Saitechinfo NEET JEE Academy

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MOVING CHARGES

Class 12 - Physics

Time Allowed: 1 hour and 29 minutes **Maximum Marks: 45**

1. Two thin long parallel wires A and B are separated by a distance r and carry current I each in the same direction. The force per unit length exerted by A on wire B is: **[1]**

   a) $\frac{\mu_0 I^2}{2\pi r}$, attractive
   b) $\frac{\mu_0 I}{2r}$, attractive
   c) $\frac{\mu_0 I}{2\pi r}$, repulsive
   d) $\frac{\mu_0 I^2}{2\pi r}$, repulsive

2. A beam of electrons at rest is accelerated by a potential V. This beam experiences a force F in a uniform magnetic field. The accelerating potential is changed to V' and the force experienced by the electrons in the same magnetic field is 2F. The ratio $\frac{V}{V'}$ is **[1]**

   a) $\frac{1}{4}$
   b) 1
   c) 2
   d) $\frac{1}{2}$

3. A loop carrying a current I clockwise is placed in x - y plane, in a uniform magnetic field directed along z-axis. The tendency of the loop will be to: **[1]**

   a) expand
   b) shrink
   c) move along x-axis
   d) move along y-axis

4. If a conducting wire carries a direct current through it, the magnetic field associated with the current will be ________. **[1]**

   a) Only outside the conductor
   b) Only inside the conductor
   c) Both inside and outside the conductor
   d) Neither inside nor outside the conductor

5. The magnetic field at the centre of a current-carrying circular loop having 1 A current and number of turns one will be (radius of the loop is 1 m): **[1]**

   a) $2\mu_0$
   b) $\frac{\mu_0}{4}$
   c) $\frac{\mu_0}{2}$
   d) $4\mu_o$

6. A charge 'cf moving along the X-axis with a velocity $\vec{v}$ is subjected to a uniform magnetic field B acting along the Z-axis as it crosses the origin O. **[2]**

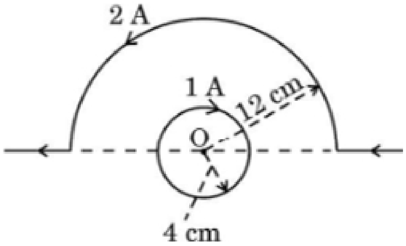
   i. Trace its trajectory
   ii. Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.

7. A galvanometer with a scale divided into 100 equal divisions has a current sensitivity of 10 divisions per mA and a voltage sensitivity of 2 divisions per mV. What adoptions are required to read (i) 5 A for full scale and (ii) 1 division per volt? **[2]**

8. Why do we prefer phosphor - bronze alloy for the suspension wire of a moving coil galvanometer? **[2]**

9. A current carrying circular loop and a straight wire bent partly in the form of a semicircle are placed as shown in **[2]**

the figure. Find the magnitude and direction of net magnetic field at point O.



10. Depict the field-line pattern due to a current-carrying solenoid of finite length. **[2]**

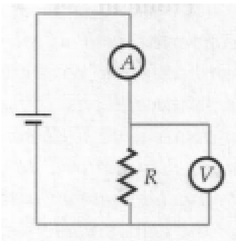
i. In what way do these lines differ from those due to an electric dipole?
ii. Why can't two magnetic field lines intersect each other?

11. i. What is the importance of a radial magnetic field and how is it produced ? **[3]**
ii. Why is it that while using a moving coil galvanometer as a voltmeter a high resistance in series is required whereas in an ammeter a shunt is used?

12. A proton, a deutron and an alpha particle having the same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to their direction of motion. Compare the radii o f their circular paths. **[3]**

13. A current loop behaves as a magnetic dipole. Obtain an expression for the magnetic dipole moment of a circular current loop. State the rule used to find the direction of the magnetic dipole moment. **[3]**

14. A voltmeter of resistance R_V and an ammeter of resistance R_A are connected in a circuit to measure, a resistance R as shown in Fig. The ratio of the meter readings gives an apparent resistance R'. Show that R and R' are related by the relation $\frac{1}{R} = \frac{1}{R'} - \frac{1}{R_V}$ **[3]**



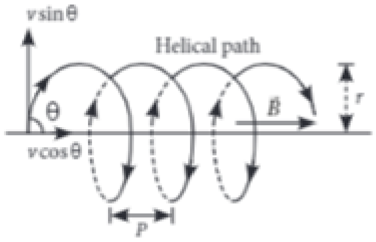
15. Why is the magnetic field radial in a moving coil galvanometer? Explain how it is achieved. **[3]**

16. i. What is current sensitivity of a galvanometer? Show how the current sensitivity of a galvanometer may be increased. "Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity." Explain. **[5]**
ii. A moving coil galvanometer has a resistance 15Ω and takes 20 mA to produce full scale deflection. How can this galvanometer be converted into a voltmeter of range 0 to $100\ V$?

17. a. Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis. **[5]**
b. In what respect is a toroid different from a solenoid? Draw and compare the pattern of the magnetic field lines in two cases.
c. How is the magnetic field inside a given solenoid made strong?

18. **Read the text carefully and answer the questions:** **[5]**

The path of a charged particle in magnetic field depends upon angle between velocity and magnetic field. If velocity $\vec{v}$ is at angle θ to $\vec{B}$, component of velocity parallel to magnetic field (v cos θ) remains constant and component of velocity perpendicular to magnetic field (v sin θ) is responsible for circular motion, thus the charge particle moves in a helical path.



The plane of the circle is perpendicular to the magnetic field and the axis of the helix is parallel to the magnetic field. The charged particle moves along helical path touching the line parallel to the magnetic field passing through the starting point after each rotation.

Radius of circular path is r = $\frac{mv\sin\theta}{qB}$

Hence the resultant path of the charged particle will be a helix, with its axis along the direction of $\vec{B}$ as shown in figure.

(a) When a positively charged particle enters into a uniform magnetic field with uniform velocity, its trajectory can be

i. a straight line
ii. a circle
iii. a helix

a) any one of (i), (ii) and (iii)
b) (i) only
c) (i) or (ii)
d) (i) or (iii)

(b) Two charged particles A and B having the same charge, mass and speed enter into a magnetic field in such a way that the initial path of A makes an angle of 30° and that of B makes an angle of 90° with the field. Then the trajectory of

a) will have smaller radius of curvature than that of A
b) both will move along the direction of their original velocities
c) A will have smaller radius of curvature than that of B
d) both will have the same curvature

(c) An electron having momentum 2.4×10^{-23} kg m/s enters a region of uniform magnetic field of 0.15 T. The field vector makes an angle of 30° with the initial velocity vector of the electron. The radius of the helical path of the electron in the field shall be

a) 0.5 mm
b) 1 mm
c) 2 mm
d) $\frac{\sqrt{3}}{2}$ mm

(d) The magnetic field in a certain region of space is giver by B = $8.35 \times 10^{-2}\,\hat{i}$ T. A proton is shot into the field with velocity $\vec{v} = \left(2 \times 10^5\,\hat{i} + 4 \times 10^5\,\hat{j}\right)$ m/s. The proton follows a helical path in the field. The distance moved by proton in the x-direction during the period of one revolution in the yz-plane will be (Mass of proton = 1.67×10^{-27} kg)

a) 0.236 m
b) 0.157 m
c) 0.053 m
d) 0.136 m

(e) The frequency of revolution of the particle is

a) $\frac{2\pi R}{v\sin\theta}$
b) $\frac{qB}{2\pi m}$

c) $\frac{2\pi R}{v\cos\theta}$

d) $\frac{m}{qB}$