ELECTROMAGNETISM

SYNOPSIS

- **INTRODUCTION:**
  - A current carrying wire is surrounded by a magnetic field. This was first discovered by Oersted. This is called magnetic effects of electric current.
  - Ampere's right hand grip rule: If a straight conductor is held in right hand such that the thumb points in the direction of the current then the direction of the curl of the remaining fingers gives the direction of the line of force.
  - Maxwell's cork screw rule: If the direction of the movement of a right handed cork screw represents the direction of current in a wire then the direction of rotation of the head of the screw gives the direction of the line of force, i.e., direction of the magnetic field around it.
- **AMPERE'S LAW:**
  - The line integral of the magnetic induction over a closed loop is equal to μ_0 times the current (I) passing through the area bounded by the loop.

    $$\int B.dl = \mu_0 i$$
  - i.e. the work done in moving a unit N-pole around a conductor carrying current is μ_0 I which is a constant. It does not depend upon the radius of the circle in which it is moved.
  - The Magnetic Induction at any point due to a straight conductor is directly proportional to the strength of the current in the conductor, and is inversely proportional to the distance of the point from the conductor.

    $$B \propto i$$

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

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

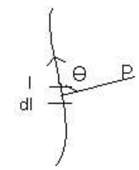
    Where μ_0 is the permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ henry m^{-1}.
- **BIOT - SAVART'S LAW :**
  - Magnetic Induction at a distance from an arbitrary shaped conductor is found using Biot-Savart's Law.
  - Magnetic induction 'dB' due to a small element of the conductor of length 'dl' carrying a current I is given by :

    $$dB = \frac{\mu_0}{4\pi}\frac{idl\sin\theta}{r^2}$$

    Due to the total conductor it will be,

    $$B = \int dB$$
  - In vector form,

    $$\overline{dB} = \frac{\mu_0}{4\pi}\frac{i\overline{dl}x\overline{r}}{r^3}$$



- Magnetic Induction on the Axis of a Circular current carrying coil is :
- $$B = \frac{\mu_0 n i r^2}{2\left(r^2 + x^2\right)^{\frac{3}{2}}}$$

  Where n is the number of turns, 'r' is the radius of the coil and 'x' is the distance of the point from the centre of the coil.

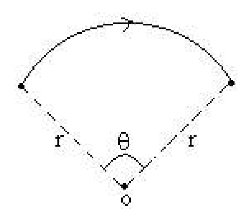
Case (A): At the center of coil (x=0)

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

Case (B) : If x >> r, then $B = \frac{\mu_0 n i r^2}{2x^3} \Rightarrow B \alpha \frac{1}{x^3}$

The magnetic induction at the centre of circular current carrying arc, subtending angle θ at center is $B = \frac{\mu_0 i}{4\pi r}(\theta)$ where 'θ' is in radians

- 1) If $\theta = \pi$, that is for semi circle



$$B = \frac{\mu_0 n i}{4r}$$

2) If $\theta = 2\pi$ that is for acircle $B = \frac{\mu_0 n i}{2r}$

- If n = 1 ; B = $\frac{\mu_0 i}{2r}$
- For half a circular Loop, n = 1/2
  B = (μ_0 i /4r)
- The magnetic moment of a circular coil of area 'A' carrying a current 'i' and having 'n' turns is, M = n i A
- An electron (Charge 'e') revolving around the nucleus in an orbit with a speed 'V' then the magnetic field induction at it's centre is

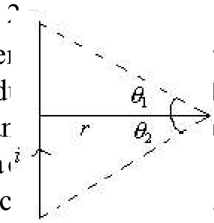
  B = $\frac{\mu_0 V e}{4\pi r^2}$
- A long solenoid carrying a current acts like a bar magnet, B = $\mu_0 n i$ along the axis of the solenoid. Where, n is the number of turns per meter length.

  At the ends of long solenoid, $B = \frac{1}{2}\mu_0 ni$

- **FIELD DUE TO AN INFINITE LONG STRAIGHT CONDUCTOR:**

- B = $\frac{\mu_0 i}{2\,[\text{illegible}]}$

  Whe[illegible] rent through the cond[illegible] the perpendicular distar[illegible] m the conductor.



- For a [illegible] length the magnetic induc[illegible].

  B = $\frac{\mu_0 i}{4\pi r}$ (Sin θ_1 + Sin θ_2)
- If the point P lies along the axis of the conductor then B = 0
- If the point P lies at a perpendicular distance r from one end of an infinitely long conductor then magnetic induction at P is.

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

Similarly for conductor of finite length perpendicular to one end, $B = \frac{\mu_0 i}{4\pi r}\sin\theta$

- **FORCE EXPERIENCED BY A CHARGE IN A MAGNETIC FIELD:**
- A moving charge in a magnetic field experiences a force. The direction of the force is given by Fleming's left hand rule. Forefinger, Central-finger and the thumb show the direction of field, current and the direction of the motion of the charge respectively.
- The Magnitude of the force is given by F = q V B sin θ In vector form F = q ($\overline{V} x \overline{B}$) where θ is the angle between $\overline{V}$ and $\overline{B}$
  Fore finger $\rightarrow$ field (B) Central finger $\rightarrow$ charge (q) Thumb $\rightarrow$ Force (F)
- i) When $\theta = 0$ or 180^0 , F = 0 charge moves in a straight line

ii) When $\theta = 90^0$ F=Bqv charge moves in a circular path

iii) For any other angle charge moves in a helical path.

- When a particle of mass 'm' and charge 'q' is moving perpendicular to a uniform magnetic field of Induction 'B' with a velocity 'v', it describes a circular path of radius 'r' then,

r = $\frac{mv}{qB}$ (since, qvB = $\frac{mv^2}{r}$)

frequency 'n' = $\frac{qB}{2\pi m}$

Time period 'T' = $\frac{2\pi m}{qB}$

n and T are independant of the radius of the circular path it describes.

7) **FORCE EXPERIENCED BY A CURRENT CARRYING CONDUCTOR PLACED IN A MAGNETIC FIELD:**
- If a current carrying conductor is placed in a magnetic field of induction 'B' such that, its length (L) is perpendicular to the field then it experiences maximum force given by
  F = Bi L
  Where 'i' is the current flowing through the conductor
- If the length makes an angle θ with the field then,
  F = BiL Sin θ or $\overline{F} = i\overline{L} X \overline{B}$

- **FORCE BETWEEN TWO INFINITELY LONG PARALLEL CONDUCTORS CARRYING CURRENT:**
- Force experienced per unit length of each conductor is,

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

  where i_1, i_2, are the currents flowing through the two conductors, r is the distance between them.

- Force experienced by a length 'l' of each conductor is F = $\frac{\mu_0 I_1 I_2 l}{2\pi r}$
- If the currents in the parallel conductors are in the same direction then they attract each other. If the currents are in opposite direction then they repel each other.
- When a small conductor 'PQ' of length 'l' carrying a current 'I_1', is in equilibrium above an infinitely long conductor carrying current 'I_2' then $\frac{\mu_0 I_1 I_2 l}{2\pi r}$ = mg

  Where mg is the weight of PQ and r is the distance between the conductors I_1 and I_2 are in opposite directions.
- If PQ is below the infinitely long conductor, then I_1 and I_2 must be in the same direction.
- If two stright parallel current carrying conductors with current $i_1, i_2 \left(i_2 > i_1\right)$ are seperated by a distance 'd' then distance of null point from conductor i_1 is $x = \frac{d}{\left(\frac{i_2}{i_1}\right) \pm 1}$

  $+ve$ for the currents in the same direction.

  $-ve$ for the current in the opposite direction.

- **TORQUE ON A CURRENT CARRYING COIL IN A UNIFORM MAGNETIC FIELD:**
  - If the plane of the coil makes an angle 'θ' with the direction of the field of induction B then

    τ = n I AB Cosθ = $MB\cos\theta$

    Where 'A' is area of the coil of 'n' turns carrying a current I and magnetic moment of coil $M = nIA$.
  - If the normal drawn to the plane of the coil makes an angle 'φ' with the direction of the magnetic field then.

    τ = n I AB sin φ

    In vector form $\bar{\tau}$ = n I $(\bar{A} x \bar{B})$ = $\bar{M} x \bar{B}$

    Magnetic moment of the coil is M = n I A
- **MOVING COIL GALVANOMETER (MCG):**
  - It works on the principle that a coil carrying current when placed in uniform magnetic field experiences a torque.
  - It is used to measure currents of the order of 10^{-9} A.
  - The horse - shoe type of magnet provides the radial field with the help of cylindrical poles and soft iron cylinder
  - The coil in MCG is suspended by a phosphor bronze ribbon and it provides the restoring torque.
  - The deflections are measured with a lamp and scale arrangement.
  - The current through the MCG,

    $$I = \left(\frac{C}{nBA}\right) \theta = K\theta$$

    Where 'K' is called as galvanometer constant and 'C' is the couple per unit twist of the suspension fibre.
  - I - θ graph is a straight line passing through the origin (θ on Y - Axis, I on X - Axis)

    Slope of the graph = (nBA)/C
  - Current sensitivity of the galvanometer = θ/I = (nBA)/C

    The Current sensitivity can be increased by,

    a) increasing the number of turns

    b) increasing the area of the coil

    c) increasing 'B'

    d) decreasing 'C'
  - Voltage sensitivity of the galvanometer, = θ/V = (nBA)/CG

    Where G is the resistance of the galvanometer
  - Table galvanometer is also a moving coil galvanometer in which the deflection of the coil and hence current is directly read by the motion of the pointer of the scale.
  - The sensitivity of a table galvanometer is less than that of a MCG..
  - If we pass same current through different galvanometers, then the galvanometer which shows more deflection is more sensitive.
- **TANGENT GALVANOMETER (TG) :**
  - It is a moving magnet galvanometer used to measure current
  - It is less sensitive than MCG. It can measure current of the order of 10^{-6} A.

    In S.I. units $I = \left(\frac{2r\,B_H}{\mu_0 n}\right)\tan\theta = K\tan\theta$

    I = K tan θ

Where K is called as T.G. constant
(or) reduction factor of T.G.
r-radius in meter

$B_H =$ Horizontal component of earth magnetic field in Tesla.

$I \rightarrow$ current in amperes

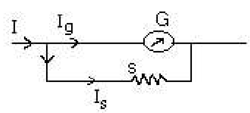
- $I = \left(\frac{10rH}{2\pi n}\right)\tan\theta$ in C.G.S. Units

$I = K \tan\theta$
Where K is called as T.G. constant
(or) reduction factor of T.G.
$r \rightarrow$ radius of coil of T.G. in centimeters
$H \rightarrow$ Horizontal of component of earth magnetic field in oersteds.
$I \rightarrow$ current in amperes

- The unit of K is ampere
- It is portable

- **ADVANTAGES OF (MCG) OVER (TG) :**
  - The scale is linear
  - It is unaffected by external magnetic material (or) magnetic fields.
  - It need not be adjusted in a particular position.
  - It can be used at the poles also
  - It is more sensitive.

- **SHUNT**



- $I = I_g + I_s$
- $I_g = \frac{IS}{G+S}$
- $I_s = \frac{IG}{G+S}$
- $\frac{I_g}{I_s} = \frac{S}{G}$; $\frac{I_g}{I} = \frac{S}{G+S}$;

$\frac{I_s}{I} = \frac{G}{G+S}$

- effective resistance of the circuit is, $\frac{GS}{G+S}$
- A shunt is a small resistance connected in parallel to a sensitive device to protect it from damage due to large currents.

- **AMMETER :**
  - A galvanometer is converted into an ammeter by connecting a low resistance in parallel called shunt resistance.
  - Shunt resistance,

$S = \frac{I_g G}{I - I_g}$

Where I_g is the full scale deflection current of the galvanometer, I is the maximum current to be read on the ammeter.

  - In electrical circuits, an ammeter is always connected in series.
  - The internal resistance of an ammeter is low. An Ideal ammeter should have zero resistance.
  - By shunting a galvanometer, the sensitivity decreases.
  - When increasing the range of an ammeter,

$S = \left(\frac{G}{n-1}\right)$

Where n = new range / old range

  - The P.D. across the terminal of an ammeter is negligible.

- **VOLTMETER:**
  - A galvanometer is converted into a Voltmeter by connecting a high resistance in series to it.
  - The resistance 'R' that should be connected to galvanometer in order to convert it into a voltmeter is,

$R = \frac{V}{I_g} - G$

where 'V' is the maximum Voltage to be read with the converted Voltmeter.

  - To change the range,
R= (n-1) G
Where, n = new range / old range
  - Resistance of Voltmeter is (G + R)
  - The internal resistance of a Voltmeter is high. An Ideal Voltmeter should have infinite resistance.
  - In electrical circuits, the voltmeter is always connected in parallel.
  - The current drawn by a voltmeter is negligible.
  - Voltmeter is converted into ammeter by connecting a low resistance in parallel with it.
  - Ammeter is converted into voltmeter by connecting a high resistance in series with it.

CONCEPTUAL QUESTIONS

1. The intensity of magnetic induction at the centre of a current-carrying circular coil is B_1 and at a point on its axis at a distance equal to its radius from the centre is B_2, then B_1/B_2 is

1) $2\sqrt{2}$ 2) $\frac{1}{2\sqrt{2}}$ 3) $\frac{1}{\sqrt{2}}$ 4) $\sqrt{2}$

2. The magnetic field due to a current element is independent of :

1) current through it 2) distance from it
3) its length 4) nature of meterial

3. If we double the radius of a current carrying coil keeping the current unchanged ,the magnetic field at its centre

1) becomes four times 2) doubled
3) remains unchanged 4) halved

4. If we double the radius of the coil keeping the current through it unchanged,the magnetic field on its axis at very very far away points

1) becomes four times 2) is doubled
3) remains unchanged 4) halved

5. A current carrying coil is placed with its plane in the magnetic meridian of the earth. When seen from the east side a clockwise current is set up in the coil.The magnetic field at its centre will be directed towards

1) north 2) south 3) west 4) east

6. A current carrying power line carries current from west to east .The direction of magnetic field 1m above is

1) north to south 2) south to north
3) east to west 4) west to east

7. A metallic pipe carries direct current. Which of the following statements about the existence of magnetic field is true?

1) it exists outside only
2) it exists inside only
3) it exists both inside & outside
4) it exists neither inside nor outside

8. A current carrying wire produces in the neighbour hood

1) Electric and magnetic fields
2) Electric field only 3) Magnetic field only
4) No field.

9. Two circular coils of equal radius carrying currents i_1, i_2 in opposite direction are at a large distance 'd'. The distance from the first coil where the resultant magnetic induction is zero is

1) $\frac{d}{1+\frac{i_2}{i_1}}$ 2) $\frac{d}{1+\sqrt{\frac{i_2}{i_1}}}$ 3) $\frac{d}{1+\left(\frac{i_2}{i_1}\right)^{\frac{1}{3}}}$ 4) $\frac{d}{1+\left(\frac{i_2}{i_1}\right)^{2}}$

10. A light body is hanging at the lower end of a vertical spring. On passing current in the spring, the body

1) Rises up 2) Goes down
3) No change 4) Oscillates up & down

11. For a given distance from a current element, the magnetic induction is maximum at an angle measured with respect to axis of the current.

1) $3\pi/4$ 2) $\pi/4$ 3) $\pi/2$ 4) 2π

12. The work done in moving a unit n-pole round a conductor carrying current in a circle of radius 10cm is w. The work done in moving it in a circle of radius 20cm is.

1) w 2) 2w 3) w/2 4) 4w

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

1) Twice the earlier value
2) half of the earlier value
3) Quarter of the earlier value
4) unchanged

14. Magnetic lines of force due to a straight conductor carrying current are

1) Straight lines 2) Elliptical
3) Circular 4) Parabolic

15. The magnetic field $\overline{dB}$ due to a small current element dl at a distance $\vec{r}$ and carrying current 'i' is

1) $\overline{dB}=\frac{\mu_0}{4\pi}i\left(\frac{\overline{dl}\times\overline{r}}{r}\right)$ 2) $\overline{dB}=\frac{\mu_0}{4\pi}i^2\left(\frac{\overline{dl}\times\overline{r}}{r^2}\right)$

3) $\overline{dB}=\frac{\mu_0}{4\pi}i^2\left(\frac{\overline{dl}\times\overline{r}}{r}\right)$ 4) $\overline{dB}=\frac{\mu_0}{4\pi}i\left(\frac{\overline{dl}\times\overline{r}}{r^3}\right)$

16. Magnetic effect of an electric current was discovered by

1) Ohm 2) Faraday 3) Oersted 4) Ampere

17. An electric charge in uniform motion produces

1) An electric field only
2) A magnetic field only
3) Both electric and magnetic fields.
4) No such field at all

18. A current 'i' amp flows along an infinitely long straight thin conductor. Then the magnetic induction at any point on the axis of the conductor is

1) infinity 2) zero 3) $\frac{\mu_0 2i}{4\pi r}$ 4) $\frac{\mu_0}{4\pi}\frac{i}{r}$

19. A current 'i' flows along an infinitely long straight conductor. If r is the perpendicular distance of a point from the middle point of the conductor then the magnetic induction B is given by

1) $B = \frac{\mu_0}{4\pi}\frac{2i}{r}$ 2) $B = \frac{\mu_0}{4\pi}\frac{i}{r}$

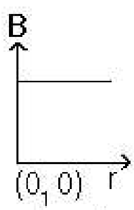
3) $B = \frac{\mu_0}{4\pi}\frac{\pi i}{r}$ 4) $B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r}$

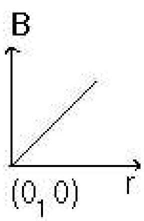
20. A current 'i' flows along an infinitely long straight conductor. If 'r' is the perpendicular distance of a point from the lower end of the conductor, then the magnetic induction B is given by

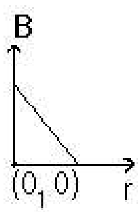
1) $B = \frac{\mu_0}{4\pi}\frac{2i}{r}$ 2) $B = \frac{\mu_0}{4\pi}\frac{i}{r}$

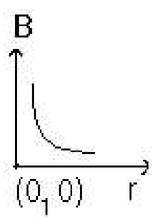
3) $B = \frac{\mu_0}{4\pi}\frac{\pi i}{r}$ 4) $B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r}$

21. A long straight thin conductor has a current of'i' ampere. The magnetic induction B away from the conductor at a distance 'r' from its axis varies as shown in

a) 

b) 

c) 

d) 

1) a 2) b 3) c 4) d

22. If the angular momentum of an electron revolving in a cirular orbit is L, then its magnetic moment is
1) eLm 2) eL/m 3) eL/2m 4) zero

23. An electron is projected parallel to electric and uniform magnetic fields acting simultaneously in the same direction .The electron
1)gains kinetic energy 2)loses kinetic energy
3)moves along circular path
4)moves along a parabolic path

24. A proton is rotating along a circular path with kinetic energy K in a uniform magnetic field B.If the magnetic field is made four times, the kinetic energy of rotation of proton is
1) 16K 2) 8K 3) 4K 4) K

25. Which of the following characteristics is independent of the angle between $\vec{V}$ and $\vec{B}$
1) Momentum 2) Radius of helical path
3) Angular speed 4) Both 1 and 2.

26. A positively charged particle fall vertically downwards. The horizontal component of earth's magnetic field will deflect it towards
1) West 2) East 3) South 4) North

27. An electron and a proton enter a magnetic field with equal velocities. The particle that experiences more force is
1) Electron 2) Proton
3) Both experience same force
4) It cannot be predicted.

28. An electron and a proton enter a magnetic field at right angle to the field with same kinetic energy. The correct statement is
1) Trajectory of electron is less curved
2) Trajectory of proton is less curved
3) Both are equally curved
4) Both move along straight line paths

29. A proton and an electron enter a region with equal speed in which a magnetic field is suddenly switched on. The force experienced by them are
1) Equal and opposite
2) Different in magnitude but same in direction
3) in the ratio of 1840
4) Same in magnitude and direction

30. The following cases in which no force is exerted by a magnetic field on a charge is
1) Moving with constant velocity
2) Moving in a circle.
3) At rest 4) Moving along a curved path.

31. Two streams of electrons are moving parallel to each other in the same direction. They
1) Attract each other 2) Repel each other
3) Cancel the electric field of each other
4) Cancel the magnetic field of each other.

32. A magnetic field exerts no force on
1) a stream of electrons
2) a stream on protons
3) Unmagnetised piece of iron
4) Stationary charge.

33. An electron beam is moving from left to right of the observer and magnetic field is acting vertically upwards the direction of force acting on electron is
1) Towards the observer
2) Away from the observer
3) Downwards 4) Upwards.

34. A charged particle enters into a uniform magnetic field the parameter that remains constant is
1) Velocity 2) Momentum
3) Kinetic energy 4) All the above.

35. A charge moving with velocity V in X direction is subjected to a field of magnetic induction in the negative X direction.As a result the charge will
1) Remain unaffected
2) Start moving in a circular path in y-z plane
3) retard along X - axis
4) Move along a helical path around X - axis.

36. The mono energetic beams of electrons moving along +y direction enter a region of unform electric and magnetic fields. If the beam goes straight through these simultaneously then field B and E are directed respectively along
1) -y axis and -z axis 2)+z axis and -x axis
3) + x axis and - x axis 4)-x axis and -y axis.

37. A unit N-pole is placed on the axis of a circular coil carrying current in anti-clockwise direction. It experiences a force
1) Towards the coil 2) Perpendicular to the coil
3) Away from the coil 4) Parallel to the coil.

38. An α - particle moves from E to W in a magnetic field perpendicular to the plane of the paper and into the paper. The particle is deflected towards
1) East 2) West 3) South 4) North

39. Two streams of protons move parallel to each other in the same direction. They will
1) Attract each other 2) Repel each other
3) Neither attract nor repel 4) Rotate.

40. A charged particle moving in a magnetic field experiences a resultant force
1) In the direction opposite to that of field.
2) In the direction opposite to that of its velocity.
3) In the direction perpendicular to both field & its velocity
4) In the direction parallel to the field.

41. An electron is projected in the same direction of uniform magnetic field. Then
1) The electron turns to right
2) The electron turns to left
3) The electron velocity remains constant
4) The electron velocity decreases in magnitude.

42. The force acting on a charge 'q' moving with a velocity V in a magnetic field of induction B is given by

1) $\frac{q}{\vec{V}\times\vec{B}}$ 2) $\frac{\vec{V}\times\vec{B}}{q}$ 3) $q(\vec{V}\times\vec{B})$ 4) $(\vec{V}\cdot\vec{B})q$

43. A charge q is moving with a velocity parallel to a magnetic field. Force on the charge due to magnetic field is
1) Q VB 2) QB/V 3) Zero 4) Bv/q

44. If the direction of the initial velocity of the charged particle is perpendicular to the magnetic field, the orbit will be
1) A straight line 2) An ellipse
3) A circle 4) A helix

45. If the direction of the initial velocity of a charged particle is neither along nor perpendicular to that of the magnetic field, then the orbit will be
1) A straight line 2) An ellipse
3) A circle 4) A helix.

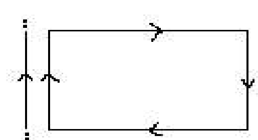
46. A free charged particle moves through a magnetic field. The particle may undergo a change in
1) Speed 2) Energy
3) Direction of motion
4) Magnitude of the velocity

47. Particles having positive charge occasionally come with high velocity from the sky towards the earth on account of magnetic field of earth, they would be deflected towards the
1) North 2) South 3) East 4) West

48. An electron of mass 'm' is accelerated through a potential difference of V and then it enters a magnetic field of induction B. normal to the lines of force. Then the radius of the circular path is

1) $\sqrt{\frac{2eV}{m}}$ 2) $\sqrt{\frac{2Vm}{eB^2}}$ 3) $\sqrt{\frac{2Vm}{eB}}$ 4) $\sqrt{\frac{2Vm}{e^2B}}$

49 A rectangular loop carrying current I is located near an infinite long straight conductor carrying current I as shown in the figure. The loop,

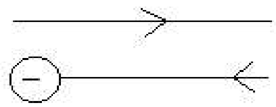


1) remain stationary
2) is attracted towards the wire
3) is repelled away from the wire
4) will rotate about an axis parallel to the wire

50. A current carrying wire is placed along east and west in a magnetic field directed north wards. If the current in the wire is directed east wards, the direction of force on the wire is
1) Due west 2) Due south
3) Vertically upwards 4) Vertically downwards

51. The direction of the magnetic field produced by a linear current is given by
1) right hand thumb rule
2) Fleming's left hand rule
3) Joule's law 4) Ampere's law

52. Immediately below the current carrying wire a stream of electrons are projected parallel to the wire as shown. They will be



1) accelerated to the right 2) retarded
3) deflected upward 4) deflected downward.

53. Two parallel, long wires carry currents i_1 & i_2 ($i_1 > i_2$) when the currents are in the same direction, the magnetic induction at a point midway between the two wires is X. If the direction of i_2 is reversed, the magnetic induction becomes 2x, then i_1/i_2 is
1) 1 2) 2 3)3 4)4

54. A straight horizontal conductor of length L meter and mass M kg carries a current 'i' ampere. The minimum magnetic induction which must exist in the region to balance its weight.
1) mg/iL 2) iL/mg 3) mgL/i 4) mL/ig

55. The dipole moment of a current loop is independent of
1) current in the loop 2) number of turns
3) area of the loop
4) magnetic field in which it is situated

56. The torque acting on a magnetic dipole of moment P_m when placed in a magnetic field is
1) $P_m B$ 2) $\overline{P}_m \times \overline{B}$ 3) $\overline{P}_m . \overline{B}$ 4) P_m/B

57. Tangent law is applicable to a dipole placed in two magnetic fields $\vec{B}$ *and* $\vec{Bo}$ when
1) $\vec{B} = \vec{B}_o$
2) $\overline{B}$ *and* $\overline{B}_0$ are perpendicular to each other
3) $\vec{B}$ makes any angle with $\vec{B}_o$
4) $\vec{B}$ is directed opposite to $\vec{B}_o$

58. A magnetic dipole placed in two perpendicular magnetic fields $\vec{B}$ and $\overline{B}_0$ is in equilibrium making an angle θ with $\vec{B}$ then.
1) $B = B_0$ 2) $B \cos\theta = B_o \sin\theta$
3) $B \sin\theta = B_o \cos\theta$ 4) $B = B_o \tan\theta$

59. A current carrying loop in a uniform magnetic field will experience
1) Force only 2) torque only
3) Both torque and force
4) Neither torque nor force.

60. The sensitivity of a moving coil galvanometer increases with the decrease in
1) Number of turns 2) Area of coil
3) Magnetic field 4) couple per unit twist

61. The sensitivity of a tangent galvanometer increases if
1) Number of turns decreases
2) Number of turns increases
3) Field increases
4) Number of turns remains same.

62. If we want to change a galvanometer into an ammeter extra resistance required is
1) Low resistance in parallel
2) High resistance in parallel
3) Low resistance in series
4) High resistance in series

63. A current carrying loop is free to turn in a uniform magnetic field. The loop will then come into equilibrium when its plane is inclined at
1) Zero degree to the direction of the field.
2) 45^0 to the direction of the field.
3) 90^0 to the direction of the field.
4) 60^0 to the direction of the field.

64. Best method to increase the sensitivity of the moving coil galvanometer is to increase.
1) Radius of the coil
2) Number of turns of the coil
3) External magnetic field
4) Both 1 and 2.

65. The plane of the coil of tangent galvanometer is parallel to the magnetic meridian
1) To avoid the influence of earth's magnetic field.
2) To increase the magnetic field due to the current in the coil.
3) To make earth's magnetic field perpendicular to that due to the current in the coil.
4) For some other reason.

66. To measure the resistance of a device using Ohm's law the mode of connection used is
1) Ammeter in series, voltmeter in parallel
2) Voltmeter in series, ammeter in parallel
3) both ammeter and voltmeter in series
4) both ammeter and voltmeter in parrallel

67. Among the following the true statement is,
1) Ammeter is a high resistance galvanometer and voltmeter is a low resistance galvanometer
2) Ammeter is a low resistance galvanometer and voltmeter is a high resistance galvanometer.
3) Ammeter and voltmeter cannot be distinguished on the basis of their resistance.
4) None of the above.

68. A galvanometer may be converted into ammeter or a voltmeter. The resistance of the device so obtained will be the largest in case of
1) Ammeter of range 1A
2) Ammeter of range 10A
3) Voltmeter of range 1V
4) Voltmeter of range 10V

69. To increase the range of an ammeter, we need to connect a suitable:
1) Low resistance in parallel
2) Low resistance in series
3) High resistance in parallel
4) High resistance in series.

70. The galvanometer constant of a tangent galvanometer depends upon
1) Earth's magnetic field 2) Current in the coil
3) Magnetic field of the coil 4) None of the above.

71. To increase the range of a voltmeter we need to connect a suitable.
1) high resistance in series
2) high resistance in parallel
3) low resistance in series
4) low resistance in parallel

72. A wire of length 'L' is made in the form of a coil in a moving coil galvanometer. To have maximum sensitiveness the shape of the coil is
1) Circular 2) Elliptical
3) Rectangular 4) Square

73. In a moving coil galvanometer a radial magnetic field is applied with concave magnetic poles, to have
1) Uniform magnetic field
2) The plane of the coil parallel to field
3) Both 1 and 2 4) Neither 1 nor 2

74. Regarding the connections of ammeter and a voltmeter in an electric circuit, the true statment is
1) Ammeter is connected in parallel and voltmeter in series
2) Ammeter is connected in parallel and voltmeter in parallel
3) Ammeter is connected in series and voltmeter in parallel
4) Ammeter is connected in series and voltmeter in series.

75. The sensitiveness of tangent galvanmmeter will be maximum if deflection in it is tending to
1) 0^0 2) 30^0 3) 45^0 4) 60^0

76. The resistance of an ideal voltmeter is
1) zero 2) infinity
3) finite, very small 4) finite and large

77. Energy in a current carrying coil is stored in the form of
1) electric field 2) magnetic field
3) dielectirc strength 4) heat.

78. A current loop placed in a magnetic field behaves like a
1) magnetic dipole 2) magnetic substance
3) magnetic pole 4) all are true.

79. Among the following the false statement is
1) Ammeter is connected in series and maximum current flows through it.
2) Voltmeter is connected in parallel and potential is maximum
3) Ammeter is connected in series and current through it is negligible
4) Voltmeter is connected in parallel and current through it is negligible.

80. A galvanometer with a shunt in parallel is used in series in a circuit. It is called.
1) Ammeter 2) Voltmeter
3) Ohmmeter 4) Multimeter

81. What is the relation between voltage sensitivity σ_V and the current sensitivity σ_i of a moving coil galvammeter? Given that G is the resistance of the galvanometer.
1) $\sigma_V = G\sigma_i$ 2) $\sigma_V = \sigma_i / G$
3) $\sigma_V \sigma_i = G$ 4) $\sigma_V \sigma_i = 1/G$

82. When a current carrying coil is placed in a uniform magnetic field of induction B, then a torque t acts on it. If I is the current, n is the number of turns and A is the face area of the coil and the normal to the coil makes an angle θ with B, Then
1) $t = B\,I\,n\,A$ 2) $t = B\,I\,n\,A\sin\theta$
3) $t = B\,I\,n\,A\cos\theta$ 4) $t = B\,I\,n\,A\tan\theta$

83. A moving coil type of galvanometer is based upon the principle that
1) A coil carrying current experiences a torque in magnetic field.
2) A coil carrying current produces a magnetic field.
3) A coil carrying current experiences impulse in a magnetic field.
4) All of these.

84. A current carrying coil tends to set itself
1) parallel to an external magnetic field.
2) Parallel to its own magnetic field
3) Perpendicular to the external magnetic field.
4) Perpendicular to the geographic meridian

85. If a galvanometer is shunted then which of the following is not true?
1) Effective range increases.
2) Equivalent resistance decreases.
3) Galvanometer becomes more sensitive
4) Galvanometer becomes more protective.

86. A conducting circular loop of radius 'r' carries a constant current 'i' It is placed in a uniform magnetic field $\overline{B}_0$ such that $\overline{B}_0$ is perpendicular to the plane of the loop. The magnetic force acting on the loop is
1) i r B_o 2) 2π ri B_o 3) zero 4) π riB_o

87. A coil of area A, turns N and carrying current i is placed with its face parallel to the lines of magnetic induction B. The work done in rotating the coil through an angle of 180^0 is
1) iNAB 2) 2iNAB 3) iNAB/2 4) zero

88. The restoring couple in the moving coil galvanometer is due to
1) Current in the coil
2) Magnetic field of the magnet.
3) Material of the coil.
4) Twist produced in the suspension wire.

89. A voltmeter has a resistance of g ohm and range of V volt. The value of resistance used in series to convert it into voltmeter of range n volt is
1) ng 2) (n-1)g 3) g/n 4) g/n-1

90. An ammeter has a resistance of G ohm and a range of 'i' ampere. The value of resistance used in parallel, to convert into an ammeter of range 'ni' ampere is
1) nG 2) (n-1)G 3) G/n 4) G/n-1

KEY

1) 1	2) 4	3) 4	4) 1	5) 3
6) 1	7) 1	8) 3	9) 3	10) 1
11) 3	12) 1	13) 4	14) 3	15) 4
16) 3	17) 3	18) 2	19) 1	20) 2
21) 4	22) 3	23) 2	24) 4	25) 3
26) 2	27) 3	28) 2	29) 1	30) 3
31) 2	32) 4	33) 2	34) 3	35) 1
36) 2	37)3	38) 3	39) 2	40) 3
41) 3	42) 3	43) 3	44) 3	45) 4
46) 3	47) 3	48) 2	49) 2	50) 3
51) 1	52) 3	53) 3	54) 1	55) 4
56) 2	57) 2	58) 2	59) 2	60) 4
61) 2	62) 1	63) 3	64) 3	65) 3
66) 1	67) 2	68) 4	69) 1	70) 4
71) 1	72) 1	73) 3	74) 3	75) 3
76) 2	77)2	78) 1	79) 3	80) 1
81) 2	82) 2	83) 1	84) 3	85) 3
86) 3	87) 2	88) 4	89) 2	90) 4

NEW PATTERN QUESTIONS

1. A flat circular coil carrying current has a magnetic moment μ.
a. μ has only magnitude, it does not have direction
b. The direction of μ is along the normal to the plane of the coil
c. The direction of μ depends on the direction of current flow
d. The direction of μ does not change if the current in the coil is reversed
1) a only correct
2) b and c are correct
3) d only correct
4) b and d are correct

2. Assertion (A): The plane of the coil of tangent galvanometer should be parallel to the magnetic meridian
Reason (R): It makes the magnetic field of the coil perpendicular to the horitzontal component of earth's magnetic field so that tangent law can be applicable
1) A and R are true and R is a correct explanation of A
2) A is true and R is true
3) both A and R are false
4) A and R are true and R is not a correct explanation of A

3. If a charged particle is projected perpen dicular to uniform magnetic field, then
a) force experienced will be perpendicular to the magnetic field and initial velocity.
b) force experienced will be perpendicular to the magnetic field and instantaneous velocity.
c) the work done by the magnetic field is zero.
d) the particle experiences both radial and tangential accelerations.
1) a, b, c are correct d is wrong
2) all are correct
3) a, b are correct, c, d are wrong
4) a, b, c are wrong, d is correct

4. Four particles (proton, deuteron, alpha particle and positron) are projected perpendicular to uniform magnetic field with same momentum. The decreasing order of curvature of their paths is
1) positron, proton, alpha particle, deuteron
2) proton, positron, deuteron, alpha particle
3) alpha particle, deuteron, positron, proton
4) positron, alpha particle, deuteron, proton

5. If a charged particle is projected perpen -dicular to a uniform magnetic field, then
a) it revolves in circular path
b) its K.E. remains constant
c) its momentum remains constant
d) its path is spiral
1) only a, b are correct 2) only a, c are correct
3) only b, d are correct 4) only a, d are correct

6. A proton is travelling due north. If a uniform magnetic field is applied vertically down then the particle
a) deflected towards west
b) revolves in anti clock wise direction
c) acquires acceleration
d) comes to rest
1) a, b, c are correct 2) a, d are wrong
3) b, d are wrong 4) b, c, d are correct

7. If a current carrying loop is placed in non uniform magnetic field, then the loop
a) experiences a force b) experiences a torque
c) will develop induced current
d) oscillates
1) a, c are correct 2) a, b, c are correct
3) b,c,d are correct 4) a,b,d are correct

8. Consider the following statements:
A) Time period of a charged particle in uniform magnetic field is independent of K.E of the particle.
B) Time period of a charged particle in uniform magnetic field depends on the angle between velocity and magnetic field.
C) Time period of a charged particle in uniform magnetic field is inversely propor tional to specific charge.
1) A, B are correct and C is wrong
2) A is correct, B and C are wrong
3) A, C are correct and B is wrong
4) All are correct

9. Assertion (A): The magnetic field due to infinite long current carrying conductor is inversely proportional to the perpendicular distance of the given point.
Reason (R): According to Biot-Savart's law
$$B \alpha \frac{1}{r^2}$$
1) A is correct, R is correct but not the correct explanation of A
2) Both are wrong 3) A is correct, R is wrong
4) A is correct, R is correct and it is the correct explanation of A

10. Assertion (A): In M.C.G., the deflection 'θ' is directly proportional to the strength of the current
Reason (R): In M.C.G., the the torque experienced by the loop is BiANcos θ
1) A is correct, R is correct reason of A
2) Both are wrong
3) Both A and R are correct and R is not the correct reason of A
4) A is correct, R is wrong

11. A charged particle is projected perpendicu lar to a uniform magnetic field. Arrange the following in correct order.
A) The direction of momentum of the particle changes
B) The particle experiences a force
C) The particle revolves in a circular path.
1) A,B,C 2) B,A,C 3) C,B,A 4) C,A,B

12. A proton, an alpha particle and an electron are projected perpendicularly into uniform transverse electric and magnetic fields. It is observed that proton travel underflected. Then
a) deflection for alpha particle > deflection for proton
b) alpha particle travels in clockwise, and electron in anti-clockwise directions.
c) both alpha particle and electron travel without deflection
d) alpha particle gets deflected but not electron.
1) Only a is correct 2)Only b, c are wrong
3) Only d is correct 4) a, b, d are wrong

13. Singly ionized helium (x), ionized deuteron(y), alpha(z) particles are projected into a uniform manetic field 3x 10^{-4} tesla with velocities 10^5 ms^{-1}, 0.4 x 10^4 ms^{-1} and 2 x 10^3 ms^{-1} respectively. The increasing order of ratio of angular momentum to magnetic moment is
1) x > y > z 2) x < y < z
3) y < x < z 4) z > x > y

14.

Resistance of galvanometer	**Shunt resistance**
A) 200 Ω	a) 50 Ω
B) 100 Ω	b) 20 Ω
C) 300 Ω	c) 50 Ω

The increasing order of sensitivity of ammete r constructed is
1) A, B, C 2) A, C, B 3) C, B, A 4) C, A, B

15. Consider the following lists and choose the correct matching

List - I	**List - II**
a) Minimum sensitivity	e) Ideal ammeter
b) Maximum resistance	f) Ammeter

c) Zero resistance g) Ideal voltmeter
d) Infinite resistance h) Galvanometer

1) a $\to$e, b$\to$f, c$\to$g, d$\to$h
2) a $\to$e, b$\to$h, c$\to$e, d$\to$g
3) a $\to$h, b$\to$g, c$\to$f, d$\to$a
4) a $\to$f, b$\to$h, c$\to$g, d$\to$a

KEY

1-2	2-1	3-1	4-2	5-1
6-1	7-2	8-4	9-1	10-3
11-2	12-4	13-2	14-1	15-2

NUMERICAL QUESTIONS

LEVEL I

1. A straight vertical conductor carries a current. At a point 5 cm due north of it, the magnetic induction is found to be 20 μT due east. The magnetic induction at a point 10 cm east of it will be
1) 5 μT north 2) 10 μT north
3) 5 μT south 4) 10 μT south
2. The magnitude of a current in a long straight conductor to produce a flux density of 2 μ T at a distance of 10 cm from the conductor is
1) 0.5 A 2) 1.0 A
3) 0.25 A 4) 2.0 A
3. A current of 5 A is flowing through a long straight copper wire. The ratio of the magnetic inductions at distances of 1.0 cm and 2.0 cm from the wire is
1) 1 : 2 2) 1 : 4 3) 2 : 1 4) 4 : 1
4. A long straight cable contains 7 strands of wire each carrying a current of 5 A. The magnetic induction at a distance of 2 cm from the axis of the cable is
1) 5×10^{-5} T 2) 3.5×10^{-6} T
3) 3.5×10^{-4} T 4) 1.1×10^{-3} T
5. A wire is bent in the form of a semi circle of radius ‘r’ and carries a current of ‘i’. The magnetic induction at the centre of the semi circle is
1) $\mu_o i/2r$ 2) $\mu_o i/8r$
3) $\mu_o i/4r$ 4) $\mu_o i/r$
6. A circular coil of radius 11 cm, carries a current of 2.5 amperes. If it has 700 turns, the flux density at the center of the coil is
1) 20 mT 2) 10 mT
3) 5 mT 4) 0.1 mT
7. The intensity of magnetic induction at the center of a circular coil carrying a current is B. If the number of turns and radius are doubled, the intensity of magnetic induction at the center with the same current will be
1) 2B 2) 4B 3) B 4) B/2
8. A wire carrying a current of 4 A is in the form of a circle. It is necessary to have a magnetic field of induction $\pi \times 10^{-5}$ T at the centre. The radius of the circle must be
1) 0.08 cm 2) 0.8 cm
3) 8 cm 4) 80 cm
9. Two concentric circular loops of radii r_1 and r_2 carry clockwise and anticlockwise currents i_1 and i_2. If the centre is a null point, i_1/i_2 must be equal to
1) r_2/r_1 2) r_2^2/r_1^2 3) r_1^2/r_2^2 4) r_1/r_2
10. A circular current carrying coil has a radius r. It’s magnetic dipole moment is proportional to
1) r 2) r^2 3) 1/r 4) $1/r^2$
11. 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. If the magnetic field is perpendicular to the length of the wire, the force acting on the wire is
1) 2.4 N 2) 1.2 N
3) 3.0 N 4) 2.0 N
12. A proton is fired with a speed of 2×10^6 m/s at an angle of 60° to the X- axis. If a uniform magnetic field of 0.1 tesla is applied along the Y- axis, the force acting on the proton is
1) $1.6\sqrt{3} \times 10^{-14}$ N 2) 1.6×10^{-14} N
3) $3.2\sqrt{3} \times 10^{-14}$ N 4) 3.2×10^{-14} N
13. If the distance as well as the current in each of two parallel current carrying wires is doubled, the force per unit length acting between them becomes
1) doubled 2) remains same
3) quadrupled 4) halved
14. Two conductors each of length 12 m are parallel to each other in air. The centre to centre distance between the two conductors is 15 cm and the current in each conductor is 300 amperes. The force in newtons between the conductors is
1) 0.144 N 2) 1.44 N
3) 14.4 N 4) 0.12 N
15. The force per unit length between two long straight conductors carrying currents 3 A each in the same direction and separated by a distance of 2.0 cm is
1) 9×10^{-7} N/m 2) 9×10^{-6} N/m
3) 9×10^{-5} N/m 4) 9×10^{-4} N/m
16. A particle of mass ‘m’ and carrying a charge ‘e’ is fired perpendicular to a uniform magnetic induction B with a velocity v. The time period of revolution for the subsequent motion is given by
1) $2\pi B/me$ 2) $2\pi e/Bm$
3) $2\pi m/Be$ 4) $2\pi Be/m$

17. A proton of mass "m" and charge "e" is fired parallel to a uniform magnetic field of induction "B". The radius of curvature of the path of the particle in the field is

1) Be/mv 2) mv/Be
3) zero 4) infinity

18. A particle of mass 'm' and charge 'q' is fired perpendicular to a uniform magnetic field of induction 'B'. While the particle moves in a circular path in the filed, its angular velocity is

1) $\frac{m}{Bq}$ 2) $\frac{Bm}{q}$ 3) $\frac{Bq}{m}$ 4) $\frac{q}{Bm}$

19. A circular coil of 1 turn and area 0.01 m^2 carries a current of 10 A. It is placed in a uniform magnetic field of induction 0.1 tesla such that the plane of the circle is perpendicular to the direction of the field, the torque acting on the coil is

1) 0.1 N m 2) 0.001 N m
3) 0.01 N m 4) Zero

20. A rectangular coil of wire of area 400 cm^2 contains 500 turns. It is placed in a magnetic field of induction 4×10^{-3} T and it makes an angle 60° with the field. A current of 0.2 A is passed through it. The torque on the coil is

1) $8\sqrt{3} \times 10^{-3}$ N m 2) 8×10^{-3} N m
3) $8\sqrt{3} \times 10^{-4}$ N m 4) 8×10^{-4} N m

21. A rectangular coil of wire carrying a current is suspended in a uniform magnetic field. The plane of the coil is making an angle of 30° with the direction of the field and the torque experienced by it is τ_1 and when the plane of the coil is making an angle of 60° with the direction of the field the torque experienced by it is τ_2. Then the ratio $\tau_1 : \tau_2$ is

1) $1 : \sqrt{3}$ 2) $\sqrt{3} : 1$ 3) 1 : 3 4) 3 : 1

22. The area of the coil in a moving coil galvanometer is 80 cm^2 and it has 200 turns. The magnetic induction of the radial field is 0.2 T and the couple per unit twist of the suspension wire is 2×10^{-6} Nm per degree. If the deflection is 4°, the current passing through it is

1) 0.25 μA 2) 2.5 μA
3) 25 μA 4) 250 μA

23. A galvanometer has a resistance 50 Ω and is shunted by a 0.5 Ω resistor. The fraction of the main current that flows through the galvanometer is

1) 1/100 2) 1/101
3) 1/10 4) 1/11

24. A galvanometer of coil resistance 100 Ω is connected to a shunt of resistance 10 Ω. The current through the galvanometer is i_1, the current through the shunt is i_2 and the total current into the combination is i_3, then the ratio $i_1 : i_2 : i_3$ is

1) 1 : 10 : 11 2) 10 : 1 : 11
3) 11 : 10 : 1 4) 10 : 11 : 1

25. The ratio of the resistances of a galvanometer and a shunt connected to it is 50 : 1. The ratio of the currents in the galvanometer and the shunt when the combination is used as an ammeter is

1) 49 : 1 2) 1 : 49 3) 1 : 50 4) 50 : 1

26. A galvanometer with a coil resistance of 100 Ω gives a full scale deflection when a current of 1 mA is passed through it. The resistance of the shunt needed in ohm units to convert this galvanometer into an ammeter of range 10 A is nearly

1) 0.01 2) 0.001 3) 0.1 4) 0.099

27. The resistance of an ammeter measuring 1 ampere is 0.018 Ω. It can be converted to an ammeter measuring 10 ampere by connecting

1) 0.18 ohm in series 2) 0.18 ohm in parallel
3) 0.002 ohm in series 4) 0.002 ohm in parallel

28. A galvanometer having a total resistance of 8 ohm is shunted by a wire of resistance 2 ohm to convert it in to an ammeter. If the total current in to the meter is I, then the part of the current I_s flowing through the shunt is

1) $I_s = 0.2$ I 2) $I_s = 0.8$ I
3) $I_s = 2$ I 4) $I_s = 8$ I

29. A galvanometer of resistance 100 ohms is shunted so that only 1/11 of the main current flows through the galvanometer. The resistance of the shunt is

1) 1 ohm 2) 11 ohms
3) 10 ohms 4) 9 ohms

30. A galvanometer has a resistance of 49 Ω. If 2% of the main current is to be passed through the meter, what should be the value of the shunt

1) 2 Ω 2) 1 Ω 3) ½ Ω 4) ¼ Ω

31. A galvanometer of resistance 5 Ω gives full scale deflection for a current of 2 mA with a series resistance of 995 Ω it can be used as

1) a micro ammeter reading up to 20 mA
2) a voltmeter reading up to 0.2 V
3) an ammeter reading up to 2 A
4) a voltmeter reading up to 2 V

32. A voltmeter has an internal resistance of 1000 Ω and gives full scale deflection when 2 V is applied across the terminals. Now a resistance of 4000 Ω is connected in series with it. Then it gives full scale deflection with

1) 8 V 2) 10 V 3) 6 V 4) 4 V

33. A voltmeter has internal resistance 'r' ohms and range 'V' volts. The value of resistance used in series to convert it into a voltmeter of range "4 V" volts is
1) 4r 2) r/4 3) 3r 4) r/3

34. A maximum current of 5 mA can be passed through a galvanometer of resistance 40 Ω. The resistance to be connected in series to convert it into a volt meter of range 0 – 50 V is
1) 960 Ω 2) 9960 Ω
3) 99,960 Ω 4) 19,960 Ω

35. A tangent galvanometer properly adjusted gives a deflection of 30° when a certain current is passed through it. When the current is changed, then it gives a deflection of 45°. The ratio of the currents in the two cases is
1) 2 : 3 2) $1:\sqrt{2}$
3) $1:\sqrt{3}$ 4) $\sqrt{3}:1$

36. In a tangent galvanometer a deflection of 30° is obtained with a certain current flowing thorough the coil. If the current is trebled, the deflection obtained will be
1) 45° 2) 60° 3) 90° 4) 30°

37. In a properly adjusted tangent galvanometer, the deflection for 1 A current is found to be 30°. Now the coil is turned through 90° about the vertical axis, the deflection for the same current will be
1) 60° 2) 30° 3) 90° 4) 0°

38. Two tangent galvanometers are connected in series across a battery. The deflections in them are found to be 30° and 60° respectively. The ratio of their reduction factors is
1) $\sqrt{3}:1$ 2) $1:\sqrt{3}$
3) 3 : 1 4) 1 : 3

39. A tangent galvanometer carrying a current of 0.8 A gave a deflection of 30°. If the earth's horizontal component of magnetic induction were to suddenly become one third of the usual value, the deflection for the same current will be
1) 60° 2) 45° 3) 90° 4) 30°

40. In a tangent galvanometer, the magnetic induction produced by the coil of wire situated in the magnetic meridian is found to be equal to the horizontal component of the earth's magnetic field. The deflection produced in it will be
1) 30° 2) 60° 3) 45° 4) 90°

41. Two tangent galvanometers are connected in series and a current is passed through the combination. If the deflections in them are θ_1 and θ_2, the ratio of their reduction factors is
1) $\theta_2 : \theta_1$ 2) $\tan\theta_1 : \tan\theta_2$
3) $\tan\theta_2 : \tan\theta_1$ 4) $\sin\theta_2 : \sin\theta_1$

42. The flux linked with a coil of 100 turns each of area 100 cm^2 when placed in a uniform magnetic field of induction 0.2 T is found to be 0.1 Wb. The angle made by the field with the plane of the coil is
1) 60° 2) 30° 3) 90° 4) 0°

43. A flux of 8.66 milliweber passes through a strip having an area A = 0.02 m^2. The plane of the strip is at an angle of 60° to the direction of the magnetic field B. The value of B is
1) 0.5 T 2) 0.866 T 3) 0.25 T 4) 0.433 T

44. If a flat circular coil of wire situated in a uniform magnetic field is to be linked with maximum flux, the normal to the plane of the coil must make an angle θ with the magnetic field, then the value of θ is
1) 0° 2) 60° 3) 90° 4) 30°

45. In a magnetic filed of induction is 0.9 Weber /m^2 a linear conductor of 0.4 meter length is moving with a velocity of 7 m/s. The value of maximum induced emf will be
1) 2.52 volt 2) 5.26 volt
3) 6.28 volt 4) 0.26 volt

AMPERE'S LAW, BIOT - SAVART'S LAW & APPLICATIONS

46. Two concentric circular coils A and B have radii 25 cm and 15 cm and carry currents 10A and 15A respectively. A has 24 turns and B has 18 turns. The direction of currents are in opposite order. The magnetic induction at the common centre of the coil is
1) 120 μ_0 T 2) 480 μ_0 T
3) 420 μ_0 T 4) μ_0

47. A wire of length 44cm is bent into a circle and a current of 9.8A is passed through it. The intensity of magnetic induction at the centre of the circle is
1) 8.8×10^{-6}T 2) 8.8×10^{-5}T
3) 8.4×10^{-6}T 4) 44×10^{-6}T.

48. A long wire carries a steady current. It is bent in to 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
1) nB 2) n^2B 3) 2nB 4) 2n^2B.

49 A circular coil of radius R carries a current i. The magnetic field at its centre is B. The distance from the centre on the axis of the coil where the magnetic field will be B/8 is
1) $\sqrt{2}$R 2) $\sqrt{3}$R 3) 2R 4) 3R

50. A coil of radius π meters, 100 turns carries a current of 3A. The magnetic induction at a point on its axis at a distance equal to $\sqrt{3}$ times its radius from its centre is
1) $7.2X10^{-6}wbm^{-2}$ 2) $7.4X10^{-6}wbm^{-2}$
3) $7.5X10^{-6}wbm^{-2}$ 4) $7.83X10^{-6}wbm^{-2}$

51. The magnetic moment of a single turn coil of radius 1 cm carrying a current of $(1/\pi)$A is (in S.I Units)
1) 100 2) 10^{-2} 3) 10^{-4} 4) 10^{4}

52. The coils A and B having the radii in the ratio 1:2 carrying currents in the ratio 5:1 and have the number of turns in the ratio 1:5. The ratio of magnetic inductions at their centres is
1) 1:2 2) 2:1 3) 1:5 4) 5:1

53. Two circular coils are made of two identical wires of same length and carry same current. If the number of turns of the two coils are 4 and 2, then the ratio of magnetic induction at the centres will be
1) 2:1 2) 1:2 3) 1:1 4) 4:1

54. The magnetic induction at a point at a large distance d on the axial line of circular coil of small radius carrying current is 120 μT. At a distance 2d the magnetic induction would be
1) 60 μT 2) 30 μT 3) 15 μT 4) 240 μT

55. Two circular coils have diameters 10cm and 20cm with same number of turns. The ratio of the magnetic field induction produced at the centre of the coils when connected in series is
1) 1:2 2) 2:1 3) 4:1 4) 1:4

56. The magnetic induction at a point 0.1m away from a long wire which carries a current of 10A($\mu_0=4\pi x10^{-7}$ S.I. Units) is
1) $2X10^{-5}$T 2) $4X10^{-5}$T 3) 10^{-5}T 4) $6X10^{-5}$T

57. The magnetic induction at a point 1cm away from a straight, long current carrying conductor is found to be $1X10^{-5}wb/m^2$. The current that is passing through the conductor is
1) 1A 2) 0.5A 3) 1.5A 4) 2A

58. A circular coil of radius 5cm has 169 turns carries a current of 2.6A. The magnetic induction at a point on the axis at a distance of 12cm from the centre of the coil is
1) 2T 2) 4.2T 3) $3.14X10^{-4}$T 4) $3.14X10^{-2}$T

59. A circular coil has a radius of 16 cm and contains 50 turns. If a current of 2amp is passed through the coil, the magnetic flux density at its centre is
1) $3.9X10^{-4}$T 2) $2X10^{-4}$T
3) $3.2X10^{-4}$T 4) $2.8X10^{-4}$T

FORCE ON A MOVING CHARGE IN A MAGNETIC FIELD

60) A proton and an α-particle enter a uniform magnetic field at right angles to the field with same speed. The ratio of the periods of α-particle and proton is
1) 1:1 2) 1:4 3) 1:2 4) 2:1

61. A Proton enters a magnetic field with a velocity of $2.5X10^{7}ms^{-1}$ making an angle 30^{0} with the magnetic field. The force on the proton is (B=25T)
1)1. $25X10^{-11}$N 2) $2.5X10^{-11}$N
3) $5.0X10^{-11}$N 4) $7.5X10^{-11}$N

62. A proton moving with a velocity of $2X10^{6}ms^{-1}$ describes a circle of radius R in a magnetic field. The speed of an α - particle to describe a circle of same radius in the same magnetic field is
1) $1X10^{6}$m/s 3) $2X10^{6}$m/s
3) $4X10^{6}$m/s 4) $8X10^{6}$m/s

63. A proton takes 10^{-12}s to complete one revolution in uniform magnetic field. The time taken in another orbit of double the radius in the same field is
1) $0.5X10^{-12}$sec 2) $2X10^{-12}$sec
3) $4X10^{-12}$sec 4) 10^{-12}sec

FORCE ON A CONDUCTOR CARRYING CURRENT PLACED IN A MAGNETIC FIELD

64 Two parallel wires carrying current I and 2I in same direction have magnetic field B at the midpoint between them. If the current 2I is switched off, the magnetic field at that point will be
1) B/2 2) B 3) 2B 4) 3B.

65. Two long straight horizontal parallel wires one above the other are separated by a distance '2a'. If the wires carry equal currents in opposite directions. The magnitude of the magnetic induction in the plane of the wires at a distance 'a' above the upper wire is
1) $\frac{\mu_o i}{2\pi a}$ 2) $\frac{\mu_o i}{2\pi a}+\frac{\mu_o i}{4\pi a}$
3) $\frac{\mu_o i}{2\pi a}-\frac{\mu_o i}{4\pi a}$ 4) $\frac{\mu_o i}{3\pi a}$

66. Two straight parallel wires carry currents of 200 mA and 1A in opposite directions. If the wires are 20cm apart, the distance of the neutral point from the 1A wire is(in cm)
1) 5 2) 15 3) 20 4) 25

67. The force on the linear conductor in magnetic field is half the maximum value when it makes an angle of ------------ with the field

1) 30^0 2) 60^0 3) 45^0 4) 15^0

68. Two long straight conductors are held parallel to each other at a distance 0.3m. If the conductors carry currents 2A and 8A in opposite directions, the distance of the neutral point from the conductor carrying smaller current is
1) 0.06m 2) 0.24m 3) 0.18m 4) 0.1m

69. Two long straight conductors are held parallel to each other 7cm apart. The conductors carry currents of 9A and 16A in opposite directions. The distance of neutral point from the conductor carrying 16A current is
1) 9cm 2) 16cm 3) 25cm 4) 63/25cm

70. The distance between two parallel wires carrying current of 1A is 1m. The force per unit length between the conductors is
1) $2X10^{7}Nm^{-1}$ 2) $2X10^{-7}Nm^{-1}$
3) $4X10^{7}Nm^{-1}$ 4) $4X10^{-7}Nm^{-1}$

71. Two long straight parallel conductors are 2cm apart and carry currents of 5A and 10A in opposite directions. The force per unit length of each conductor is
1) $5X10^{-6}Nm^{-1}$ 2) $5X10^{-4}Nm^{-1}$
3) $2X10^{-6}Nm^{-1}$ 4) $5X10^{-8}Nm^{-1}$

72. In an electric motor, wires carrying a current of 5A are placed at right angles to a magnetic field of induction 0.8 T. If each wire has length of 20cm, then the force acting on each wire is
1) 0.2N 2) 0.4N 3) 0.6N 4) 0.8N

MCG, AMMETER, VOLTMETER &TG

73. The sensitivity of a galvanometer of resistance 990 Ω is increased by 10 times. The shunt used is
1) 100 Ω 2) 120 Ω 3) 110 Ω 4) 50 Ω

74 A current of 10^{-5} A produces a deflection of 10^0 in a moving coil galvanometer. A current of 10^{-6} amp in the same galvanometer produces a deflection of
1) 1^0 2) 0.1^0 3) 10^0 4) $(1/100)^0$

75. When a high resistance 'R' is connected in series with a voltmeter of resistance G, the range of the voltmeter increases 5 times. Then G:R will be
1) 4:1 2) 1:2 3) 8:1 4) 1:4

76. The coils in two moving coil galvanometers have their areas in the ratio of 2:3 and number of turns in the ratio 4:5. These two coils carry the same current and are situated in the same field. The deflections produced by these two coil will be in the ratio of
1) 8:15 2) 15:8 3) 8:1 4) 1:4

77. A current of 0.5 A produces a deflection of 60^0 in a tangent galvanometer. The current that produces a deflection of 30^0 in the same galvanometer is
1) 0.5/2 A 2) 0.5/3 A
3) $0.5/\sqrt{2}$ A 4) $0.5/\sqrt{3}$ A

78. A rectangular coil of length 10cm and breadth 20cm is placed in uniform magnetic field of induction 20 Wbm^{-2}. A current of 2A is passed through the coil. If it consists of 100 turns, the torque experienced is
1) 40Nm 2) 80Nm 3) 4000Nm 4) 8000Nm

79. If a resistance of 20 Ω is connected parallel to a galvanometer of internal resistance 100 ohm, the part of the current in the circuit passes through galvanometer is
1) 1/6 2) 1/4 3) 1/5 4) 1/8

80. The maximum potential that can be measured with a voltmeter of resistance 1000 Ω is 6V. Resistance that must be connected to measure a potential of 30V with it is
1) 4000 Ω in Series 2) 6000 Ω in Series
3) 12000 Ω in Series 4) 2000 Ω in Series

81. The resistance of a galvanometer is 100 Ω. A shunt of 5 Ω is connected to it to convert it into an ammeter. The internal resistance of the ammeter is
1) 5.2 Ω 2) 4.8 Ω 3) 4.6 Ω 4) 4.2 Ω

82. A galvanometer of 100 Ω resistance gives a full scale deflection for one milliampere. The value of the shunt to be connected so that it can be used to measure a current of 10 ampere is
1) 100/99 Ω 2) 100/999 Ω
3) 10/9999 Ω 4) 100/9999 Ω

83. A galvanometer of 25 Ω internal resistance is joined with a shunt of 0.5 Ω. If the combination is used as an ammeter, the ratio of the currents flowing through the galvanometer and the shunt is
1) 50:1 2) 1:50 3) 1:100 4) 100:1

84. To convert a voltmeter measuring 15 V into a voltmeter measuring 150V, if the resistance of the voltmeter is 1000 Ω, the resistance to be connected is
1) 10,000 Ω in Series 2) 9,000 Ω in Series
3) 11,000 Ω in Series 4) 8,000 Ω in Series

85. A galvanometer has a resistance of 99 Ω. It is shunted with one ohm resistance. The ratio of the currents flowing through the galvanometer and through the shunt is
1) 1:99 2) 99:1 3) 1:100 4) 100:1

86. A galvanometer has a resistance of 500 Ω. It is shunted so that 1/101th of the total current flows through it. The shunt resistance is
1) 2 Ω 2) 4 Ω 3) 5 Ω 4) 6 Ω

87. If a shunt is to be applied to a galvanometer of resistance 50 Ω so that only 5% of total current passes through the galvanometer. The resistance of shunt should be
1) 1.63 Ω 2) 4.2 Ω 3) 3.5 Ω 4) 2.63 Ω

88. A galvanometer of internal resistance 100 Ω has a full scale deflection current of 1mA. To convert it into a voltmeter of range 0-10V, the resistance to be connected is
1) 9000 Ω in Series 2) 10,000 Ω in Series
3) 9,900 Ω in Series 4) 9,800 Ω in Series

89. The ratio of a shunt resistance and the resistance of a galvanometer is 1:499. If the full scale deflection current of the galvanometer is 2mA, the range of the ammeter is
1) 2A 2) 1.4A 3) 1.6A 4)1A

90. A voltmeter has a range of 50V and has an internal resistance of 10^6 ohm. To convert it into a voltmeter to read upto 100V, the resistance to be connected is
1) $2X10^6\,\Omega$ 2) $10^6\,\Omega$
3) $3X10^6\,\Omega$ 4) $0.5X10^6\,\Omega$

91. An ammeter has a range of 1A and an internal resistance of 0.1 Ω. If another shunt of 0.1 Ω is connected across its terminals, its new range is
1) 2A 2) 1.5A 3) 1.8A 4) 2.4A

92. A milli ammeter of 10 Ω. internal resistance has a full scale deflection current of 10 mA. To read up to 10 A, the resistance to be connected is
1)100/999 Ω. in parallel
2)10/999 Ω. in parallel
3)10/99 Ω. in parallel 4)100/90 Ω. in parallel

93. The internal resistance of an ammeter is 0.2 Ω. Its full scale deflection current is 10A. The P.D across the terminals when a current of 5A is flowing through it is
1) 1V 2) 1.6V 3) 1.2V 4) 1.4V

94. In a tangent galvanometer when a current of (2/3)A passes, the deflection is 30^0. If the deflection is 60^0, the current that is passing is
1) 2A 2) 1.6A 3) 1.8A 4) 1.2A

95. A vertical rectangular coil of sides 5cm X 2cm has 10turns and carries a current of 2A.The torque(couple) on the coil when it is placed in a uniform horizontal magnetic field of 0.1T with its plane perpendicular to the field is
1) $4X10^{-3}$N-m 2) Zero
3) $2X10^{-3}$N-m 4) 10^{-3}N-m

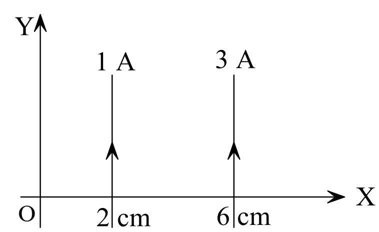
KEY

01) 4	02) 2	03) 3	04) 3	05) 3	06) 2
07) 3	08) 3	09) 4	10) 2	11) 2	12) 2
13) 1	14) 2	15) 3	16) 3	17) 4	18) 3
19) 4	20) 2	21) 2	22) 3	23) 2	24) 1
25) 3	26) 1	27) 4	28) 2	29) 3	30) 2
31) 4	32) 2	33) 3	34) 2	35) 3	36) 2
37) 4	38) 3	39) 1	40) 3	41) 3	42) 2
43) 1	44) 1	45) 1	46) 3	47) 2	48) 2
49)2	50) 3	51) 3	52) 2	53) 4	54) 3
55) 2	56) 1	57) 2	58) 3	59) 1	60) 4
61) 3	62) 1	63) 4	64) 2	65) 4	66) 4
67) 1	68) 4	69) 2	70) 2	71) 2	72) 4
73) 3	74) 1	75) 4	76) 1	77) 2	78) 2
79) 1	80) 1	81) 2	82) 4	83) 2	84) 2
85) 1	86) 3	87) 4	88) 3	89) 4	90) 2
91) 1	92) 2	93) 1	94) 1	95) 2	

LEVEL-II

1. A current of 5 A flows downwards in a long straight vertical conductor and the earth's horizontal flux density is 2×10^{-5} T. Then the neutral point is
1) due north and 10 cm from the wire
2) due east and 10 cm from the wire
3) due east and 5 cm from the wire
4) due west and 5 cm from the wire

2. Two long parallel conductors are placed at right angles to a metre scale at the 2cm and 6 cm marks, as shown in the figure.



They carry currents of 1 A and 3 A respectively. They will produce zero magnetic field at the (ignore the earth's magnetic field)
1) 5 cm mark 2) 3 cm mark
3) 1 cm mark 4) 8 cm mark

3. A square loop of side 'L' carries a clockwise current 'i' in all the sides. The magnetic induction at the center of the square is
1)zero 2) $\frac{\mu_o}{4\pi}\frac{16\sqrt{2}i}{L}$ 3) $\frac{\mu_o}{4\pi}\frac{8\sqrt{2}i}{L}$ 4) $\frac{\mu_o}{4\pi}\frac{2\sqrt{2}i}{L}$

4. A straight wire of length 'L' carries a current of 'i' amperes. A point 'P' when joined with the ends of the wire forms an equilateral triangle. The magnetic induction at 'P' will be

1) $\dfrac{\mu_o i}{2\sqrt{3}\pi L}$ 2) $\dfrac{\mu_o i}{\sqrt{3}\pi L}$ 3) $\dfrac{\mu_o i}{4\sqrt{3}\pi L}$ 4) $\dfrac{\mu_o i}{4\pi L}$

5. A wire of length 10 cm is bent into an arc of a circle such that it subtends an angle of 1 radian at the centre. If a current of 1 A is passed through the wire, the magnetic induction at the centre of the circle will be
1) 2×10^{-4} tesla 2) 1×10^{-6} tesla
3) 1×10^{-4} tesla 4) 2×10^{-6} tesla

6. The ends of a circular coil of radius 'r' and number of turns 'n' is connected to the two terminals of a cell. The magnetic field at the centre of the coil is B. If the number of turns be made '2n' keeping the radius same, the magnetic field at the centre of the coil will be
1) B 2) 2B 3) B/2 4) 4B

7. A circular coil of wire is connected to a battery of negligible internal resistance and has magnetic induction 'B' at its centre. If the coil is unwound and rewound to have double the number of turns, and is connected to the same battery, then the magnetic induction at the centre is
1) 2B 2) 4B 3) B 4) B/2

8. A wire of length 'l' is bent into a semi circle and carries a current 'i'. The magnetic induction at the centre of the semi circle is
1) $\mu_o \pi i/2l$ 2) $\mu_o \pi i/4l$
3) $\mu_o i/4\pi l$ 4) $\mu_o i/2\pi l$

9. A straight conductor carrying a current is kept in a uniform magnetic field so as to experience maximum force. If now the conductor is turned in its own plane such that the force acting on it is half of the maximum force, then the angle made by the conductor in the final position with respect to the field is
1) 60° 2) 45° 3) 30° 4) 90°

10. A north pole of strength π A m, is moved around a circle or radius 10 cm which lies around a long straight conductor carrying a current of 10 A. The work done is nearly
1) 4 μJ 2) 40 μJ 3) 400 μJ 4) 0.4 μJ

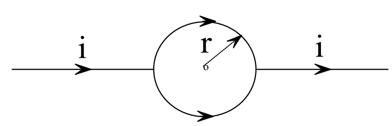
11. A wire carrying a current of $\sqrt{5}$ amperes is bent into the form of a circle of radius 5 cm. The flux density at a distance of 10 cm on the axis passing through the centre of the coil and perpendicular to its plane is
1) $8\pi \times 10^{-3}$ T 2) $4\pi \times 10^{-3}$ T
3) $8\pi \times 10^{-5}$ T 4) $4\pi \times 10^{-5}$ T

12. A length of wire carries a steady current. It is first bent to form a circular coil of one turn. The same length is now bent more sharply to give a loop of two turns of smaller radius. The magnetic field at the centre caused by the same current now will be
1) a quarter of its first value
2) same as that of the first value
3) four times the first value 4) double of its first value

13. Two points P and Q are on the axis at distances r and 3r from the centre of a circular coil of radius r and carrying a current. The ratio of magnetic inductions at P and Q is
1) 3 : 1 2) 1 : $5\sqrt{5}$ 3) $5\sqrt{5}$: 1 4) 1 : 3

14. The earth's magnetic induction at a certain point is 7×10^{-5} T. This field is to be annulled by the magnetic induction at the centre of a circular conducting loop 5.0 cm in radius. The required current is nearly
1) 0.56 A 2) 5.6 A 3) 56 A 4) 2.8 A

15. A straight conductor carrying a current i is split into identical semicircular turns of radius 'r' as shown. What is the magnetic induction at the centre C of the circular loop?



1) $\mu_o i/4r$ 2) $\mu_o i/8r$ 3) $\mu_o i/2r$ 4) zero

16. A proton moving with a velocity of $(6i + 8j) \times 10^5$ ms^{-1} enters uniform magnetic field of induction $5k \times 10^{-3}$ tesla. The magnitude of the force acting on the proton is (i, j and k are unit vectors forming a right handed triad)
1) zero 2) 8×10^{-16} N
3) 3×10^{-16} N 4) 4×10^{-16} N

17. A circular loop of radius 5 cm carries an electric current. Let P and Q be two points on the axis of the loop at distance 1 m and 2 m respectively from the center. If the magnetic field at P due to the current is 16μT, that at Q will be about
1) 8 μ T 2) 4 μ T 3) 2 μ T 4) 1 μ T

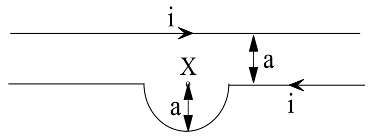
18. A uniform copper wire of length "L" is bent into a circular coil of two turns and a current "i" is passed through it. The coil now behaves like a magnetic dipole of moment
1) $i L^2 / 16 \pi$ 2) $i L^2 / 8 \pi$
3) $i L^2 / 4 \pi$ 4) $i L^2 / 2 \pi$

19. A charge 'e' moves round a circle of radius 'r' with a uniform speed 'v'. The magnitude of the magnetic induction at the centre of the circle is
1) $\mu_o ev/4\pi r$ 2) $\mu_o ev/4\pi r^2$
3) $\mu_o ev/4\pi r^3$ 4) $\mu_o er/4\pi v$

20. An electron of charge "e" has a time period of revolution of "T" in a Bohr orbit of radius "r". The dipole moment of the electron is

1) $\pi r^2 eT$ 2) $\pi r^2 e/T$ 3) $\pi r^2 T/e$ 4) $T/\pi r^2 e$

21. Two wires, each carrying a current "i"are shown in the diagram to the right. Both wires extend in a straight line for a very long distance on both the right and the left. One wire contains a semi circular loop of radius "a" centered on point X. what is the correct expression for the magnetic field at point X?

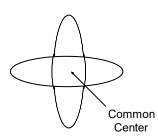


1) $\mu_0 i/(4a) + \mu_0 i/(2\pi a)$ out of the page
2) $\mu_0 i/(4a) + \mu_0 i/(2\pi a)$ in to the page
3) $\mu_0 i/(4a) - \mu_0 i/(2\pi a)$ into the page
4) $\mu_0 i/(4a) - \mu_0 i/(2\pi a)$ out of the page

22. An electron of charge 'e' mass 'm' moves in an orbit of radius 'r' with an angular velocity 'ω'. The ratio of the magnetic moment of the orbiting electron to its angular momentum is

1) e/m 2) 2e/m 3) e/2m 4) 2m/e

23. Two identical circular loops each of radius 'r' and carrying a current 'i' are arranged concentric with each other and in perpendicular planes as shown in the diagram. The magnetic induction at the common center is



1) $\frac{\mu_o i}{2r}$ 2) $\frac{\mu_o i}{\sqrt{2}\,r}$ 3) zero 4) $\frac{\mu_o i}{r}$

24. A circular coil of radius 'r' having 'n' turns carries a current 'i'. The magnetic induction at the center of the coil is 'B'. Now the coil is unwound and rewound with half the original radius. If the magnetic induction at the center of the coil is to be the same, the current that should be passed through the coil is

1) 2i 2) i 3) i/2 4) i/4

25. Magnetic induction at the center of a circular loop carrying a current is 'B'. If 'A' is the area of the coil, the magnetic dipole moment of the loop is

1) $\frac{BA^2}{\mu_o \pi}$ 2) $\frac{BA\sqrt{A}}{\mu_o}$ 3) $\frac{BA\sqrt{A}}{\mu_o \pi}$ 4) $\frac{2BA}{\mu_o}\sqrt{\frac{A}{\pi}}$

26. A circular coil of wire of "n" turns has a radius "r" and carries a current "i". Its magnetic dipole moment is "M". Now the coil is unwound and again rewound in to a circular coil of half the initial radius and the same current is passed through it, then the dipole moment of this new coil is

1) M / 2 2) M / 4 3) M 4) 2 M

27. A galvanometer coil has a resistance of "G" ohms. If it is be converted in to a voltmeter that can measure "n" times the maximum allowed potential difference across the galvanometer, the value of the high resistance in ohms to be connected in series is

1) $G \times n$ 2) $G \times (n-1)$ 3) $\frac{G}{n}$ 4) $\frac{G}{n-1}$

28. A 100 V voltmeter having an internal resistance of 20 kΩ when connected in series with a large resistance R across a 110 V line reads 5 V. The magnitude of R is

1) 210 KΩ 2) 315 KΩ 3) 420 kΩ 4) 440 kΩ

29. A cell of negligible internal resistance is connected to a tangent galvanometer and the deflection produced is 30°. If three such cells are connected in series and the combination is connected to the same galvanometer, the deflection will be

1) 30° 2) 60° 3) 90° 4) 45°

30. The resistance of the coil of a tangent galvanometer is 60 Ω. It is connected to a battery of negligible internal resistance. The deflection is found to be 60°. Now a shunt resistance of 30 Ω is connected across the coil of the tangent galvanometer. The deflection produced will be

1) 30° 2) 45° 3) 60° 4) 37°

31. When a resistance of 60,000 Ω is connected in series with a voltmeter, the combination now can measure five times more voltage than the original voltmeter. The internal resistance of the voltmeter is

1) 12,000 Ω 2) 15,000 Ω 3) 2,40,000 Ω 4) 3,00,000 Ω

32. A proton of energy 'E' is moving along a circular path in a uniform magnetic field. If an alpha particle describes the same circular path, its energy should be

1) 4E 2) 2E 3) E 4) E/2

33. Electrons accelerated by a potential difference V enter a uniform magnetic field of flux density B at right angles to the field. They describe a circular path of radius 'r'. If now V is doubled and B is also doubled, the radius of the new circular path is

1) 4r 2) 2r 3) $2\sqrt{2}r$ 4) $r/\sqrt{2}$

34. A charged particle moving at right angles to a uniform magnetic field and starts moving along a circular arc of radius of curvature 'r'. In the field it now penetrates a layer of lead and loses 3/4th of its initial kinetic energy. The radius of curvature of its path now will be
1) 4r 2) 2r 3) r/4 4) r/2

35. Acceleration experienced by a particle with specific charge 1×10^7 C/kg when fired perpendicular to a magnetic field of induction 100 μT with a velocity 10^5 ms^{-1} is
1) 10^8 ms^{-2} 2) 10^{-6} ms^{-2}
3) 10^{14} ms^{-2} 4) 10^{-8} ms^{-2}

36. An electron of charge 'e' and mass 'm' describes a circular path of radius 'r' when it is projected with a velocity 'v' perpendicular to a uniform magnetic field of induction 'B'. An expression for its frequency of revolution is
1) $\frac{1}{2\pi}\sqrt{\frac{Be}{m}}$ 2) $\frac{1}{2\pi}\frac{Be}{m}$
3) $\frac{1}{2\pi}\frac{m}{Be}$ 4) $\frac{1}{2\pi}\frac{me}{2}$

37. An alpha particle in an electric field of intensity E experiences the same force as when it moves perpendicular to a magnetic field of induction B. The magnitude of its velocity in the magnetic field is given by
1) B/E 2) E/B 3) B^2/E 4) E^2/B

38. A galvanometer has a coil resistance "R" and a safe current of "i". If it is to be converted to an ammeter with a range of "n i", then which of the following will be suitable? Connect
1) R/(n–1) in series 2) R(n– 1) in series
3) R(n – 1) in parallel 4) R/(n – 1) in parallel

39. The magnetic induction of a uniform field is given by $\bar{B} = 3\hat{i} + 4\hat{j} - 2\hat{k}\ T$. A coil of 2 turns in the field has an area given by $\bar{A} = 2\hat{i} - \hat{j} - 3\hat{k}\ m^2$. The magnetic flux linked with the coil is
1) 8 Wb 2) 4 Wb
3) 16 Wb 4) 32 Wb

40. Ions of same charge and velocity but of different masses pass through a uniform transverse magnetic field, the radii of the paths depends on the masses.(This is the principle of a mass spectrograph). Which of the following is the correct relation between the radius and mass ?
1) $r \propto 1/m$ 2) $r \propto 1/\sqrt{m}$
3) $r \propto m$ 4) $r \propto \sqrt{m}$

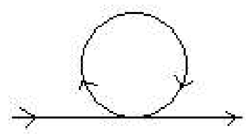
41. Different types of charged particles are fired at right angles to a uniform magnetic field with same velocity. The curvature of their circular orbits in the field are proportional to (specific charge)^X, then the value of X is
1) 1 2) – 1 3) 2 4) – 2

AMPERE'S LAW, BIOT-SAVART'S LAW & APPLICATIONS

42. An infinite long straight wire is bent into a semicircle of radius R, as shown in the figure. A current I is sent through the conductor. The magnetic field at the centre of the semicircle is.

(1) Infinite (2) Zero
(3) $\frac{\mu_0}{4R}I$ 4) $\frac{\mu_0 I}{4\pi R}(\pi + 1)$

43 The magnetic field at the centre of circular loop in the circuit shown below is



1) $\frac{\mu_0}{4\pi}\frac{2I}{r}(1+\pi)$ 2) $\frac{\mu_0}{4\pi}\frac{2I}{r}(\pi-1)$
3) $\frac{\mu_0}{4\pi}\frac{2I}{r}$ 4) $\frac{\mu_0}{4\pi}\frac{I}{r}(\pi+1)$