire is 10^{-3} T. What is the magnetic induction at another point Q which is at a distance of 12 cm from this current-carrying wire? **[1]**
9. A current is set up in a long copper pipe. Is there a magnetic field (i) inside (ii) outside the pipe? **[1]**
10. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 500 turns. It carries a current of 5 A. What is the magnitude of the magnetic field inside the solenoid? **[1]**
11. State the principle of working of a galvanometer. A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto $\frac{V}{2}$ volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read upto 2V. Also, find the resistance G of the galvanometer in terms of R_1 and R_2. **[3]**
12. A current of 7.0 A is flowing in a plane circular coil of radius 1.0 cm having 100 turns. The coil is placed in a uniform magnetic field of 0.2 Wbm^{-2}. If the coil is free to rotate, what orientations would correspond to its **[3]**
    i. stable equilibrium and
    ii. unstable equilibrium?

    Calculate the potential energy of the coil in these cases.

[3]

13. i. Define the current sensitivity of a galvanometer. Write its expression.

ii. A galvanometer has resistance G and shows full-scale deflection for current I_g.

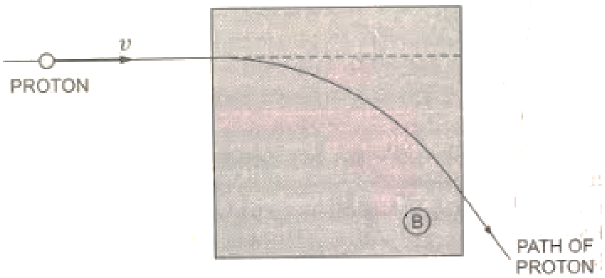
a. How can it be converted into an ammeter to measure current up to I_0 ($I_0 > I_g$)?

b. What is the effective resistance of this ammeter?

14. A length L of a wire carries A current I. Show that if the wire is formed into a circular coil, the maximum torque in a given magnetic field it developed when the coil has one turn only and the maximun torque has the value $\tau = L^2 IB/4\pi$ **[3]**

15. A voltmeter reads 5.0 V at full-scale deflection and is graded according to its resistance per volt at full-scale deflection as 5000 ΩV^{-1}. How will you convert it into a voltmeter that reads 20 V at full scale deflection? Will it still be graded as 5000 $\Omega\ V^{-1}$? Will you prefer this voltmeter to one that is graded as 2000 $\Omega\ V^{-1}$? **[3]**

16. A proton, travelling in a vacuum at a speed of 4.5×10^6 ms^{-1}, enter a region of the uniform magnetic field of flux density 0.12T. The path of the proton in the field is a circular arc, as illustrated in Fig. **[5]**



a. i. State the direction of the magnetic field.

ii. Calculate the radius of the path of the proton in the magnetic field.

b. A uniform electric field is now created in the same region as the magnetic field in the figure, so that the proton passes undeviated through the region of the two field

i. Predict the direction of the electric field.

ii. Calculate the magnitude of the electric field strength.

c. Suggest why gravitational forces on the proton have not been considered in the calculations in (a) and (b).

17. A solenoid 60 cm long and of radius 4.0 cm has 3 layers of windings of 300 turns each. A 2.0 cm long wire of mass 2.5 g lies inside the solenoid (near its centre) normal to its axis; both the wire and the axis of the solenoid are in the horizontal plane. The wire is connected through two leads parallel to the axis of the solenoid to an external battery which supplies a current of 6.0 A in the wire. What value of current (with an appropriate sense of circulation) in the windings of the solenoid can support the weight of the wire? g = 9.8 ms^{-2}. **[5]**

18. An electron and a positron are released from (0, 0, 0) and (0, 0, 1.5R) respectively, in a uniform magnetic field $B = B_0\ \hat{\mathbf{i}}$, each with an equal momentum of magnitude p = e BR. Under what conditions on the direction of momentum will the orbits be non intersecting circles? **[5]**

19. i. Show how Biot-Savart's law can be alternatively expressed in the form of Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside a solenoid of length l, cross-sectional area A having 'n' closely wound turns and carrying a steady current 'I'. Draw the magnetic field lines of a finite solenoid carrying current I. **[5]**

ii. A straight horizontal conducting rod of length 0.45 m and mass 60 g is suspended by two vertical wires at its ends. A current of 5.0 A is set up in the rod through the wires.

Find the magnitude and direction of the magnetic field which should be set up in order that the tension in the wire is zero.