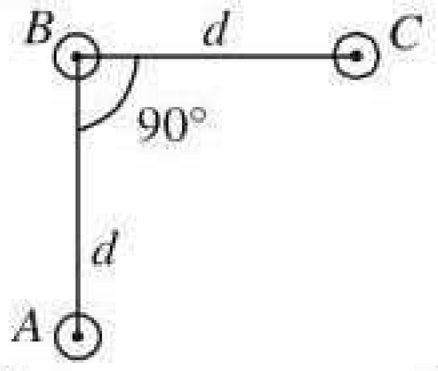
Chapter 14. Moving Charges and Magnetism

1. An arrangement of three parallel straight wires placed perpendicular to plane of paper carrying same current 'I' along the same direction as shown in figure. Magnitude of force per unit length on the middle wire 'B' is given by



(a) $\frac{2\mu_0 I^2}{\pi d}$ (b) $\frac{\sqrt{2}\mu_0 I^2}{\pi d}$

(c) $\frac{\mu_0 I^2}{\sqrt{2}\pi d}$ (d) $\frac{\mu_0 I^2}{2\pi d}$

(NEET 2017)

2. A long wire carrying a steady current is bent into a circular loop of one turn. The magnetic field at the centre of the loop is B. It is then bent into a circular coil of n turns. The magnetic field at the centre of this coil of n turns will be

(a) nB (b) n^2B

(c) $2nB$ (d) $2n^2B$

(NEET-II 2016)

3. An electron is moving in a circular path under the influence of a transverse magnetic field of 3.57×10^{-2} T. If the value of e/m is 1.76×10^{11} C kg^{-1}, the frequency of revolution of the electron is

(a) 1 GHz (b) 100 MHz

(c) 62.8 MHz (d) 6.28 MHz

(NEET-II 2016)

4. A long straight wire of radius a carries a steady current I. The current is uniformly distributed over its cross-section. The ratio of the magnetic fields B and B', at radial distances $\frac{a}{2}$ and $2a$ respectively, from the axis of the wire is

(a) 1 (b) 4

(c) $\frac{1}{4}$ (d) $\frac{1}{2}$

(NEET-I 2016)

5. A square loop $ABCD$ carrying a current i, is placed near and coplanar with a long straight conductor XY carrying a current I, the net force on the loop will be

(a) $\frac{2\mu_0 IiL}{3\pi}$ (b) $\frac{\mu_0 IiL}{2\pi}$

(c) $\frac{2\mu_0 Ii}{3\pi}$ (d) $\frac{\mu_0 Ii}{2\pi}$

(NEET-I 2016)

6. A proton and an alpha particle both enter a region of uniform magnetic field B, moving at right angles to the field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV, the energy acquired by the alpha particle will be

(a) 1.5 MeV (b) 1 MeV

(c) 4 MeV (d) 0.5 MeV

(2015)

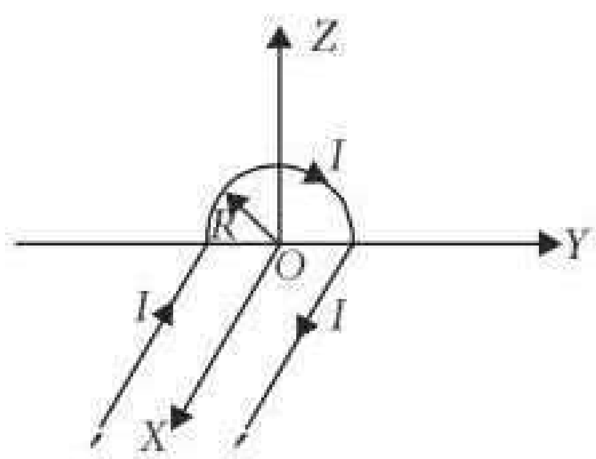
7. An electron moving in a circular orbit of radius r makes n rotations per second. The magnetic field produced at the centre has magnitude

(a) $\frac{\mu_0 n^2 e}{r}$ (b) $\frac{\mu_0 ne}{2r}$

(c) $\frac{\mu_0 ne}{2\pi r}$ (d) Zero

(2015 Cancelled)

8. A wire carrying current I has the shape as shown in adjoining figure.



Linear parts of the wire are very long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is

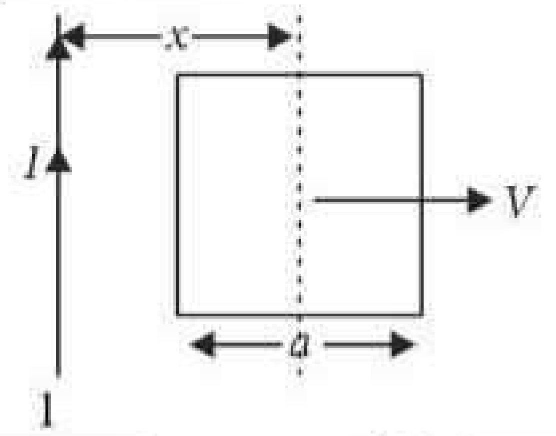
(a) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i}+2\hat{k}\right)$

(b) $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i}-2\hat{k}\right)$

(c) $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i}+2\hat{k}\right)$

(d) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i}-2\hat{k}\right)$ *(2015 Cancelled)*

9. A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to



(a) $\frac{1}{(2x+a)^2}$ (b) $\frac{1}{(2x-a)(2x+a)}$

(c) $\frac{1}{x^2}$ (d) $\frac{1}{(2x-a)^2}$

(2015 Cancelled)

10. In an ammeter 0.2% of main current passes through the galvanometer. If resistance of galvanometer is G, the resistance of ammeter will be

(a) $\frac{1}{499}G$ (b) $\frac{499}{500}G$

(c) $\frac{1}{500}G$ (d) $\frac{500}{499}G$

(2014)

11. Two identical long conducting wires AOB and COD are placed at right angle to each other, with one above other such that O is their common point for the two. The wires carry I_1 and I_2 currents, respectively. Point P is lying at distance d from O along a direction perpendicular to the plane containing the wires. The magnetic field at the point P will be

(a) $\frac{\mu_0}{2\pi d}\left(\frac{I_1}{I_2}\right)$ (b) $\frac{\mu_0}{2\pi d}(I_1+I_2)$

(c) $\frac{\mu_0}{2\pi d}(I_1^2-I_2^2)$ (d) $\frac{\mu_0}{2\pi d}(I_1^2+I_2^2)^{1/2}$

(2014)

12. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ toward west. The electric and magnetic fields in the room are

(a) $\frac{ma_0}{e}$ east, $\frac{3ma_0}{ev_0}$ up

(b) $\frac{ma_0}{e}$ east, $\frac{3ma_0}{ev_0}$ down

(c) $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ up

(d) $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ down *(NEET 2013)*

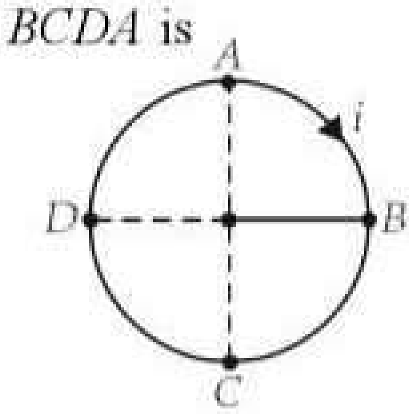
13. A long straight wire carries a certain current and produces a magnetic field 2×10^{-4} Wb m^{-2} at a perpendicular distance of 5 cm from the wire. An electron situated at 5 cm from the wire moves with a velocity 10^7 m/s towards the wire along perpendicular to it. The force experienced by the electron will be (charge on electron 1.6×10^{-19} C)

(a) 3.2 N (b) 3.2×10^{-16} N

(c) 1.6×10^{-16} N (d) zero

(Karnataka NEET 2013)

14. A circular coil $ABCD$ carrying a current 'i' is placed in a uniform magnetic field. If the magnetic force on the segment AB is $\vec{F}$, the force on the remaining segment $BCDA$ is



(a) $-\vec{F}$

(b) $3\vec{F}$

(c) $-3\vec{F}$

(d) $\vec{F}$

(Karnataka NEET 2013)

15. Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $2I$, respectively. The resultant magnetic field induction at the centre will be

(a) $\frac{\sqrt{5}\mu_0 I}{2R}$ (b) $\frac{\sqrt{5}\mu_0 I}{R}$

(c) $\frac{\mu_0 I}{2R}$ (d) $\frac{\mu_0 I}{R}$ *(2012)*

16. A milli voltmeter of 25 milli volt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be

(a) 0.001 (b) 0.01

(c) 1 (d) 0.05 *(2012)*

17. An alternating electric field, of frequency υ, is applied across the dees (radius = R) of a cyclotron that is being used to accelerate protons (mass = m). The operating magnetic field (B) used in the cyclotron and the kinetic energy (K) of the proton beam, produced by it, are given by

(a) $B = \frac{m\upsilon}{e}$ and $K = 2m\pi^2\upsilon^2R^2$

(b) $B = \frac{2\pi m\upsilon}{e}$ and $K = m^2\pi\upsilon R^2$

(c) $B = \frac{2\pi m\upsilon}{e}$ and $K = 2m\pi^2\upsilon^2R^2$

(d) $B = \frac{m\upsilon}{e}$ and $K = m^2\pi\upsilon R^2$ *(2012)*

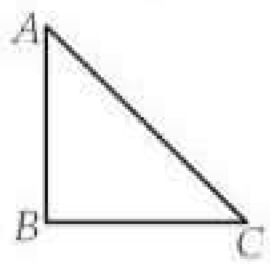
18. A proton carrying 1 MeV kinetic energy is moving in a circular path of radius R in uniform magnetic field. What should be the energy of an α-particle to describe a circle of same radius in the same field?

(a) 2 MeV (b) 1 MeV

(c) 0.5 MeV (d) 4 MeV

(Mains 2012)

19. A current carrying closed loop in the form of a right angle isosceles triangle ABC is placed in a uniform magnetic field acting along AB. If the magnetic force on the arm BC is $\vec{F}$, the force on the arm AC is



(a) $-\sqrt{2}\vec{F}$

(b) $-\vec{F}$

(c) $\vec{F}$

(d) $\sqrt{2}\vec{F}$ *(2011)*

20. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron

(a) will turn towards right of direction of motion

(b) speed will decrease

(c) speed will increase

(d) will turn towards left of direction of motion *(2011)*

21. A galvanometer of resistance, G, is shunted by a resistance S ohm. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is

(a) $\frac{G}{(S+G)}$ (b) $\frac{S^2}{(S+G)}$

(c) $\frac{SG}{(S+G)}$ (d) $\frac{G^2}{(S+G)}$

(Mains 2011)

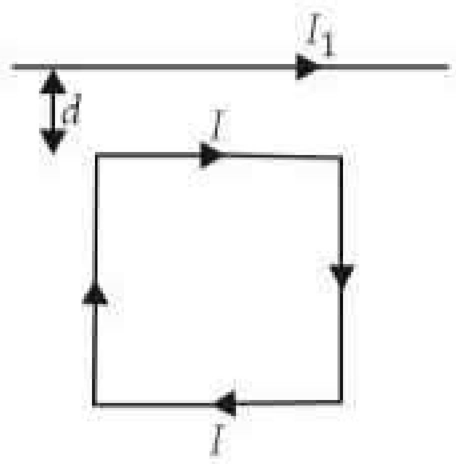
22. Charge q is uniformly spread on a thin ring of radius R. The ring rotates about its axis with a uniform frequency f Hz. The magnitude of magnetic induction at the center of the ring is

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

(c) $\frac{\mu_0 q}{2fR}$ (d) $\frac{\mu_0 q}{2\pi fR}$

(Mains 2011, 2010)

23. A square loop, carrying a teady current I, is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in figure. The loop will experience



(a) a net attractive force towards the conductor

(b) a net repulsive force away from the conductor

(c) a net torque acting upward perpendicular to the horizontal plane

(d) a net torque acting downward normal to the horizontal plane *(Mains 2011)*

24. A galvanometer has a coil of resistance 100 ohm and gives a full scale deflection for 30 mA current. If it is to work as a voltmeter of 30 volt range, the resistance required to be added will be

(a) 900 Ω (b) 1800 Ω

(c) 500 Ω (d) 1000 Ω *(2010)*

25. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is the net force on the remaining three arms of the loop is

(a) $3\vec{F}$ (b) $-\vec{F}$
(c) $-3\vec{F}$ (d) $\vec{F}$ *(2010)*

26. A current loop consists of two identical semicircular parts each of radius R, one lying in the x-y plane and the other in x-z plane. If the current in the loop is i. The resultant magnetic field due to the two semicircular parts at their common centre is

(a) $\dfrac{\mu_0 i}{2\sqrt{2}R}$ (b) $\dfrac{\mu_0 i}{2R}$
(c) $\dfrac{\mu_0 i}{4R}$ (d) $\dfrac{\mu_0 i}{\sqrt{2}R}$ *(Mains 2010)*

27. A closely wound solenoid of 2000 turns and area of cross-section 1.5×10^{-4} m^2 carries a current of 2.0 A. It is suspended through its centre and perpendicular to its length, allowing it to turn in a horizontal plane in a uniform magnetic field 5×10^{-2} tesla making an angle of 30° with the axis of the solenoid. The torque on the solenoid will be

(a) 3×10^{-3} N m (b) 1.5×10^{-3} N m
(c) 1.5×10^{-2} N m (d) 3×10^{-2} N m *(Mains 2010)*

28. A particle having a mass of 10^{-2} kg carries a charge of 5×10^{-8} C. The particle is given an initial horizontal velocity of 10^5 m s^{-1} in the presence of electric field $\vec{E}$ and magnetic field $\vec{B}$. To keep the particle moving in a horizontal direction, it is necessary that

(1) $\vec{B}$ should be perpendicular to the direction of velocity and $\vec{E}$ should be along the direction of velocity
(2) Both $\vec{B}$ and $\vec{E}$ should be along the direction of velocity
(3) Both $\vec{B}$ and $\vec{E}$ are mutually perpendicular and perpendicular to the direction of velocity.
(4) $\vec{B}$ should be along the direction of velocity and $\vec{E}$ should be perpendicular to the direction of velocity

Which one of the following pairs of statements is possible?

(a) (1) and (3) (b) (3) and (4)
(c) (2) and (3) (d) (2) and (4) *(Mains 2010)*

29. A galvanometer having a coil resistance of 60 Ω shows full scale deflection when a current of 1.0 amp passes through it. It can be converted into an ammeter to read currents upto 5.0 amp by

(a) putting in series a resistance of 15 Ω
(b) putting in series a resistance of 240 Ω
(c) putting in parallel a resistance of 15 Ω
(d) putting in parallel a resistance of 240 Ω *(2009)*

30. The magnetic force acting on a charged particle of charge -2 μC in a magnetic field of 2 T acting in y direction, when the particle velocity is $(2\hat{i}+3\hat{j})\times 10^6$ ms^{-1} is

(a) 4 N in z direction
(b) 8 N in y direction
(c) 8 N in z direction
(d) 8 N in $-z$ direction *(2009)*

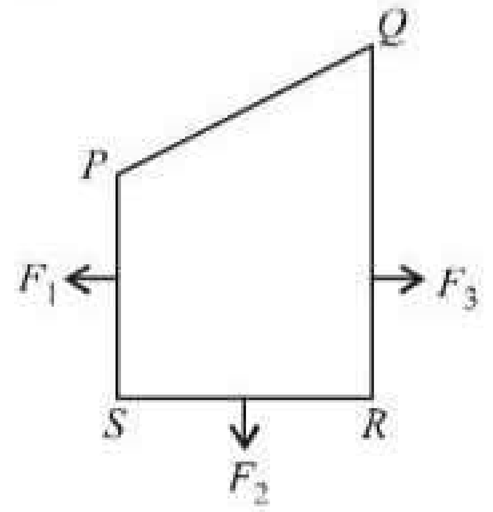
31. Under the influence of a uniform magnetic field, a charged particle moves with constant speed v in a circle of radius R. The time period of rotation of the particle

(a) depends on R and not on v
(b) is independent of both v and R
(c) depends on both v and R
(d) depends on v and not on R *(2009, 2007)*

32. A particle of mass m, charge Q and kinetic energy T enters a transverse uniform magnetic field of induction $\vec{B}$. After 3 seconds the kinetic energy of the particle will be

(a) T (b) $4T$
(c) $3T$ (d) $2T$ *(2008)*

33.



A closed loop $PQRS$ carrying a current is placed in a uniform magnetic field. If the magnetic forces on segments PS, SR and RQ are F_1, F_2 and F_3 respectively and are in the plane of the paper and along the directions shown, the force on the segment QP is

(a) $\sqrt{(F_3 - F_1)^2 - F_2^2}$ (b) $F_3 - F_1 + F_2$

(c) $F_3 - F_1 - F_2$ (d) $\sqrt{(F_3 - F_1)^2 + F_2^2}$

(2008)

34. A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with a resistance of 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the resistance in series should be

(a) 6050 Ω (b) 4450 Ω

(c) 5050 Ω (d) 5550 Ω *(2008)*

35. The resistance of an ammeter is 13 Ω and its scale is graduated for a current upto 100 amps. After an additional shunt has been connected to this ammeter it becomes possible to measure currents upto 750 amperes by this meter. The value of shunt-resistance is

(a) 2 Ω (b) 0.2 Ω

(c) 2 kΩ (d) 20 Ω.

(2007)

36. When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that

(a) angle between is either zero or 180°

(b) angle between is necessarily 90°

(c) angle between can have any value other than 90°

(d) angle between can have any value other than zero and 180°.

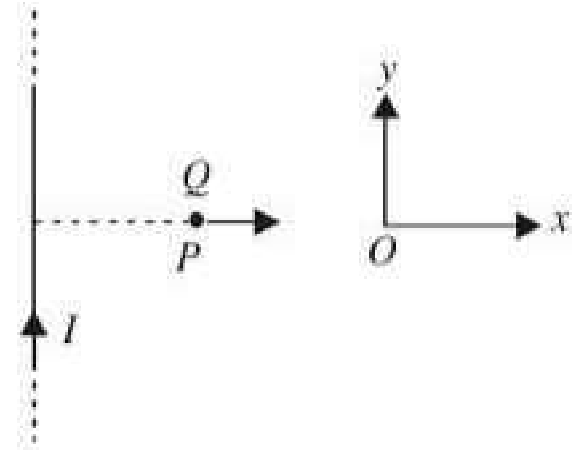
(2006)

37. Two circular coils 1 and 2 are made from the same wire but the radius of the 1st coil is twice that of the 2nd coil. What potential difference in volts should be applied across them so that the magnetic field at their centres is the same?

(a) 2 (b) 3

(c) 4 (d) 6. *(2006)*

38. A very long straight wire carries a current I. At the instant when a charge $+Q$ at point P has velocity $\vec{v}$, as shown, the force on the charge is



(a) along Oy (b) opposite to Oy

(c) along Ox (d) opposite to Ox.

(2005)

39. An electron moves in a circular orbit with a uniform speed v. It produces a magnetic field B at the centre of the circle. The radius of the circle is proportional to

(a) $\sqrt{B/v}$ (b) B/v

(c) $\sqrt{v/B}$ (d) v/B *(2005)*

40. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 volts, it should be connected with a resistance of

(a) 2500 Ω as a shunt (b) 2450 Ω as a shunt

(c) 2550 Ω in series (d) 2450 Ω in series

(2004)

41. To convert a galvanometer into a voltmeter one should connect a

(a) high resistance in series with galvanometer

(b) low resistance in series with galvanometer

(c) high resistance in parallel with galvanometer

(d) low resistance in parallel with galvanometer.

(2004, 2002)

42. A charged particle moves through a magnetic field in a direction perpendicular to it. Then the

(a) speed of the particle remains unchanged

(b) direction of the particle remains unchanged

(c) acceleration remains unchanged

(d) velocity remains unchanged

(2003)

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

(a) $B/2$ (b) B

(c) $2B$ (d) $4B$ *(2003)*

44. A charge q moves in a region where electric field and magnetic field both exist, then force on it is

(a) $q(\vec{v} \times \vec{B})$ (b) $q\vec{E} + q(\vec{v} \times \vec{B})$

(c) $q\vec{E} + \vec{q}\,(\vec{B} \times \vec{v})$ (d) $q\vec{B} + q(\vec{E} \times \vec{v})$. *(2002)*

45. 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) $B/4$ (b) $B/2$

(c) $4B$ (d) $2B$. *(2002)*

46. If number of turns, area and current through a coil is given by n, A and i respectively then its magnetic moment will be

(a) niA (b) n^2iA

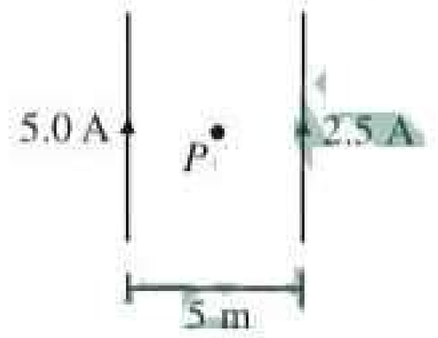
(c) niA^2 (d) $\frac{ni}{\sqrt{A}}$. *(2001)*

47. An electron having mass m and kinetic energy E enter in uniform magnetic field B perpendicularly, then its frequency will be

(a) $\frac{eE}{qvB}$ (b) $\frac{2\pi m}{eB}$

(c) $\frac{eB}{2\pi m}$ (d) $\frac{2m}{eBE}$ *(2001)*

48. The magnetic field at centre, P will be



(a) $\frac{\mu_0}{4\pi}$ (b) $\frac{\mu_0}{\pi}$

(c) $\frac{\mu_0}{2\pi}$ (d) $4\mu_0\pi$. *(2000)*

49. Magnetic field due to 0.1 A current flowing through a circular coil of radius 0.1 m and 1000 turns at the centre of the coil is

(a) 6.28×10^{-4} T (b) 4.31×10^{-2} T

(c) 2×10^{-1} T (d) 9.81×10^{-4} T *(1999)*

50. A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by the another wire of 1 mm diameter carrying the same current. The strength of the magnetic field far away is

(a) one-quarter of the earlier value

(b) one-half of the earlier value

(c) twice the earlier value

(d) same as the earlier value *(1999, 1997)*

51. If a long hollow copper pipe carries a current, then produced magnetic field will be

(a) both inside and outside the pipe

(b) outside the pipe only

(c) inside the pipe only

(d) neither inside nor outside the pipe *(1999)*

52. Magnetic field intensity at the centre of coil of 50 turns, radius 0.5 m and carrying a current of 2 A, is

(a) 3×10^{-5} T (b) 1.25×10^{-4} T

(c) 0.5×10^{-5} T (d) 4×10^{6} T *(1999)*

53. A charge having e/m equal to 10^8 C/kg and with velocity 3×10^5 m/s enters into a uniform magnetic field $B = 0.3$ tesla at an angle 30° with direction of field. The radius of curvature will be

(a) 0.01 cm (b) 0.5 cm

(c) 1 cm (d) 2 cm. *(1999)*

54. 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) 5×10^{-8} N/m (b) 2×10^{-8} N/m

(c) 2×10^{-7} N/m (d) 10^{-7} N/m *(1998)*

55. A galvanometer having a resistance of 9 ohm is shunted by a wire of resistance 2 ohm. If the total current is 1 amp, the part of it passing through the shunt will be

(a) 0.2 amp (b) 0.8 amp

(c) 0.25 amp (d) 0.5 amp *(1998)*

56. A coil of one turn is made of a wire of certain length and then from the same length a coil of two turns is made. If the same current is passed in both the cases, then the ratio of the magnetic inductions at their centres will be

(a) 4 : 1 (b) 1 : 4

(c) 2 : 1 (d) 1 : 2 *(1998)*

57. Two parallel wires in free space are 10 cm apart and each carries a current of 10 A in the same direction. The force exerted by one wire on the other, per metre length is

(a) 2×10^{-4} N, repulsive

(b) 2×10^{-7}N, repulsive

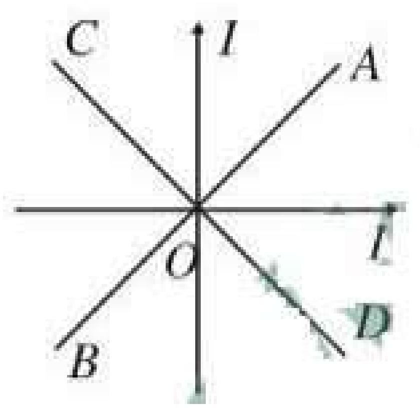
(c) 2×10^{-4} N, attractive

(d) 2×10^{-7}N, attractive. *(1997)*

58. A positively charged particle moving due East enters a region of uniform magnetic field directed vertically upwards. This particle will
(a) move in a circular path with a decreased speed
(b) move in a circular path with a uniform speed
(c) get deflected in vertically upward direction
(d) move in circular path with an increased speed.
(1997)

59. Tesla is the unit of
(a) electric field (b) magnetic field
(c) electric flux (d) magnetic flux.
(1997, 1988)

60. 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 currents. Where do we expect the resultant magnetic field to be zero?



(a) On CD
(b) On AB
(c) On both OD and BO
(d) On both AB and CD.
(1996)

61. The magnetic field $d\vec{B}$ due to a small current element $d\vec{l}$ at a distance $\vec{r}$ and element carrying current i is

(a) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{l} \times \vec{r}}{r}\right)$

(b) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{l} \times \vec{r}}{r^3}\right)$

(c) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{l} \times \vec{r}}{r}\right)$

(d) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{l} \times \vec{r}}{r^2}\right)$ *(1996)*

62. A 10 eV electron is circulating in a plane at right angles to a uniform field at magnetic induction 10^{-4} Wb/m^2 (= 1.0 gauss), the orbital radius of electron is
(a) 11 cm (b) 18 cm
(c) 12 cm (d) 16 cm. *(1996)*

63. A beam of electrons is moving with constant velocity in a region having electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T at right angles to the direction of motion of the electrons. What is the velocity of the electrons?
(a) 8 ms^{-1} (b) 5.5 ms^{-1}
(c) 20 ms^{-1} (d) 40 ms^{-1}. *(1996)*

64. A circular loop of area 0.01 m^2 carrying a current of 10 A, is held perpendicular to a magnetic field of intensity 0.1 T. The torque acting on the loop is
(a) 0.001 N m (b) 0.8 N m
(c) zero (d) 0.01 N m.
(1994)

65. 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) moving along a helical path around X-axis
(1993)

66. A coil carrying electric current is placed in uniform magnetic field
(a) torque is formed
(b) e.m.f is induced
(c) both (a) and (b) are correct
(d) none of these *(1993)*

67. To convert a galvanometer into a ammeter, one needs to connect a
(a) low resistance in parallel
(b) high resistance in parallel
(c) low resistance in series
(d) high resistance in series *(1992)*

68. 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 *(1992)*

69. The magnetic field at a distance r from a long wire carrying current i is 0.4 tesla. The magnetic field at a distance $2r$ is
(a) 0.2 tesla (b) 0.8 tesla
(c) 0.1 tesla (d) 1.6 tesla *(1992)*

70. A uniform magnetic field acts right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm. If the speed of electrons 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 *(1991)*

71. A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 metre in a plane perpendicular to 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 *(1991)*

72. The magnetic induction at a pont point P which is at the 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 will be

(a) 3.33×10^{-4} T (b) 1.11×10^{-4} T
(c) 33×10^{-3} T (d) 9×10^{-3} T *(1990)*

73. Energy in a current carrying coil is stored in the form of

(a) electric field only
(b) magnetic field only
(c) dielectric strength
(d) both (a) and (b) *(1989)*

74. A current carrying coil is subjected to a uniform magnetic field. The coil will orient so that its plane becomes

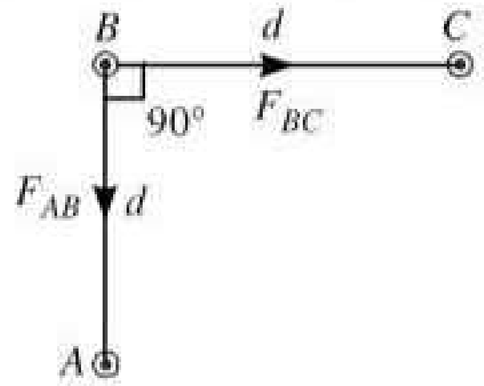
(a) inclined at 45º to the magnetic field
(b) inclined at any arbitrary angle to the magnetic field
(c) parallel to the magnetic field
(d) perpendicular to magnetic field *(1988)*

Answer Key

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(a)	**5.**	(c)	**6.**	(b)	**7.**	(b)	**8.**	(a)	**9.**	(b)	**10.**	(c)
11.	(d)	**12.**	(d)	**13.**	(b)	**14.**	(a)	**15.**	(a)	**16.**	(a)	**17.**	(c)	**18.**	(b)	**19.**	(b)	**20.**	(b)
21.	(d)	**22.**	(b)	**23.**	(a)	**24.**	(a)	**25.**	(b)	**26.**	(a)	**27.**	(c)	**28.**	(c)	**29.**	(c)	**30.**	(d)
31.	(b)	**32.**	(a)	**33.**	(d)	**34.**	(b)	**35.**	(a)	**36.**	(d)	**37.**	(c)	**38.**	(a)	**39.**	(c)	**40.**	(d)
41.	(a)	**42.**	(a)	**43.**	(b)	**44.**	(b)	**45.**	(c)	**46.**	(a)	**47.**	(c)	**48.**	(c)	**49.**	(a)	**50.**	(d)
51.	(b)	**52.**	(b)	**53.**	(d)	**54.**	(c)	**55.**	(b)	**56.**	(b)	**57.**	(c)	**58.**	(b)	**59.**	(b)	**60.**	(b)
61.	(b)	**62.**	(a)	**63.**	(d)	**64.**	(c)	**65.**	(a)	**66.**	(a)	**67.**	(a)	**68.**	(b)	**69.**	(a)	**70.**	(c)
71.	(d)	**72.**	(a)	**73.**	(d)	**74.**	(b)												

EXPLANATIONS

1. **(c)** : Force between wires A and B = force between wires B and C



$\therefore \quad F_{BC} = F_{AB} = \frac{\mu_0 I^2 l}{2\pi d}$

As, $\vec{F}_{AB} \perp \vec{F}_{BC}$ net force on wire B,

$$F_{\text{net}} = \sqrt{2}F_{BC} = \frac{\sqrt{2}\mu_o I^2 l}{2\pi d}$$

$$F_{\text{net}} = \frac{\mu_o I^2 l}{\sqrt{2}\pi d} \quad \text{or} \quad \frac{F_{\text{net}}}{l} = \frac{\mu_o I^2}{\sqrt{2}\pi d}$$

2. **(b)** : Let l be the length of the wire. Magnetic field at the centre of the loop is

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

$$\therefore \quad B = \frac{\mu_0 \pi I}{l} \qquad (\because l = 2\pi R) \qquad \text{...(i)}$$

$$B' = \frac{\mu_0 n I}{2r} = \frac{\mu_0 n I}{2\left(\frac{l}{2n\pi}\right)}$$

$$B' = \frac{\mu_0 n^2 \pi I}{l} \qquad \text{...(ii)}$$

From eqns. (i) and (ii), we get

$B' = n^2 B$

3. **(a)** : Here, $B = 3.57 \times 10^{-2}$ T,

$\frac{e}{m} = 1.76 \times 10^{11}$ C kg^{-1}

Frequency of revolution of the electron,

$$\upsilon = \frac{1}{T} = \frac{v}{2\pi r} \qquad \text{...(i)}$$

Also, $\frac{mv^2}{r} = evB \Rightarrow \frac{v}{r} = \frac{eB}{m}$ ...(ii)

From eqns. (i) and (ii),

$$\upsilon = \frac{1}{2\pi} \times \frac{eB}{m} = \frac{1}{2 \times 3.14} \times 1.76 \times 10^{11} \times 3.57 \times 10^{-2}$$
$$= 10^9 \text{ Hz} = 1 \text{ GHz}$$

4. **(a)** : Magnetic field at a point inside the wire at distance $r\left(=\frac{a}{2}\right)$ from the axis of wire is

$$B = \frac{\mu_0 I}{2\pi a^2} r = \frac{\mu_0 I}{2\pi a^2} \times \frac{a}{2} = \frac{\mu_0 I}{4\pi a}$$

Magnetic field at a point outside the wire at distance $r(= 2a)$ from the axis of wire is

$$B' = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0 I}{2\pi} \times \frac{1}{2a} = \frac{\mu_0 I}{4\pi a} \qquad \therefore \quad \frac{B}{B'} = 1$$

5. **(c)** : Force on arm AB due to current in conductor XY is

$$F_1 = \frac{\mu_0}{4\pi} \frac{2IiL}{(L/2)} = \frac{\mu_0 Ii}{\pi}$$

acting towards XY in the plane of loop.

Force on arm CD due to current in conductor XY is

$$F_2 = \frac{\mu_0}{4\pi} \frac{2IiL}{3(L/2)} = \frac{\mu_0 Ii}{3\pi}$$

acting away from XY in the plane of loop.

$\therefore$ Net force on the loop = $F_1 - F_2$

$$= \frac{\mu_0 Ii}{\pi}\left[1 - \frac{1}{3}\right] = \frac{2}{3}\frac{\mu_0 Ii}{\pi}$$

6. **(b)** : The kinetic energy acquired by a charged particle in a uniform magnetic field B is

$$K = \frac{q^2 B^2 R^2}{2m} \quad \left(\text{as} \quad R = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}\right)$$

where q and m are the charge and mass of the particle and R is the radius of circular orbit.

$\therefore$ The kinetic energy acquired by proton is

$$K_p = \frac{q_p^2 B^2 R_p^2}{2m_p}$$

and that by the alpha particle is

$$K_\alpha = \frac{q_\alpha^2 B^2 R_\alpha^2}{2m_\alpha}$$

Thus, $\frac{K_\alpha}{K_p} = \left(\frac{q_\alpha}{q_p}\right)^2 \left(\frac{m_p}{m_\alpha}\right)\left(\frac{R_\alpha}{R_p}\right)^2$

or $\quad K_\alpha = K_p \left(\frac{q_\alpha}{q_p}\right)^2 \left(\frac{m_p}{m_\alpha}\right)\left(\frac{R_\alpha}{R_p}\right)^2$

Here, $K_p = 1$ MeV, $\frac{q_\alpha}{q_p} = 2$, $\frac{m_p}{m_\alpha} = \frac{1}{4}$

and $\frac{R_\alpha}{R_p} = 1$

$\therefore \quad K_\alpha = (1\text{ MeV})(2)^2\left(\frac{1}{4}\right)(1)^2 = 1\text{ MeV}$

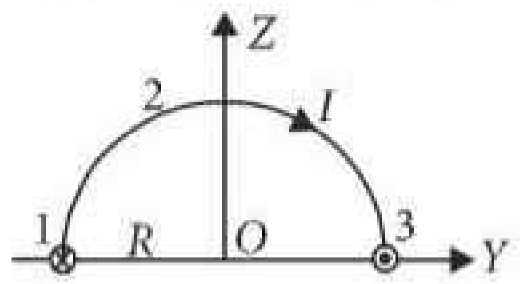
7. **(b)** : Current in the orbit, $I = \frac{e}{T}$

$$I = \frac{e}{(2\pi/\omega)} = \frac{\omega e}{2\pi} = \frac{(2\pi n)e}{2\pi} = ne$$

Magnetic field at centre of current carrying circular coil is given by

$$B = \frac{\mu_0 I}{2r} = \frac{\mu_0 ne}{2r}$$

8. **(a)** : Given situation is shown in the figure.



Parallel wires 1 and 3 are semi-infinite, so magnetic field at O due to them

$$\vec{B}_1 = \vec{B}_3 = -\frac{\mu_0 I}{4\pi R}\hat{k}$$

Magnetic field at O due to semi-circular arc in YZ-plane is given by $\vec{B}_2 = -\frac{\mu_0 I}{4R}\hat{i}$

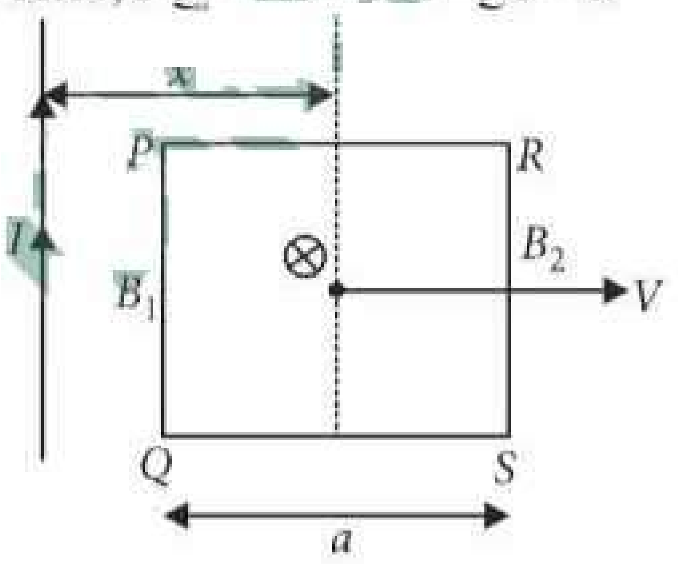
Net magnetic field at point O is given by

$$\vec{B} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$$

$$= -\frac{\mu_0 I}{4\pi R}\hat{k} - \frac{\mu_0 I}{4R}\hat{i} - \frac{\mu_0 I}{4\pi R}\hat{k}$$

$$= -\frac{\mu_0 I}{4\pi R}(\pi\hat{i} + 2\hat{k})$$

9. **(b)** : Here, $PQ = RS = PR = QS = a$



Emf induced in the frame

$$\varepsilon = B_1(PQ)V - B_2(RS)V$$

$$= \frac{\mu_0 I}{2\pi(x - a/2)}aV - \frac{\mu_0 I}{2\pi(x + a/2)}aV$$

$$= \frac{\mu_0 I}{2\pi}\left[\frac{2}{(2x-a)} - \frac{2}{(2x+a)}\right]aV$$

$$= \frac{\mu_0 I}{2\pi} \times 2\left[\frac{2a}{(2x-a)(2x+a)}\right]aV$$

$$\therefore \quad \varepsilon \propto \frac{1}{(2x-a)(2x+a)}$$

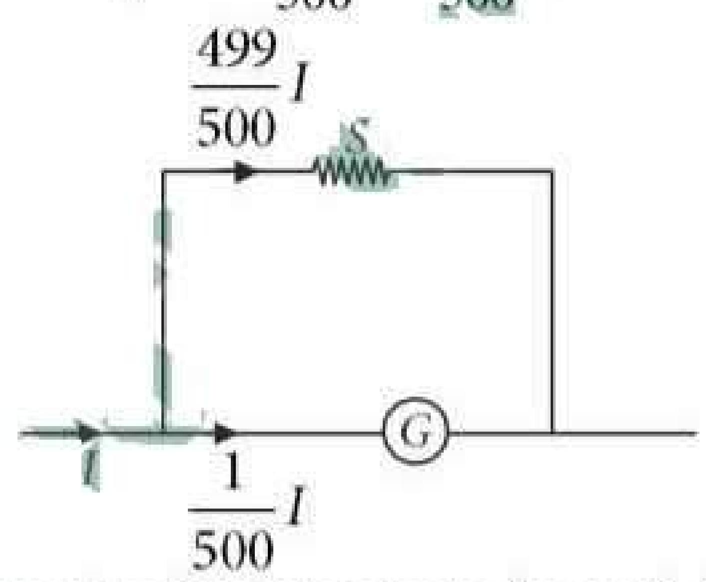
10. **(c)** : Here, resistance of the galvanometer = G

Current through the galvanometer,

$$I_G = 0.2\% \text{ of } I = \frac{0.2}{100}I = \frac{1}{500}I$$

$\therefore$ Current through the shunt,

$$I_S = I - I_G = I - \frac{1}{500}I = \frac{499}{500}I$$



As shunt and galvanometer are in parallel

$\therefore \quad I_G G = I_S S$

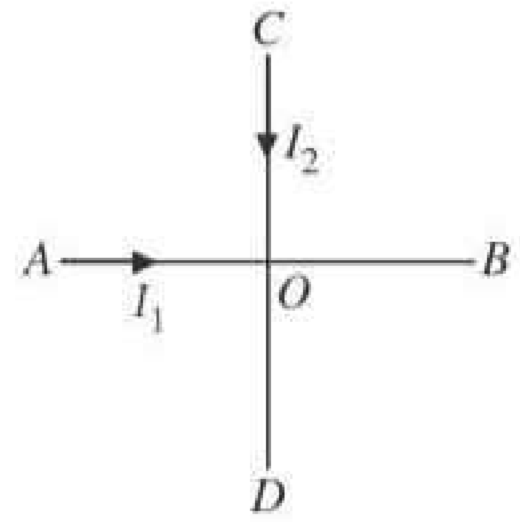
$$\left(\frac{1}{500}I\right)G = \left(\frac{499}{500}\right)S \text{ or } S = \frac{G}{499}$$

Resistance of the ammeter R_A is

$$\frac{1}{R_A} = \frac{1}{G} + \frac{1}{S} = \frac{1}{G} + \frac{1}{\frac{G}{499}} = \frac{500}{G}$$

$$R_A = \frac{1}{500}G$$

11. **(d)** : The magnetic field at the point P, at a perpendicular distance d from O in a direction perpendicular to the plane $ABCD$ due to currents through AOB and COD are perpendicular to each other. Hence,

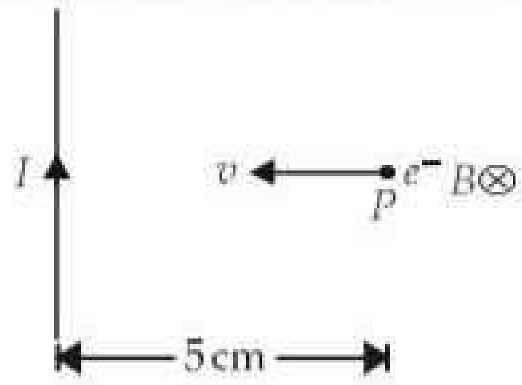


$$B = (B_1^2 + B_2^2)^{1/2} = \left[\left(\frac{\mu_0}{4\pi}\frac{2I_1}{d}\right)^2 + \left(\frac{\mu_0}{4\pi}\frac{2I_2}{d}\right)^2\right]^{1/2}$$

$$= \frac{\mu_0}{2\pi d}(I_1^2 + I_2^2)^{1/2}$$

12. **(d)**

13. (b) : The situation is as shown in the figure.



Here, $v = 10^7$ m/s, $B = 2 \times 10^{-4}$ Wb/m^2

The magnitude of the force experienced by the electron is

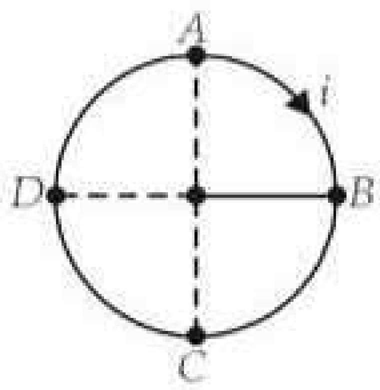
$F = evB\sin\theta$

($\because$ $\vec{v}$ and $\vec{B}$ are perpendicular to each other)

$= evB\sin 90° = 1.6 \times 10^{-19} \times 10^7 \times 2 \times 10^{-4} \times 1$

$= 3.2 \times 10^{-16}$ N

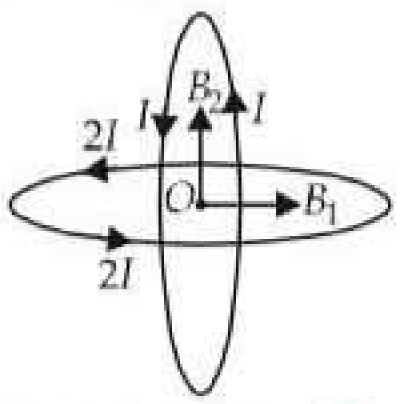
14. (a) : The net magnetic force on a current loop in a uniform magnetic field is always zero.



$\therefore \quad \vec{F}_{AB} + \vec{F}_{BCDA} = 0$

$\vec{F}_{BCDA} = -\vec{F}_{AB} = -\vec{F}$

15. (a) :



Magnetic field induction due to vertical loop at the centre O is

$$B_1 = \frac{\mu_0 I}{2R}$$

It acts in horizontal direction.

Magnetic field induction due to horizontal loop at the centre O is

$$B_2 = \frac{\mu_0 2I}{2R}$$

It acts in vertically upward direction.

As B_1 and B_2 are perpendicular to each other, therefore the resultant magnetic field induction at the centre O is

$$B_{\text{net}} = \sqrt{B_1^2 + B_2^2} = \sqrt{\left(\frac{\mu_0 I}{2R}\right)^2 + \left(\frac{\mu_0 2I}{2R}\right)^2}$$

$$B_{\text{net}} = \frac{\mu_0 I}{2R}\sqrt{(1)^2 + (2)^2} = \frac{\sqrt{5}\mu_0 I}{2R}$$

16. (a) : $S = \dfrac{V_g}{(I - I_g)}$

Neglecting I_g

$\therefore \quad S = \dfrac{V_g}{I} = \dfrac{25 \times 10^{-3}\ \text{V}}{25\ \text{A}} = 0.001\ \Omega$

17. (c) : Frequency, $\upsilon = \dfrac{eB}{2\pi m}$

or $B = \dfrac{2\pi m\upsilon}{e}$ ...(i)

As $\dfrac{mv^2}{R} = evB$

or $v = \dfrac{eBR}{m} = \dfrac{e2\pi m\upsilon R}{me}$ (Using (i))

$= 2\pi\upsilon R$ ...(ii)

Kinetic energy, $K = \dfrac{1}{2}mv^2 = \dfrac{1}{2}m(2\pi\upsilon R)^2$ (Using (ii))

$= 2m\pi^2\upsilon^2R^2$

18. (b) : Kinetic energy of a charged particle,

$$K = \frac{1}{2}mv^2 \text{ or } v = \sqrt{\frac{2K}{m}}$$

Radius of the circular path of a charged particle in uniform magnetic field is given by

$$R = \frac{mv}{Bq} = \frac{m}{Bq}\sqrt{\frac{2K}{m}} = \frac{\sqrt{2mK}}{Bq}$$

Mass of a proton, $m_p = m$

Mass of an α-particle, $m_\alpha = 4m$

Charge of a proton, $q_p = e$

Charge of an α-particle, $q_\alpha = 2e$

$$\therefore \quad R_p = \frac{\sqrt{2m_pK_p}}{Bq_p} = \frac{\sqrt{2mK_p}}{Be}$$

$$\text{and } R_\alpha = \frac{\sqrt{2m_\alpha K_\alpha}}{Bq_\alpha} = \frac{\sqrt{2(4m)K_\alpha}}{B(2e)} = \frac{\sqrt{2mK_\alpha}}{Be}$$

$$\therefore \quad \frac{R_p}{R_\alpha} = \sqrt{\frac{K_p}{K_\alpha}}$$

As $R_p = R_\alpha$ (given) $\quad \therefore \ K_\alpha = K_p = 1$ MeV

19. (b) : Here, $\vec{F}_{BC} = \vec{F}$

$\because \quad \vec{F}_{AB} = 0$

The net magnetic force on a current carrying closed loop in a uniform magnetic field is zero.

$\therefore \quad \vec{F}_{AB} + \vec{F}_{BC} + \vec{F}_{AC} = 0$

$\Rightarrow \quad \vec{F}_{AC} = -\vec{F}_{BC}$ $\quad (\because \ \vec{F}_{AB} = 0)$

20. (b) : Force on electron due to electric field,

$\vec{F}_E = -e\vec{E}$

Force on electron due to magnetic field,

$\vec{F}_B = -e(\vec{v} \times \vec{B}) = 0$

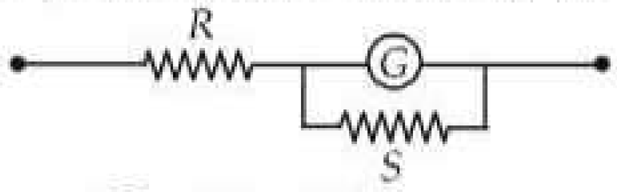
Since $\vec{v}$ and $\vec{B}$ are in the same direction.

Total force on the electron,

$\vec{F} = \vec{F}_E + \vec{F}_B = -e\vec{E}$

Electric field opposes the motion of the electron, hence speed of the electron will decrease.

21. (d) : Let resistance R is to be put in series with galvanometer G to keep the main current in the circuit unchanged.



$\therefore \quad \frac{GS}{G+S} + R = G$

$R = G - \frac{GS}{G+S} \Rightarrow R = \frac{G^2 + GS - GS}{G+S}$

$R = \frac{G^2}{G+S}$

22. (b) : The current flowing in the ring is

$I = qf$ ...(i)

The magnetic induction at the centre of the ring is

$B = \frac{\mu_0 2\pi I}{4\pi R} = \frac{\mu_0 q f}{2R}$ (Using (i))

23. (a)

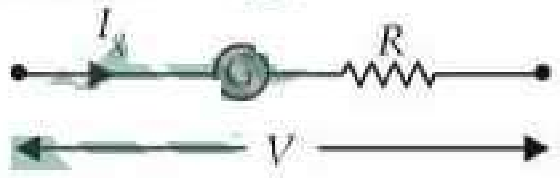
24. (a) : Here,

Resistance of galvanometer, $G = 100\ \Omega$

Current for full scale deflection, $I_g = 30$ mA $= 30 \times 10^{-3}$ A

Range of voltmeter, $V = 30$ V

To convert the galvanometer into an voltmeter of a given range, a resistance R is connected in series with it as shown in the figure.



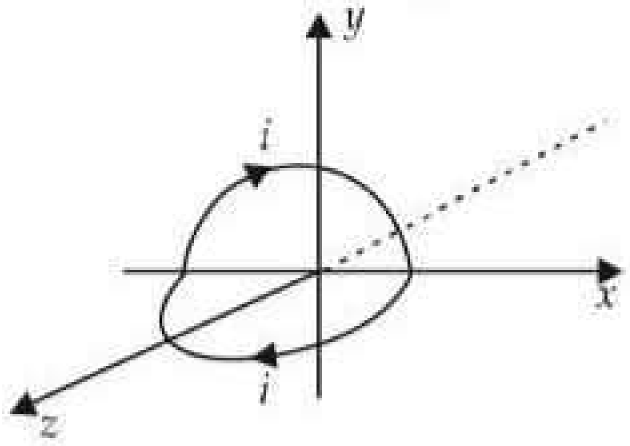
From figure, $V = I_g(G + R)$

or $\quad R = \frac{V}{I_g} - G = \frac{30}{30 \times 10^{-3}} - 100\ \Omega$

$= 1000 - 100 = 900\ \Omega$

25. (b)

26. (a) : The loop mentioned in the question must look like one as shown in the figure.



Magnetic field at the centre due to semicircular loop lying in x-y plane, $B_{xy} = \frac{1}{2}\left(\frac{\mu_0 i}{2R}\right)$ negative z direction.

Similarly field due to loop in x-z plane,

$B_{xz} = \frac{1}{2}\left(\frac{\mu_0 i}{2R}\right)$ in negative y direction.

$\therefore$ Magnitude of resultant magnetic field,

$$B = \sqrt{B_{xy}^2 + B_{xz}^2} = \sqrt{\left(\frac{\mu_0 i}{4R}\right)^2 + \left(\frac{\mu_0 i}{4R}\right)^2}$$

$$= \frac{\mu_0 i}{4R}\sqrt{2} = \frac{\mu_0 i}{2\sqrt{2}R}$$

27. (c) : Magnetic moment of the loop.

$M = NIA = 2000 \times 2 \times 1.5 \times 10^{-4} = 0.6$ J/T

Torque $\tau = MB\sin 30°$

$= 0.6 \times 5 \times 10^{-2} \times \frac{1}{2} = 1.5 \times 10^{-2}$ N m

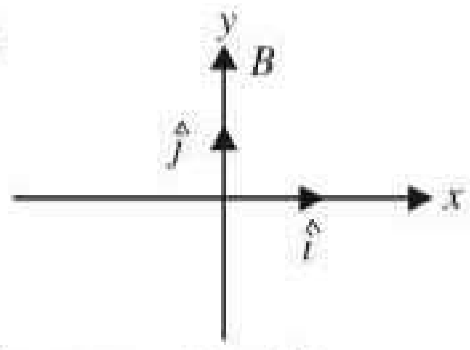
28. (c)

29. (c) : $iG = (I - i)S$ where G is the galvanometer resistance and S is the shunt used with the ammeter.

$1.0 \times 60 = (5 - 1)S$ where S is the shunt used to read a 5 A current when the galvanometer can stand by 1 A.

$S = \frac{1.0 \times 60}{4} = 15\ \Omega$ in parallel.

30. (d) :



Lorentz force $= q(\vec{v} \times \vec{B})$

$= (-2 \times 10^{-6})[(2\hat{i} + 3\hat{j}) \times 10^6 \times 2\hat{j}] = -8\hat{k}$ N.

$= 8$ N in $-z$ direction.

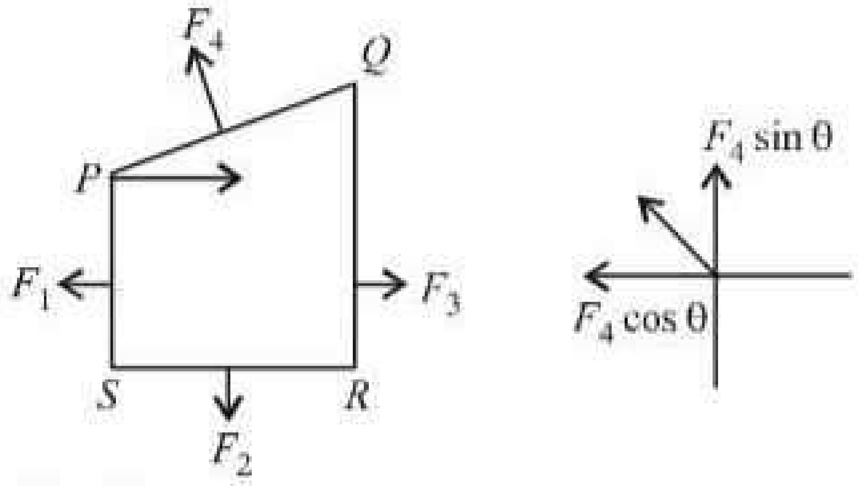
31. (b) : For the circular motion in a cyclotron,

$qvB = \frac{mv^2}{r} \Rightarrow qB = m\omega = \frac{m \times 2\pi}{T}$

$\therefore \quad T = \frac{2\pi m}{qB}$ is independent of v and r.

32. (a) : When a charged particle having a given K.E, T enters in a field of magnetic induction, which is perpendicular to its velocity, it takes a circular trajectory. It does not increase in energy, therefore T is the K.E.

33. (d) :



$F_4 \sin\theta = F_2$
$F_4 \cos\theta = (F_3 - F_1)$

$\therefore\ F_4 = \sqrt{(F_3 - F_1)^2 + F_2^2}$

For a closed loop there is no translation.

34. (b) : Total initial resistance

$= R_G + R_1 = (50 + 2950)\ \Omega = 3000\ \Omega$
$\varepsilon = 3\ \text{V}$

$\therefore$ Current $= \dfrac{3\text{V}}{3000\ \Omega} = 1 \times 10^{-3}$ mA

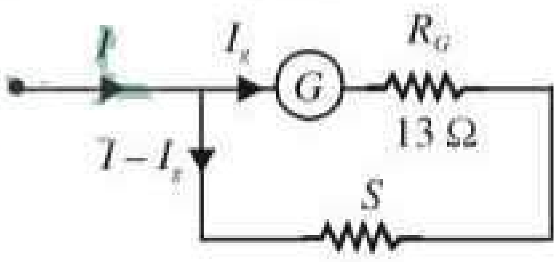
If the deflection has to be reduced to 20 divisions, current $i = 1\ \text{mA} \times \dfrac{2}{3}$ as the full deflection scale for 1 mA = 30 divisions.

$$3\text{V} = 3000\ \Omega \times 1\ \text{mA} = x\ \Omega \times \frac{2}{3}\ \text{mA}$$

$$\Rightarrow\ x = 3000 \times 1 \times \frac{3}{2} = 4500\ \Omega$$

But the galvanometer resistance = 50 Ω
Therefore the resistance to be added
$= (4500 - 50)\Omega = 4450\ \Omega$.

35. (a) : Let the shunt resistance be S.
Given: $I = 750$ A,
$I_g = 100$ A, $R_G = 13\ \Omega$
From the figure,



$I_g R_G = (I - I_g)S$
or $100 \times 13 = [750 - 100]S$
or $1300 = 650\ S$
$\therefore\ S = 1300/650 = 2\ \Omega$.

36. (d) : Force acting on a charged particle moving with velocity $\vec{v}$ is subjected to magnetic field $\vec{B}$ is given by

$\vec{F} = q(\vec{v} \times \vec{B})$ or, $F = qvB\sin\theta$

(i) When $\theta = 0°$, $F = qvB\sin 0° = 0$
(ii) When $\theta = 90°$, $F = qvB\sin 90° = qvB$
(iii) When $\theta = 180°$, $F = qvB\sin 180° = 0$

This implies force acting on a charged particle is non-zero, when angle between $\vec{v}$ and $\vec{B}$ can have any value other than zero and 180°.

37. (c) : Question is not correct.
The magnetic field at the centre of the coil,

$$B = \frac{\mu_0 ni}{2r}$$

where r is the radius. $E/R = i$.

$\therefore\ R \propto 2\pi r \ \Rightarrow\ R = cr$, where c is a constant.

$\therefore$ In the first coil,

$$B_1 = \frac{\mu_0 ni_1}{2r_1} = \frac{\mu_0 nE}{2r_1(cr_1)} = \frac{\mu_0 nE}{2cr_1^2}$$

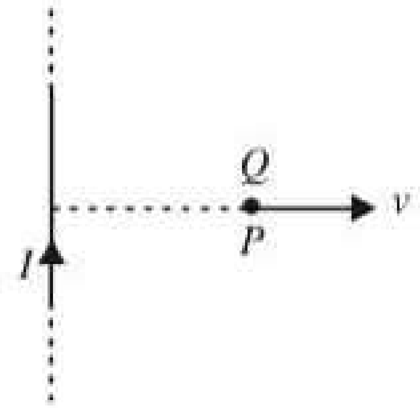
If $r_1 = 2r_2$, $B_1 = \dfrac{\mu_0 nE_1}{2c(2r_2)^2} = \dfrac{\mu_0 nE_1}{2c \cdot 4r_2^2}$

$$B_2 = \frac{\mu_0 nE_2}{2cr_2^2}$$

As B_1 will not be equal to B_2 unless E_1 is different from E_2, E_1 and E_2 will not be the same.
It is wrong to ask what potential difference should be applied across them. It should be perhaps the ratio of potential differences.
In that case, $B_1 = B_2$,

$$\frac{E_1}{4} = E_2 \ \Rightarrow\ E_1 = 4E_2.\ \therefore\ \frac{E_1}{E_2} = 4.$$

38. (a) : According to Fleming's left hand rule direction of force is along Oy axis which is perpendicular to wire.



$\vec{F} = e(\vec{v} \times \vec{B})$.

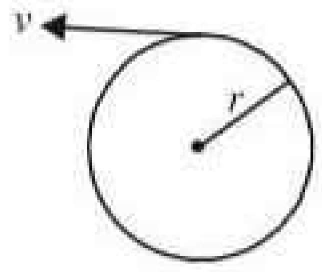
B due to i is acting inwards *i.e.* into the paper. v is along Ox.

$$\therefore\ F = Q^+ \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ v & 0 & 0 \\ 0 & 0 & -B \end{vmatrix} \Rightarrow F = Q^+[-\hat{j}(-vB) + 0]$$

$\therefore\ \vec{F} = +QvB\,\hat{j}$. *i.e.* in Oy direction.

39. (c) : The magnetic field produce by moving electron in circular path $B = \dfrac{\mu_0 i}{2r}$

where $i = \dfrac{q}{t} = \dfrac{q}{2\pi r} \times v$

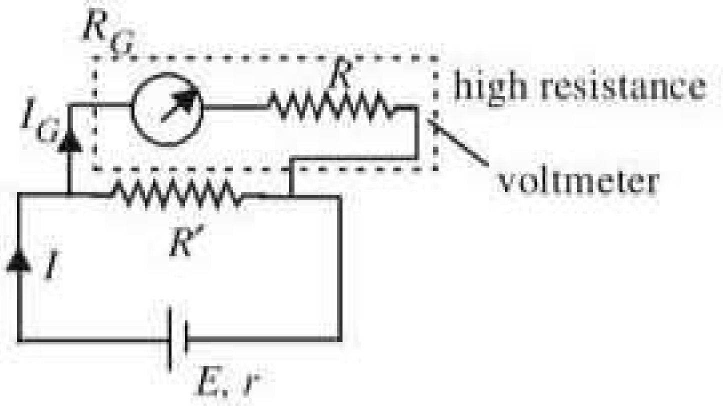


$$\therefore\ B = \frac{\mu_0 qv}{4\pi r^2} \ \Rightarrow\ r \propto \sqrt{\frac{v}{B}}.$$

40. (d) : The total current shown by the galvanometer $= 25 \times 4 \times 10^{-4}$ A.
$I_g = 10^{-2}$ A.
The value of resistance connected in series to convert galvanometer into voltmeter of 25 V is

$$R = \frac{V}{I_g} - G = \frac{25}{10^{-2}} - 50 = 2450\ \Omega.$$

41. (a) : Voltmeter is used to measure the potential difference across a resistance and it is connected in parallel with the circuit. A high resistance is connected to the galvanometer in series so that only a small fraction (I_g) of the main circuit current (I) passes through it. If a considerable amount of current is allowed to pass through the voltmeter, then the reading obtained by this voltmeter will not be close to the actual potential difference between the same two points.



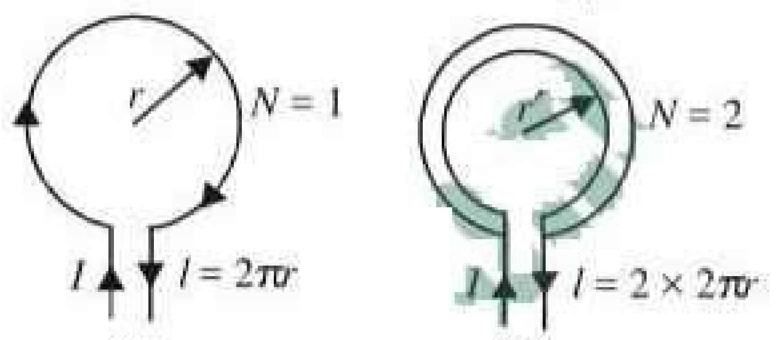
42. (a) : If a moving charged particle is subjected to a perpendicular uniform magnetic field, then according to $F = qvB \sin\theta$, it will experience a maximum force which will provide the centripetal force to particle and it will describe a circular path with uniform speed.

43. (b) : Magnetic field induction at point inside the solenoid of length l, having n turns per unit length carrying current i is given by
$B = \mu_0 ni$
If $i \rightarrow$ doubled, $n \rightarrow$ halved then $B \rightarrow$ remains same.

44. (b) : The force experienced by a charged particle moving in space where electric and magnetic field exists is called Lorentz force.
When a charged particle carrying charge q is subjected to an electric field of strength $\vec{E}$, it experiences a force given by $\vec{F}_e = q\vec{E}$ whose direction is same as $\vec{E}$ or opposite of $\vec{E}$ depending on the nature of charge, positive or negative.
If a charged particle is moving in a magnetic field of strength $\vec{B}$ with a velocity $\vec{v}$ it experiences a force given by $\vec{F}_m = q(\vec{v} \times \vec{B})$. The direction of this force is in the direction of $\vec{v} \times \vec{B}$ *i.e.* perpendicular to the plane containing $\vec{v}$ and $\vec{B}$ and is directed as given by right hand screw rule.
Due to both the electric and magnetic fields, the total force experienced by the charge q is given by

$$\vec{F} = \vec{F}_e + \vec{F}_m = q\vec{E} + q(\vec{v} \times \vec{B}).$$

45. (c) : The magnetic field B produced at the centre of a circular coil due to current I flowing through this is given by $B = \frac{\mu_0 NI}{2r}$, N is number of turns and r is radius of the coil. Here $B = \frac{\mu_0 I}{2r}[N = 1]$.



(a) (b)

$\therefore$ $2 \times 2\pi r' = 2\pi r$ (same length). $\therefore$ $r' = r/2$.
$\therefore$ Magnetic field at the centre for two turns ($N = 2$) is given by

$$B' = \frac{\mu_0 \times 2I}{2r'} = \frac{\mu_0 \times 2I}{2r/2} = \frac{4\mu_0 I}{2r} = 4B.$$

46. (a) : Magnetic moment $M = niA$

47. (c) : The frequency of revolution of charged particle in a perpendicular magnetic field is

$$\upsilon = \frac{1}{T} = \frac{1}{2\pi r/v} = \frac{v}{2\pi r} = \frac{v}{2\pi} \times \frac{eB}{mv} = \frac{eB}{2\pi m}.$$

48. (c) : $B = \frac{\mu_0}{4\pi}\frac{2i_2}{(r/2)} - \frac{\mu_0}{4\pi}\frac{2i_1}{(r/2)} = \frac{\mu_0}{4\pi}\frac{4}{r}(i_2 - i_1)$

$$= \frac{\mu_0}{4\pi}\frac{4}{5}(2.5 - 5.0) = -\frac{\mu_0}{2\pi}.$$

–ve sign show that B is acting inwards *i.e.* into the plane.

49. (a) :

$$B = \frac{\mu_0 Ni}{2r} = \frac{4\pi \times 10^{-7} \times 1000 \times 0.1}{2 \times 0.1} = 6.28 \times 10^{-4}\ \mathrm{T}$$

50. (d) : Diameter of first wire (d_1) = 0.5 mm; Current in first wire (I_1) = 1A; Diameter of second wire (d_2) = 1 mm and current in second wire (I_2) = 1A.
Strength of magnetic field due to current flowing in a conductor, (B) = $\frac{\mu_0}{4\pi} \times \frac{2I}{a}$ or $B \propto I$.
Since the current in both the wires is same, therefore there is no change in the strength of the magnetic field.

51. (b) : Use Ampère's law

$$\oint B.dl = \mu_0\, i_{\text{enclosed}}.$$

Outside : $i_{\text{enclosed}} \neq 0$ (some value) $\Rightarrow B \neq 0$
Inside = $i_{\text{enclosed}} = 0 \Rightarrow B = 0$.

52. (b) :

$$B=\frac{\mu_0(Ni)}{2r}=\frac{4\pi\times10^{-7}\times50\times2}{2\times0.5}=1.256\times10^{-4}\ \text{T}$$

53. (d) : $qvB\sin\theta = \frac{mv^2}{R}$

$$R=\frac{mv}{qB\sin\theta}=\frac{3\times10^5}{10^8\times0.3\times\frac{1}{2}}=2\ \text{cm}$$

54. (c) : $F=\frac{\mu_0}{4\pi}\ \frac{2I_1I_2}{r}$

$$=\frac{10^{-7}\times2(1)\times(1)}{1}=2\times10^{-7}\ \text{N/m}$$

55. (b) : The shunt and galvanometer are in parallel.

Therefore, $\frac{1}{R_{eq}}=\frac{1}{9}+\frac{1}{2}$ or, $R_{eq}=\frac{18}{11}\ \Omega$.

Using Ohm's law, $V=IR_{eq}=1\times\frac{18}{11}=\frac{18}{11}$ V.

$\therefore$ Current through shunt $=\frac{V}{R_s}$

$$=\frac{18/11}{2}=\frac{9}{11}\simeq0.8\ \text{amp.}$$

56. (b) : Magnetic field at the centre of the coil,

$$B=\frac{\mu_0}{2\pi}\frac{NI}{a}$$

Let l be the length of the wire, then

$$B_1=\frac{\mu_0}{2\pi}\cdot\frac{1\times I}{l/2\pi}=\frac{\mu_0 I}{l}$$

and $B_2=\frac{\mu_0}{2\pi}\cdot\frac{2\times I}{l/4\pi}=\frac{4\mu_0 I}{l}$

Therefore, $\frac{B_1}{B_2}=\frac{1}{4}$ or, $B_1 : B_2 = 1 : 4$.

57. (c) : Distance between two parallel wires $(x) = 10$ cm $= 0.1$ m;
Current in each wire $= I_1 = I_2 = 10$ A and length of wire $(l) = 1$ m.

Force on the wire $(F)=\frac{\mu_0 I_1\cdot I_2\times l}{2\pi x}$

$$=\frac{(4\pi\times10^{-7})\times10\times10\times1}{2\pi\times0.1}=2\times10^{-4}\ \text{N.}$$

Since the current is flowing in the same direction, therefore the force will be attractive.

58. (b) : When a positively charged particle enters in a region of uniform magnetic field, directed vertically upwards, it experiences a centripetal force which will move it in circular path with a uniform speed.

59. (b)

60. (b) : The direction of the magnetic field, due to current, is given by the right-hand rule. At axis AB, the components of magnetic field will cancel each other and the resultant magnetic field will be zero.

61. (b) : According to Biot-Savart's law,

$$d\vec{B}\propto i\left(\frac{d\vec{l}\times\vec{r}}{r^3}\right)=\frac{\mu_0}{4\pi}i\left(\frac{d\vec{l}\times\vec{r}}{r^3}\right).$$

62. (a) : Kinetic energy of electron $\left(\frac{1}{2}\times mv^2\right)=10$ eV and magnetic induction $(B) = 10^{-4}$ Wb/m^2.

Therefore $\frac{1}{2}(9.1\times10^{-31})v^2=10\times(1.6\times10^{-19})$

or, $v^2=\frac{2\times10\times(1.6\times10^{-19})}{9.1\times10^{-31}}=3.52\times10^{12}$

or, $v = 1.876\times10^6$ m.

Centripetal force $=\frac{mv^2}{r}=Bev$.

Therefore $r=\frac{mv}{Be}=\frac{(9.1\times10^{-31})\times(1.876\times10^6)}{10^{-4}\times(1.6\times10^{-19})}$

$=11\times10^{-2}$ m $= 11$ cm.

63. (d) : Electric field $(E) = 20$ V/m and magnetic field $(B) = 0.5$ T.
The force on electron in a magnetic field $= evB$
Force on electron on an electric field $= eE$
Since the electron is moving with constant velocity, therefore the resultant force on electron is zero.
i.e., $eE = evB \Rightarrow v = E/B = 20/0.5 = 40\ \text{ms}^{-1}$

64. (c) : Area $(A) = 0.01$ m^2; Current $(I) = 10$ A; Angle $(\phi) = 90°$ and magnetic field $(B) = 0.1$ T.
Therefore acutal angle $\theta = (90° - \phi) = (90° - 90°) = 0°$.
And torque acting on the loop $(\tau) = IAB\sin\theta$
$= 10\times0.01\times0.1\times\sin0° = 0$.

65. (a) : The force acting on a charged particle in magnetic field is given by

$\vec{F}=q(\vec{v}\times\vec{B})$ or $F=qvB\sin\theta$

$\therefore\ F=0$

when angle between v and B is 180°.

66. (a) : A current carrying coil has magnetic dipole moment. Hence a torque $p_m\times B$ acts on it in magnetic field.

67. (a) : To convert a galvanometer into ammeter, one needs to connect a low resistance in parallel so that maximum current passes through the shunt wire and ammeter remains protected.

68. (b) : $F = il\times B = 1.2\times0.5\times2 = 1.2$ N.

69. (a) : $B = \frac{\mu_0 i}{2\pi r}$ or $B \propto \frac{1}{r}$

When r is doubled, the magnetic field becomes halved *i.e.*,now the magnetic field will be 0.2 T.

70. (c) : $r = \frac{mv}{qB}$ or $r \propto v$

As v is doubled, the radius also becomes doubled. Hence radius = 2 × 2 = 4 cm.

71. (d) : For a charged particle orbiting in a circular path in a magnetic field

$$\frac{mv^2}{r} = Bvq \Rightarrow v = \frac{Bqr}{m}$$

$$mv^2 = Bqvr$$

$$E_K = \frac{1}{2}mv^2 = \frac{1}{2}Bqvr = Bq\frac{r}{2}\cdot\frac{Bqr}{m} = \frac{B^2q^2r^2}{2m}$$

For deuteron, $E_1 = \frac{B^2q^2 \times r^2}{2 \times 2m}$

For proton, $E_2 = \frac{B^2q^2r^2}{2m}$

$$\frac{E_1}{E_2} = \frac{1}{2} \Rightarrow \frac{50\text{ keV}}{E_2} = \frac{1}{2} \Rightarrow E_2 = 100\text{ keV}$$

72. (a) : $B \propto 1/r$. By Ampère's law.

As the distance is increased to three times, the magnetic induction reduces to one third.

Hence $B = \frac{1}{3} \times 10^{-3}$ tesla = 3.33×10^{-4} tesla

73. (d) : When current flows in a coil, its electric field is perpendicular to the magnetic field always.

Therefore (a) and (b).

74. (b) : The plane of coil will orient itself so that area vector aligns itself along the magnetic field.