MOVING CHARGES AND MAGNETISM

FACT/DEFINITION TYPE QUESTIONS

1. According to oersted, around a current carrying conductor, magnetic field exists
   (a) as long as there is current in the wire
   (b) even after removing the current in the wire
   (c) only few seconds after removing the current
   (d) None of these
2. The magnetic field $d\vec{B}$ due to a small current element $d\vec{\ell}$ at a distance $\vec{r}$ and element carrying current i is,
   (a) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{\ell} \times \vec{r}}{r} \right)$ (b) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{\ell} \times \vec{r}}{r} \right)$
   (c) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{\ell} \times \vec{r}}{r^2} \right)$ (d) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{\ell} \times \vec{r}}{r^3} \right)$
3. Ampere's circuital law states that
   (a) the surface integral of magnetic field over the open surface is equal to μ_0 times the total current passing through the surface.
   (b) the surface integral of magnetic field over the open surface is equal to μ_0 times the total current passing near the surface.
   (c) the line integral of magnetic field along the boundary of the open surface is equal to μ_0 times the total current passing near the surface.
   (d) the line integral of magnetic field along the boundary of the open surface is equal to μ_0 times the total current passing through the surface.
4. Biot-Savart law indicates that the moving electrons velocity (V) produce a magnetic field B such that
   (a) B || V
   (b) $B \perp V$
   (c) it obeys inverse cube law
   (d) it is along the line joining electron and point of observation
5. Ampere's circuital law is equivalent to
   (a) Biot-Savart law (b) Coulomb's law
   (c) Faraday's law (d) Kirchhoff's law
6. Ampere's circuital law is given by
   (a) $\oint \vec{H} . \vec{dl} = \mu_0 I_{enc}$ (b) $\oint \vec{B} . \vec{dl} = \mu_0 I_{enc}$
   (c) $\oint \vec{B} . \vec{dl} = \mu_0 I$ (d) $\oint \vec{H} . \vec{dl} = \mu_0 I$
7. The magnetic field around a long straight current carrying wire is
   (a) spherical symmetry (b) cylindrical symmetry
   (c) cubical symmetry (d) unsymmetrical
8. A current is passed through a straight wire. The magnetic field established around it has its lines of force
   (a) circular and endless
   (b) oval in shape and endless
   (c) straight
   (d) All of the above
9. If a copper rod carries a direct current, the magnetic field associated with the current will be
   (a) only inside the rod
   (b) only outside the rod
   (c) both inside and outside the rod
   (d) neither inside nor outside the rod
10. Magnetic field at the centre of a circular coil of radius r, through which a current I flows is
    (a) directly proportional to r
    (b) inverseley proportional to I
    (c) directly proportional to I
    (d) directly proprotional to I^2
11. The magnetic field B at a point on one end of a solenoid having n turns per metre length and carrying a current of i ampere is given by
    (a) $\frac{\mu_0 ni}{e}$ (b) $\frac{1}{2}\mu_0 ni$
    (c) $4\pi\mu_0 ni$ (d) ni
12. Magnetic field inside a solenoid is
    (a) directly proportional to its length
    (b) directly proportional to current
    (c) inversely proportional to total number of turns
    (d) inversely porportional to current

13. A long solenoid has a radius a and number of turns per unit length n. If it carries a current i, then the magnetic field on its axis is directly proportional to
(a) ani (b) ni
(c) $\frac{ni}{a}$ (d) $n^2 i$

14. If a current is passed through a spring then the spring will
(a) expand (b) compress
(c) remains same (d) None of these

15. Lorentz force is
(a) electrostatic force acting on a charged particle.
(b) magnetic force acting on a moving charged particle.
(c) the vector sum of electrostatic and magnetic force acting on a moving charged particle.
(d) the vector sum of gravitational and magnetic force acting on a moving charged particle.

16. Which one of the following is the correct expression for magnetic field on the axis of a circular current loop with x-axis as its axis ?
(a) $\vec{B} = \frac{\mu_0 IR^2 \cdot \hat{i}}{2(x^2 + R^2)^2}$ (b) $\vec{B} = \frac{\mu_0 IR^2}{2(x^2 + R^2)^{3/2}}\hat{i}$
(c) $\vec{B} = \frac{\mu_0 IR}{2(x^2 + R^2)^{3/2}}\hat{i}$ (d) $\vec{B} = \frac{\mu_0 IR^{3/2}}{2(x^2 + R^2)^2}\hat{i}$

17. Which of the following is true ?
(a) Parallel currents repel, and antiparallel currents attract.
(b) Parallel currents attract, and antiparallel currents repel.
(c) Both parallel and antiparallel currents attract.
(d) Both parallel and antiparallel currents repel.

18. Which of the following is the correct definition of ampere?
(a) The ampere is the value of that steady current which when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^7 N/m of length.
(b) The ampere is the value of that steady current which when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one centimetre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} N/m of length.
(c) The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} N/m of length.
(d) The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed ten metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} N/m of length.

19. The work done by a magnetic field, on a moving charge is
(a) zero because $\vec{F}$ acts parallel to $\vec{v}$
(b) positive because $\vec{F}$ acts perpendicular to $\vec{v}$
(c) zero because $\vec{F}$ acts perpendicular to $\vec{v}$
(d) negative because $\vec{F}$ acts parallel to $\vec{v}$

20. An electron having a charge e moves with a velocity v in X-direction. An electric field acts on it in Y-direction? The force on the electron acts in
(a) positive direction of Y-axis
(b) negative direction of Y-axis
(c) positive direction of Z-axis
(d) negative direction of Z-axis

21. An electric charge in uniform motion produces
(a) an electric field only
(b) a magnetic field only
(c) both electric and magnetic fields
(d) no such field at all

22. If a long hollow copper pipe carries a direct current, the magnetic field associated with the current will be
(a) only inside the pipe
(b) only outside the pipe
(c) neither inside nor outside the pipe
(d) both inside and outside the pipe

23. Energy in a current carrying coil is stored in the form of
(a) electric field (b) magnetic field
(c) dielectric strength (d) heat

24. Lorentz force can be calculated by using the formula
(a) $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$ (b) $\vec{F} = q(\vec{E} - \vec{v} \times \vec{B})$
(c) $\vec{F} = q(\vec{E} + \vec{v} . \vec{B})$ (d) $\vec{F} = q(\vec{E} \times \vec{B} + \vec{v})$

25. Two free parallel wires carrying currents in the opposite directions
(a) attract each other
(b) repel each other
(c) do not attract each other
(d) get rotated to be perpendicular to each other

26. 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 forces between them
(d) magnetic forces between them

27. A wire is placed parallel to the lines of force in a magnetic field and a current flows in the wire. Then
(a) the wire will experience a force in the direction of the magnetic field
(b) the wire will not experience any force at all
(c) the wire will experience a force in a direction opposite to the field
(d) it experiences a force in a direction perpendicular to lines of force

28. A current carrying loop is placed in a uniform magnetic field. The torque acting on it does not depend upon
(a) shape of the loop (b) area ot the loop
(c) value of the current (d) magnetic field

29. The magnetic force $\vec{F}$ on a current carrying conductor of length I in an exteranal magnetic field $\vec{B}$ is given by

(a) $\frac{I\times\vec{B}}{\vec{I}}$ (b) $\frac{\vec{I}\times\vec{B}}{I}$

(c) $I(\vec{I}\times\vec{B})$ (d) $I^2\vec{I}\times\vec{B}$

30. A charged particle moves through a magnetic field in a direction perpendicular to it. Then the
(a) velocity remains unchanged
(b) speed of the particle remains unchanged
(c) direction of the particle remains unchanged
(d) acceleration remains unchanged

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

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

(c) $\sqrt{\frac{v}{B}}$ (d) $\frac{v}{B}$

32. A charged particle of mass m and charge q travels on a circular path of radius r that is perpendicular to a magnetic field B. The time taken by the particle to complete one revolution is

(a) $\frac{2\pi q^2 B}{m}$ (b) $\frac{2\pi mq}{B}$

(c) $\frac{2\pi m}{qB}$ (d) $\frac{2\pi qB}{m}$

33. In cyclotron the gyro radius is
(a) proportional to momentum
(b) proportional to energy
(c) inversely proportional to momentum
(d) inversely proportional to energy

34. In cyclotron the resonance condition is
(a) the frequency of revolution of charged particle is equal to the frequency of A.C. voltage sources
(b) the frequency of revolution of charged particle is equal to the frequency of applied magnetic field
(c) the frequency of revolution of charged particle is equal to the frequency of rotation of earth
(d) the frequency of revolution of charged particle, frequency of A.C. source and frequency of magnetic field are equal

35. A long solenoid has n turns per meter and current I A is flowing through it. The magnetic field within the solenoid is

(a) $\frac{\mu_0 nI}{2}$ (b) $\mu_0 nI$

(c) zero (d) $2\mu_0 nI$

36. Two thin, long, parallel wires, separated by a distance 'd' carry a current of 'i' A in the same direction. They will

(a) repel each other with a force of $\mu_0 i^2/(2\pi d)$

(b) attract each other with a force of $\mu_0 i^2/(2\pi d)$

(c) repel each other with a force of $\mu_0 i^2/(2\pi d^2)$

(d) attract each other with a force of $\mu_0 i^2/(2\pi d^2)$

37. A charge q is moving with a velocity v parallel to a magnetic field B. Force on the charge due to magnetic field is
(a) q v B (b) q B/v
(c) zero (d) B v/q

38. A particle of 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

39. Cyclotron is used to accelerate
(a) electrons (b) neutrons
(c) positive ions (d) negative ions

40. The magnetic dipole moment of a current loop is independent of
(a) magnetic field in which it is lying
(b) number of turns
(c) area of the loop
(d) current in the loop

41. Magnetic dipole moment of a rectangular loop is
(a) inversely proportional to current in loop
(b) inversely proportional to area of loop
(c) parallel to plane of loop and porportional to area of loop
(d) perpendicular to plane of loop and porportional to area of loop

42. If m is magnetic moment and B is the magnetic field, then the torque is given by

(a) $\vec{m}.\vec{B}$ (b) $\frac{|\vec{m}|}{|\vec{B}|}$

(c) $\vec{m}\times\vec{B}$ (d) $|\vec{m}|.|\vec{B}|$

43. 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 of the wire in the coil

44. 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

45. The deflection in a moving coil galvanometer is
(a) directly proportional to the torsional constant
(b) directly proportional to the number of turns in the coil
(c) inversely proportional to the area of the coil
(d) inversely proportional to the current flowing

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

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

48. Two parallel circular coils of equal radii having equal number of turns placed coaxially and separated by a distance equal to the radii of the coils carrying equal currents in same direction are known as
(a) Biot-savart's coils (b) Ampere's coils
(c) Helmholtz coils (d) Oersted's coils.

49. The current sensitivity of a galvanometer is defined as
(a) the current flowing through the galvanometer when a unit voltage is applied across its terminals.
(b) current per unit deflection.
(c) deflection per unit current.
(d) dflection per unit current when a unit voltage is applied across its terminals

STATEMENT TYPE QUESTIONS

50. Similarities of Biot–Savart's law and Coulomb's law for the electrostatics are
I. both are long range and inversely proportional to the square of distance from the source to the point of interest.
II. both are linear in source.
III. both are produced by scalar sources.
IV. both follow principle of superposition.
(a) I, II and III (b) II, III and IV
(c) I, II and IV (d) I, III and IV

51. Direction of force due to magnetic field on a moving charged particle is
I. perpendicular to direction of velocity of charged particle.
II. perpendicular to direction of magnetic field.
III. parallel to direction of velocity of charged particle.
IV. parallel to the direction of magnetic field.
Correct statements are
(a) I and IV (b) I and II
(c) I and III (d) III and IV

52. Consider a moving charged particle in a region of magnetic field. Which of the following statements are correct ?
I. If **v** is parallel to **B**, then path of particle is spiral.
II. If **v** is perpendicular to **B**, then path of particle is a circle.
III. If **v** has a component along **B**, then path of particle is helical.
IV. If **v** is along **B**, then path of particle is a circle.
(a) I and II (b) II and III
(c) III and IV (d) IV and I

53. Consider the following statements and select the incorrect statement(s).
I. The presence of a large magnetic flux through a coil maintains a current in the coil if the circuit is continuous
II. A coil of a metal wire kept stationary in a non–uniform magnetic field has an e.m.f induced in it
III. A charged particle enters a region of uniform magnetic field at an angle of 85° to the magnetic lines of force, the path of the particle is a circle
IV. There is no change in the energy of a charged particle moving in a magnetic field although a magnetic force is acting on it
(a) I and II (b) II and III
(c) II only (d) IV only

54. When a positively charged particle enters a region of uniform magnetic field, its trajectory can be
I. a straight line. II. a circle.
III. a helix. IV. a spiral
(a) Only I (b) II or III
(c) I or II (d) Anyone of I, II or III

55. A velocity selector; (a region of perpendicular electric and magnetic field)
I. allows charged particles to pass straight when $v = E/B$.
II. deflects particles in the direction of electric field when $v < E/B$.
III. deflects particles in a direction perpendicular to both v and B, when $v < E/B$.
IV. deflects all particles in a direction perpendicular to both E and B.
Which of the above statements are correct?
(a) I, III and IV (b) II, III and IV
(c) I, II and III (d) I, II and IV

56. Select the correct statements about Lorentz Force.
I. In presence of electric field $\vec{E}(r)$ and magnetic field $\vec{B}(r)$ the force on a moving electric charge is $\vec{F} = q[\vec{E}(r) + v \times \vec{B}(r)]$
II. The force, due to magnetic field on a negative charge is opposite to that on a positive charge.
III. The force due to magnetic field are become zero if velocity and magnetic field are parallel or antiparallel.
IV. For a static charge the magnetic force is maximum.
(a) I and II only (b) II and III only
(c) I, II and III (d) I, II, III and IV

57. Which of the following statements is/are correct ?
I. The magnetic field in the open space inside the toroid is constant.
II. The magnetic field in the open space exterior to the toroid is constant.
III. The magnetic field inside the core of toroid is constant.

(a) I and II (b) II and III
(c) III only (d) I only

58. A proton and a deuterium nucleus having certain kinetic energy enter in a uniform magnetic field perpendicular to it. Which of the following statements are incorrect ?
I. Proton has more frequency of revolution.
II. Deuterium nucleus has more frequency of revolution.
III. The particle which has greater speed has more frequency of revolution.
(a) I and II (b) II and III
(c) I and III (d) I, II and III

59. The galvanometer cannot as such be used as an ammeter to measure the value of current in a given circuit. The following reasons are
I. galvanometer gives full scale deflection for a small current.
II. galvanometer has a large resistance.
III. a galvanometer can give inaccurate values.
The correct reasons are:
(a) I and II (b) II and III
(c) I and III (d) I, II and III

MATCHING TYPE QUESTIONS

60. Match Column I and Column II.

Column I	Column II
(A) Biot-Savart's law	(1) $\oint \vec{B}.\vec{dl} = \mu_0 \Sigma i$
(B) Ampere's circuital law	(2) $q[\vec{E}+(\vec{V}\times\vec{B})]$
(C) Force between two parallel current carrying conductors	(3) $\oint \vec{B}.\vec{dl} = \mu_0 \Sigma i$
(D) Lorentz force	(4) $\vec{B} = \frac{\mu_0 i}{4\pi}\int \frac{dl \sin\theta}{r^2}\hat{n}$

(a) (A) → (4) ; (B) → (3) ; (C) → (1) ; (D) → (2)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

61. Match the entries given in Column I to their analogue entries of electrostatics given in Column II.

Column I	Column II
(A) Ampere's circuital law	(1) Electric dipole
(B) Biot-Savart's law	(2) Gauss's law in electrostatics
(C) Planar current loop	(3) Permitivity of free space
(D) Permeability of free space	(4) Coulomb's law

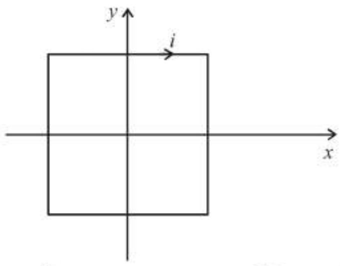
(a) (A) → (2) ; (B) → (4) ; (C) → (1) ; (D) → (3)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

62. A charged particle having charge q and mass m is to be subjected to a combination of constant uniform magnetic field $(\vec{B})$ and a constant uniform gravitational field $(\vec{G})$. Apart from these field forces there exists no other force. Now match the column.

Column-I	Column-II
(A) The charged particle moves without change in its direction.	(1) It is possible that both $\vec{B}$ and $\vec{G}$ are zero.
(B) The charged particle moves without change in its velocity.	(2) It is possible that both $\vec{B}$ and $\vec{G}$ are non zero.
(C) The charged particle takes a circular path	(3) It is possible that $\vec{B}$ is zero and $\vec{G}$ is not zero.
(D) The charged particle takes a parabolic path	(4) It is possible that $\vec{B}$ is non zero and $\vec{G}$ is zero.

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (1,2,3,4) ; (B) → (1,2,4) ; (C) → (4) ; (D) → (3)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

63. A square loop of side a and carrying current i as shown in the figure is placed in gravity free space having magnetic field $B = B_0\hat{k}$. Now match following :



Column-I	Column-II
(A) Torque on loop	(1) is zero
(B) Net force on loop	(2) is in direction $(-\hat{k})$
(C) Potential energy of loop	(3) has minimum magnitudes
(D) Magnetic moment of loop	(4) has maximum magnitudes

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (1,2) ; (B) → (1) ; (C) → (4) ; (D) → (2)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

64. Match the physical quantities of Column I with their mathematical expressions in Column II.

Column I	Column II
(A) Torque on a circular current loop placed in uniform magnetic field	(1) $\frac{\mu_0 i}{2R}$
(B) Force per unit length between parallel current carrying wires	(2) $iAB \sin\theta$
(C) Magnetic field at the centre of a circular current carrying loop.	(3) $\frac{mV}{qB}$
(D) Radius of circular path of a charge particle moving in uniform magnetic field.	(4) $\frac{\mu_0 i_1 i_2}{2\pi d}$

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (4) ; (C) → (1) ; (D) → (3)

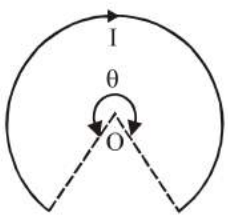
65. A circular current carrying loop with magnetic moment parallel to the magnetic field is rotated by an angle of 90° slowly about one of its diameter in a uniform magnetic field. Match the quantities of Column I with Column II.

	Column I		Column II
(A)	Torque on the loop	(1)	Decreases from maximum to zero.
(B)	Potential energy of the loop	(2)	Remains constant
(C)	Magnetic moment of the loop	(3)	Increases from zero to maximum
(D)	Magnetic flux through the loop	(4)	Increases from minimum to zero.

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (3) ; (B) → (4) ; (C) → (3) ; (D) → (1)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

DIAGRAM TYPE QUESTIONS

66. A current of I ampere flows in a wire forming a circular arc of radius r metres subtending an angle θ at the centre as shown. The magnetic field at the centre O in tesla is

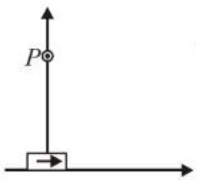


(a) $\frac{\mu_0 I\theta}{4\pi r}$ (b) $\frac{\mu_0 I\theta}{2\pi r}$

(c) $\frac{\mu_0 I\theta}{2r}$ (d) $\frac{\mu_0 I\theta}{4r}$

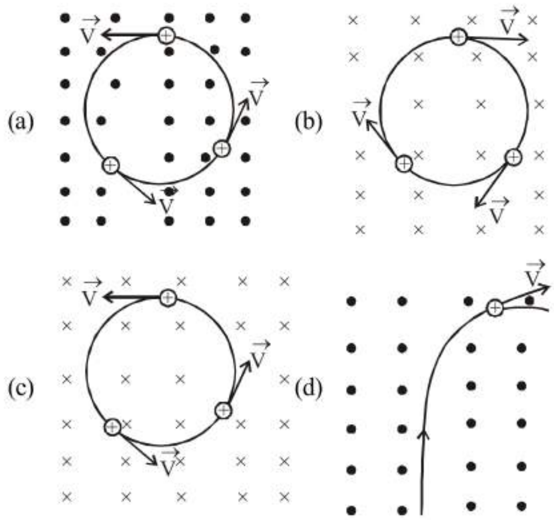
67. An element of $0.05\,\hat{i}\ m$ is placed at the origin as shown in figure which carries a large current of 10 A. distance of 1 m in perpendicular direction. The value of magnetic field is

(a) 4.5×10^{-8} T
(b) 5.5×10^{-8} T
(c) 5.0×10^{-8} T
(d) 7.5×10^{-8} T

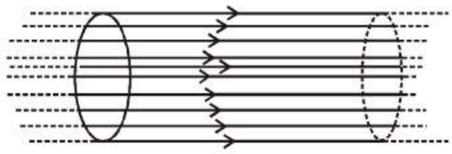


$\Delta x\ 0.05\,\hat{i}\ m$

68. A positively charged particle enters in a uniform magnetic field with velocity perpendicular to the magnetic field. Which of the following figures shows the correct motion of charged particle?



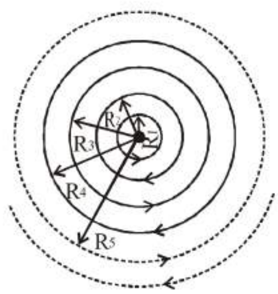
69. The figure shows n (n being an even number) wires placed along the surface of a cylinder of radius r. Each wire carries current i in the same direction. The net magnetic field on the axis of the cylinder is



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

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

70. The figure shows a system of infinite concentric circular current loops having radii $R_1, R_2, R_3 \rightarrow R_n$. The loops carry net current i alternately in clockwise and anticlockwise direction. The magnitude of net magnetic field of the centre of the loops is



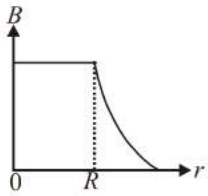
(a) $\frac{\mu_0 i}{2}\left[\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}\ldots\right]$

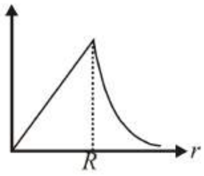
(b) $\frac{\mu_0 i}{2}\left[\frac{1}{R_1}-\frac{1}{R_2}+\frac{1}{R_3}-\frac{1}{R_4}+\ldots\right]$

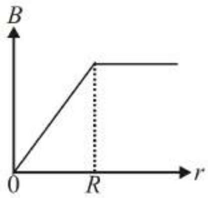
(c) $\frac{\mu_0 i}{4\pi}\left[\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}+\ldots\right]$

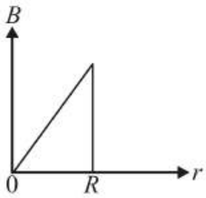
(d) $\frac{\mu_0 i}{4\pi}\left[\frac{1}{R_1}-\frac{1}{R_2}+\frac{1}{R_3}-\frac{1}{R_4}+\ldots\right]$

71. The correct plot of the magnitude of magnetic field $\vec{B}$ vs distance r from centre of the wire is, if the radius of wire is R

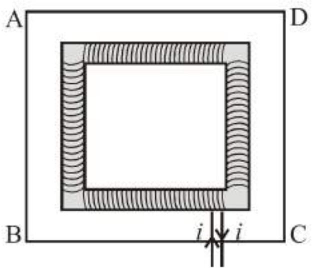
(a) 

(b) 

(c) 

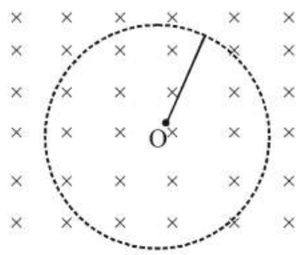
(d) 

72. The figure shows a closely wound coil on a square core of inside edge length l. The no. of turns per unit length of the coil is n. Each turn carries current i into the plane of paper and out of the plane of papers. ABCD is an Amperian loop enclosing an open surface in the plane of the paper. The current enclosed by the loop is



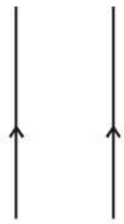
(a) 4 ni (b) 4 nli
(c) 8 nli (d) zero

73. The figure shows a thin metalic rod whose one end is pivoted at point O. The rod rotates about the end O in a plane perpendicular to the uniform magnetic field with angular frequency w in clockwise direction. Which of the following is correct ?

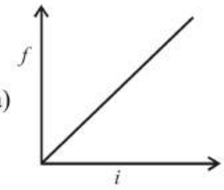


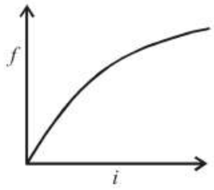
(a) The free electrons of the rod move towards the outer end
(b) The free electrons of the rod move towards the pivoted end.
(c) The free electrons of the rod move towards the mid-point of the rod.
(d) The free electrons of the rod do not move towards any end of the rod as rotation of rod has no effect on motion of free electrons.

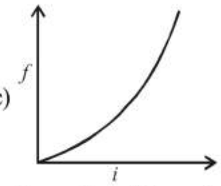
74. The figure shows two long straight current carrying wire separated by a fixed distance d. The magnitude of current, flowing in each wire varies with time but the magnitude of current in each wire is equal at all times.

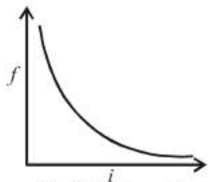


Which of the following graphs shows the correct variation of force per unit length f between the two wires with current i?

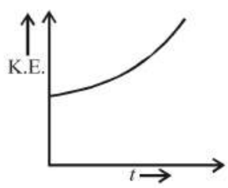
(a) 

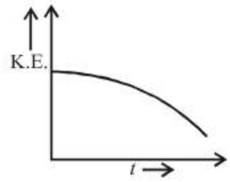
(b) 

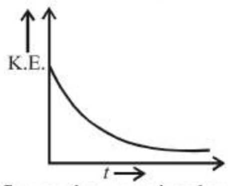
(c) 

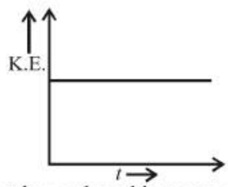
(d) 

75. A charged particle enters in a magnetic field in a direction perpendicular to the magnetic field. Which of the following graphs show the correct variation of kinetic energy of the particle with time t?

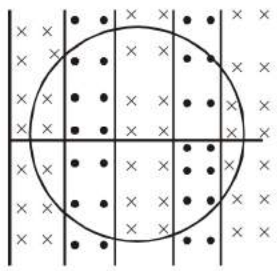
(a) 

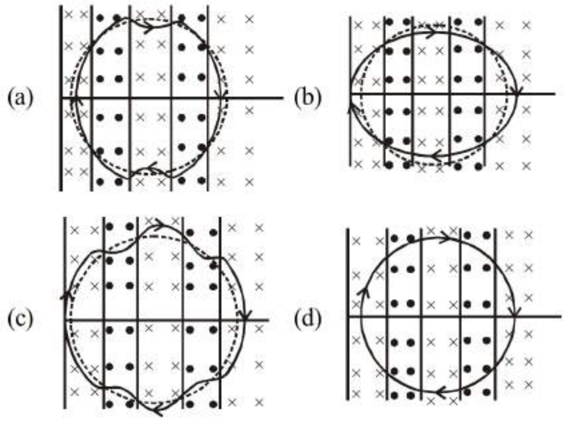
(b) 

(c) 

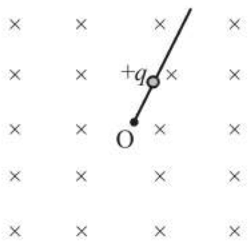
(d) 

76. The figure shows a circular current loop placed in magnetic fields. When current flows through the loop in clockwise direction, which of the following figures shows the correct shape of current loop ?





77. The figure shows a thin rod pivoted at point O and rotating clockwise in the plane of paper with constant angular velocity w. A bead having charge $+q$ can slide freely on the rod as the rod rotates.



Which of the following statements is incorrect ?

(a) Magnetic moment of current loop generated by the bead increases.

(b) Angular momentum of the bead increases.

(c) Torque on current loop generated is zero.

(d) Potentential energy of current loop generated decreases.

78. The figure shows a closed loop bent in the form of a semi-circle. One bead having charge $+q$ slides from A to B along the diameter in uniform motion and other bead having the same charge slides along the arc from A to B in uniform circular motion. Both take some time to travel from A to B. When both the beads are at the mid-point of their journey, then the forces exerted by lower bead and upper bead are respectively

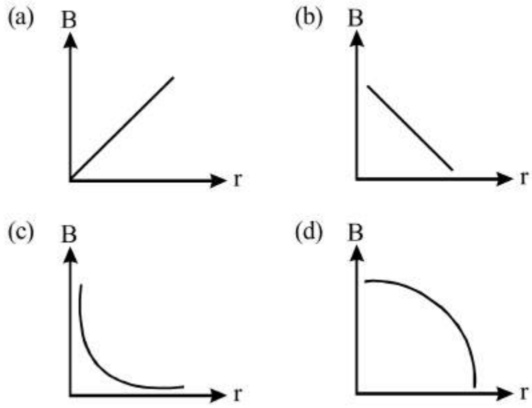
(a) gravitational and magnetic

(b) magnetic and electric

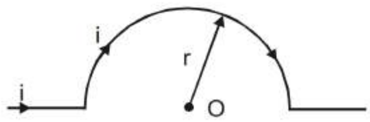
(c) electric and gravitational

(d) gravitational and electric.

79. The magnetic flux density B at a distance r from a long straight wire carrying a steady current varies with r as



80. A portion of a conductive wire is bent in the form of a semicircle of radius r as shown below in fig. At the centre of semicircle, the magnetic induction will be



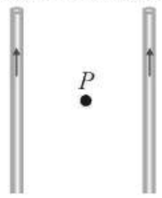
(a) zero

(b) infinite

(c) $\frac{\mu_0}{4\pi}.\frac{\pi i}{r}$ gauss

(d) $\frac{\mu_0}{4\pi}.\frac{\pi i}{r}$ tesla

81. Two long straight wires are set parallel to each other. Each carries a current i in the same direction and the separation between them is $2r$. The intensity of the magnetic field midway between them is



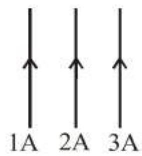
(a) $\mu_0 i / r$

(b) $4\mu_0 i / r$

(c) zero

(d) $\mu_0 i / 4r$

82. Three wires are situated at the same distance. A current of 1A, 2A, 3A flows through these wires in the same direction. What is ratio of F_1/F_2, where F_1 is force on 1 and F_2 on 2?



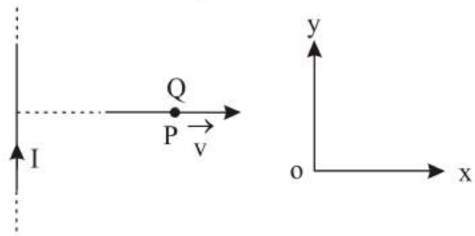
(a) 7/8

(b) 1

(c) 9/8

(d) None of these

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



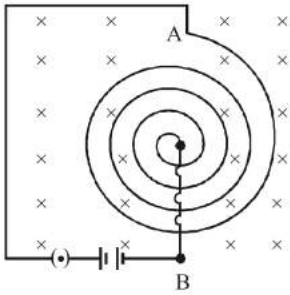
(a) along oy

(b) opposite to oy

(c) along ox

(d) opposite to ox

84. Figure shows a spiral coil of negligible mass lying in a plane perpendicular to uniform magnetic field. When the key is closed the spiral coil will



(a) contract
(b) expand
(c) neither contract nor expand
(d) tend to rotate about an axis passing through A and B.

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

85. **Assertion :** Ampere's law used for the closed loop shown in figure is written as $\oint \vec{B} \cdot d\vec{\ell} = \mu_0 (i_1 - i_2)$. Right side of it does not include i_3, because it produces no magnetic field at the loop.

Reason : The line integral of magnetic field produced by i_3 over the close loop is zero.

86. **Assertion:** Ampere's circuital law is independent of Biot-Savart's law.
Reason: Ampere's circuital law can be derived from the Biot-savart's law.

87. **Assertion :** The magnetic field due to a very large current carrying loop is zero at its centre.
Reason : Magnetic field at the centre of loop is, $B = \frac{\mu_0 i}{2R}$.

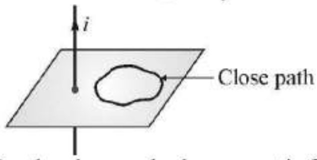
88. **Assertion :** Figure shows a current carrying circular loop. The magnetic field at the centre of loop is zero.

Reason : Magnetic field at the centre of loop is given by $B = \frac{\mu_0 ni}{2R}$.

89. **Assertion :** If the current in a solenoid is reversed in direction while keeping the same magnitude, the magnetic field energy stored in the solenoid decreases.
Reason : Magnetic field energy density is proportional to square of current.

90. **Assertion :** If a charged particle is released from rest in a region of uniform electric and magnetic fields parallel to each other, it will move in a straight line.
Reason : The electric field exerts no force on the particle but the magnetic field does.

91. **Assertion :** Figure shows a current carrying conductor and a close path. For the close path $\oint \vec{B} \cdot d\vec{\ell} = 0$.



Reason : For the close path, the magnetic field at each point on the path is zero.

92. **Assertion :** A charged particle moves in a uniform magnetic field. The velocity of the particle at same instant makes an acute angle with the magnetic field. The path of the particle is a helix with constant pitch.
Reason : The force on the particle is given by $\vec{F} = q(\vec{v} \times \vec{B})$.

93. **Assertion:** The work done by magnetic force on a charged particle is zero.
Reason: The work done by magnetic force on a charged particle is zero when the force is perpendicular to velocity of particle, in other cases it is not zero.

94. **Assertion :** Alternating current shows no magnetic effect.
Reason : The magnetic field produced by alternating current in complete cycle is zero.

95. **Assertion :** A direct current flows through a thin conductor produces magnetic field only outside the conductor.
Reason : There is no flow of charge carriers inside the conductor.

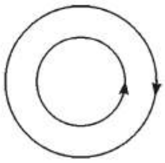
96. **Assertion :** The force between two parallel current carrying conductors carrying currents in same direction is attractive because there is no electrical interaction between them.
Reason : The force between two electrons streams moving in the same direction repulsive because there is no magnetic interaction between them.

97. **Assertion :** The net charge in a current carrying wire is zero and so magnetic force on the wire in magnetic field is zero.
Reason :
The force on a current carrying wire is given by $F=Bi\ell \sin\theta$.

98. **Assertion :** A current carrying loop placed in a magnetic field must experience a torque.
Reason : Torque on the loop is given by τ=MBsinθ.

99. **Assertion:** The frequency of circular motion of a charged particle in cyclotron is independent of the mass of the particle.
Reason: Greater the mass of the particle less will be the frequency of the particle.

100. **Assertion :** The figure shows the circular paths of two particles : electron and proton that travel at the same speed in a uniform magnetic field $\vec{B}$, which is directed into the page. The electron follows the path of smaller radius.



Reason : The radius of path in the perpendicular magnetic field is given by $r = \frac{mv}{qB}$.

101. **Assertion :** A cyclotron cannot accelerate neutrons.
Reason : Neutrons are neutral.

102. **Assertion:** To convert a galvanometer into an ammeter a small resistance is connected in parallel with it.
Reason: The small resistance increases the combined resistance of the combination.

CRITICAL THINKING TYPE QUESTIONS

103. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then
(a) the magnetic field at all points inside the pipe is the same, but not zero
(b) the magnetic field is zero only on the axis of the pipe
(c) the magnetic field is different at different points inside the pipe
(d) the magnetic field at any point inside the pipe is zero

104. The magnetic field due to a current carrying circular loop of radius 3 cm at a point on the axis at a distance of 4 cm from the centre is 54 μT. What will be its value at the centre of loop ?
(a) 125 μT (b) 150 μT
(c) 250 μT (d) 75 μT

105. A current i ampere flows along an infinitely long straight thin walled tube, then the magnetic induction at any point inside the tube is
(a) $\frac{\mu_0}{4\pi}.\frac{2i}{r}$ tesla (b) zero
(c) infinite (d) $\frac{2i}{r}$ tesla

106. A long straight wire in the horizontal plane carries a current of 75 *A* in north of south direction, magnitude and direction of field *B* at a point 3 m east of the wire is
(a) 4×10^{-6} T, vertical up
(b) 5×10^{-6} T, vertical down
(c) 5×10^{-6} T, vertical up
(d) 4×10^{-6} T, vertical down

107. Two concentric coils each of radius equal to 2 π cm are placed at right angles to each other. 3 ampere and 4 ampere are the currents flowing in each coil respectively. The magnetic induction in weber/m^2 at the centre of the coils will be $(\mu_0 = 4\pi \times 10^{-7} \text{Wb/A.m})$
(a) 10^{-5} (b) 12×10^{-5}
(c) 7×10^{-5} (d) 5×10^{-5}

108. A coil of one turn is made of a wire of certain length and then from the same length a coil of two turns is made. If the same current is passed in both the cases, then the ratio of the magnetic inductions at their centres will be
(a) 2 : 1 (b) 1.4
(c) 4 : 1 (d) 1 : 2

109. A circular coil of wire consisting of 100 turns each of radius 9 cm carries a current of 0.4 A. The magnitude of manetic field at the centre of the coil is
(a) 2.4×10^{-4} T (b) 3.5×10^{-4} T
(c) 2.79×10^{-4} T (d) 3×10^{-4} T

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

111. A solenoid of length 1.5 m and 4 cm diameter possesses 10 turns per cm. A current of 5A is flowing through it, the magnetic induction at axis inside the solenoid is
$(\mu_0 = 4\pi \times 10^{-7} \text{ weber amp}^{-1} \text{m}^{-1})$
(a) $4\pi \times 10^{-5}$ gauss (b) $2\pi \times 10^{-5}$ gauss
(c) $4\pi \times 10^{-5}$ tesla (d) $2\pi \times 10^{-5}$ tesla

112. A long solenoid is formed by winding 20 turns/cm. The current necessary to produce a magnetic field of 20 millitesla inside the solenoid will be approximately
$(\frac{\mu_0}{4\pi} = 10^{-7} \textit{ tesla – metre / ampere})$
(a) 8.0 A (b) 4.0 A
(c) 2.0 A (d) 1.0 A

113. A solenoid of length 0.6 *m* has a radius of 2 cm and is made up of 600 turns If it carries a current of 4 A, then the magnitude of the magnetic field inside the solenoid is
(a) 6.024×10^{-3} T (b) 8.024×10^{-3} T
(c) 5.024×10^{-3} T (d) 7.024×10^{-3} T

114. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is $\vec{F}$, the net force on the remaining three arms of the loop is
(a) $3\vec{F}$ (b) $-\vec{F}$
(c) $-3\vec{F}$ (d) $\vec{F}$

115. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, the new value of the magnetic field is
(a) 4 B (b) B/2
(c) B (d) 2 B

116. A current of I ampere flows along an infinitely long straight thin walled hollow metallic cylinder of radius r. The magnetic field at any point inside the cylinder at a distance x from the axis of the cylinder is

(a) infinite (b) $\frac{\mu_0 I}{2\pi r}$

(c) $\frac{\mu_0 I}{2\pi x}$ (d) zero

117. If we double the radius of a coil keeping the current through it unchanged, then the magnetic field at any point at a large distance from the centre becomes approximately

(a) double (b) three times

(c) four times (d) one-fourth

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

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

(c) $\frac{\mu_0 q}{2\pi f R}$ (d) $\frac{\mu_0 qf}{2\pi R}$

119. A current i ampere flows in a circular arc of wire which subtends an angle $(3\pi/2)$ radians at its centre, whose radius is R. The magnetic induction B at the centre is

(a) $\mu_0 i/R$ (b) $\mu_0 i/2R$

(c) $2\mu_0 i/R$ (d) $3\mu_0 i/8R$

120. A steady current I flows down a hollow cylindrical tube of radius a and is uniformly distributed around the tube. Let r be the distance from the axis of symmetry of the tube to a given point. What is the magnitiude of the magnetic field B at a point inside the tube?

(a) 0 (b) $2\,I/r\,c$

(c) $2\,I\,r/a^2c$ (d) $4\pi(r-a)\,I/r^2$

121. A current i ampere flows along an infinitely long straight thin walled tube, then the magnetic induction at any point inside the tube is

(a) infinite (b) zero

(c) $\frac{\mu_0}{4\pi}.\frac{2i}{r}$ tesla (d) $\frac{2i}{r}$ tesla

122. A conducting circular loop of radius r carries a constant current i. It is placed in a uniform magnetic field **B** such that B is perpendicular to the plane of the loop. The magnetic force acting on the loop is

(a) irB (b) $2\pi riB$

(c) zero (d) πriB

123. If a charged particle has a velocity component in a direction parallel to magnetic field in addition to the component perpendicular to magnetic field then charged particle moves in magnetic field in a

(a) circular path (b) parabolic path

(c) helical path (d) straight line

124. A charged particle enters in a uniform magnetic field with a certain velocity. The power delivered to the particle by the magnetic field depends on

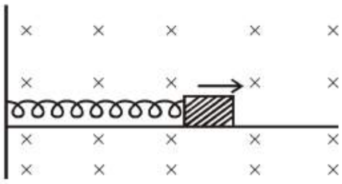
(a) force exerted by magnetic field and velocity of the particle.

(b) angular speed *w* and radius *r* of the circular path.

(c) angular speed *w* and acceleration of the particle.

(d) None of these

125. The figure shows a spring-block system executing SHM in a uniform magnetic field. The block slides on the frictionless surface of a weighing machine. The block is having charge $+q$ on it. Assume that the block is so heavy that any force exerted by magnetic field cannot lift it. Select the correct option from the following.



(a) When the block moves to right the machine shows more reading and when to left, less reading.

(b) When the block moves to right the machine shows less reading and when to left, more reading.

(c) The machine shows same reading which is less than the actual weight of the block in both cases.

(d) The machine shows same reading which is more than the actual weight of the block in both cases.

126. A proton and a deuterium nucleus having certain kinetic energies enter in a uniform magnetic field with same component of velocity in the direction of magnetic field. Which of the following is correct ?

(a) Proton has greater pitch of helical motion.

(b) Deuterium nucleus has greater pitch of helical motion.

(c) Both particles have same pitch of helical motion.

(d) Which particle has greater pitch depends on the fact that which particle has greater component of velocity perpendicular to magnetic field.

127. A charged particle goes undeflected in a region containing electric and magnetic fields. It is possible that

(a) $\vec{E}\,||\,\vec{B},\ \vec{v}\,||\,\vec{E}$

(b) $\vec{E}$ is not parallel to $\vec{B}$

(c) $\vec{v}\,||\,\vec{B}$ but $\vec{E}$ is not parallel to $\vec{B}$

(d) $\vec{E}\,||\,\vec{B}$ but $\vec{v}$ is not parallel to $\vec{E}$

128. A positively charged particle moving due east enters a region of uniform magnetic field directed vertically upwards. This particle will

(a) get deflected in vertically upward direction

(b) move in circular path with an increased speed

(c) move in a circular path with decreased speed

(d) move in a circular path with uniform speed

129. A proton moving with a constant velocity passes through a region of space without any change in its velocity. If E and B represent the electric and magnetic fields respectively, this region of space may not have
(a) $E=0, B=0$ (b) $E=0, B\neq 0$
(c) $E\neq 0, B=0$ (d) $E\neq 0, B\neq 0$

130. A charged particle enters into a magnetic field with a velocity vector making an angle of 30º with respect to the direction of magnetic field. The path of the particle is
(a) circular (b) helical
(c) elliptical (d) straight line

131. If a charged particle goes unaccelerated in a region containing electric and magnetic fields, then
(a) $\vec{E}$ must be perpendicular to $\vec{B}$
(b) $\vec{v}$ must be perpendicular to $\vec{E}$
(c) $\vec{E}$ must be perpendicular to $v\vec{B}$
(d) None of these

132. 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

133. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(a) $\vec{v}=\vec{B}\times\vec{E}/E^2$ (b) $\vec{v}=\vec{E}\times\vec{B}/B^2$
(c) $\vec{v}=\vec{B}\times\vec{E}/B^2$ (d) $\vec{v}=\vec{E}\times\vec{B}/E^2$

134. A uniform electric field and uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron
(a) will turn towards right of direction of motion
(b) speed will decrease
(c) speed will increase
(d) will turn towards left direction of motion

135. If an electron and a proton having same momenta enter perpendicular to a magnetic field, then
(a) curved path of electron and proton will be same (ignoring the sense of revolution)
(b) they will move undeflected
(c) curved path of electron is more curved than that of the proton
(d) path of proton is more curved

136. In a region, steady and uniform electric and magnetic fields are present. These two fields are parallel to each other. A charged particle is released from rest in this region. The path of the particle will be a
(a) helix (b) straight line
(c) ellipse (d) circle

137. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity then
(a) its velocity will increase
(b) its velocity will decrease
(c) it will turn towards left of direction of motion
(d) it will turn towards right of direction of motion

138. Under the influence of a uniform magnetic field a charged particle is moving in a circle of radius R with constant speed v. The time period of the motion
(a) depends on both R and v
(b) is independent of both R and v
(c) depends on R and not v
(d) depends on v and not on R

139. If an electron describes half a revolution in a circle of radius r in a magnetic field B, the energy acquired by it is
(a) zero (b) $\frac{1}{2}mv^2$
(c) $\frac{1}{4}mv^2$ (d) $\pi r\times Bev$

140. A cell is connected between two points of a uniformly thick circular conductor and i_1 and i_2 are the currents flowing in two parts of the circular conductor of radius a. The magnetic field at the centre of the loop will be
(a) zero (b) $\frac{\mu_0}{4\pi}(I_1-I_2)$
(c) $\frac{\mu_0}{2a}(I_1+I_2)$ (d) $\frac{\mu_0}{a}(I_1+I_2)$

141. 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) $\frac{\mu_0}{2\pi a}(I_1^2+I_2^2)^{\frac{1}{2}}$ (d) $\frac{\mu_0}{2\pi a}\frac{I_1 I_2}{I_1+I_2}$

142. A current carrying conductor placed in a magnetic field experiences maximum force when angle between current and magnetic field is
(a) $3\pi/4$ (b) $\pi/2$
(c) $\pi/4$ (d) zero

143. A current of 3 A is flowing in a linear conductor having a length of 40 cm. The conductor is placed in a magnetic field of strength 500 gauss and makes an angle of 30º with the direction of the field. It experiences a force of magnitude
(a) 3×10^{-4} N (b) 3×10^{-2} N
(c) 3×10^{2} N (d) 3×10^{4} N

144. A current of 10 A is flowing in a wire of length 1.5 m. A force of 15 N acts on it when it is placed in a uniform magnetic field of 2 T. The angle between the magnetic field and the direction of the current is
(a) 30° (b) 45°
(c) 60° (d) 90°

145. An 8 cm long wire carrying a current of 10 A is placed inside a solenoid perpendicular to its axis. If the magnetic field inside the solenoid is 0.3 T, then magnetic force on the wire is
(a) 0.14 N (b) 0.24 N
(c) 0.34 N (d) 0.44 N

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

147. An electron (mass = 9×10^{-31} kg, charge = 1.6×10^{-19} C) moving with a velocity of 10^6 m/s enters a magnetic field. If it describes a circle of radius 0.1m, then strength of magnetic field must be
(a) 4.5×10^{-5} T (b) 1.4×10^{-5} T
(c) 5.5×10^{-5} T (d) 2.6×10^{-5} T

148. A charged particle with velocity 2×10^3 m/s passes undeflected through electric and magnetic field. Magnetic field is 1.5 tesla. The electric field intensity would be
(a) 2×10^3 N/C (b) 1.5×10^3 N/C
(c) 3×10^3 N/C (d) $4/3 \times 10^{-3}$ N/C

149. What is cyclotron frequency of an electron with an energy of 100 e V in the earth's magnetic field of 1×10^{-4} weber / m^2 if its velocity is perpendicular to magnetic field?
(a) 0.7 MHz (b) 2.8 MHz
(c) 1.4 MHz (d) 2.1 MHz

150. The orbital speed of electron orbiting around a nucleus in a circular orbit of radius 50 pm is 2.2×10^6 ms^{-1}. Then the magnetic dipole moment of an electron is
(a) 1.6×10^{-19} Am^2 (b) 5.3×10^{-21} Am^2
(c) 8.8×10^{-24} Am^2 (d) 8.8×10^{-26} Am^2

151. A helium nucleus makes a full rotation in a circle of radius 0.8 meter in 2 sec. The value of the magnetic field induction B in tesla at the centre of circle will be
(a) $2 \times 10^{-19} \mu_0$ (b) $10^{-19}/\mu_0$
(c) $10^{-19} \mu_0$ (d) $2 \times 10^{-20}/\mu_0$

152. Two long parallel wires P and Q are held perpendicular to the plane of paper with distance of 5 m between them. If P and Q carry current of 2.5 amp. and 5 amp. respectively in the same direction, then the magnetic field at a point half-way between the wires is
(a) $\mu_0/17$ (b) $\sqrt{3}\mu_0/2\pi$
(c) $\mu_0/2\pi$ (d) $3\mu_0/2\pi$

153. 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

154. A circular loop of area 0.02 m^2 carrying a current of 10A, is held with its plane perpendicular to a magnetic field induction 0.2 T. The torque acting on the loop is
(a) 0.01 Nm (b) 0.001 Nm
(c) zero (d) 0.8 Nm

155. A coil carrying a heavy current and having large number of turns is mounted in a N-S vertical plane. A current flows in the clockwise direction. A small magnetic needle at its centre will have its north pole in
(a) east-north direction (b) west-north direction
(c) east-south direction (d) west-south direction

156. A galvanometer having a resistance of 80 ohms is shunted by a wire of resistance 2 ohms. If the total current is 1amp., the part of it passing through the shunt will be
(a) 0.25 amp (b) 0.8 amp
(c) 0.02 amp (d) 0.5 amp

157. A moving coil galvanometer has a resistance of 900 Ω. In order to send only 10% of the main current through this galvanometer, the resistance of the required shunt is
(a) 0.9 Ω (b) 100 Ω
(c) 405 Ω (d) 90 Ω

158. A galvanometer of resistance 5 ohms gives a full scale deflection for a potential difference of 10 mV. To convert the galvanometer into a voltmeter giving a full scale deflection for a potential difference of 1 V, the size of the resistance that must be attached to the voltmeter is
(a) 0.495 ohm (b) 49.5 ohm
(c) 495 ohm (d) 4950 ohm

159. 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 1 A, 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

FACT/DEFINITION TYPE QUESTIONS

1. (a)

2. (d) $dB = \frac{\mu_0}{4\pi} \cdot \frac{id\ell \sin\theta}{r^2} \Rightarrow \quad d\vec{B} = \frac{\mu_0}{4\pi} \cdot \frac{i(d\vec{\ell} \times \vec{r})}{r^3}$

3. (d) According to Ampere's circuital law $\int \vec{B}.\vec{dl} = \mu_o I$

4. (b) 5. (a) 6. (b)

7. (b) Magnetic field is given by $B = \frac{\mu_0 i}{2\pi r}$ i.e., $B \propto \frac{1}{r}$ which implies that field has cylindrical symmetry.

8. (a) 9. (c)

10. (c) Field at the center of a circular coil of radius r is

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

11. (b) Magnetic field at a point on one end of a solenoid

$$B = \frac{1}{2}\mu_0 ni$$

12. (b) $B = \mu_0 ni$

13. (b) Because $B = \mu_0 ni \Rightarrow B \propto ni$

14. (b) It will compress due to the force of attraction between two adjacent coils carrying current in the same direction.

15. (c) As Lorentz force is given by

$$\vec{F} = q(\vec{E} + \vec{V} \times \vec{B}) = q\vec{E} + q(\vec{V} \times \vec{B})$$

$$\vec{F} = \vec{F}_E + \vec{F}_B$$

16. (b)

17. (b) Parallel currents attract and anti-parallel currents repel can be verified by the application of right hand thumb rule.

18. (c) 19. (c) 20. (b) 21. (c) 22. (b)

23. (b)

24. (a) Lorentz force is given by

$$\vec{F} = \vec{F_e} + \vec{F_m}$$

$$= q\vec{E} + q(\vec{v} \times \vec{B}) = q[(\vec{E} + (\vec{v} \times \vec{B})]$$

25. (b) 26. (d) 27. (b)

28. (a) Because $\tau = NiAB \cos\theta$

29. (c)

30. (b) Magnetic force acts perpendicular to the velocity. Hence speed remains constant.

31. (d) $r = \frac{mv}{qB} \Rightarrow r \propto \frac{v}{B}$

32. (c) Equating magnetic force to centripetal force,

$$\frac{mv^2}{r} = qvB \sin 90^\circ$$

Time to complete one revolution,

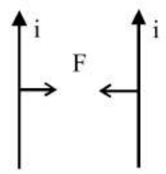
$$T = \frac{2\pi r}{v} = \frac{2\pi m}{qB}$$

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

34. (a)

35. (b)

36. (b)



$$\frac{F}{\ell} = \frac{\mu_0 i_1 i_2}{2\pi d} = \frac{\mu_0 i^2}{2\pi d}$$

(attractive as current is in the same direction)

37. (c)

38. (d) $\because F = qVB = \frac{mv^2}{R} \quad \therefore R = \frac{mv}{Bq}$

39. (c)

40. (a) Current loop acts as a magnetic dipole. Its magnetic moment is given by
$M = NIA$
where N = number of turns, I = current in a loop,
A = area of the loop
From the above relation, we can conclude that magnetic dipole moment of a current loop is independent of magnetic field in which it is lying.

41. (d) Mgnetic dipole moment, $M = NiA$

42. (c)

43. (c) $M = NiA \Rightarrow M \propto A \Rightarrow M \propto r^2$
[As $\ell = 2\pi r \Rightarrow \ell \propto r$]
$\Rightarrow M \propto \ell^2$

44. (c)

45. **(b)** $\theta = \frac{NiAB}{C} \Rightarrow \theta \propto N$ [Number of turns]

46. **(b)** $i = \frac{C\theta}{NAB} \Rightarrow i \propto \theta$

47. **(d)** $\tau = MB \sin\theta \Rightarrow \tau_{max} = NiAB$, [$\theta = 90°$]

48. **(c)**

49. **(c)** Current sensitivity of a galvanometer is the amount of deflection produced in the galvanometer when unit current flows through it.

STATEMENT TYPE QUESTIONS

50. **(c)** The Biot–Savart's law for the magnetic field has certain similarities as well as differences with the Coulomb's law for the electrostatic field. Some of these are :

(i) Both are long range, since both depend inversely on the square of distance from the source to the point of interest. The principle of superposition applies to both fields. In this connection, note that the magnetic field is linear in the source *Idl* just as the electrostatic field is linear in its source the electric charge.

(ii) The electrostatic field is produced by a scalar source, namely, the electric charge. The magnetic field is produced by a vector source *Idl*.

51. **(b)**

(i) Lorentz force depends on q, **v** and **B** (charge of the particle, the velocity and the magnetic field). Force on a negative charge is opposite to that on a positive charge.

(ii) The magnetic force q [**v** × **B**] includes a vector product of velocity and magnetic field. The vector product makes the force due to magnetic field vanish (become zero) if velocity and magnetic field are parallel or anti-parallel. The force acts in a (sideways) direction perpendicular to both the velocity and the magnetic field. Its direction is given by the screw rule.

52. **(b)** If v ⊥ B, then path is circular and if v has a component along B, then path will be helical.

53. **(d)** When charged particle enters perpendicularly in a magnetic field, it moves in a circular path with a constant speed. Hence its kinetic energy also remains constant.

54. **(d)** When v || B, F = 0, then path is a straight line. If v ⊥ B , F = Bqv, so path is a circle. while v makes some angle θ with B, then $F = Bqv\sin\theta$ so path is helical.

55. **(c)** In a velocity selector, where F_e and F_B are electric and magetic field, we get

Case I $F_e = F_B \Rightarrow v = \frac{E}{B}$

Case II $F_e > F_B \Rightarrow v < \frac{E}{B}$

Case III $F_e < F_B \Rightarrow v > E / B$

56. **(c)** If charge is not moving then the magnetic force is zero.

Since $\vec{F}_m = q(\vec{v} \times \vec{B})$

As $\vec{v} = 0$, for stationary charge

$\therefore \vec{F}_m = 0$

57. **(c)**

58. **(b)** The frequency of revolution is given by

$\nu = \frac{qB}{2\pi m}$.

If charge is constant, then $\nu \propto \frac{1}{m}$

59. **(a)** The galvanometer cannot as such be used as an ammeter to measure the value of the current in a given circuit. This is for two reasons (i) Galvanometer is a very sensitive device, it gives a full-scale deflection for a current of the order of μA. (ii) For measuring currents, the galvanometer has to be connected in series and as it has a large resistance, this will change the value of the current in the circuit.

MATCHING TYPE QUESTIONS

60. **(a)** (A) → (4); (B) → (3); (C) → (1); (D) → (2)

61. **(a)** (A) → (2); (B) → (4); (C) → (1); (D) → (3)

62. **(c)** (A) → (1, 2, 3, 4); (B) → (1, 2, 4); (C) → (4); (D) → (3)

63. **(b)** (A) → (1,2); (B) → (1); (C) → (4); (D) → (2)

64. **(d)** (A) → (2); (B) → (4); (C) → (1); (D) → (3)

65. **(b)** A - (3) $I = mB \sin\theta$, as $\sin\theta$ from $0 \to 1$.

B - (4) $U(\theta) = -mB\cos\theta$, as $\cos\theta$ from $1 \to 0$, then $U(\theta)$ from $U(\theta)_{min} = -mB \to 0$.

C - (3) as $\vec{m} = i\vec{A}$.

D -(1) as $\phi_B = BA\cos\theta$. As $\cos\theta$ from $1 \to 0$, then ϕ_B from $BA = (\phi_B)_{max} \to 0$.

DIAGRAM TYPE QUESTIONS

66. **(a)** $B = \frac{\mu_0 I}{2r} \times \frac{\theta}{2\pi} = \frac{\mu_0 I\theta}{4\pi r}$

67. **(c)** $dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$

Here, $dl = \Delta x = 0.05\ m$, $I = 10\ A$, $r = 1\ m$

$\sin\theta = \sin 90° = 1$,

$\therefore dB = 10^{-7} \times \frac{10 \times 0.05 \times 1}{(1)^2}$

$= 0.50 \times 10^{-7} = 5.0 \times 10^{-8}$ T

68. **(c)** Force, $\vec{F}_B = q(\vec{V} \times \vec{B})$

which gives direction of force towards centre.

69. **(c)** Since n is an even number, we can assume the wires in pairs such that the two wires forming a pair is placed diametrically opposite to each other on the surface of cylinder. The fields produced on the axis by them are equal and opposite and can get cancelled with each other.

70. **(b)** Field at the centre of a circular current loop is given by

$B = \frac{\mu i}{2R}$. Since the currents are alternately in opposite directions therefore the correct net field at centre is given by vector sum of field produced by each loop which are alternately in opposite directions.

71. **(b)** The magnetic field from the centre of wire of radius R is given by

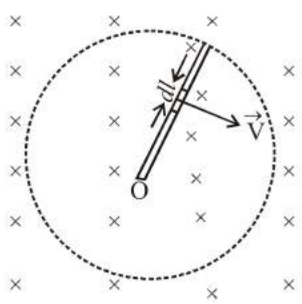
$B = \left(\frac{\mu_0 I}{2R^2}\right)r \quad (r < R) \Rightarrow B \propto r$

and $B = \frac{\mu_0 I}{2\pi r} \quad (r > R) \Rightarrow B \propto \frac{1}{r}$

From the above descriptions, we can say that the graph (b) is a correct representation.

72. **(d)** Since the total current going into the surface is equal to total current coming out of the surface, therefore current enclosed is zero.

73. **(b)** The application of equation $\vec{F}_B = q(\vec{V} \times \vec{B})$ on the element dl of the rod gives force on positive charge towards the outer end. Therefore electrons will move towards pivoted end.



74. **(c)** The force per unit length is given by $f = \frac{\mu_0 i^2}{2\pi d}$

i.e., $f \propto i^2$

75. **(d)** The change in K.E. is equal to work done by net force which is zero because the magnetic force is perpendicular to velocity. K.E. remains constant.

76. **(c)** The equation $d\vec{F}_B = i\,d\vec{l} \times \vec{B}$ gives the direction of force radially outward in those regions where the field is directed into the plane of paper and radially inward on the section of loop where the field is pointing towards the reader.

77. **(d)** Since P.E. $= -\vec{m}\cdot\vec{B} = -mB\cos 0°$

$\therefore$ P.E. $= -mB$

Since $\vec{m}$ increases in magnitude, therefore P.E. decreases.

78. **(d)** Obviously gravitational and electric force is there as both the particle have mass and charge. Since both charges are in motion so they constitute currents which generate magnetic fields around them and thus exert magnetic force on each other.

79. **(c)**

80. **(d)** The straight part will not contribute magnetic field at the centre of the semicircle because every element of the straight part will be 0° or 180° with the line joining the centre and the element

Due to circular portion, the field is $\frac{1}{2}\frac{\mu_0 i}{2r} = \frac{\mu_0 i}{4r}$

Hence total field at O $= \frac{\mu_0 i}{4r}$ tesla

81. **(c)** $B = \frac{\mu_0}{2\pi}\cdot\frac{i}{r} - \frac{\mu_0}{2\pi}\cdot\frac{i}{r} = 0$

82. **(a)** Due to flow of current in same direction at adjacent side, an attractive magnetic force will be produced.

83. **(a)** The direction of B is along $(-\hat{k})$

$\therefore$ The magnetic force

$\vec{F} = Q(\vec{v} \times \vec{B}) = Q(v\hat{i}) \times B(-\hat{k}) = QvB\hat{j}$

$\Rightarrow$ along OY.

84. **(b)** As the current flows in the spiral in clockwise direction, the application of equation $d\vec{F}_B = i\,d\vec{l} \times \vec{B}$ given the force on current element dl in radially outward direction hence expand.

ASSERTION- REASON TYPE QUESTIONS

85. **(d)** The magnetic field at any point on the closed loop is due to all the three currents, but line integral of i_3 over the closed loop will be zero.

86. **(d)** Ampere's circuital law can be derived from Biot-Savart law and is not independent of Biot-Savart law.

87. **(a)** Magnetic field at the centre of circular loop is given by

$B=\frac{\mu_0 i}{2R}$, as $R\to\infty$, and so $B\to 0$.

88. **(a)** The magnetic field of two equal halfs of the loop is equal and opposite and so $\vec{B}=0$.

89. **(a)** Reversing the direction of the current reverses the direction of the magnetic field. However, it has no effect on the magnetic-field energy density, which is proportional to the square of the magnitude of the magnetic field.

90. **(c)** Due to electric field, the force is $\vec{F}=q\vec{E}$ in the direction of $\vec{E}$. Since $\vec{E}$ is parallel to $\vec{B}$, the particle velocity $\vec{v}$ (acquired due to force $\vec{F}$) is parallel to $\vec{B}$. Hence $\vec{B}$ will not exert any force since $\vec{v}\times\vec{B}=0$ and the motion of the particle is not affected by $\vec{B}$.

91. **(c)** We know that, $\oint\vec{B}.d\vec{\ell}=\mu_0 i_{in}$. Since $i_{in}=0$ and so $\oint\vec{B}.d\vec{\ell}=0$. The magnetic field on any point on the close loop is zero.

92. **(b)**

93. **(c)** Since the magnetic force is always perpendicular to the velocity of the charged particle so, work done is always zero.

94. **(d)** Current shows magnetic effect, but in one cmplete cycle the net magnetic field beocmes zero.

95. **(c)** The magnetic field inside conductor is given by

$B=\frac{\mu_0}{2\pi}.\frac{ir}{a^2}$

For thin conductor, the point is on the axis of the conductor and so $r=0$, $B=0$.

96. **(c)** In case of two electron streams the electric repulsion is greater than magnetic attraction.

97. **(d)** The magnetic force acts only on moving electrons, and so net force on the conductor is non-zero.

98. **(d)** The value of torque depends on θ. For $\theta=0$, $\tau=MBx\sin 0°=0$.

99. **(d)** The frequency of revolution is given by

$\nu=\frac{qB}{2\pi m}$, hence Statement I is false and II is true.

100. **(a)** The radius of path, $r=\frac{mv}{qB}$. As mass of electron is smaller than mass of proton, so radius of electron is smaller.

101. **(b)** Neutrons are neutral.

102. **(c)** An ammeter should have a low resistance which we get when we connect low resistance in parallel with galvanometer.

CRITICALTHINKING TYPE QUESTIONS

103. **(d)** There is no current inside the pipe. Therefore

$\oint\vec{B}.\vec{dt}=\mu_o I$

$I=0 \qquad \therefore\ B=0$

104. **(c)** $B=\frac{\mu_0 i\, a^2}{2(x^2+a^2)^{3/2}}$

$$B'=\frac{\mu_0 i}{2a}=\frac{\mu_0 i\, a^2}{2a(x^2+a^2)^{3/2}}\left(\frac{(x^2+a^2)^{3/2}}{a^2}\right)$$

$$B'=\frac{B.(x^2+a^2)^{3/2}}{a^3}$$

Put $x=4$ & $a=3 \Rightarrow B'=\frac{54(5^3)}{3\times3\times3}=250\mu T$

105. **(b)** Using Ampere's law at a distance r from axis, B is same from symmetry.

$\int B.dl=\mu i$

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

Here i is zero, for $r<R$, whereas R is radius

$\therefore B=0$

106. **(c)** From Ampere circuital law

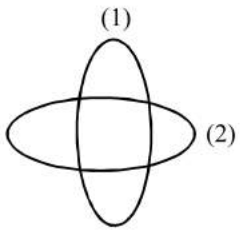
$\oint\vec{B}.\vec{dl}=\mu_0 I_{enc}$

$B\times 2\pi R=\mu_0 I_{enc}$

$B=\frac{\mu_0 I_{enc}}{2\pi R}=2\times10^{-7}\times\frac{75}{3}=5\times10^{-6}\,T$

The direction of field at the given point will be vertical up determined by the screw rule or right hand rule.

107. (d)



The magnetic field due to circular coil,

$$B_1 = \frac{\mu_0 i_1}{2r} = \frac{\mu_0 i_1}{2(2\pi \times 10^{-2})} = \frac{\mu_0 \times 3 \times 10^2}{4\pi}$$

$$B_2 = \frac{\mu_0 i_2}{2(2\pi \times 10^{-2})} = \frac{\mu_0 \times 4 \times 10^2}{4\pi}$$

$$B = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0}{4\pi} . 5 \times 10^2$$

$$\Rightarrow B = 10^{-7} \times 5 \times 10^2 \Rightarrow B = 5 \times 10^{-5} \text{ Wb/m}^2$$

108. (b) Let ℓ be length of wire

Ist case : $\ell = 2\pi r \Rightarrow r = \frac{\ell}{2\pi}$

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

2nd Case : $\ell = 2(2\pi r') \Rightarrow r' = \frac{\ell}{4\pi}$

$$B' = \frac{\mu_0 In}{2\pi \frac{\ell}{4\pi}} = \frac{2\mu_0 I}{\frac{\ell}{2}} \text{ (where n = 2)}$$

on putting the value of B $\Rightarrow B' = 4\left(\frac{\mu_0 I}{l}\right) = 4B$

109. (c) Here, $N = 100$

$R = 9$ cm $= 9 \times 10^{-2}$ m, and $I = 0.4$ A

$$\text{Now, } B = \frac{\mu_0 NI}{2R} = \frac{2\pi \times 10^{-7} \times 100 \times 0.4}{9 \times 10^{-2}}$$

$$= \frac{2 \times 3.14 \times 0.4}{9} \times 10^{-3}$$

$$= 0.279 \times 10^{-3} \text{ T} = 0.279 \times 10^{-4} \text{ T}$$

110. (a) $\frac{B_2}{B_1} = \frac{\mu_0 n_2 i_2}{\mu_0 n_1 i_1} \Rightarrow \frac{B_2}{6.28 \times 10^{-2}} = \frac{100 \times \frac{i}{3}}{200 \times i}$

$$\Rightarrow B_2 = \frac{6.28 \times 10^{-2}}{6} = 1.05 \times 10^{-2} \text{ Wb/m}^2$$

111. (d) $B = \mu_0 nI = 4\pi \times 10^{-7} \times 10 \times 5 = 2\pi \times 10^{-5}$ T.

112. (a) $B = \mu_0 ni \Rightarrow i = \frac{B}{\mu_0 n}$

$$= \frac{20 \times 10^{-3}}{4\pi \times 10^{-7} \times 20 \times 100} = 7.9 \text{ A} = 8 \text{ A}$$

113. (c) Here, $n = \frac{600}{0.6} = 1000$ turns / m $I = \mu A$

$I = 0.6$ m, $r = 0.02$ m $\because \frac{1}{r} = 30$ *i.e.* $I >> r$

Hence, we can use long solenoid formula, them

$\therefore$ $B = \mu_0 nI = 4 \times 10^{-7} \times 10^3 \times 4$

$= 50.24 \times 10^{-4} = 5.024 \times 10^{-3}$ T

114. (b) The force on the two arms parallel to the field is zero.

$\therefore$ Force on remaining arms $= -F$

115. (c) $B = \mu_0 N_0 i$; $B_1 = (\mu_0)\left(\frac{N_0}{2}\right)(2\text{ i}) = \mu_0 N_0 i = B$

$\Rightarrow B_1 = B$

116. (d) Since no current is enclosed inside the hollow conductor. Hence $B_{inside} = 0$.

117. (c) $B_{axis} = \left(\frac{\mu_0 NI}{2x^3}\right) R^2$

$B \propto R^2$

So, when radius is doubled, magnetic field becomes four times.

118. (a) Magnetic field at the centre of the ring is

$$\frac{\mu_0 qf}{2R}$$

119. (d) **120. (a)** **121. (b)** **122. (c)**

123. (c) With parallel component it will move in the direction of magnetic field and with perpendicular component it will trace circular path and the combination of both these yield helical path.

124. (d) Power $= \frac{\text{work done}}{\text{time}}$

As no work is done by magnetic force on the charged particle because magnetic force is perpendicular to velocity, hence power delivered is zero.

125. (b) When the block moves to the right application of equation $\vec{F}_B = q(\vec{V} \times \vec{B})$ gives magnetic force in upward direction similarly when block moves left, $\vec{F}_B$ is in downward direction.

126. (b) Due to perpendicular component both will execute circular motion for which $T = \frac{2\pi m}{qB}$. Since q is same, therefore $T \propto m$. Hence deuterium nucleus will travel more distance.

127. (a) 128. (d) 129. (c)
130. (b) 131. (a) 132. (a)

133. (b) Here, $\vec{E}$ and $\vec{B}$ are perpendicular to each other and the velocity $\vec{v}$ does not change; therefore

$$qE = qvB \Rightarrow v = \frac{E}{B}$$

If velocity $\vec{v}$ is $\perp^r$ to both $\vec{E}$ and $\vec{B}$,

$$\text{Also, } \left|\frac{\vec{E}\times\vec{B}}{B^2}\right| = \frac{E\,B\sin\theta}{B^2} = \frac{E\,B\sin 90^\circ}{B^2} = \frac{E}{B} = |\vec{v}| = v$$

134. (b) $\vec{v}$ and $\vec{B}$ are in same direction so that magnetic force on electron becomes zero, only electric force acts. But force on electron due to electric field is opposite to the direction of velocity.

135. (a) r = mv/Bq is same for both.

136. (b) The charged particle will move along the lines of electric field (and magnetic field). Magnetic field will exert no force. The force by electric field will be along the lines of uniform electric field. Hence the particle will move in a straight line.

137. (b) Due to electric field, it experiences force and accelerates i.e. its velocity decreases.

138. (b) In a uniform magnetic field, a charged particle is moving in a circle of radius R with constant speed v.

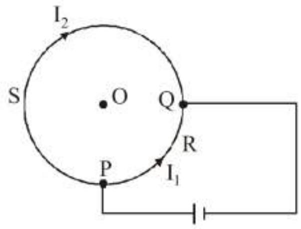
$$\therefore \frac{mv^2}{R} = Bqv \quad \text{or, } R = \frac{mv}{Bq} \quad .....(1)$$

$$\text{Time period, } T = \frac{2\pi R}{v} = \frac{2\pi mv}{Bqv} = \frac{2\pi m}{Bq} \quad .....(2)$$

Time period T does not depend on both R and v because when v is changed, R is also changed proportionately and for period, it is R/v that is taken.

139. (a) Since magnetic force is always perpendicular to the velocity of electron, so it can only change the direction of velocity of electron, but it (the magnetic force) cannot accelerate or deaccelerate the electron.

140. (a) Let ℓ_1, ℓ_2 be the lengths of the two parts PRQ and PSQ of the conductor and ρ be the resistance per unit length of the conductor. The resistance of the portion PRQ will be $R_1 = \ell_1 \rho$



The resistance of the portion PSQ will be $R_2 = \ell_2 \rho$

Pot. diff. across P and Q $= I_1 R_1 = I_2 R_2$

or $I_1 \ell_1 \rho = I_2 \ell_2 \rho$ or $I_1 \ell_1 = I_2 \ell_2$ ...(1)

Magnetic field induction at the centre O due to currents through circular conductors PRQ and PSQ will be

$$= B_1 - B_2 = \frac{\mu_0}{4\pi}\frac{I_1\ell_1 \sin 90^\circ}{r^2} - \frac{\mu_0}{4\pi}\frac{I_2\ell_2 \sin 90^\circ}{r^2} = 0.$$

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

142. (b) F = iB l sin θ. This is maximum when sin θ = 1 or θ = π/2.

143. (b) $F = I\ell B \sin\theta = 3 \times 0.40 \times (500 \times 10^{-4}) \times \sin 30^\circ = 3 \times 10^{-2}$ N.

144. (a) $F = IlB \sin\theta$ or $\sin\theta = \frac{F}{IlB}$

$$\sin\theta = \frac{15}{10 \times 1.5 \times 2} = \frac{1}{2} \quad \text{or } \theta = 30^\circ$$

145. (b) $F = IlB$

Here, $\theta = 90^\circ$, $I = 10\ A$

$l = 8$ cm $= 8 \times 10^{-2}\ m$, $B = 0.3\ T$

$\therefore F = 10 \times 8 \times 10^{-2} \times 0.3 \times \sin 90^\circ = 0.24\ N$

146. (b) [Hint $\Rightarrow \frac{mv^2}{r} = qvB$].

147. (c) $$Bqv = \frac{mv^2}{r} \text{ or } B = \frac{mv}{rq} = \frac{(9\times10^{-31})\times10^6}{0.1\times(1.6\times10^{-19})}$$

$$= 5.5 \times 10^{-5}\ T$$

148. (c) $E = vB = 2\times10^3 \times 1.5 = 3\times10^3\ V/m.$

149. (b)

150. (c) Magnetic dipole moment

$$m = iA = \frac{e}{T}\times \pi r^2 = \frac{e}{(2\pi r/v)}\times \pi r^2 = \frac{erv}{2}.$$

$$= \frac{1.6\times10^{-19}\times 50\times10^{-12}\times 2.2\times10^6}{2}$$

$$= 8.8\times10^{-24}\ Am^2.$$

151. (c) $B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r}$ where

$$i = \frac{2e}{t} = \frac{2\times1.6\times10^{-19}}{2} = 1.6\times10^{-19}\ A$$

$$\therefore\ \mathbf{B} = \frac{\mu_0 \mathbf{i}}{\mathbf{2r}} = \frac{\mu_0\times\mathbf{1.6\times10^{-19}}}{\mathbf{2\times0.8}} = \mu_0\times\mathbf{10^{-19}\,T}$$

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

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

153. (b) $F = \frac{\mu_0}{4\pi}\frac{2I_1I_2}{r}\times\ell = \frac{10^{-7}\times2\times10\times2}{0.1}\times2 = 8\times10^{-5}\ N$

154. (c)

155. (b)

156. (c) [Hint $\Rightarrow S\times(I-I_g) = R_g\times I_g$]

157. (b) $I_g = 0.1I,\ I_s = 0.9I;\ S = I_g\ R_g/I_s$

$$= 0.1\times900/0.9 = 100\,\Omega.$$

158. (c) $I_g = 10\times10^{-3}/5 = 2\times10^{-3}\ A;$

$$R = \frac{V}{I_g} - R_g = \frac{1}{2\times10^{-3}} - 5 = 495\,\Omega.$$

159. (b) Here, $R_g = 100\,\Omega;\ I_g = 10^{-5}\,A;\ I = 1A;\ S = ?$

$$S = \frac{I_gR_g}{I - I_g} = \frac{10^{-5}\times100}{1-10^{-5}} = 10^{-3}\,\Omega \text{ in parallel}$$