18 Moving Charges and Magnetism

Conceptual MCQs

1. A straight section PQ of a circuit lies along the X-axis from $x=-\frac{a}{2}$ to $x=\frac{a}{2}$ and carries a steady current i. The magnetic field due to the section PQ at a point $X=+a$ will be
(a) proportional to a (b) proportional to a^2
(c) proportional to $1/a$ (d) zero

2. A proton (mass = 1.7×10^{-27} kg) moves with a speed of 5×10^5 m/s in a direction perpendicular to a magnetic field of 0.17 T. The acceleration of the proton is
(a) zero (b) 2×10^{12} m/s^2
(c) 4×10^{12} m/s^2 (d) 8×10^{12} m/s^2

3. 4 ampere current is passing through a coil of radius 5 cm and 100 turns. The magnetic moment of the coil is
(a) 3.14 Am^2 (b) 4.254 A cm^2
(c) 314 Am^2 (d) 0.0314 A cm^2

4. An electron enters a region where magnetic field (B) and electric field (E) are mutually perpendicular, then
(a) it will always move in the direction of B
(b) it will always move in the direction of E
(c) it always possesses circular motion
(d) it can go undeflected also

5. A uniform magnetic field acts at right angles to the direction of motion of electron. As a result, the electron moves in a circular path of radius 2cm. If the speed of electron is doubled, then the radius of the circular path will be
(a) 2.0 cm (b) 0.5 cm (c) 4.0 cm (d) 1.0 cm

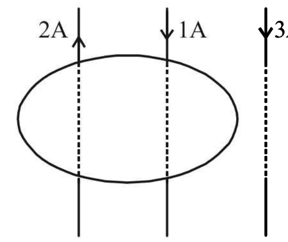
6. A charged particle of mass m and charge q travels in a circular path of radius r that is perpendicular to a magnetic field B. The time taken by the particle to complete one revolution is
(a) $\frac{2\pi qB}{m}$ (b) $\frac{2\pi m}{qB}$ (c) $\frac{2\pi mq}{B}$ (d) $\frac{2\pi q^2 B}{m}$

7. Magnetic field intensity at the centre of a coil of 50 turns, radius 0.5 m and carrying a current of 2 A is
(a) 0.5×10^{-5} T (b) 1.25×10^{-4} T
(c) 3×10^{-5} T (d) 4×10^{-5} T

8. A 10 eV electron is circulating in a plane at right angles to a uniform field of magnetic induction 10^{-4} Wb/m^2 (= 1.0 gauss). The orbital radius of the electron is
(a) 12 cm (b) 16 cm (c) 11 cm (d) 18 cm

9. A charge moving with velocity v in X-direction is subjected to a field of magnetic induction in negative X-direction. As a result, the charge will
(a) remain unaffected
(b) start moving in a circular path Y–Z plane
(c) retard along X-axis
(d) move along a helical path around X-axis

10. Two wires with currents 2A and 1A are enclosed in a circular loop. Another wire with current 3A is situated outside the loop as shown. The $\oint \vec{B}.d\vec{l}$ around the loop is



(a) μ_0 (b) $3\mu_0$ (c) $6\mu_0$ (d) $2\mu_0$

11. A conducting wire of length ℓ is turned in the form of a circular coil and a current i is passed through it. For torque due to magnetic field produced at its centre, to be maximum, the minimum number of turns in the coil will be
(a) 1 (b) 2
(c) 5 (d) of any value

12. A moving coil galvanometer has N number of turns in a coil of effective area A, it carries a current I. The magnetic field B is radial. The torque acting on the coil is
(a) NA^2B^2I (b) $NABI^2$ (c) N^2ABI (d) $NABI$

13. Two long parallel wires are at a distance of 1 metre. Both of them carry one ampere of current. The force of attraction per unit length between the two wires is
(a) 2×10^{-7} N/m (b) 2×10^{-8} N/m
(c) 5×10^{-8} N/m (d) 10^{-7} N/m

14. In a moving coil galvanometer, the deflection of the coil θ is related to the electrical current i by the relation
(a) $i \propto \tan\theta$ (b) $i \propto \theta$ (c) $i \propto \theta^2$ (d) $i \propto \sqrt{\theta}$

15. To convert a 800 mV range milli voltmeter of resistance 40 Ω into a galvanometer of 100 mA range, the resistance to be connected as shunt is
(a) 10 Ω (b) 20 Ω (c) 30 Ω (d) 40 Ω

Application Based MCQs

16. A straight wire of length 0.5 metre and carrying a current of 1.2 ampere is placed in uniform magnetic field of induction 2 tesla. The magnetic field is perpendicular to the length of the wire. The force on the wire is

(a) 2.4 N (b) 1.2 N
(c) 3.0 N (d) 2.0 N

17. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be

(a) 8 m/s (b) 20 m/s (c) 40 m/s (d) $\frac{1}{40}$ m/s

18. A wire of length l m carrying a current I A is bent into a circle. The magnitude of the magnetic moment is

(a) $\frac{Il^2}{2\pi}$ (b) $\frac{Il^2}{4\pi}$

(c) $\frac{l^2 I}{2\pi}$ (d) $\frac{l^2 I}{4\pi}$

19. A galvanometer having a coil resistance of 100 Ω gives a full scale deflection, when a currect of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10 A, is :

(a) 0.1 Ω (b) 3Ω
(c) 0.01Ω (d) 2Ω

20. A ring of radius R, made of an insulating material carries a charge Q uniformly distributed on it. If the ring rotates about the axis passing through its centre and normal to plane of the ring with constant angular speed ω, then the magnitude of the magnetic moment of the ring is

(a) $Q\omega R^2$ (b) $\frac{1}{2}Q\omega R^2$ (c) $Q\omega^2 R$ (d) $\frac{1}{2}Q\omega^2 R$

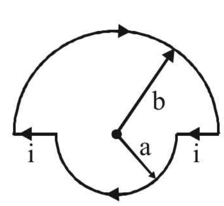
21. You are given a closed circuit with radii a and b as shown in fig carrying current i. The magnetic dipole moment of the circuit is

(a) $\pi(a^2 + b^2)\,i$

(b) $\frac{1}{2}\pi(a^2 + b^2)\,i$

(c) $\pi(a^2 - b^2)\,i$

(d) $\frac{1}{2}\pi(a^2 - b^2)\,i$



22. 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. The field of induction at a distance 12 cm from the current carrying wire will be

(a) 3.33×10^{-4} T (b) 1.11×10^{-4} T
(c) 3×10^{-3} T (d) 9×10^{-3} T

23. At what distance from a long straight wire carrying a current of 12 A will the magnetic field be equal to $3 \times 10^{-5}\, Wb/m^2$?

(a) 8×10^{-2} m (b) 12×10^{-2} m
(c) 18×10^{-2} m (d) 24×10^{-2} m

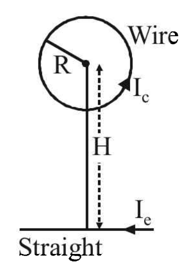
24. Circular loop of a wire and a long straight wire carry currents I_c and I_e, respectively as shown in figure. Assuming that these are placed in the same plane. The magnetic fields will be zero at the centre of the loop when the separation H is

(a) $\frac{I_e R}{I_c \pi}$

(b) $\frac{I_c R}{I_e \pi}$

(c) $\frac{\pi I_c}{I_e R}$

(d) $\frac{I_e \pi}{I_c R}$



25. What should be the current in a circular coil of radius 5 cm to annul $B_H = 5 \times 10^{-5} T$?

(a) 0.4 A (b) 4 A
(c) 40 A (d) 1 A

26. A current of 1 A is flowing along positive x-axis through a straight wire of length 0.5 m placed in a region of a magnetic field given by $\vec{B} = (2\hat{i} + 4\hat{j})T$. The magnitude and the direction of the force experienced by the wire respectively are

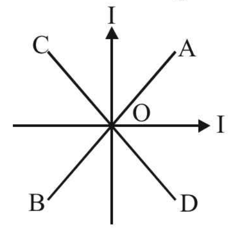
(a) $\sqrt{18}$N, along positive z-axis

(b) $\sqrt{20}$N, along positive x-axis

(c) 2N, along positive z-axis

(d) 4N, along positive y-axis

27. Two equal electric currents are flowing perpendicular to each other as shown in the figure. AB and CD are perpendicular to each other and symmetrically placed with respect to the current flow. Where do we expect the resultant magnetic field to be zero?



(a) On AB
(b) On CD
(c) On both AB and CD
(d) On both OD and BO

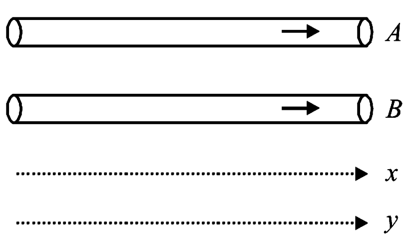
28. Two long parallel wires P and Q are held perpendicular to the plane of the paper at a separation of 5 m. If P and Q carry currents of 2.5 A and 5 A respectively in the same direction, then the magnetic field at a point midway between P and Q is

(a) $\frac{\mu_0}{\pi}$ (b) $\sqrt{3}\frac{\mu_0}{\pi}$ (c) $\frac{\mu_0}{2\pi}$ (d) $\frac{3\mu_0}{2\pi}$

29. A current of 5 ampere is flowing in a wire of length 1.5 metres. A force of 7.5 N acts on it when it is placed in a uniform magnetic field of 2 tesla. The angle between the magnetic field and the direction of the current is

(a) 30° (b) 45° (c) 60° (d) 90°

30. *A* and *B* are two conductors carrying a current *i* in the same direction. *x* and *y* are two electron beams moving in the same direction. Then



(a) there will be repulsion between *A* and *B*, attraction between *x* and *y*
(b) there will be attraction between *A* and *B*, repulsion between *x* and *y*
(c) there will be repulsion between *A* and *B* and also *x* and *y*
(d) there will be attraction between *A* and *B* and also *x* and *y*

31. A coil in the shape of equilateral triangle of side 0.2 m is suspended from the vertex such that it is hanging in a vertical plane between the pole-pieces of a permanent magnet producing a horizontal magnetic field of 5×10^{-2} tesla. The couple acting on the coil when a current of 0.1 amp is passed through it and the magnetic field is parallel to its plane will be

(a) 3.28×10^{-7} Nm (b) 5.28×10^{-7} Nm
(c) 8.66×10^{-7} Nm (d) 1.23×10^{-7} Nm

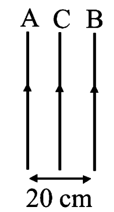
32. An electric current of 30 ampere is flowing in each of two parallel conducting wires placed 5 cm apart. The force acting per unit length on either of the wires will be

(a) 3.6×10^{-3} N/m (b) 3.6×10^{-3} dyne/cm
(c) 3.6×10^{-5} N/m (d) 3.6×10^{-2} N/m

33. The distance between the wires of electric mains is 12 cm. These wires experience 4 mg wt. per unit length. The value of current flowing in each wire will be

(a) 4.85 A (b) 0
(c) 4.85×10^{-2} A (d) 4.85×10^{-4} A

34. In the adjoining figure, two very long parallel wires A and B carry currents of 10 ampere and 20 ampere respectively, and are at a distance 20 cm apart. If a third wire C (length 15 cm) having a current of 10 ampere is placed between them, then how much force will act on C. The direction of current in all the three wires is same.



(a) 3×10^{-5} N (left)
(b) 3×10^{-5} N (right)
(c) 6×10^{-5} N (left)
(d) 6×10^{-5} N (right)

35. A 5 cm × 12 cm coil with number of turns 600 is placed in a magnetic field of strength 0.10 Tesla. The maximum magnetic torque acting on it when a current of 10^{-5} A is flowing through it will be

(a) 3.6×10^{-6} N-m (b) 3.6×10^{-6} dyne-cm
(c) 3.6×10^{6} N-m (d) 3.6×10^{6} dyne-m

36. The length of a solenoid is 0.4 m and the number of turns in it is 500. A current of 3 amp is flowing in it. In a small coil of radius 0.01 m and number of turns 10, a current of 0.4 amp. is flowing. The torque necessary to keep the axis of this coil perpendicular to the axis of solenoid will be

(a) 5.92×10^{-6} N-m (b) 5.92×10^{-4} N-m
(c) 5.92×10^{-6} dyne-cm (d) 5.92×10^{-4} dyne-cm

37. A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 metre in a plane perpendicular to the magnetic field B. The kinetic energy of the proton that describes a circular orbit of radius 0.5 metre in the same plane with the same B is

(a) 25 keV (b) 50 keV (c) 200 keV (d) 100 keV

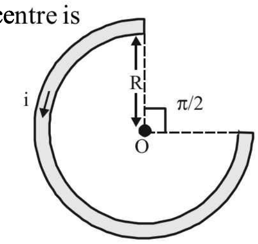
38. A charged particle of charge q and mass m enters perpendicularly in a magnetic field $\vec{B}$. Kinetic energy of the particle is E; then frequency of rotation is

(a) $\frac{qB}{m\pi}$ (b) $\frac{qB}{2\pi m}$
(c) $\frac{qBE}{2\pi m}$ (d) $\frac{qB}{2\pi E}$

39. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, the new value of the magnetic field is

(a) 4B (b) B/2
(c) B (d) 2B

40. A current i ampere flows in a circular arc of wire whose radius is R, which subtends an angle $\frac{3\pi}{2}$ radian at its centre. The magnetic induction B at the centre is



(a) $\frac{\mu_0 i}{R}$ (b) $\frac{\mu_0 i}{2R}$

(c) $\frac{2\mu_0 i}{R}$ (d) $\frac{3\mu_0 i}{8R}$

41. The distance at which the magnetic field on axis as compared to the magnetic field at the center of the coil carrying current I and radius R is $\frac{1}{8}$, would be

(a) R (b) $\sqrt{2}R$ (c) 2R (d) $\sqrt{3}R$

42. The current in the windings of a toroid is 2.0A. There are 400 turns and the mean circumferential length is 40 cm. If the inside magnetic field is 1.0T, the relative permeability is near to

(a) 100 (b) 200 (c) 300 (d) 400

43. A charged particle is moving in a circular orbit of radius 6 cm with a uniform speed of 3×10^6 m/s under the action of a uniform magnetic field 2×10^{-4} wb/m^2 at right angles to the plane of the orbit. The charge to mass ratio of the particle is

(a) 5×10^9 C/kg (b) 2.5×10^{11} C/kg

(c) 5×10^{11} C/kg (d) 5×10^{12} C/kg

44. Mixed He^+ and O^{2+} ions (mass of He^+ = 4 amu and that of O^{2+} = 16 amu) beam passes a region of constant perpendicular magnetic field. If kinetic energy of all the ions is same then

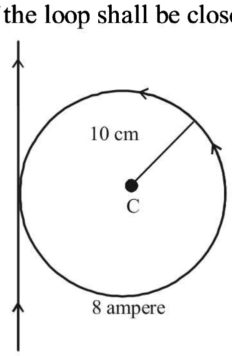
(a) He^+ ions will be deflected more than those of O^{2+}

(b) He^+ ions will be deflected less than those of O^{2+}

(c) All the ions will be deflected equally

(d) No ions will be deflected

45. A long straight wire is turned into a loop of radius 10 cm (see figure) If a current of 8 amperes is passed through the loop, then the value of the magnetic field and its direction at the centre C of the loop shall be close to



(a) 5.0×10^{-5} Newton/(amp-meter), upward

(b) 3.4×10^{-5} Newton/(amp-meter), upward

(c) 1.6×10^{-5} Newton/(amp-meter), downward

(d) 1.6×10^{-5} Newton/(amp-meter), upward

46. A conducting circular loop of radius r carries a constant current i. It is placed in a uniform magnetic field $\vec{B}$, such that $\vec{B}$ is perpendicular to the plane of the loop. The magnetic force acting on the loop is

(a) $ir\vec{B}$ (b) $2\pi ri\vec{B}$ (c) Zero (d) $\pi ri\vec{B}$

47. Two concentric coils each of radius equal to 2 π cm are placed at right angles to each other. 3 ampere and 4 ampere are the currents flowing in each coil respectively. The magnetic induction in Weber / m^2 at the centre of the coils will be $\left(\mu_0 = 4\pi \times 10^{-7} Wb/A.m\right)$

(a) 10^{-5} (b) 12×10^{-5}

(c) 7×10^{-5} (d) 5×10^{-5}

48. A long straight wire of radius *a* carries a steady current *i*. The current is uniformly distributed across its cross section. The ratio of the magnetic field at *a*/2 and 2*a* is

(a) 1/2 (b) 1/4

(c) 4 (d) 1

49. Two identical wires A and B, each of length '*l*', carry the same current I. Wire A is bent into a circle of radius R and wire B is bent to form a square of side 'a'. If B_A and B_B are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is:

(a) $\frac{p^2}{16}$ (b) $\frac{p^2}{8\sqrt{2}}$ (c) $\frac{p^2}{8}$ (d) $\frac{p^2}{16\sqrt{2}}$

50. A ring of mass m, radius r having charge q uniformly distributed over it and free to rotate about its own axis is placed in a region having a magnetic field B parallel to its axis. If the magnetic field is suddenly switched off, the angular velocity acquired by the ring is

(a) $\frac{qB}{m}$ (b) $\frac{2qB}{m}$

(c) $\frac{qB}{2m}$ (d) None of these

Skill Based MCQs

51. Two straight long conductors AOB and COD are perpendicular to each other and carry currents i_1 and i_2. The magnitude of the magnetic induction at a point P at a distance a from the point O in a direction perpendicular to the plane ABCD is

(a) $\frac{\mu_0}{2\pi a}(i_1+i_2)$ (b) $\frac{\mu_0}{2\pi a}(i_1-i_2)$

(c) $\frac{\mu_0}{2\pi a}(i_1^2+i_2^2)^{1/2}$ (d) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1+i_2)}$

52. An electron and a proton are moving on straight parallel paths with same velocity. They enter a semi infinite region of uniform magnetic field perpendicular to the velocity. Which of the following statement(s) is true?

(a) They will never come out of the magnetic field region.

(b) They will come out travelling along perpendicular paths.

(c) They will come out at the same time.

(d) They will come out at different times.

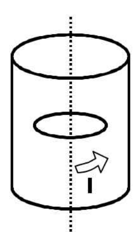
53. A long circular tube of length 10 m and radius 0.3 m carries a current I along its curved surface as shown. A wire-loop of resistance 0.005 ohm and of radius 0.1 m is placed inside the tube with its axis coinciding with the axis of the tube. The current varies as $I = I_0\cos(300\,t)$ where I_0 is constant. If the magnetic moment of the loop is $N\mu_0 I_0 \sin(300\,t)$, then 'N' is

(a) 6

(b) 8

(c) 7

(d) 4



54. Axis of a solid cylinder of infinite length and radius R lies along y-axis, it carries a uniformly distributed current i along +y direction. Magnetic field at a point $\left(\frac{R}{2}, y, \frac{R}{2}\right)$ is

(a) $\frac{\mu_0 i}{4\pi R}(\hat{i}-\hat{k})$ (b) $\frac{\mu_0 i}{2\pi R}(\hat{j}-\hat{k})$

(c) $\frac{\mu_0 i}{4\pi R}\hat{j}$ (d) $\frac{\mu_0 i}{4\pi R}(\hat{i}+\hat{k})$

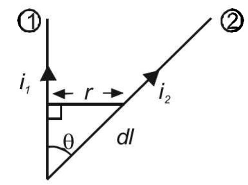
55. Wires 1 and 2 carrying currents i_1 and i_2 respectively are inclined at an angle θ to each other. What is the force on a small element dl of wire 2 at a distance of r from wire 1 (as shown in figure) due to the magnetic field of wire 1?

(a) $\frac{\mu_0}{2\pi r} i_1 i_2\, dl \tan\theta$

(b) $\frac{\mu_0}{2\pi r} i_1 i_2\, dl \sin\theta$

(c) $\frac{\mu_0}{2\pi r} i_1 i_2\, dl \cos\theta$

(d) $\frac{\mu_0}{4\pi r} i_1 i_2\, dl \sin\theta$



56. A particle of mass m and charge q, accelerated by potential difference V enters a region of uniform transverse magnetic field B. If d is the thickness of region of magnetic field, then the deviation of the particle from initial direction when it leaves the field is

(a) $\sin^{-1}\left[Bd\left(\frac{q}{2mV}\right)^{1/2}\right]$ (b) $\cos^{-1}\left[Bd\left(\frac{q}{2mV}\right)^{1/2}\right]$

(c) $\tan^{-1}\left[Bd\left(\frac{q}{2mV}\right)^{1/2}\right]$ (d) zero

57. A uniform magnetic field of 1.5 T exists in a cylindrical region of radius 10.0 cm, it's direction being parallel to the axis along east to west. A current carrying wire in north south direction passes through this region. The wire intersects the axis and experience a force of 1.2 N downward. If the wire is turned from North south to north east-south west direction, then magnitude and direction of force is

(a) 1.2 N, upward (b) $1.2\sqrt{2}$ N, downward

(c) 1.2 N, downward (d) $\frac{1.2}{\sqrt{2}}$ N, downward

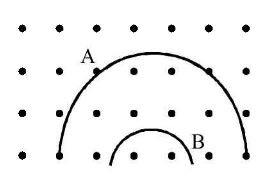
58. Two particles A and B of masses m_A and m_B respectively and having the same charge are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speeds of the particles are v_A and v_B respectively, and the trajectories are as shown in the figure. Then

(a) $m_A v_A < m_B v_B$

(b) $m_A v_A > m_B v_B$

(c) $m_A < m_B$ and $v_A < v_B$

(d) $m_A = m_B$ and $v_A = v_B$



59. An insulating rod of length ℓ carries a charge q distributed uniformly on it. The rod is pivoted at its mid point and is rotated at a frequency f about a fixed axis perpendicular to rod and passing through the pivot. The magnetic moment of the rod system is $\frac{1}{2a}\pi q f \ell^2$. Find the value of a.

(a) 6 (b) 4
(c) 5 (d) 8

60. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then

(a) $\vec{v} = \vec{B} \times \vec{E} / E^2$ (b) $\vec{v} = \vec{E} \times \vec{B} / B^2$
(c) $\vec{v} = \vec{B} \times \vec{E} / B^2$ (d) $\vec{v} = \vec{E} \times \vec{B} / E^2$

ANSWER KEY																			
Conceptual MCQs																			
1	(d)	**3**	(a)	**5**	(c)	**7**	(b)	**9**	(a)	**11**	(a)	**13**	(a)	**15**	(a)				
2	(d)	**4**	(d)	**6**	(b)	**8**	(c)	**10**	(a)	**12**	(d)	**14**	(b)						
Application Based MCQs																			
16	(b)	**20**	(b)	**24**	(a)	**28**	(c)	**32**	(a)	**36**	(a)	**40**	(d)	**44**	(c)	**48**	(d)		
17	(c)	**21**	(b)	**25**	(b)	**29**	(a)	**33**	(a)	**37**	(d)	**41**	(d)	**45**	(b)	**49**	(b)		
18	(d)	**22**	(a)	**26**	(c)	**30**	(b)	**34**	(b)	**38**	(b)	**42**	(d)	**46**	(c)	**50**	(c)		
19	(c)	**23**	(a)	**27**	(a)	**31**	(c)	**35**	(a)	**39**	(c)	**43**	(b)	**47**	(d)				
Skill Based MCQs																			
51	(c)	**52**	(d)	**53**	(a)	**54**	(a)	**55**	(c)	**56**	(a)	**57**	(c)	**58**	(b)	**59**	(a)	**60**	(b)