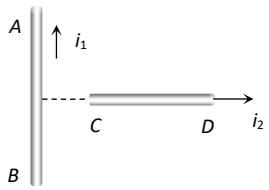
MOVING CHARGES AND MAGNETISM

Single Correct Answer Type

1. An infinitely long straight conductor AB is fixed and a current is passed through it. Another movable straight wire CD of finite length and carrying current is held perpendicular to it and released. Neglect weight of the wire



a) The rod CD will move upwards parallel to itself
b) The rod CD will move downward parallel to itself
c) The rod CD will move upward and turn clockwise at the same time
d) The rod CD will move upward and turn anti-clockwise at the same time

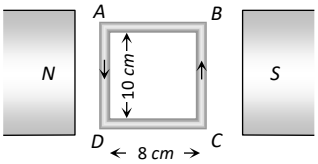
2. A wire in the form of a circular loop of one turn carrying a current produces a magnetic field B at the centre. If the same wire is looped into a coil of two turns and carries the same current, the new value of magnetic induction at the centre is

a) 3B b) 5B
c) 4B d) 2B

3. Through two parallel wires A and B, 10A and 2A of currents are passed respectively in opposite directions. If the wire A is infinitely long and the length of the wire B is 2m, then force on the conductor B, which is situated at 10 cm distance from A, will be

a) 8×10^{-7} N b) 8×10^{-5} N
c) 4×10^{-7} N d) 4×10^{-5} N

4. A 100 turns coil shown in figure carries a current of 2 amp in a magnetic field $B = 0.2$ Wb/m^2. The torque acting on the coil is



a) 0.32 Nm tending to rotated the side AD out of the page
b) 0.32 Nm tending to rotated the side AD into the page
c) 0.0032 Nm tending to rotated the side AD out of the page
d) 0.0032 Nm tending to rotated the side AD into the page

5. A straight wire of length (π^2) metre is carrying a current of 2A and the magnetic field due to it is measured at a point distance 1 cm from it. If the wire is to be bent into a circle and is to carry the same current as before, the ratio of the magnetic field at its centre to that obtained in the first case would be

a) 50 : 1 b) 1 : 50
c) 100 : 1 d) 1 : 100

6. A beam of protons is moving parallel to a beam of electrons. Both the beams will tend to

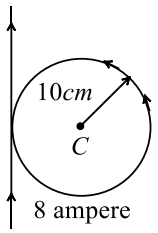
a) Repel each other b) Come closer
c) Move more apart d) Either (b) or (c)

7. A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis of the coil, where the magnetic induction is $\frac{1}{8}$ th of its value at the centre of the coil is

a) $\sqrt{3}$R b) R/$\sqrt{3}$

c) $\left(\frac{2}{\sqrt{3}}\right)$R d) $\frac{R}{2\sqrt{3}}$

8. 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 lop, then the value of the magnetic field and its direction as 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

9. A current of 2 amp, flows in a long, straight wire of radius 2 mm. The intensity of magnetic field on the axis of the wire is

a) $\left(\frac{\mu_0}{\pi}\right) \times 10^3$tesla b) $\left(\frac{\mu_0}{2\pi}\right) \times 10^3$tesla

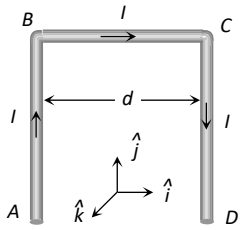
c) $\left(\frac{2\mu_0}{\pi}\right) \times 10^3$tesla d) Zero

10. The proton is energy 1 MeV describes a circular path in plane at right angles to a uniform magnetic field of $6.28 \times 10^{-4}\ T$. The mass of the proton is $1.7 \times 10^{-27}\ kg$. The cyclotron frequency of the proton is very nearly equal to

a) $10^7\ Hz$ b) $10^5 Hz$

c) $10^6\ Hz$ d) $10^4\ Hz$

11. AB and CD are long straight conductors, distance d apart, carrying a current I. The magnetic field at the midpoint of BC is



a) $\frac{-\mu_0 I}{2\pi d}\hat{k}$ b) $\frac{-\mu_0 I}{\pi d}\hat{k}$

c) $\frac{-\mu_0 I}{4\pi d}\hat{k}$ d) $\frac{-\mu_0 I}{8\pi d}\hat{k}$

12. Magnetic field at the centre of a circular loop of area A is B. The magnetic moment of the loop will be

a) $\frac{BA^2}{\mu_0\pi}$ b) $\frac{BA^{3/2}}{\mu_0\pi}$

c) $\frac{BA^{3/2}}{\mu_0\pi^{1/2}}$ d) $\frac{2\,BA^{3/2}}{\mu_0\pi^{1/2}}$

13. If the current is doubled, the deflection is also doubled in

a) A tangent galvanometer b) A moving coil galvanometer

c) Both (a) and (b) d) None of these

14. A proton of mass 1.67×10^{-27} kg and charge $1.6 \times 10^{-19}\ C$ is projected with a speed of $2 \times 10^{6}\ ms^{-1}$ at an angle of 60° to the X-axis. If a uniform magnetic field of 0.104 T is applied along Y-axis, the path of proton is

a) A circle of radius =0.2 m and time period $= 2\pi \times 10^{-7}$ s

b) A circle of radius $= 0.1$ m and time period $= 2\pi \times 10^{-7}\ s$

c) A helix of radius 0.1 m and time period $= 2\pi \times 10^{-7}$ s

d) A helix of radius 0.2 m and time period $= 2\pi \times 10^{-7}$ s

15. A thin circular disk of radius R is uniformly charged with density $\sigma > 0$ per unit area. The disk rotates about its axis with a uniform angular speed ω. The magnetic moment of the disk is

a) $2\pi R^4 \sigma\omega$ b) $\pi R^4 \sigma\omega$

c) $\frac{\pi R^4}{2}\sigma\omega$ d) $\frac{\pi R^4}{4}\sigma\omega$

16. A particle having a mass of $10^{-2}\ kg$ carries a charge of $5 \times 10^{-8} C$. The particle is given an initial horizontal velocity of $10^{5}\ ms^{-1}$ 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 of the following pairs of statements is possible

a) (1) and (3) b) (3) and (4)

c) (2) and (3) d) (2) and (4)

17. An electron beam travels with a velocity of $1.6 \times 10^{7}\ ms^{-1}$ perpendicularly to magnetic field of intensity 0.1 T. The radius of the path of the electron beam ($m_e = 9 \times 10^{-31}\ kg$)

a) $9 \times 10^{-5}\ m$ b) $9 \times 10^{-2}\ m$

c) $9 \times 10^{-4}\ m$ d) $9 \times 10^{-3}\ m$

18. The magnetic field induction at a point 4 cm from a long current carrying wire is 10^{-3} T. The magnetic field induction at a distance of 1.0 cm from the same current wire will be

a) 2×10^{-4} T b) 3×10^{-4} T

c) 4×10^{-3} T d) 1.11×10^{-4} T

19. A particle of charge q and mass m moving with a velocity v along the x-axis enters the region $x > 0$ with uniform magnetic field B along the $\hat{k}$ direction. The particle will penetrate in this region in the x-direction upto a distance d equal to

a) Zero b) $\frac{mv}{qB}$

c) $\frac{2mv}{qB}$ d) Infinity

20. A horizontal metal wire is carrying an electric current from the north to the south. Using a uniform magnetic field, it is to be prevented from falling under gravity. The direction of this magnetic field should be towards the

a) North b) South

c) East d) West

21. The magnetic moment of a current (i) carrying circular coil of radius (r) and number of turns (n) varies as

a) $1/r^2$ b) $1/r$

c) r d) r^2

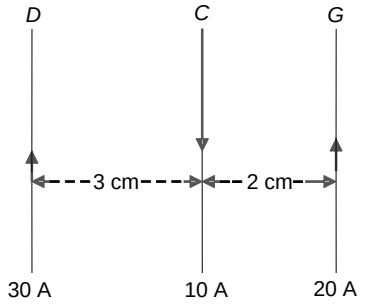
22. A direct current I flows along the length of an infinitely long straight thin walled pipe, then the magnetic field is
    a) Uniform throughout the pipe but not zero
    b) Zero only along the axis of the pipe
    c) Zero at any point inside the pipe
    d) Maximum at the centre and minimum at the edge

23. An electron of mass m and charge q is travalling with a speed v along a circular path of radius r at right angles to a uniform of magnetic field B. If speed of the electron is doubled and the magnetic field is halved, then resulting path would have a radius of
    a) $\frac{r}{4}$ b) $\frac{r}{2}$
    c) $2r$ d) $4r$

24. If two parallel wires carry current in opposite directions
    a) The wires attract each other
    b) The wires repel each other
    c) The wires experience neither attraction nor repulsion
    d) The forces of attraction or repulsion do not depend on current direction

25. Two long wires are hanging freely. They are joined first in parallel and then in series and then are connected with a battery. In both cases, which type of force acts between the two wires
    a) Attraction force when in parallel and repulsion force when in series
    b) Repulsion force when in parallel and attraction force when in series
    c) Repulsion force in both cases
    d) Attraction force in both cases

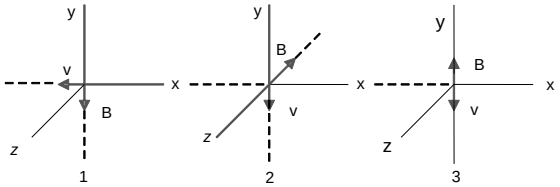
26. Three long, straight parallel wires, carrying current, are arranged as shown in figure. The force experienced by a 25 cm length of wire C is



    a) $10^{-3}\ N$ b) $2.5 \times 10^{-3}\ N$
    c) Zero d) 1.5×10^{-3}

27. 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 distance $x = +a$ will be
    a) Proportional to a b) Proportional to $1/\ a$
    c) Proportional to a^2 d) Zero

28. The figure shows three situations when an electron with velocity $\boldsymbol{v}$ travels through a uniform magnetic field $\boldsymbol{B}$. In each case, what is the direction of magnetic force on the electron?

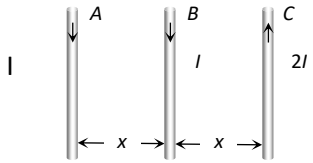


    a) $+ve\ z-axis, -ve\ x-axis, +ve\ y-axis$
    b) $-ve\ z-axis, -ve\ x-axis\ and\ zero$
    c) $+ve\ z-axis, +ve\ y-axis\ and\ zero$
    d) $-ve\ z-axis, +ve\ y-axis\ and\ zero$

29. A steady electric current is flowing through a cylindrical conductor
    a) The magnetic field in the vicinity of the conductor is zero
    b) The electric field in the vicinity of the conductor is non-zero
    c) The magnetic field at the axis of the conductor is zero
    d) The electric field at the axis of the conductor is zero

30. A long solenoid has 200 turns/cm and carries a current i. The magnetic field at its centre is $6.28 \times 10^{-2}\ Wb/m^2$. Another long solenoid has 100 turns/cm and it carries a current $i/3$. The value of the magnetic field at its centre is
    a) $1.05 \times 10^{-2}\ Wbm^{-2}$ b) $1.05 \times 10^{-5}\ Wbm^{-2}$
    c) $1.05 \times 10^{-3}\ Wbm^{-2}$ d) $1.05 \times 10^{-4}\ Wbm^{-2}$

31. A, B and C are parallel conductors of equal length carrying currents I, I and $2I$ respectively. Distance between A and B is x. Distance between B and C is also x. F_1 is the force exerted by B on A and F_2 is the force exerted by C on A. Choose the correct answer

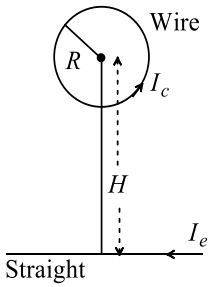


    a) $F_1 = 2F_2$ b) $F_2 = 2F_1$
    c) $F_1 = F_2$ d) $F_1 = -F_2$

32. $1A$ current flows through an infinitely long straight wire. The magnetic field produced at a point 1 $metre$ away from it is
    a) $2 \times 10^{-3} tesla$ b) $\frac{2}{10} tesla$
    c) $2 \times 10^{-7} tesla$ d) $2\pi \times 10^{-6} tesla$

33 A solenoid consists of 100 turns of wire and has a length of 10.0 cm. The magnetic field inside the solenoid when it carries a current of 0.500 A will be
    a) $6.28 \times 10^{-4}\ T$ b) $6.28 \times 10^{-5}\ T$
    c) $3.14 \times 10^{-4}\ T$ d) None of these

34. Circular loop of a wire and 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) $\frac{I_e \pi}{I_c R}$

35. The magnetic moment of a circular coil carrying current is
    a) Directly proportional to the length of the wire in the coil
    b) Inversely proportional to the length of the wire in the coil
    c) Directly proportional to the square of the length of the wire in the coil
    d) Inversely proportional to the square of the length f the wire in the coil

36. A galvanometer of resistance 100 Ω gives a full scale deflection for a current of 10^{-5} A. To convert it into a ammeter capable of measuring upto 1A, we should connect a resistance of
a) 1 Ω in parallel
b) 10^{-3} Ω in parallel
c) 10^{5} Ω in series
d) 100 Ω in series

37. An arc of a circle of radius R subtends an angle $\pi/2$ at the centre. It carries a current i. The magnetic field at the centre will be
a) $\frac{\mu_0 i}{2R}$
b) $\frac{\mu_0 i}{8R}$
c) $\frac{\mu_0 i}{4R}$
d) $\frac{2\mu_0 i}{5R}$

38. The earth's magnetic induction at certain point is $7 \times 10^{-5}\ Wb/m^2$. This is to be annulled by the magnetic induction at the centre of a circular conducting loop of radius 5 cm. The required current in the loop is
a) 0.56 A
b) 5.6 A
c) 0.28 A
d) 2.8 A

39. In a cyclotron, the angular frequency of a charged particle is independent of
a) Mass
b) Speed
c) Charge
d) Magnetic field

40. An electron and a proton are projected at right angles to a uniform magnetic field with the same kinetic energy. Then
a) The electron trajectory will be less curved than proton trajectory
b) The electron trajectory will be more curved than proton trajectory
c) Both the trajectories will be equally curved
d) Both particles continue to move along a straight line

41. The unit of electric current "$ampere$" is the current which when flowing through each of two parallel wires spaced 1 m apart in vacuum and of infinite length will give rise to a force between them equal to
a) $1\ N/m$
b) $2 \times 10^{-7} N/m$
c) $1 \times 10^{-2} N/m$
d) $4\pi \times 10^{-7} N/m$

42. An electron moving in a circular orbit of radius r makes n rotations per second. The magnetic field produced at the centre has a magnitude of
a) $\frac{\mu_0 ne}{2r}$
b) $\frac{\mu_0 n^2 e}{2r}$
c) $\frac{\mu_0 ne}{2\pi r}$
d) Zero

43. A cell is connected between two points of a uniformly thick circular conductor. The magnetic field at the centre of the lop will be
(Here i_1 and i_2 are the currents flowing in the two parts of the circular conductor of radius $'a'$ and μ_0 has the usual meaning)
a) Zero
b) $\frac{\mu_0}{2a}(i_1 - i_2)$
c) $\frac{\mu_0}{2a}(i_1 + i_2)$
d) $\frac{\mu_0}{a}(i_1 + i_2)$

44. An α-particle with a specific charge of $2.5 \times 10^{7}\ C\ kg^{-1}$ moves with a speed of $2 \times 10^{5}\ ms^{-1}$ in a perpendicular magnetic field of 0.05 T. Then the radius of the circular path described by it is
a) 8 cm
b) 4 cm
c) 16 cm
d) 2 cm

45. The magnetic force on a charged particle moving in the field does not work, because
a) Kinetic energy of the charged particle does not change
b) The charge of the particle remains same
c) The magnetic force is parallel to velocity of the particle
d) The magnetic force is parallel to magnetic field

46. A winding wire which is used to frame a solenoid can bear a maximum 10 A current. If length of solenoid is 80 cm and it's cross sectional radius is 3 cm then required length of winding wire is ($B = 0.2\ T$)

a) $1.2 \times 10^2\ m$ b) $4.8 \times 10^2\ m$

c) $2.4 \times 10^3\ m$ d) $6 \times 10^3\ m$

47. A wire in the form of a square of side 'a' carries a current i. Then the magnetic induction at the centre of the square wire is (Magnetic permeability of free space= μ_o)

a) $\frac{\mu_0 i}{2\pi a}$ b) $\frac{\mu_0 i\sqrt{2}}{\pi a}$

c) $\frac{2\sqrt{2}\mu_0 i}{\pi a}$ d) $\frac{\mu_0 i}{\sqrt{2}\pi a}$

48. A small coil of N turns has area A and a current I flows through it. The magnetic dipole moment of this coil will be

a) NI/A b) NI^2A

c) N^2AI d) NIA

49. Two parallel beam of electrons moving in the same direction produce a mutual force

a) Of attraction in plane of paper

b) Of repulsion in plane of paper

c) Upwards perpendicular to plane of paper

d) Downward perpendicular to plane of paper

50. A proton, a deuteron and an $\alpha -$ particle with the same kinetic energy enter a region of uniform magnetic field moving at right angles to B. What is the ratio of the radii of their circular paths?

a) $1 : \sqrt{2} : \sqrt{2}$ b) $1 : \sqrt{2} : 1$

c) $\sqrt{2} : 1 : 1$ d) $\sqrt{2} : \sqrt{2} : 1$

51. The forces existing between two parallel current carrying conductors is F. If the current in each conductor is doubled, then the value of force will be

a) $2F$ b) $4\ F$

c) $5\ F$ d) $F/2$

52. An electron and a proton have equal kinetic energies. They enter in a magnetic field perpendicular to B, then

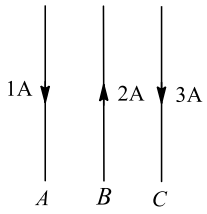
a) Both will follow a circular path with same radius

b) Both will follow a helical path

c) Both will follow a parabolic path

d) All the statements are false

53. Three infinite straight wires $A, B\ and\ C$ carry currents as shown. The net force on the wire B is directed



a) Toward A b) Toward C

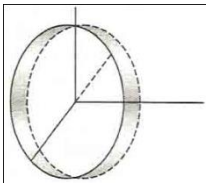
c) Normal to plane of paper d) zero

54. A beam of electrons and protons move parallel to each other in the same direction, then they

a) Attract each other b) Repel each other

c) No relation d) Neither attract nor repel

55. Two insulated rings, one of slightly smaller diameter than the other are suspended along the common diameter as shown. Initially the planes of the rings are mutually perpendicular. When a steady current is set up in each of them,



a) The two rings rotate into a common plane
b) The inner ring oscillates about its initial position
c) The inner rings stays stationary while the outer one moves into plane of the inner ring
d) The outer ring stays stationary while the inner one moves into plane of the outer ring

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

a) nB b) n^2B
c) $2nB$ d) $2n^2B$

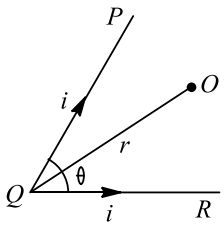
57. An ammeter has resistance R_0 and $range$ I. What resistance should be connected in parallel with it to increase its range by nI?

a) $R_0/(n-1)$ b) $R_0/(n+1)$
c) R_0/n d) None of these

58. A man carrying suitable instruments for measuring electric and magnetic field passes by a stationary electron with velocity V. Then these instruments will note

a) Electric field b) Magnetic field
c) Both a and b d) None of these

59. Two wires PQ and QR, carry equal currents i as shown in figure. One end of both the wires extends to infinity $\angle PQR = \theta$. The magnitude of the magnetic field at O on the bisector angle of these two wires at a distance r $from$ $point$ Q is



a) $\frac{\mu_0}{4\pi}\frac{i}{r}sin\left(\frac{\theta}{2}\right)$ b) $\frac{\mu_0}{4\pi}\frac{i}{r}cot\left(\frac{\theta}{2}\right)$
c) $\frac{\mu_0}{4\pi}\frac{i}{r}tan\left(\frac{\theta}{2}\right)$ d) $\frac{\mu_0}{4\pi}\frac{i}{r}\frac{(1+cos\theta/2)}{(sin\,\theta/2)}$

60. If two streams of protons move parallel to each other in the same direction, then they

a) Do not exert any force on each other
b) Repel each other
c) Attract each other
d) Get rotated to be perpendicular to each other

61. The magnetic field at the point of intersection of diagonals of a square wire loop of side L carrying a current I is

a) $\frac{\mu_0 I}{\pi L}$ b) $\frac{2\mu_0 I}{\pi L}$
c) $\frac{\sqrt{2}\mu_0 I}{\pi L}$ d) $\frac{2\sqrt{2}\mu_0 I}{\pi L}$

62. A short bar magnet placed with its axis at30°, with a uniform external magnetic field of 0.25 T experiences a torque of 4.5×10^{-2}N-m. Magnetic moment of the magnet is

a) $0.36\ J\ T^{-1}$ b) $0.72\ J\ T^{-1}$

c) $0.18\ J\ T^{-1}$ d) Zero

63. Two parallel wires carrying currents in the same direction attract each other because of

a) Potential difference between them b) Mutual inductance between them

c) Electric force between them d) Magnetic force between them

64. The deflection in a galvanometer falls from 50 division to 20 when a 12 Ω shunt is applied. The galvanometer resistance is

a) $18\ \Omega$ b) $36\ \Omega$

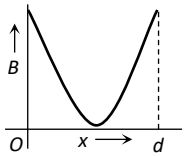
c) $24\ \Omega$ d) $30\ \Omega$

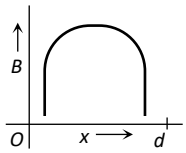
65. A wire of length L is bent in the form of a circular coil and current i is passed through it. If this coil is placed in a magnetic field then the torque acting on the coil will be maximum when the number of turns is

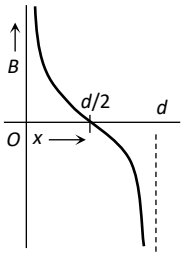
a) As large as possible b) Any number

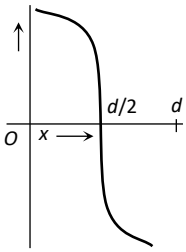
c) 2 d) 1

66. Two parallel beams of protons and electrons, carrying equal currents are fixed at a separation d. The protons and electrons move in opposite directions. P is a point on a line joining the beams, at a distance x from any one beam. The magnetic field at P is B. If B is plotted against x, which of the following best represents the resulting curve

a) 

b) 

c) 

d) 

67. A particle of mass M and charge Q moving with velocity $\vec{v}$ describes a circular path of radius R when subjected to a uniform transverse magnetic field of induction B. The work done by the field when the particle completes one full circle is

a) $BQv2\pi R$ b) $\left(\frac{Mv^2}{R}\right)2\pi R$

c) Zero d) $BQ2\pi R$

68. An electron rotates about a proton, the induced magnetic field is $14T$ at the centre, find out the angular velocity of electron if radius of rotation is 0.5 nm

a) $4.4 \times 10^{17} rad/sec$ b) $4.4 \times 10^{12} rad/sec$

c) $3.14 \times 10^{-15} rad/sec$ d) $4.2 \times 10^{10} rad/sec$

69. 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 part at their common centre is

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

c) $\frac{\mu_0 i}{4R}$ d) $\frac{\mu_0 i}{\sqrt{2}R}$

70. A current carrying loop is free to turn in a uniform magnetic field. The loop will them come into equilibrium when its plane is inclined at
a) 0° to the direction of the field
b) 45° to the direction of the field
c) 90° to the direction of the field
d) 135° to the direction of the field

71. A positive charge is moving towards an observer. The direction of magnetic induction is
a) Clockwise
b) Anticlockwise
c) Right
d) Left

72. If a current is passed in a spring, it
a) Gets compressed
b) Get expanded
c) Oscillates
d) Remains unchanged

73. A metal wire of mass m slides without friction on two rails placed at a distance l aprt. The track lies in a uniform vertical magnetic field B. A constant current i flows along the rails across the wire and brack down the other rail. The acceleration of the wire is
a) $\frac{B\,m\,i}{l}$
b) $mBi\,l$
c) $\frac{Bil}{m}$
d) $\frac{mi\,l}{B}$

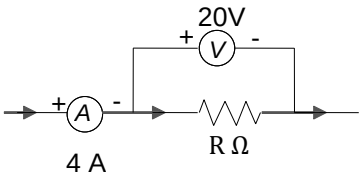
74. We have a galvanometer of resistance 25 Ω. It is shunted by a 2.5 Ω wire. The part of total current i_0 that flows through the galvanometer is given as
a) $(i/i_0) = (1/11)$
b) $(i/i_0) = (1/10)$
c) $(i/i_0) = (1/9)$
d) $(i/i_0) = (2/11)$

75. A particle of mass 0.6 g and having charge of 25 nC is moving horizontally with a uniform velocity $1.2 \times 10^4\ ms^{-1}$ in a uniform magnetic field, then the value of the magnetic induction is $(g = 10\ ms^{-2})$
a) Zero
b) 10 T
c) 20 T
d) 200 T

76. A pulsar is a neutron star having magnetic field is 10^{12} G at its surface. The maximum magnetic force experienced by an electron moving with velocity 0.9 c is
a) 43.2 N
b) 4.32×10^{-3} N
c) 4.32×10^{3} N
d) zero

77. A closely wound flat circular coil of 25 turns of wire has diameter of 10 cm and carries a current of 4 $ampere$. Determine the flux density at the centre of a coil
a) $1.679 \times 10^{-5} tesla$
b) $2.028 \times 10^{-4} tesla$
c) $1.257 \times 10^{-3} tesla$
d) $1.512 \times 10^{-6} tesla$

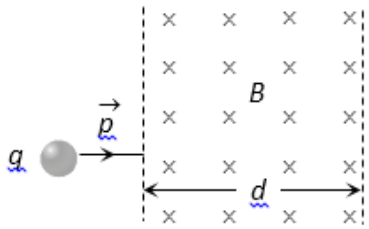
78. A candidate connects a moving coil ammeter A and a moving coil voltmeter V and a resistance R as shown in figure



If the voltmeter reads 20 V and the ammeter reads 4 A, $then$ R is
a) Equal to 5 Ω
b) Greater than 5 Ω
c) Less than 5 Ω
d) Greater or less than 5 Ω depending upon its material

79. A current carrying coil is subjected to a uniform magnetic field. The coil will orient so that its plane becomes
a) Inclined at 45° to the magnetic field
b) Inclined at any arbitrary angle to the magnetic field
c) Parallel to the magnetic field
d) Perpendicular to the magnetic field

80. A particle with charge q, moving with a momentum p, enters a uniform magnetic field normally. The magnetic field has magnitude B and is confined to a region of width d, where $d < \frac{p}{Bq}$. If the particle is deflected by an angle θ in crossing the field, then



a) $sin\,\theta = \frac{Bqd}{p}$ b) $sin\,\theta = \frac{p}{Bqd}$

c) $sin\,\theta = \frac{Bp}{qd}$ d) $sin\,\theta = \frac{pd}{Bq}$

81. A current carrying circular loop is freely suspended by a long thread. The plane of the loop will point in the direction

a) Wherever left free b) North-south

c) East-west d) At 45° with the east-west direction

82. 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 $\frac{a}{2}$ and $2a$ is

a) $\frac{1}{4}$ b) 4

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

83. Uniform magnetic B is directed vertically upwards and 3 wires of equal length L, carrying equal current i are lying in a horizontal plane such that the first one is along north, second one along north-east and the third one at 60° north of east. Force exerted by magnetic field B on them is

a) Zero on the first b) $\frac{BiL}{\sqrt{2}}$ on the second

c) $\sqrt{3}\frac{BiL}{2}$ on the third d) BiL on all of them

84. A particle of charge e and mass m moves with a velocity v in a magnetic field B applied perpendicular to the motion of the particle. The radius r of its path in the field is

a) $\frac{Bv}{em}$ b) $\frac{ev}{Bm}$

c) $\frac{Be}{mv}$ d) $\frac{mv}{Be}$

85. A conduction rod of 1 m length and 1 kg mass is suspended by two vertical wires through its ends. An external magnetic field of 2 T is applied normal to the rod. Now the current to be passed through the rod so as to make the tension in the wires zero is
$[Take\ g = 10\ ms^{-2}]$

a) 0.5 A b) 15 A

c) 5 A d) 1.5 A

86. A straight wire of length 0.5 $metre$ and carrying a current of 1.2 $ampere$ is placed in a 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

87. A moving charge will gain energy due to the application of

a) Electric field b) Magnetic field

c) Both of these d) None of these

88. Two concentric coils of 10 turns each are placed in the same plane. Their radii are 20 cm and 40 cm and carry 0.2 A and 0.3 A current respectively in opposite directions. The magnetic induction (in tesla) at the centre is

a) $\frac{3}{4}\mu_0$ b) $\frac{5}{4}\mu_0$

c) $\frac{7}{4}\mu_0$ d) $\frac{9}{4}\mu_0$

89. Two particles of masses m_a *and* m_b and same charge are projected in a perpendicular magnetic field. They travel along circular paths of radius r_a *and* r_b such that $r_a > r_b$. Then which is true?

a) $m_a\, v_a > m_b\, v_b$ b) $m_a > m_b$ *and* $v_a > v_b$

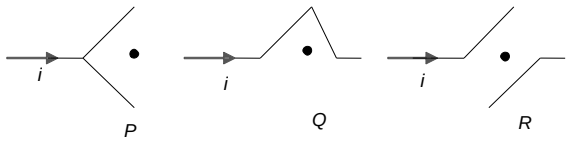
c) $m_a = m_b$ *and* $v_a = v_b$ d) $m_b\, v_b > m_a\, v_a$

90. The maximum velocity to which a proton can be accelerated in a cyclotron of 10 MHz frequency and radius 50 cm is

a) $6.28 \times 10^8\ m/s$ b) $3.14 \times 10^8\ m/s$

c) $6.28 \times 10^7\ m/s$ d) $3.14 \times 10^7\ m/s$

91. Two thick wires and two thin wires, all of same material and same length, form a square in three different ways P, Q *and* R as shown in the figure. With correct connections shown, the magnetic field due to the current flow, at the centre of the loop will be zero in case of



a) Q *and* R b) P *only*

c) P *and* Q d) P *and* R

92. A charged particle enters a magnetic field H with its initial velocity making an angle of 45° with H. The path of the particle will be

a) A straight line b) A circle

c) An ellipse d) A helix

93. Which is a vector quantity

a) Density b) Magnetic flux

c) Intensity of magnetic field d) Magnetic potential

94. 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) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1+i_2)}$

95. The magnetic field at the centre of a circular coil of radius r carrying current I is B_1. The field at the centre of another coil of radius $2\,r$ carrying same current I is B_2. The ratio $\frac{B_1}{B_2}$ is

a) 1/2 b) 1

c) 2 d) 4

96. A proton, a deutron and an $\alpha-$ particle having the same kinetic energy are moving in circular trajectories in a constant magnetic field. If r_p, r_d and r_α denote respectively the radii of the trajectories of these particles, then

a) $r_\alpha = r_d > r_p$ b) $r_\alpha = r_d = r_p$

c) $r_\alpha < r_d < r_p$ d) $r_\alpha = r_p < r_d$

97. One $Tesla$ is equal to
a) $10^7 gauss$ b) $10^{-4} gauss$
c) $10^4 gauss$ d) $10^{-8} gauss$

98. A vertical straight conductor carries a current vertically upwards. A point P lies to the east of it at a small distance and another point Q lies to the west at the same distance. The magnetic field at P is
a) Greater than at Q
b) Same as at Q
c) Less than at Q
d) Greater or less than at Q depending upon the strength of the current

99. Magnetic fields at two points on the axis of a circular coil at a distance of $0.05\ m$ and $0.2m$ from the centre are in the ratio 8:1. The radius of the coil is
a) $1.0\ m$ b) $0.1\ m$
c) $0.15\ m$ d) $0.2\ m$

100. A triangular loop of side l carries a current I. It is placed in a magnetic field B such that the plane of the loop is in the direction of B. The torque on the loop is
a) Zero b) IBl
c) $\frac{\sqrt{3}}{2} Il^2 B^2$ d) $\frac{\sqrt{3}}{4} IBl^2$

101. A particle mass m and charge q enters a magnetic field B perpendicularly with a velocity v. The radius of the circular path described by it will be
a) Bq/mv b) mq/Bv
c) mB/qv d) mv/Bq

102. A uniform electric field and a uniform magnetic field exist in a region in the same direction. An electron is projected with a velocity pointed in the same direction. Then the electron will
a) Be deflected to the left without increase in speed
b) Be deflected to the right without increase in speed
c) Not be deflected but its speed will decrease
d) Not be deflected but its speed will increase

103. The radius of curvature of the path of the charged particle in a uniform magnetic field is directly proportional to
a) The charge on the particle b) The momentum of the particle
c) The energy of the particle d) The intensity of the field

104. A straight wire carrying current i is turned into a circular loop. If the magnitude of magnetic moment associated with it in MKS unit is M, the length of wire will be
a) $\frac{4\pi}{M}$ b) $\sqrt{\frac{4\,\pi\,M}{i}}$
c) $\sqrt{\frac{r\,\pi\,i}{M}}$ d) $\frac{M\,\pi}{4\,i}$

105. Maximum kinetic energy of the positive ion in the cyclotron is
a) $\frac{q^2 B r_0}{2m}$ b) $\frac{qB^2 r_0}{2m}$
c) $\frac{q^2 B^2 r_0^2}{2m}$ d) $\frac{qBr_0}{2m^2}$

106. A steady current i flows in a small square loop of wire of side l in a horizontal plane. The loop is now folded about its middle such that half of it lies in a vertical plane. Let $\widehat{M}_1$ and $\widehat{M}_2$ respectively denote the magnetic moments due to current loop before and after folding. Then
a) $\widehat{M}_2 = 0$ b) $\widehat{M}_1$ and $\widehat{M}_2$ are in the same direction
c) $M_1/M_2 = \sqrt{2}$ d) $M_1/M_2 = 1/\sqrt{2}$

107. 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) $1/2\ Q\omega R^2$

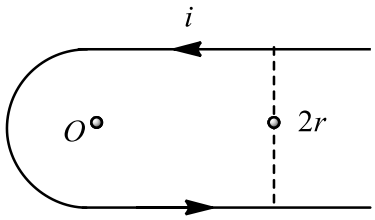
c) $Q\omega^2 R$ d) $1/2\ Q\omega^2 R$

108. An ammeter has a resistance of $G\ \Omega$ and a range of i ampere. The value of resistance used in parallel to convert in into an ammeter of range in ampere is

a) $n\ G$ b) $(n-1)G$

c) $\frac{G}{n}$ d) $\frac{G}{n-1}$

109. In the figure shown, the magnetic field induction at the point O will be



a) $\frac{\mu_0 i}{2\pi r}$ b) $\left(\frac{\mu_0}{4\pi}\right)\left(\frac{i}{r}\right)(\pi+2)$

c) $\left(\frac{\mu_0}{4\pi}\right)\left(\frac{i}{r}\right)(\pi+1)$ d) $\frac{\mu_0}{4\pi}\frac{i}{r}(\pi-2)$

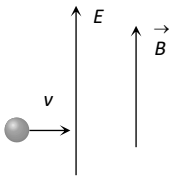
110. A current carrying small loop behaves like a small magnet. If A be its area and M its magnetic moment, the current in the loop will be

a) M/A b) A/M

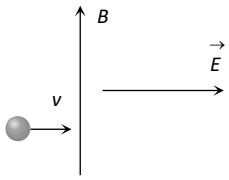
c) MA d) A^2M

111. A uniform magnetic field B and a uniform electric field E, act in a common region. An electron is entering this region of space. The correct arrangement for it to escape undeviated is

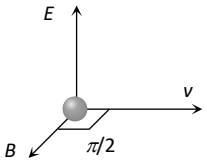
a)



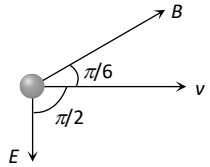
b)



c)



d)



112. A uniform magnetic field B is acting from south to north and is of magnitude 1.5 wb/m^2. If a proton having mass $= 1.7 \times 10^{-27} kg$ and charge $= 1.6 \times 10^{-19} C$ moves in this field vertically downward with energy 5 MeV, then the force acting on it will be

a) $7.4 \times 10^{12}\ N$ b) $7.4 \times 10^{-12}\ N$

c) $7.4 \times 10^{19}\ N$ d) $7.4 \times 10^{-19}\ N$

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

a) $2 \times 10^{-4} N$, attractive b) $2 \times 10^{-4} N$, repulsive

c) $2 \times 10^{-7} N$, attractive d) $2 \times 10^{-7} N$, repulsive

114. A cyclotron is used to accelerate protons, deuterons α – particle etc. If the energy attained, after acceleration, by the protons is E, the energy attained by α – particles shall be

a) $4\,E$ b) $2E$

c) E d) $E/4$

115. Two long conductors, separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3 d. The new value of the force between them is

a) $-2\,F$ b) $F/3$

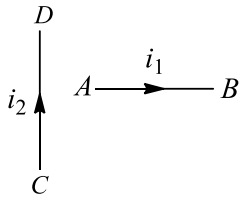
c) $-2F/3$ d) $-F/3$

116. Magnetic effect of current was discovered by

a) Faraday b) Oersted

c) Ampere d) Bohr

117. A current i_1 carrying wire AB is placed near an another long wire CD carrying current i_2 as shown in figure. If free to move, wire AB will have



a) Rotational motion only

b) Translational motion only

c) Rotational as well as translational motion

d) Neither rotational nor translational motion

118. A beam of electrons passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off and the same magnetic field is maintained the electrons move

a) In an elliptical orbit b) In a circular orbit

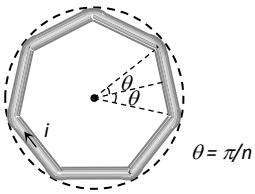
c) Along a parabolic path d) Along a straight line

119. A charged particle enters a uniform magnetic field with a certain speed at right angles to it. In the magnetic field a change could occur in its

a) Kinetic energy b) Angular momentum

c) Linear momentum d) Speed

120. In the following figure a wire bent in the form of a regular polygon of n sides is inscribed in a circle of radius a. Net magnetic field at centre will be



a) $\frac{\mu_0 i}{2\pi a} tan\frac{\pi}{n}$ b) $\frac{\mu_0 ni}{2\pi a} tan\frac{\pi}{n}$

c) $\frac{2}{\pi}\frac{ni}{a}\mu_0\, tan\frac{\pi}{n}$ d) $\frac{ni}{2a}\mu_0\, tan\frac{\pi}{n}$

121. An electron enters a magnetic field whose direction is perpendicular to the velocity of the electron. Then

a) The speed of the electron will increase

b) The speed of the electron will decrease

c) The speed of the electron will remain the same

d) The velocity of the electron will remain the same

122. A charged particle moving in a magnetic field experiences a resultant force
   a) In the direction of field
   b) In the direction opposite to the field
   c) In the direction perpendicular to both the field and its velocity
   d) None of the above

123. In the above question, the magnetic induction at O due to the whole length of the conductor is
   a) $\frac{\mu_0 i}{r}$ b) $\frac{\mu_0 i}{2r}$
   c) $\frac{\mu_0 i}{4r}$ d) Zero

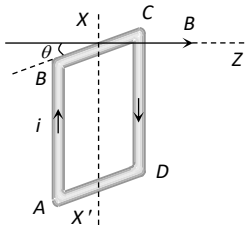
124. A magnetic field can be produced by
   a) A moving charge b) A changing electric field
   c) None of these d) Both of these

125. A coil carrying electric current is placed in uniform magnetic field, then
   a) Torque is formed b) E.M.f. is induced
   c) Both (a) and (b) are correct d) None of these

126. Potential energy of a bar magnet of magnetic moment M placed in a magnetic field of induction B such that it makes an angle θ with the direction of B is
   a) $MB\ sin\ \theta$ b) $-MB\ cos\theta$
   c) $MB(1 - cos\theta)$ d) $MB(1 + cos\theta)$

127. Two magnets have the same length and the same pole strength. But one of the magnets has a small hole at its center. Then
   a) Both the equal magnetic moment
   b) One with hole has smaller magnetic moment
   c) One with hole has large magnetic moment
   d) One with hole has loses magnetism through the hole

128. The square loop $ABCD$, carrying a current i, is placed in uniform magnetic field B, as shown. The loop can rotate about the axis XX'. The plane of the loop makes an angle θ ($\theta < 90°$) with the direction of B. Through what angle will the loop rotate by itself before the torque on it becomes zero



   a) θ b) $90° - \theta$
   c) $90° + \theta$ d) $180° - \theta$

129. A circular coil of 20 turns and radius 10 cm is placed in uniform magnetic field of 0.10 T normal to the plane of the coil. If the current in coil is 5 A, then the torque acting on the coil will be
   a) 31.4 Nm b) 3.14 Nm
   c) 0.314 Nm d) zero

130. A charged particle is moving in a uniform magnetic field in a circular path. Radius of circular path is R. When energy of particle is doubled, then new radius will be
   a) $R\sqrt{2}$ b) $R\sqrt{3}$
   c) $2\ R$ d) $3\ R$

131. 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) Angles between $\vec{V}$ and $\vec{B}$ can have any value other than zero and 180°
   b) Angel between $\vec{V}$ and $\vec{B}$ is either zero or 180°
   c) Angle between $\vec{V}$ and $\vec{B}$ is necessarily 90°
   d) Angle between $\vec{V}$ and $\vec{B}$ can have any value other than 90°

132. A current carrying conductor produces
a) Only electric field b) Only magnetic field
c) Both electric and magnetic fields d) Neither electric nor magnetic field

133. The direction of magnetic lines of force produced by passing a direct current in a conductor is given by
a) Lenz's law b) Fleming' left hand rule
c) Right hand palm rule d) Maxwell's law

134. "On flowing current in a conducting wire the magnetic field produces around it." It is a law of
a) Lenz b) Ampere
c) Ohm d) Maxwell

135. A proton moving with a velocity $2.5 \times 10^7\ m/s$, enters a magnetic field of intensity $2.5T$ making an angle 30° with the magnetic field. The force on the proton is
a) $3 \times 10^{-12}N$ b) $5 \times 10^{-12}N$
c) $6 \times 10^{-12}N$ d) $9 \times 10^{-12}N$

136. A charge particle of mass m and charge q enters a region of uniform magnetic field **B** perpendicular of its velocity **v**. The particle initially at rest was accelerated by a potential difference V (volts) before it entered the region of magnetic field. What is the diameter of the circular path followed by the charged particle in the region of magnetic field?
a) $\frac{2}{B}\sqrt{\frac{mV}{q}}$ b) $\frac{2}{B}\sqrt{\frac{2mV}{q}}$
c) $B\sqrt{\frac{2mV}{q}}$ d) $\frac{B}{q}\sqrt{\frac{2mV}{B}}$

137. A proton, a deutron and a α- particle enter a magnetic field perpendicular to field with same velocity. What is the ratio of the radii of circular paths?
a) $1:2:2$ b) $2:1:1$
c) $1:1:2$ d) $1:2:1$

138. A circular coil carrying a certain current produces a magnetic field B_0 at its centre. The coil is now rewound so as to have 3 turns and the same current is passed through it. The new magnetic field at the centre is
a) $\frac{B_0}{9}$ b) $9B_0$
c) $\frac{B_0}{3}$ d) $3B_0$

139. Energy in a current carrying coil is stored in the form of
a) Electrical energy b) Magnetic field
c) Heat d) None of these

140. A long hollow copper tube carries a current I. Then which of the following will be true?
a) The magnetic field B will be zero at all points inside the tube
b) The magnetic field B will be zero only at points on the axis of the tube
c) The magnetic field B will be maximum at points on the axis of the tube
d) The magnetic field will be zero at any point outside the tube

141. An electron enters a region where electrostatic field is $20N/C$ and magnetic field is $5T$. If electron passes undeflected through the region, the velocity of electron will be
a) $0.25ms^{-1}$ b) $2ms^{-1}$
c) $4ms^{-1}$ d) $8ms^{-1}$

142. To make the field radial in a moving coil galvanometer
a) The number of turns in the coil is increased
b) Magnet is taken in the form of horse-shoe
c) Poles are cylindrically cut
d) Coil is wounded on aluminium frame

143. When the current flowing in a circular coil is doubled and the number of turns of the coil in it is halved, the magnetic field at its centre will become

a) Four times b) Same

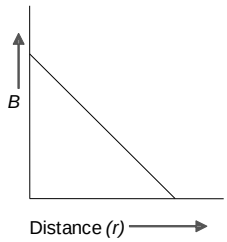
c) Half d) Double

144. Biot-Savart's law may be represented in vector form as

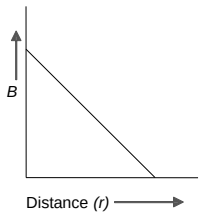
a) $\boldsymbol{dB} = \frac{\mu_0}{4\pi} i \frac{\boldsymbol{dl}\times\boldsymbol{r}}{r^3}$ b) $\boldsymbol{dB} = \frac{\mu_0}{4\pi} i\, \boldsymbol{dl} \times \boldsymbol{r}$

c) $\boldsymbol{dB} = \frac{\mu_0}{4\pi} i \frac{\boldsymbol{dl}\times\boldsymbol{r}}{r^2}$ d) $\boldsymbol{dB} = \frac{\mu_0}{4\pi} i \frac{\boldsymbol{dl}\times\boldsymbol{r}}{r}$

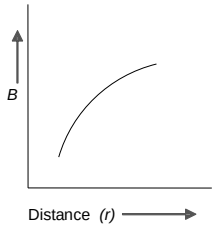
145. Which of the following graphs represent variation of magnetic field B with distance r for a straight long wire carrying current?



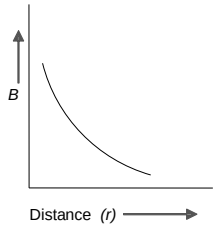
a)



b)



c)



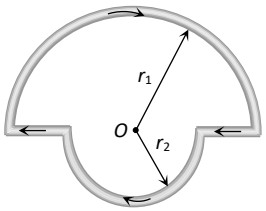
d)

146. An electron, a proton, a deuteron and an alpha particle, each having the same speed are in a region of constant magnetic field perpendicular to the direction of the velocities of the particles. The radius of the circular orbits of these particles are respectively R_e, R_p, R_d and R_α. If follows that

a) $R_e = R_p$ b) $R_p = R_d$

c) $R_d = R_\alpha$ d) $R_p = R_\alpha$

147. In the figure shown there are two semicircles of radii r_1 and r_2 in which a current i is flowing. The magnetic induction at the centre O will be



a) $\frac{\mu_0 i}{r}(r_1 + r_2)$ b) $\frac{\mu_0 i}{4}(r_1 - r_2)$

c) $\frac{\mu_0 i}{4}\left(\frac{r_1+r_2}{r_1 r_2}\right)$ d) $\frac{\mu_0 i}{4}\left(\frac{r_2-r_1}{r_1 r_2}\right)$

148. The magnetic field at the centre of current carrying coil is

a) $\frac{\mu_0 ni}{2r}$ b) $\frac{\mu_0}{2\pi}\frac{\text{ni}}{r}$

c) $\frac{\mu_0 ni}{4r}$ d) $\mu_0 ni$

149. If a particle of charge $10^{-12}\ C$ moving along the x-direction with a velocity of $10^5\ m/s$ experience a force of $10^{-10}\ N$ in y-direction due to magnetic field, then the minimum value of magnetic field is

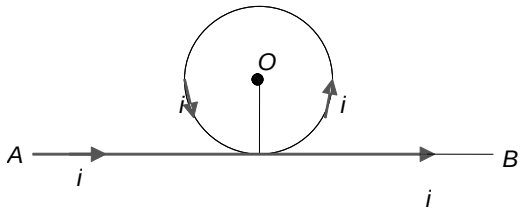
a) $6.25 \times 10^3\ T\ in\ z - direciton$ b) $10^{-15}\ T\ in\ z - direction$

c) $6.25 \times 10^{-3}\ T\ in\ z - direction$ d) $10^{-3}\ T\ in\ z - direciton$

150. An electron is travelling along the x-direction. It encounters a magnetic field in the y-direction. Its subsequent motion will be

a) Straight line along the x-direction
b) A circle in the xz-plane
c) A circle in the yz-plane
d) A circle in the xy-plane

151. A part of a long wire carrying a current i is bent into a circle of radius r as shown in figure. The net magnetic field at the centre O of the circular loop is



a) $\frac{\mu_0 i}{4r}$
b) $\frac{\mu_0 i}{2r}$
c) $\frac{\mu_0 i}{2\pi r}(\pi + 1)$
d) $\frac{\mu_0 i}{2 \pi r}(\pi - 1)$

152. Electrons move at right angles to a magnetic field of $1.5 \times 10^{-2} tesla$ with a speed of $6 \times 10^{7} m/s$. If the specific charge of the electron is $1.7 \times 10^{11} C/kg$, the radius of the circular path will be

a) 2.9 cm
b) 3.9 cm
c) 2.35 cm
d) 3 cm

153. In order to increase the sensitivity of a moving coil galvanometer, one should decrease

a) The strength of its magnet
b) The torsional constant of its suspension
c) The number of turns in its coil
d) The area of its coil

154. The resultant magnetic moment of neon atom will be

a) Infinity
b) μ_B
c) Zero
d) $\mu_B/2$

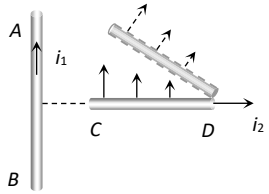
: ANSWER KEY :

1)	c	2)	c	3)	b	4)	a	5)	b	6)	c	7)	a	8)	b
9)	d	10)	d	11)	b	12)	d	13)	b	14)	c	15)	d	16)	c
17)	c	18)	c	19)	b	20)	c	21)	d	22)	c	23)	d	24)	b
25)	a	26)	c	27)	d	28)	b	29)	c	30)	a	31)	d	32)	c
33)	a	34)	a	35)	c	36)	b	37)	b	38)	b	39)	b	40)	b
41)	b	42)	a	43)	a	44)	c	45)	a	46)	c	47)	c	48)	d
49)	b	50)	b	51)	b	52)	d	53)	a	54)	a	55)	a	56)	b
57)	c	58)	c	59)	d	60)	b	61)	d	62)	a	63)	d	64)	a
65)	d	66)	c	67)	c	68)	a	69)	a	70)	c	71)	b	72)	a
73)	c	74)	c	75)	c	76)	b	77)	c	78)	b	79)	d	80)	a
81)	c	82)	c	83)	d	84)	d	85)	c	86)	b	87)	a	88)	b
89)	a	90)	d	91)	d	92)	d	93)	c	94)	c	95)	c	96)	a
97)	c	98)	b	99)	b	100)	d	101)	d	102)	c	103)	b	104)	b
105)	c	106)	c	107)	b	108)	d	109)	b	110)	a	111)	c	112)	b
113)	a	114)	c	115)	c	116)	b	117)	c	118)	b	119)	c	120)	b
121)	c	122)	c	123)	c	124)	d	125)	a	126)	b	127)	b	128)	c
129)	d	130)	a	131)	a	132)	b	133)	c	134)	b	135)	b	136)	d
137)	a	138)	b	139)	b	140)	d	141)	c	142)	c	143)	b	144)	a
145)	d	146)	c	147)	c	148)	a	149)	d	150)	b	151)	c	152)	c
153)	b	154)	c												

: HINTS AND SOLUTIONS :

1 **(c)**

Since the force on the rod CD is non-uniform it will experience force and torque. From the left hand side it can be seen that the force will be upward and torque is clockwise



2 **(c)**

Magnetic field at the centre of a current carrying loop is given by

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

Here, $n =$ no. of turns in loop

$i =$ current, $r_1 =$ radius of loop, $r_1 = r$

For $n = 1$ turn

$$B = \frac{\mu_0 i}{2r_1} \quad \ldots(i)$$

When $n = 2$ turns and radius $r_2 = \frac{r}{2}, i_2 = i$

$$B_2 = \frac{\mu_0 \times 2 \times i}{2\left(\frac{r}{2}\right)}$$

or $B_2 = \frac{2\mu_0 i \times 2}{2r} \quad \ldots(ii)$

Now, from Eqs. (i) and (ii)

$$\frac{B_2}{B} = 4$$

Hence, $B_2 = 4B$

3 **(b)**

$$F = \frac{\mu_0}{4\pi}\frac{2i_1 i_2}{r} l$$

$$= \frac{10^{-7} \times 2 \times 10 \times 2}{0.1} \times 2 = 8 \times 10^{-5}\ N$$

4 **(a)**

$\tau = NBiA = 100 \times 0.2 \times 2 \times (0.08 \times 0.1) = 0.32N \times m$

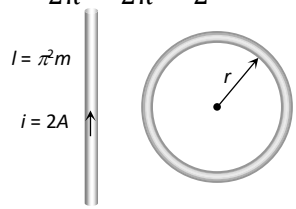
Direction can be found by Fleming's left hand rule

5 **(b)**

If a wire of length l is bent in the form of a circle of radius r then $2\pi r = l \Rightarrow$

$$r = \frac{l}{2\pi}$$

$$r = \frac{l}{2\pi} = \frac{\pi^2}{2\pi} = \frac{\pi}{2}$$



Magnetic field due to straight wire $B_1 = \frac{\mu_0}{4\pi}.\frac{2i}{r} = \frac{\mu_0}{4\pi} \times \frac{2\times 2}{1\times 10^{-2}}$ also magnetic field due to circular loop

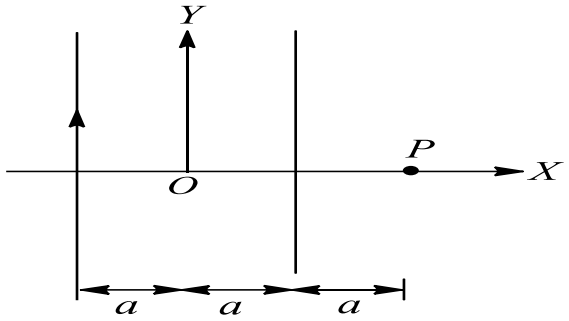
$$B_2 = \frac{\mu_0}{4\pi}.\frac{2\pi i}{r} = \frac{\mu_0}{4\pi}.\frac{2\pi \times 2}{\pi/2} \Rightarrow \frac{B_2}{B_1} = \frac{1}{50}$$

6 **(c)**

Current corresponding to the beams of protons and electrons are in opposite direction. Therefore, both will experience a force of repultion and therefore move more apart.

7 **(a)**

For a circular coil of radius a carrying a current i, the magnetic field at point P, distance x from coil is given by



$$B = \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}}\ NA^{-1}\ m^{-1} \qquad \ldots (i)$$

At the centre of coil $x = 0$

$$\therefore B' = \frac{\mu_0 i}{2a}\ NA^{-1}\ m^{-1} \qquad \ldots (ii)$$

Given, $B = \frac{1}{8} B'$

$$\therefore \frac{\mu_0 i a^2}{2(a^2 + x^2)^{3/2}} = \frac{1}{8}\left(\frac{\mu_0 i}{2a}\right)$$

$$\Rightarrow \frac{a^2}{(a^2 + x^2)^{3/2}} = \frac{1}{8a}$$

$$\Rightarrow 8a^3 = (a^2 + x^2)^{3/2}$$

$$\Rightarrow a^2 + x^2 = 4a^2$$

$$\Rightarrow x = \sqrt{3.a}$$

Given, $a = R$

$$\therefore x = \sqrt{3}R$$

8 **(b)**

B at the centre of a coil carrying a current, i is

$B_{Coil} = \frac{\mu_0 i}{2r}$ [upward]

B due to wire $B_{wire} = \frac{\mu_0 i}{2\pi r}$ [downward]

Given $i = 8A; r = 10 \times 10^{-2} m$

$$\frac{\mu_0}{4\pi} = 10^{-7}$$

Magnetic field at centre C,

$B_C = B_{coil} + B_{wire}$

$= \frac{\mu_0 i}{2r}$(upward) $+ \frac{\mu_0 i}{2\pi r}$ [downward]

$$= \frac{\mu_0 i}{2r} - \frac{\mu_0 i}{2\pi r} = \frac{\mu_0 i}{2r}\left(1 - \frac{1}{\pi}\right) \text{ upward}$$

$$= \frac{4\pi \times 10^{-7} \times 8}{2 \times 10 \times 10^{-2}}\left(1 - \frac{1}{3.14}\right) \text{upward}$$

$$= \frac{4 \times 3.14 \times 10^{-7} \times 8 \times 2.14}{2 \times 10 \times 10^{-2} \times 3.14} = 3.424 \times 10^{-5} \text{ upward}$$

9 **(d)**

Magnetic field on the axis of conductor is zero

10 **(d)**

Cyclotron frequency is given by

$$v = \frac{qB}{2\pi m}$$

$$\therefore v = \frac{1.6 \times 10^{-19} \times 6.28 \times 10^{-4}}{2 \times 3.14 \times 1.7 \times 10^{-27}}$$

$$= 0.94 \times 10^4 \approx 10^4 \text{ Hz}$$

11 **(b)**

The field at the midpoint of BC due to AB is $\left(-\frac{\mu_0}{4\pi} \cdot \frac{i}{d/2}\hat{k}\right)$ and the same is due to CD. Therefore the total field is $\left[-\left(\frac{\mu_0 i}{\pi d}\right)\hat{k}\right]$

12 **(d)**

$$B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r} = \frac{\mu_0}{4\pi} \quad \text{or} \quad i = \frac{2\,B\,r}{\mu_0};$$

Also, $A = \pi r^2$ or $r = \left(\frac{A}{\pi}\right)^{1/2}$

Magnetic moment, $M = iA = \frac{2Br}{\mu_0} A$

$$= \frac{2BA}{\mu_0} \times \left(\frac{A}{\pi}\right)^{1/2} = \frac{2\,BA^{3/2}}{\mu_0 \pi^{1/2}}$$

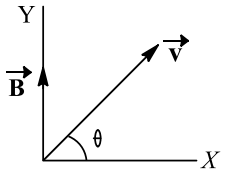
13 **(b)**

In moving coil galvanometer $i \propto \theta$

14 **(c)**

Since, the proton is entering the magnetic field at some angle other than 90°, its path is helix. Component velocity of proto along X-axis,

$v_x = v\cos 60° = 2 \times 10^6 \times 1/2 = 10^6 \text{ ms}^{-1}$



Due to component velocity v_x, the radius of the helix described is given by the relation

$r = \frac{mv_x}{qB} = \frac{1.67\times10^{-27}\times10^6}{1.6\times10^{-19}\times0.104} = 0.1$ m.

Now , $T = \frac{2\pi r}{v_x} = \frac{2\pi\times0.1}{10^6} = 2\pi \times 10^{-7}$s.

15 **(d)**

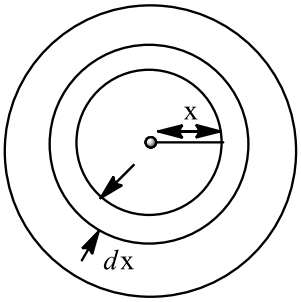
Let us consider the disc to be made up of large number of concentric elementary rings.

Consider one such ring of radius x and thickness dx.

Charge on this elementary ring,

$dq = \sigma \times 2\pi x dx$

$= 2\pi\sigma x dx$



Current associated with this elementary ring,

$dI = \frac{dq}{dt}$

$= dr \times f = \sigma\omega x dx$

Magnetic moment of this elementary ring,

$dM = dI\pi x^2 = \pi\sigma\omega x^3 dx$

∴ Magnetic moment of the entire disc,

$M = \int_0^R dM$

$= \pi\sigma\omega \int_0^R x^3 dx = \frac{1}{4}\pi R^4 \sigma\omega$

16 **(c)**

(2) and (3)

17 **(c)**

In a perpendicular magnetic field, the radius of circular path travelled by electron beam is

$r = \frac{mv}{eB}$

$\therefore \quad r = \frac{9 \times 10^{-31} \times 1.6 \times 10^7}{1.6 \times 10^{-19} \times 0.1}$

$= 9 \times 10^{-4}$ m

18 **(c)**

$B_1/B_2 = r_2/r_1 \quad$ or $\quad B_2 = B_1\, r_1/r_2$

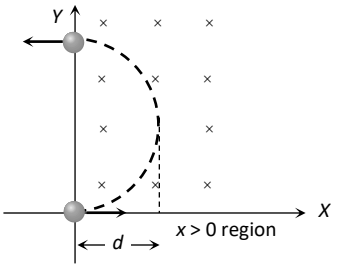
$= 10^{-3} \times 4/1 = 4 \times 10^{-3}$ T

19 **(b)**

It is easy to understand the given problem, along with the following figure

d = radius of path

$= \frac{mv}{qB}$



20 **(c)**

According to Fleming's left hand rule, the direction of magnetic field is towards the east

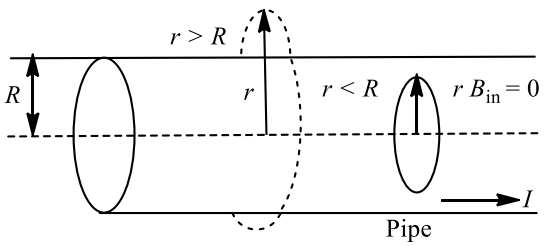
21 **(d)**

$M = niA = ni(\pi r^2) \Rightarrow M \propto r^2$

22 **(c)**

Required arrangement is shown in figure. According to Ampere's circuital law

$B_{out} = \frac{m_0}{4p}\frac{2I}{r}$



For an internal point, r < R

$B_{internal} = \frac{\mu_0(0)}{2\pi r} = 0$

For a point on the pipe, r = R

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

For an external point, r < R

$B_{external} = \frac{\mu_0 I}{2\pi r}$

Therefore, option (c) is correct.

23 **(d)**

In a perpendicular magnetic field,

Magnetic force = centripetal force

ie, $Bqv = \frac{mv^2}{r}$

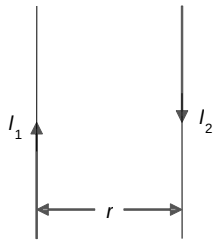
$\Rightarrow \quad r = \frac{mv}{Br} \Rightarrow r \propto v^2$

$\therefore \frac{r_2}{r} = \frac{v_2^2}{v_1^2} = \left(\frac{2v}{v}\right)^2 = 4$

$\Rightarrow r_2 = 4r$

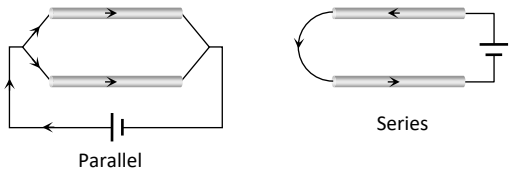
24 **(b)**

According to Fleming's left hand rule, if the two parallel conductors carry currents in opposite direction, they repel each other.



25 **(a)**

When connected in parallel the current will be in the same direction and when connected in series the current will be in the opposite direction



26 **(c)**

Force on wire C due to wire D.

$F_1 = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r} l$ (repulsive)

$= 2 \times 10^{-7} \times \frac{30 \times 10}{3 \times 10^{-2}} \times 25 \times 10^{-2}$

$= 2 \times 10^{-7} \times 2500 = 5 \times 10^{-4}$ N

Force on wire C due to wire G

$F_2 = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r} l$ (repulsive)

$= \frac{2 \times 10^{-7} \times 10 \times 20}{2 \times 10^{-2}} \times 25 \times 10^{-2}$

$= 2 \times 10^{-7} \times 2500 = 5 \times 10^{-4}$ N

Net force $= F_1 - F_2 = 5 \times 10^{-4}$ N $- 5 \times 10^{-4}$ N $= 0$

27 **(d)**

For a point at a distance $x = +a$, the angle between $d\vec{l}$ and $\vec{r}$ is zero. Hence, $d\vec{l} \times \vec{r} = 0$.

28 **(b)**

According to Fleming's left hand rule, in figures (1) and (2) magnetic force on the electron will be directed in – ve z – axis and – ve x – axis respecively. In figure (3) velocity of electron and direction of magnetic field are antiparallel so, no force will act on electron.

29 **(c)**

The magnetic field outside the cylinder at point P is

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

And inside the cylinder at point P

$$B = \frac{\mu_0 Ir}{2\pi R^2}$$

At the axis $r = 0$

So, the magnetic field at the axis of the conductor is zero.

30 **(a)**

Magnetic field due to a long solenoid is given by

$$B = \mu_0 ni$$

From given data,

$6.28 \times 10^{-2} = \mu_0 \times 200 \times 10^2 \times i$ ...(i)

and $B = \mu_0 \times 100 \times 10^2 \times \left(\frac{i}{3}\right)$ ...(ii)

Solving Eqs. (i) and (ii), we get

$$B = 1.05 \times 10^{-2} \text{ Wb/m}^2$$

31 **(d)**

$$F = \frac{\mu_0}{4\pi}\frac{2l^2}{a}$$

$F_1 = \frac{\mu_0}{4\pi}.\frac{2i^2}{x}$ [Attraction]

$F_2 = \frac{\mu_0}{4\pi}\frac{2i \times 2i}{2x} = \frac{\mu_0}{4\pi}\frac{2i_2}{x}$ [Repulsion]

Thus $F_1 = -F_2$

32 **(c)**

$$B = 10^{-7} \times \frac{2i}{r} = 10^{-7} \times \frac{2 \times 1}{1} = 2 \times 10^{-7} T$$

33 **(a)**

If the solenoid is of infinite length and the point taken is inside the solenoid, then

$B_{in} = \mu_0 ni$

$= 4\pi \times 10^{-7} \times \frac{100}{10 \times 10^{-2}} \times 0.5$

$= 6.28 \times 10^{-4}$ T

34 **(a)**

$$\frac{\mu_0 I_c}{2R} = \frac{\mu_0 I}{2\pi H} \Rightarrow H = \frac{I_e R}{\pi I_c}$$

35 **(c)**

$M = NiA \Rightarrow M \propto A \Rightarrow M \propto r^2$ [As $I = 2\pi r \Rightarrow l \propto r$]

$\Rightarrow M \propto l^2$

36 **(b)**

$G = 100\ \Omega$

$I_g = 10^{-5}$ A

$I = 1$ A

$S = ?$

$I_g \times G = (I - I_g) \times S$

$S = \left(\frac{I_g}{I - I_g}\right) \times G = \frac{10^{-5}}{1 - 10^{-5}} \times 100$

Or $= \frac{10^{-3}}{1 - 0.00001} = 10^{-3}\ \Omega$

37 **(b)**

$B = \frac{\mu_0}{4\pi}\frac{\theta i}{r} = \frac{\mu_0}{4\pi} \times \frac{\pi}{2} \times \frac{i}{R} = \frac{\mu_0 i}{8R}$

38 **(b)**

$\frac{\mu_0}{4\pi} \times \frac{2\pi i}{r} = H \Rightarrow \frac{(10^{-7}) \times 2 \times 3.142 \times i}{0.05} = 7 \times 10^{-5}$

$\therefore i = \frac{7 \times 0.05 \times 10^{-5}}{2 \times 3.142 \times 10^{-7}} = \frac{35}{2 \times 3.142} = 5.6$ amp

39 **(b)**

$\omega = \frac{2\pi}{T} = \frac{qB}{m} \Rightarrow \omega \propto v^{\circ} \left[\because T = \frac{2\pi m}{qB}\right]$

40 **(b)**

$r = \frac{mv}{qB} = eV = evB \Rightarrow v = \frac{E}{B}$

Radius of electron's orbit will be more, so proton's trajectory will be less curved.

41 **(b)**

Force per unit length on two parallel current carrying conductors is given by $\frac{F}{l} = 10^{-7} \times 2\frac{i_1 i_2}{a}$

$\Rightarrow \frac{F}{l} = 10^{-7} \times 2 \times \frac{1 \times 1}{1} = 2 \times 10^{-7}$N/m

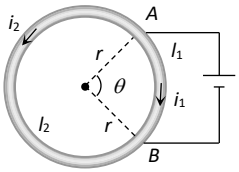
42 **(a)**

Corresponding current $i = en$

So $B = \frac{\mu_0}{4\pi} \cdot \frac{2\pi(en)}{r} = \frac{\mu_0 ne}{2r}$

43 **(a)**

Direction of currents in two parts is different, so direction of magnetic fields due to these currents is opposite. Also applying Ohm's law across AB



$i_1 R_1 = i_2 R_2 \Rightarrow i_1 I_2 = i_2 I_2$

$\left[\because R = \rho\frac{l}{A}\right]$

Also $B_1 = \frac{\mu_0}{4\pi} \times \frac{i_1 l_1}{r^2}$ and $B_2 = \frac{\mu_0}{4\pi} \times \frac{i_2 l_2}{r^2}$ $[\because l = r\theta]$

$\therefore \frac{B_2}{B_1} = \frac{i_1 l_1}{i_2 l_2} = 1$

Hence, two field induction's are equal but of opposite direction. So, resultant magnetic induction at the centre is zero and is independent of θ

44 **(c)**

$$r = \frac{mv}{Bq}$$

$$\Rightarrow \quad r = \frac{v}{B\frac{q}{m}} = \frac{2 \times 10^5}{0.05 \times 2.5 \times 10^7}$$

$$= \frac{2 \times 10^7}{12.5 \times 10^7} = \frac{200}{12.5}\ \text{cm} = 16\ \text{cm}$$

45 **(a)**

Kinetic energy of the charged particle does not change

46 **(c)**

$B = \frac{\mu_0 NI}{l}$, where N = Total number of turns, l = length of the solenoid

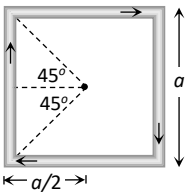
$$\Rightarrow 0.2 = \frac{4\pi \times 10^{-7} \times N \times 10}{0.8} \Rightarrow N = \frac{4 \times 10^4}{\pi}$$

Since N turns are made from the winding wire so length of the wire $(L) = 2\pi r \times N$[$2\pi r$ = length of each turns]

$$\Rightarrow L = 2\pi \times 3 \times 10^{-2} \times \frac{4 \times 10^4}{\pi} = 2.4 \times 10^3 \text{m}$$

47 **(c)**

$$B_0 = 4 \times \frac{\mu_0}{4\pi} \times \frac{i}{(a/2)}[\sin 45° + \sin 45°]$$



$$= 4 \times \frac{\mu_0}{4\pi} \times \frac{2i}{a} \times \frac{2}{\sqrt{2}}$$

$$= \frac{\mu_0 i 2\sqrt{2}}{\pi a}$$

48 **(d)**

Magnetic dipole moment of coil = NIA

49 **(b)**

Of repulsion in plane of paper

50 **(b)**

$$\frac{mv^2}{R} = qvB$$

For proton, $R_p = \frac{mv}{Bq} = \frac{\sqrt{2M_pE}}{q_pB}$

Similarly for deuteron and α-particle

$R_d = \frac{\sqrt{2M_dE}}{q_pB}$ and $R_\alpha = \frac{\sqrt{2M_\alpha E}}{q_\alpha B}$

According to the question

$\therefore R_p : R_d : R_\alpha$

or $\frac{\sqrt{M_p}}{q_p} : \frac{\sqrt{M_d}}{q_d} : \frac{\sqrt{M_\alpha}}{q_a}$

$\therefore \frac{\sqrt{1}}{1} : \frac{\sqrt{2}}{1} : \frac{\sqrt{4}}{2}$ or $1 : \sqrt{2} : 1$

51 **(b)**

As, $F = \frac{\mu_0}{4\pi}\frac{2i_1 i_2}{r}$ ie, $F \propto i_1 i_2$. Therefore force will becomes four time ie, 4F.

52 **(d)**

For such a motion, magnetic force = centripetal force

$$qvB = \frac{mv^2}{r}$$

$$\Rightarrow \quad qB = \frac{mv}{r}$$

$$\Rightarrow \quad r = \frac{mv}{qB}$$

$$\therefore \quad \frac{r_p}{r_c} = \frac{m_p v_p}{qB} \times \frac{qB}{m_e v_e}$$

but $K_e = K_p$ (given)

$$\Rightarrow \quad \frac{1}{2} m_e v_e^2 = \frac{1}{2} m_p v_p^2$$

$$\Rightarrow \quad \frac{m_p}{m_e} = \left(\frac{v_e}{v_p}\right)^2$$

$$\therefore \quad \frac{r_p}{r_e} = \left(\frac{v_e}{v_p}\right)^2 \frac{v_p}{v_e} = \frac{v_e}{v_p}$$

Hence, the electron and proton will follow circular paths but with different radii.

53 **(a)**

Force on wire B due to A,

$F_{BA} = \frac{\mu_0 \times 1 \times 2}{2\pi r} = \frac{\mu_0}{\pi r}$ towards C

Force on wire B due to C

$F_{BC} = \frac{\mu_0 \times 2 \times 3}{2\pi r} = \frac{3\mu_0}{\pi r}$ towards A

Clearly $F_{BC} > F_{BA}$ therefore force on B is directed towards A

54 **(a)**

Attract each other

55 **(a)**

Both the rings rotate due to magnetic field induction of the other, till both come along the common plane.

56 **(b)**

The magnetic field at the centre of circular coil is

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

Where, r = radius of circle $= \frac{l}{2\pi}$ $(\because l = 2\pi r)$

$$\therefore B = \frac{\mu_0 i}{2} \times \frac{2\pi}{l}$$

$$= \frac{\mu_0 i \pi}{l} \quad \ldots (i)$$

When wire of length l bents into a circular loops of n turns, then

$$l = n \times 2\pi r'$$

$$\Rightarrow r' = \frac{1}{n \times 2\pi}$$

Thus, new magnetic field

$$B' = \frac{\mu_0 n i}{2r'} = \frac{\mu_0 n i}{2} \times \frac{n \times 2\pi}{l}$$

$= \frac{\mu_0 i\pi}{l} \times n^2$

$= n^2 B$ [From Eq. (i)]

57 **(c)**

Given, $i_g = i, G = R_0$;

$i = n\,i + i = (n+1)\,i$

$\therefore\ S = \frac{i_g\,G}{i - i_g} = \frac{iR_0}{(n+1)i - i} = \frac{R_0}{n}$

58 **(c)**

A man carrying suitable instruments will measure both electric and magnetic fields when the passes by a stationary electron. If can be solved by assuming the instruments to be at rest and the electron to be moving with velocity V in opposite direction to that of man, due to which there will be magnetic field as well as electric field

59 **(d)**

Perpendicular to O from PQ.

Or QR, $a = r\sin\theta/2$

Magnetic field induction at O due to current through PQ and QR is

$B = \frac{\mu_0}{4\pi}\frac{i}{a}\,[\sin(90° - \theta/2) + \sin 90°]\ \times 2$

$= \frac{\mu_0}{2\pi}\,\frac{i}{\sin\theta/2}(\cos\theta/2 + 1) = \frac{\mu_0}{2\pi}\frac{i}{r}\,\frac{(1+\cos\theta/2)}{\sin\theta/2}$

60 **(b)**

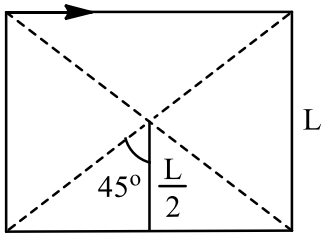
For charge particles, if they are moving freely in space, electrostatic force is dominant over magnetic force between them. Hence due to electric force they repel each other

61 **(d)**

$B = 4\left[\frac{\mu_0}{4\pi}\frac{I}{\left(\frac{1}{2}\right)}\,(\sin 45° + \sin 45°)\right]$

$= \frac{\mu_0}{4\pi}\frac{2I}{L}\cdot\frac{2}{\sqrt{2}}$

$B = \frac{\mu_0}{\pi}\frac{2\sqrt{2}I}{L}$



62 **(a)**

From $\tau = MB\sin\theta, M = \frac{\tau}{B\sin\theta}$

$= \frac{4.5 \times 10^{-2}}{0.25\sin 30°} = 0.36\ JT^{-1}$

63 **(d)**

Two parallel wires carrying currents in the same direction attract each other because magnetic forces on the two wires act towards each other

64 **(a)**

$i = 50\ k;\ i_g = 20k$, where k is the figure of metit of galvanometer; $S = i_g G/(i - i_g)$;

So, $12 = \frac{20k.G}{(50k-20k)}$

On solving we get $G = 18\Omega$.

65 **(d)**

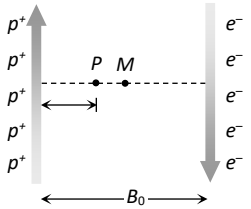
$\tau_{max} = MB$ or $\tau_{max} = ni\pi r^2 B$. Let number of turns in length l be n, so $l = n(2\pi r)$ or $\alpha = \frac{l}{2\pi n}$

$$\Rightarrow \tau_{max} = \frac{ni\pi Bl^2}{4\pi^2 n^2} = \frac{l^2 iB}{4\pi\, n_{min}} \Rightarrow \tau_{max} \propto \frac{1}{n_{min}} \Rightarrow n_{min} = 1$$

66 **(c)**

The magnetic field at point to the right of the proton beam acts perpendicular to the paper inwards (×). The magnetic field at points to the left of the electron beam acts perpendicular to the paper outward (·).

Magnetic field at mid point M is zero



Magnetic field at the points closer to proton beam acts perpendicular to the paper inwards (i. e., (×)) and at the points closer to electron beam it acts outwards i. e., (·). In the given options graph (c) satisfies all the condition

67 **(c)**

$W = F.d\cos 90° = 0$

68 **(a)**

$$B = \frac{\mu_0 I}{2r} \Rightarrow B = \frac{\mu_0}{2r} \times \frac{e\omega}{2\pi} = \frac{\mu_0 e\omega}{4\pi r}$$

$$\Rightarrow 14 = \frac{10^{-7} \times 1.6 \times 10^{-19} \times \omega}{0.5 \times 10^{-9}}$$

$$\Rightarrow \omega = \frac{14 \times 0.5 \times 10^{-9}}{1.6 \times 10^{-26}} = \frac{7}{1.6} \times 10^{26-9}$$

$$\Rightarrow \frac{70}{16} \times 10^{17} = \frac{35}{8} \times 10^{17} = 4.4 \times 10^7 \text{rad/sec}$$

69 **(a)**

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

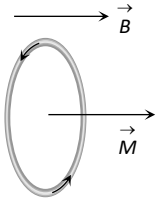
$|\vec{B}_1| = |\vec{B}_2| = \frac{\mu_0 i}{4R}$

$|\vec{B}| = \sqrt{B_1^2 + B_2^2}$

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

70 **(c)**

In equilibrium angle between $\vec{M}$ and $\vec{B}$ is zero. It happens when plane of the coil is perpendicular to $\vec{B}$



71 **(b)**

Anticlockwise

72 **(a)**

In adjoining loops of spring, the current being in the same direction, there will be attraction. Due to which the spring gets compressed.

73 **(c)**

Force on wire, $F = Bil\sin 90° = Bil$. It acts perpendicular to the magnetic field as well as the length of wire. The acceleration in the wire

$$a = \frac{F}{m} = \frac{Bil}{m}$$

74 **(c)**

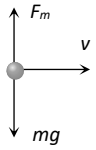
$$i_g = \frac{iS}{G+S} = \frac{i_0 \times 2.5}{25 + 2.5} = \frac{i_0}{9}.$$

75 **(c)**

Particle will move with uniform velocity when it's acceleration is zero

i. e., $|F_m| = mg \Rightarrow mg = qvB$

$$\Rightarrow B = \frac{mg}{qv} = \frac{0.6 \times 10^{-3} \times 10}{25 \times 10^{-9} \times 1.2 \times 10^{4}} = 20\ T$$



76 **(b)**

$F_{max} = evB$

$= (1.6 \times 10^{-19}) \times (0.9 \times 3 \times 10^{8}) \times (10^{8})$

$= 4.32 \times 10^{-3}\ N$

77 **(c)**

$$B = 10^{-7}\frac{2\pi ni}{r} = 10^{-7} \times \frac{2 \times \pi \times 25 \times 4}{5 \times 10^{-2}} = 1.257 \times 10^{-3} T$$

78 **(b)**

Here, $i = 4A; V = 20$ Volt; so,

$R = \frac{V}{I} = \frac{20}{4} = 5A$. Since, voltmeter is connected in parallel with resistance R, the effective resistance of this combination is 5 Ω only if the resistance R is greater than 5Ω, since total resistance in parallel combination becomes less than individual resistance.

79 **(d)**

Torque $\vec{\tau} = \vec{M} \times \vec{B}$ or $\tau = BM\sin\theta$, where $\vec{M}$ is perpendicular to the plane of the coil. Due to this torque, the coil will orient itself so that the torque on the coil is zero. ie, $\theta = 0^0$. It means $\vec{M}$ is parallel to $\vec{B}$. So, the plane of the coil is perpendicular to this direction of magnetic field.

80 **(a)**

From figure it is clear that

$$\sin\theta = \frac{d}{r} \text{ also } r = \frac{p}{qB}$$

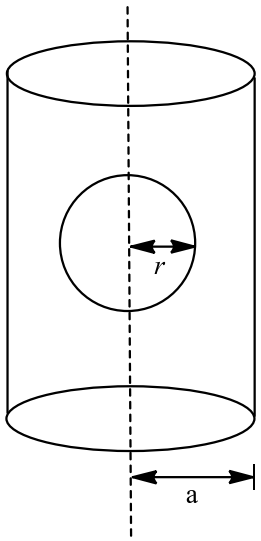
$$\therefore \sin\theta = \frac{Bqd}{p}$$

81 **(c)**

The direction of earth's magnetic field is south to north. Torque on current carrying loop in a uniform magnetic field, $\vec{\tau} = \vec{M} \times \vec{B}$, which will rotate the coil. The loop will come to rest when torque is zero. It will be so if angle between $\vec{M}$ and $\vec{B}$ is zero. ie, magnetic field is perpendicular to the plane of the coil. Therefore, the plane of the coil will be in east-west direction in equilibrium of rest.

82 **(c)**

Current density $J = \frac{i}{\pi a^2}$



From Ampere's circuital law

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

For $r < a$

$B \times 2\pi r = \mu_0 \times J \times \pi r^2$

$\Rightarrow \quad B = \frac{\mu_0 i}{\pi a^2} \times \frac{r}{2}$

At $r = \frac{a}{2}$

$B_1 = \frac{\mu_0 i}{4\pi a}$

For $r > a$

$B \times 2\pi r = \mu_0 i \Rightarrow B = \frac{\mu_0 i}{2\pi r}$

At $r = 2a, \quad B_2 = \frac{\mu_0 i}{4\pi a}$

So, $\frac{B_1}{B_2} = 1$

83 **(d)**

$F = I.(L_{eff})B$

$L_{eff} = L + L\cos 45° + L\sin 60°$

$= L + L \times \frac{1}{\sqrt{2}} + L \times \frac{\sqrt{3}}{2}$

$= L\left(\frac{2 + \sqrt{2} + \sqrt{3}}{2}\right)$

Force on each wire = I. L. B sin θ [Because angle between current element and magnetic field = 90°]

= I. L. B. sin 90° = I. L. B.

84 **(d)**

$r = \frac{mv}{Bq} = \frac{mv}{Be}$

85 **(c)**

Magnetic force on the rod = BIl

Weight of the rod = mg

For no tension in wire, BIl = mg

or $I = \frac{mg}{Bl} = \frac{1\times10}{2\times1} = 5\ A$

86 **(b)**

$F = Bil = 2 \times 1.2 \times 0.5 = 1.2N$

87 **(a)**

A moving charge gains energy in electric field only because in magnetic field energy remains constant

88 **(b)**

Two coils carry currents in opposite directions, hence net magnetic field at centre will be difference of the two fields.

ie, $B_{net} = \frac{\mu_0}{4\pi} . 2\pi N \left[\frac{i_1}{r_1} - \frac{i_2}{r_2}\right]$

$= \frac{10\mu_0}{2}\left[\frac{0.2}{0.2} - \frac{0.3}{0.4}\right]$

$= \frac{5}{4}\mu_0$

89 **(a)**

Radius of circular path $r_a = \frac{m_a v_a}{qB}$

And $r_b = \frac{m_b v_b}{qB}$

According to question

$r_a > r_b$

$\therefore \frac{m_a v_a}{qB} > \frac{m_b v_b}{qB}$

or $m_a v_a > m_b v_b$

90 **(d)**

The motion of proton is magnetic field will be circular.

$v = 2\pi rf$

$= 2 \times 3.14 \times 50 \times 10^{-2} \times 10 \times 10^6$

$= 3.14 \times 10^7\ m/s$

91 **(d)**

In P and R, current divides equally in two halves because of equal resistances in the two halves. Due to equal currents in two halves the magnetic field at the centre will be zero.

92 **(d)**

The component of velocity perpendicular to H will make the motion circular while that parallel to H will make it move along a straight line. The two together will make the motion helical

93 **(c)**

Intensity of magnetic field

94 **(c)**

The point P is lying symmetrically w.r.t. the two long straight current carrying conductors. The magnetic field at P due to these current carrying conductors are mutually perpendicular.

$B_1 = \frac{\mu_0}{2\pi} . \frac{i_1}{a}$

$B_2 = \frac{\mu_0}{2\pi}.\frac{i_2}{a}$

$B = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0}{2\pi a}(i_1^2 + i_2^2)^{1/2}$

95 **(c)**

$B \propto \frac{1}{r} \Rightarrow \frac{B_1}{B_2} = \frac{r_2}{r_1} = \frac{2r}{r} = 2$

96 **(a)**

$r_\alpha = r_d > r_p$

97 **(c)**

1 tesla $= 10^4$ gauss

98 **(b)**

If distance is same, field will be same $\left[\because B = \frac{\mu_0}{4\pi}\cdot\frac{2i}{r}\right]$

99 **(b)**

$B = \frac{\mu_0}{4\pi} \times \frac{2\pi N i R^2}{(R^2 + x^2)^{3/2}} \Rightarrow B \propto \frac{1}{(r^2 + x^2)^{3/2}}$

$\Rightarrow \frac{8}{1} = \frac{(R^2 + x_2^2)^{3/2}}{(R^2 + x_1^2)^{3/2}} \Rightarrow \left(\frac{8}{1}\right)^{2/3} = \frac{R^2 + 0.04}{R^2 + 0.0025}$

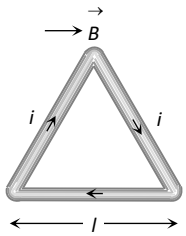
$\Rightarrow \frac{4}{1} = \frac{R^2+0.04}{R^2+0.0025}$. On solving $R = 0.1$ m

100 **(d)**

Since $\theta = 90°$

Hence $\tau = NIAB = 1 \times I \times \left(\frac{\sqrt{3}}{4}l^2\right) B$

$= \frac{\sqrt{3}}{4} l^2 B\, I$



101 **(d)**

mv/Bq

102 **(c)**

Magnetic force on electron = Bev sin θ

= Bev sin 0 = zero

Electron will not be deflected due to magnetic field. Electric force on electron = Ee

This force is opposite to direction of motion of the electron. The speed of electron will decrease. Hence the electron will not be deflected but its speed is decreased

103 **(b)**

$r = \frac{p}{qB} \Rightarrow r \propto p$

104 **(b)**

$l = 2\pi r$ or $r = l/2\pi$

Area of circular loop, $A = \pi r^2$

Magnetic moment $M = lA = i\pi r^2$

$= i\pi \times l^2/4\pi^2$ or $l = \sqrt{4\pi M/i}$

105 **(c)**

$K_{max} = \frac{1}{2}mv^2$ and $r_0 = \frac{mv}{qb} \Rightarrow v = \frac{qBr_0}{m}$

$\Rightarrow K_{max} = \frac{1}{2}m\left(\frac{qBr_0}{m}\right)^2 = \frac{q^2B^2r_0^2}{2m}$

106 **(c)**

$M_1 = l^2 i$, and

$M_2 = \sqrt{\left(\frac{l}{2} \times l \times i\right)^2 + \left(\frac{l}{2} \times l \times i\right)^2} = \frac{l^2 i}{\sqrt{2}}$

$\therefore \quad \frac{M_1}{M_2} = \sqrt{2}$

107 **(b)**

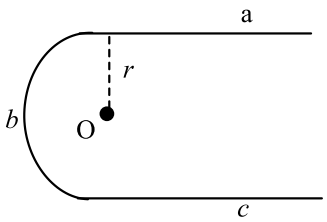
$M = iA = i \times \pi R^2$ also $i = \frac{Q\omega}{2\pi} \Rightarrow M = \frac{1}{2}Q\omega R^2$

108 **(d)**

$S = \frac{i_g G}{i - i_g} = \frac{iG}{ni - i} = \frac{G}{n-1}$

109 **(b)**

Field due to a straight wire of infinite length is $\frac{\mu_0 i}{4\pi r}$ if the point is on a line perpendicular to its length while at the centre of a semicircular coil is $\frac{\mu_0 \pi i}{4\pi r}$.



$\therefore \quad B = B_a + B_b + B_c$

$= \frac{\mu_0}{4\pi}\frac{i}{r} + \frac{\mu_0}{4\pi}\frac{\pi i}{r} + \frac{\mu_0}{4\pi}\frac{i}{r}$

$= \frac{\mu_0}{4\pi}\frac{i}{r}(\pi + 2)$ out of the page

110 **(a)**

$M = iA \Rightarrow i = M/A$

111 **(c)**

For undeviated motion $|\vec{F_e}| = |\vec{F_m}|$, which happens when $\vec{v}, \vec{E}$ and $\vec{B}$ are mutually perpendicular to each other

112 **(b)**

$F = qvB$ and $K = \frac{1}{2}mv^2 \Rightarrow F = qB\sqrt{\frac{2k}{m}}$

$= 1.6 \times 10^{-19} \times 1.5\sqrt{\frac{2 \times 5 \times 10^6 \times 1.6 \times 10^{-19}}{1.7 \times 10^{-27}}}$

$= 7.344 \times 10^{-12} N$

113 **(a)**

$F = \frac{\mu_0}{4\pi}\frac{2i_1 i_2}{a} = 10^{-7} \times \frac{2 \times 10 \times 10}{0.1} = 2 \times 10^{-4} N$

Direction of current is same, so force is attractive

114 **(c)**

Kinetic energy of the ions,

$\frac{1}{2}mv^2 = \frac{q^2B^2R^2}{2m}$

For α particle, the charge is two times that of the proton but mass is 4 times that of the proton

Therefore, compared to proton' kinetic energy, for the same conditions in the cyclotron, energy of alpha particle is E

115 **(c)**

Force acting between two current carrying conductors

$F = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} l$ ... (i)

Where, d = distance between the conductors,

l = length of each conductor.

Again, $F' = \frac{\mu_0}{2\pi}\frac{(-2I_1)(I_2)}{(3d)} . l$

$= -\frac{\mu_0}{2\pi}\frac{2I_1 I_2}{3d} . l$ ... (ii)

Thus, from Eqs. (i) and (ii)

$\frac{F'}{F} = -\frac{2}{3}$

$\Rightarrow \quad F' = -\frac{2}{3} F$

116 **(b)**

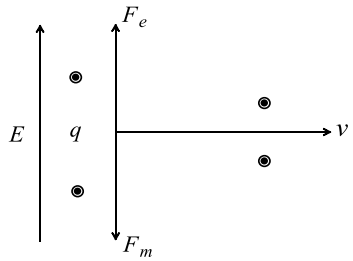
Oersted

117 **(c)**

Since, the magnetic field, due to current through wire CD at various locations on wire AB is not uniform, Therefore, the wire AB, carrying current i_1 is subjected to variable magnetic field. Due to which, neither the force nor the torque on the wire AB will be zero. As a result of which the wire AB will have both translation and rotational motion.

118 **(b)**

If both electric and magnetic fields are present and perpendicular to each other and the particle is moving perpendicular to both of them with $F_e = F_m$. In this situation $\vec{\mathbf{E}} \neq 0$ and $\vec{\mathbf{B}} \neq 0$.



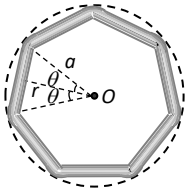
But if electric field becomes zero, then only force due to magnetic field exists. Under this force, the charge moves along a circle

119 **(c)**

Linear momentum

120 **(b)**

Magnetic field at the centre due to one side



$B_1 = \frac{\mu_0}{4\pi}.\frac{2i\sin\theta}{r}$, where $r = a\cos\theta$

So $B_1 = \frac{\mu_0}{4\pi}.\frac{2i\sin\theta}{a\cos\theta} = \frac{\mu_0 i}{2\pi a}\tan\theta$

Hence net magnetic field

$B_{net} = n \times \frac{\mu_0 i}{2\pi a}\tan\frac{\pi}{n}$

121 **(c)**

Force acts perpendicular to the velocity in a magnetic field, so speed of electron will remain same

122 **(c)**

$\vec{F} = q\vec{v} \times \vec{B}$

123 **(c)**

The induction due to AB and CD will be zero. Hence the whole induction will be due to the semicircular part BC. $B = \frac{\mu_0 i}{4r}$

124 **(d)**

A moving charge and changing electric field both produce magnetic field

125 **(a)**

Torque is formed

126 **(b)**

$PE = -MB(\cos\theta_2 - \cos\theta_1)$

When $\theta_1 = 90°$ (position of zero PE), $\theta_2 = \theta$

$PE = -MB\cos\theta$

127 **(b)**

Hole reduces the effective length of the magnet and hence magnetic moment reduces.

128 **(c)**

In the position shown. AB is outside and CD is inside the plane of the paper. The Ampere force on AB acts into the paper. The torque on the loop will be clockwise, as seen from above. The loop must rotate through an angle $(90° + \theta)$ before the plane of the loop becomes normal to the direction of the direction of B and the torque becomes zero

129 **(d)**

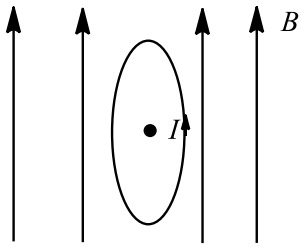
Torque (τ) acting on a loop placed in a magnetic field B is given by

$\tau = nBIA\sin\theta$

Where A is area of loop, I the current through it, n the number of turns, and θ the angle which axis of loop makes with magnetic field B.

Since, magnetic field (B) of coil is parallel to the field applied, hence $\theta = 0°$ and $\sin 0° = 0$

$\therefore \ \tau = 0$



130 **(a)**

$r = \frac{\sqrt{2mK}}{qB} \Rightarrow r \propto \sqrt{K} \Rightarrow \frac{R}{R_2} = \sqrt{\frac{K}{2K}} \Rightarrow R_2 = R\sqrt{2}$

131 **(a)**

Force acting on a charged particle moving with velocity $\vec{v}$ 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 $\theta = 90°, F = qv\sin 90° = qvB$

(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°

132 **(b)**

A current carrying conductor produces magnetic fields only.

133 **(c)**

Right hand palm rule

134 **(b)**

Ampere

135 **(b)**

$F = qvB\sin\theta = 1.6 \times 10^{-19} \times 2.5 \times 2.5 \times 10^{7} \sin 30°$

$F = 1.6 \times 10^{-19} \times 6.25 \times 10^{7} \times \frac{1}{2} = 5 \times 10^{-12}\text{N}$

136 **(d)**

$Bqv = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{Bq}$ ... (i)

Since particle was initially at rest and gained a velocity v due to a potential difference of V volt. So,

KE of particle $= \frac{1}{2}mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}}$ ... (ii)

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

$r = \frac{m}{Bq}\sqrt{\frac{2qV}{m}}$

$r = \frac{1}{B}\sqrt{\frac{2mV}{q}}$

∴ Diameter of the circular path

$d = 2r = \frac{2}{B}\sqrt{\frac{2mV}{q}}$

137 **(a)**

$r = \frac{mv}{Bq}$ or $r \propto \frac{m}{q}$ for the same value of v and B.

$\therefore \quad r_P : r_d : r_\alpha = \frac{m_P}{q_D} : \frac{m_d}{q_d} : \frac{m_\alpha}{q_\alpha}$

$= \frac{m}{l} : \frac{2m}{l} : \frac{4m}{2l} = 1 : 2 : 2$

138 **(b)**

The magnetic field produced at the centre of the circular coil carrying current is given by

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

For one turn $N = 1$

$$B_0 = \frac{\mu_0 I}{2r}$$

As the coil is rewound

$$r' = \frac{r}{3}, \quad N' = 3$$

$$\therefore B' = \frac{\mu_0 I \times 3}{2 \times \left(\frac{r}{3}\right)}$$

$$= \frac{9\mu_0 I}{2r} = 9B_0$$

139 **(b)**

Magnetic field

140 **(d)**

The magnetic field B will be uniform inside the long hollow tube, excepts near the ends. Also magnetic field is zero at any point outside the tube.

141 **(c)**

$$v = \frac{E}{B} = \frac{20}{5} = 4 \text{ m/s}$$

142 **(c)**

Poles are cylindrically cut

143 **(b)**

$$\frac{\mu_0}{4\pi} \cdot \frac{2\pi ni}{r} \Rightarrow B \propto ni$$

144 **(a)**

Biot-Savart's law in vector form is given as

$$\mathbf{dB} = \frac{\mu_0}{4\pi} i \frac{\mathbf{d1} \times \mathbf{r}}{r^3}$$

145 **(d)**

$$B \propto \frac{1}{r}$$

Hence, graph will be a rectangular hyperbola.

146 **(c)**

In perpendicular magnetic field magnetic force = centripetal force.

$\therefore$ By the relation

$$qvB = \frac{mv^2}{r}$$

$$\Rightarrow \quad r = \frac{mv}{qB} \Rightarrow \; r \propto \frac{m}{q}$$

Since, $\frac{m}{q}$ ratio for deuteron and α-particle is same.

$\left(\frac{m}{q} = \frac{4}{2} = 2 \text{ for } \alpha - \text{particle}\right)$ and $\frac{m}{q} = \frac{2}{1} = 2$ for deuteron.

Hence, radius is same for both.

147 **(c)**

The magnetic induction due to both semicircular parts will be in the same direction perpendicular to the paper inwards

$$\therefore B = B_1 + B_2 = \frac{\mu_0 i}{4r_1} + \frac{\mu_0 i}{4r_2} = \frac{\mu_0 i}{4}\left(\frac{r_1 + r_2}{r_1 r_2}\right) \otimes$$

148 **(a)**

Magnetic field at the centre of current carrying coil is

$$B = \frac{\mu_0}{4\pi}.\frac{2\pi ni}{r} = \frac{\mu_0 ni}{2r}$$

149 **(d)**

The minimum value of magnetic field

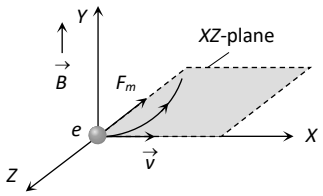
$$B = \frac{F}{qv\sin 90°}$$

$$= \frac{10^{-10}}{10^{-12}\times 10^{5}} = 10^{-3}\text{ T in z} - \text{direction}$$

150 **(b)**

$\vec{F} = -e(\vec{v}\times\vec{B}) \Rightarrow \vec{F} = -e[v\hat{i}\times B\hat{j}] = evB[-\hat{k}]$

i. e. Force on electron is acting towards negative z-axis. Hence particle will move in a circle in xz-plane



151 **(c)**

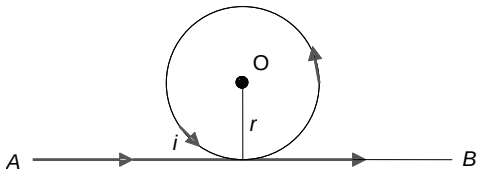
The magnitude of the magnetic field at point O due to straight part of wire is

$$B_1 = \frac{\mu_0 i}{2\pi r}$$

B_1 is perpendicular to the plane of the page, directed upwards (right hand plam rule 1).

The field at the centre O due to the current loop of radius r is

$$B_2 = \frac{\mu_0 i}{2r}$$



B_2 is also perpendicular to the page, directed upwards (right hand screw rule).

$$B_1 + B_2 = \frac{\mu_0 i}{2r}\left(\frac{1}{\pi}+1\right)$$

$$= \frac{\mu_0 i}{2\pi r}(\pi+1)$$

152 **(c)**

$$r = \frac{mv}{qB} = \frac{6\times 10^{7}}{1.7\times 10^{11}\times 1.5\times 10^{-2}} = 2.35\text{ cm}$$

153 **(b)**

$$\text{Sensitivity} = \frac{NAB}{C}$$

154 **(c)**

Neon molecule is diatomic, so it's net magnetic moment is zero