

ELECTRO MAGNETISM

Biot – Savart’s Law and Ampere’s Circuital Law

- 1. A current is flowing due north along a power line. The direction of the magnetic field above it, neglecting the earth’s field is:**
(1) North (2) east (3) south (4) west
- 2. A vertical straight conductor carries a current vertically upwards. A point P lies to the east of it at a small distance and another point Q lies to the west at the same distance. The magnetic field at P neglecting earth’s field is:**
(1) Greater than at Q (2) same as at Q (3) less than at Q
(4) Greater or lesser than that at Q, depending upon the strength of current.
- 3. A square conducting loop of length L on a side has a current ‘i’ in it. The magnetic induction at the centre of the loop is:**
(1) independent of L (2) directly proportional L
(3) inversely proportional to L (4) inversely proportional to L^2
- 4. Field at the centre of circular coil of radius r, through which a current I flows is**
(1) directly proportional to r (2) inversely proportional to I
(3) directly proportional to I (4) directly proportional to I^2
- 5. Lines of magnetic field around a current carrying straight conductor will be**
1) straight lines parallel to conductor
2) circular in a plane parallel to conductor
3) circular in a plane perpendicular to conductor
4) straight perpendicular to conductor

6 Magnetic induction at a point due to a small element of current carrying conductor is

- 1) inversely proportional to the square of the distance of the point from the conductor
- 2) inversely proportional to the distance of the point from the conductor
- 3) directly proportional to the square of the length of conductor
- 4) directly proportional to the square of the current

7. Imagine a man swimming along a current carrying conductor in a direction opposite to that of current and facing the conductor. A magnetic needle free to rotate in a horizontal plane is mounted on a stand under the wire. Then

- 1) The north pole of the needle will deflect towards his left hand
- 2) The south pole of the needle will deflect towards his left hand
- 3) The needle will not deflect
- 4) The needle will oscillate

8. Statement A: current is scalar

Statement B: current element is vector

- 1) A and B are true 2) A and B are false 3) Only A is true 4) Only B is true

9. Statement (A): Ampere's law states that the line integral of $\vec{B} \cdot d\vec{\ell}$ along a closed path round the current carrying conductor is equal to $\mu_0 i$ (i is the net current through the surface bounded by the closed path)

Statement (B): Ampere's law can be derived from Biot savart's law

- 1) A is true B is false 2) A is false B is true 3) A and B are true 4) A and B is false

10. A vertical straight conductor carries a current vertically upwards. A point P lies to the east of it at a small distance and another point Q lies to the west at the same distance. The magnetic field at P is

- 1) Greater than at Q 2) Same as at Q 3) Less than at Q
- 4) Greater or less than at Q depending upon the magnetic field of the current.

11. A current I flows along an infinitely long straight thin walled tube. The magnetic induction at a point inside the tube at a distance r from its wall is

- 1) Infinite 2) zero 3) $\frac{\mu_0}{4\pi} \cdot \frac{2I}{r}$ 4) $\frac{2I}{r}$

12. The magnetic field \vec{dB} due to a small current element $\vec{d\ell}$ at a distance \vec{r} and element carrying current i is (or) Vector form of Biot - savart's law is

- 1) $\vec{dB} = \frac{\mu_0}{4\pi} i \left(\frac{\vec{d\ell} \times \vec{r}}{r} \right)$ 2) $\vec{dB} = \frac{\mu_0}{4\pi} i^2 \left(\frac{\vec{d\ell} \times \vec{r}}{r} \right)$
3) $\vec{dB} = \frac{\mu_0}{4\pi} i^2 \left(\frac{\vec{d\ell} \times \vec{r}}{r^2} \right)$ 4) $\vec{dB} = \frac{\mu_0}{4\pi} i \left(\frac{\vec{d\ell} \times \vec{r}}{r^3} \right)$

13. The current through a circular coil appears to be flowing in clock-wise direction for an observer. The magnetic induction at the centre of the coil is:

- 1) perpendicular to the plane of the coil and towards the observer
2) perpendicular to the plane of the coil and away from the observer
3) parallel to plane of the coil
4) inclined at 45° at the plane of coil

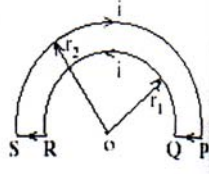
14. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil B . It is then bent into a circular loop of n turns. The magnetic field at the centre of the coil will be:

- 1) nB 2) n^2B 3) $2nB$ 4) $2n^2B$

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

- 1) directed normal to plane of the coil 2) directed parallel to plane of the coil
3) Zero 4) radial from centre of the coil

16. A wire loop PQRSP is constructed by joining two semi circular coils of radii r_1 and r_2 respectively as shown in the fig. current is flowing in the loop. The magnetic induction at point 'O' will be



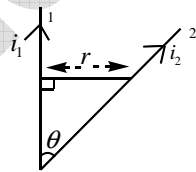
- 1) $\frac{\mu_0 i}{4} \left[\frac{1}{r_1} - \frac{1}{r_2} \right]$ 2) $\frac{\mu_0 i}{4} \left[\frac{1}{r_1} + \frac{1}{r_2} \right]$ 3) $\frac{\mu_0 i}{2} \left[\frac{1}{r_1} - \frac{1}{r_2} \right]$ 4) $\frac{\mu_0 i}{2} \left[\frac{1}{r_1} + \frac{1}{r_2} \right]$

17. If the resistance of upper half of a rigid loop is twice that of the lower half the magnitude of magnetic induction at the centre is equal to



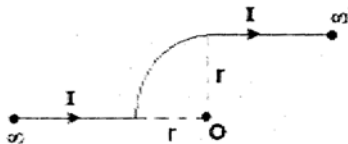
- 1) zero 2) $\frac{\mu_0 I}{4a}$ 3) $\frac{\mu_0 I}{8a}$ 4) $\frac{\mu_0 I}{12a}$

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



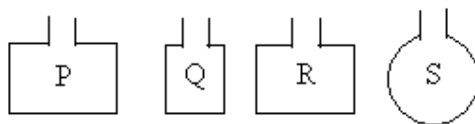
- 1) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \tan \theta$ 2) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \sin \theta$ 3) $\frac{\mu_0}{2\pi r} i_1 i_2 dl \cos \theta$ 4) $\frac{\mu_0}{4\pi r} i_1 i_2 dl \sin \theta$

19. What is the magnetic field at the center of the circular part in the figure below?



- 1) $B = \frac{\mu_0 i}{8r} \left[1 + \frac{2}{r} \right]$ 2) $B = \frac{\mu_0 i}{8r} \left[\pi + \frac{2}{\pi} \right]$ 3) $B = \frac{\mu_0 i}{8r} \left[1 - \frac{2}{\pi} \right]$ 4) $B = \frac{\mu_0 i}{8r} \left[1 + \frac{2}{\pi} \right]$

20. Four wires each of length 2m are bent into four loops P, Q, R, and S and then suspended into a uniform magnetic field same current is passed in each loop. The correct statement is



- 1) couple on loop P will be highest
2) couple on loop Q will be highest
3) couple on loop R will be highest
4) couple on loop S will be highest
21. A current of $1/4\pi$ amp is flowing in a long straight conductor. The line integral of magnetic induction around a closed path enclosing the current carrying conductor is

- 1) 10^{-7} weber per metre
2) $4\pi \times 10^{-7}$ weber per metre
3) $16\pi^2 \times 10^{-7}$ weber/metre
4) zero

22. The magnetic induction field at the centroid of an equilateral triangle of side 'l' and carrying a current 'i' is

- 1) $\frac{2\sqrt{2}\mu_0 i}{\pi l}$ 2) $\frac{9\mu_0 i}{2\pi l}$ 3) $\frac{4\mu_0 i}{\pi l}$ 4) $\frac{3\sqrt{3}\mu_0 i}{\pi l}$

23. The electric current in a circular coil of two turns produced a magnetic induction of 0.2T at its centre. The coil is unwound and rewound in to a coil of four turns. The magnetic induction at the centre of the coil now is, in tesla (if the same current flows in the coil)

- 1) 0.2 2) 0.4 3) 0.6 4) 0.8

24. In an atom the electron has a time period of 0.16×10^{-15} s in a circular orbit of radius 0.5 \AA . The magnetic induction at the centre of the orbit will be (in tesla)

- 1) 12.56 2) 125.6 3) 1.256 4) 25.12

25. A circular arc of wire subtends an angle $\pi/2$ at the centre. If it carries a current i and its radius of curvature is R then the magnetic field at the centre of the arc is

- 1) $\frac{\mu_0 i}{R}$ 2) $\frac{\mu_0 i}{2R}$ 3) $\frac{\mu_0 i}{4R}$ 4) $\frac{\mu_0 i}{8R}$

26. A circular coil 'A' has a radius R and the current flowing through it is I . Another circular coil 'B' has a radius $2R$ and if $2I$ is the current flowing through it, then the magnetic fields at the centre of the circular coil are in the ratio of

- 1) 4: 1 2) 2: 1 3) 3: 1 4) 1: 1

27. Two circular coils of radii 20cm and 30 cm having number of turns 50 and 100 made of same material are connected in series. The ratio of the magnetic field of induction at their centre is

- 1) 3: 4 2) 2:3 3) 1:2 4) 3:5

28. An electron revolves in a circle of radius 0.4\AA with a speed of 10^6 ms^{-1} in a hydrogen atom. The magnetic field produced at the centre of the orbit due to motion of the electron, in tesla, is [$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$]

- 1) 0.1 2) 1.0 3) 10 4) 100

29. A wire of length 'L' meters carrying a current 'i' amperes is bent in the form of a circle. The magnitude of its magnetic moment is

- 1) $\frac{iL}{4\pi}$ 2) $\frac{iL^2}{4\pi}$ 3) $\frac{i^2L}{4\pi}$ 4) $\frac{i^2L^2}{4\pi}$

30. Two identical coils have a common centre and their planes are at right angles to each other and carry equal currents. If the magnitude of the induction field at the centre due to one of the coil is 'B', then the resultant magnetic induction field due to combination at their common centre is

- 1) B 2) $\sqrt{2}B$ 3) $B/\sqrt{2}$ 4) 2B

31. A ring of radius 'r' is uniformly charged with a charge 'q'. If the ring is rotated about its own axis with an angular frequency ' ω ' then the magnetic induction field at the centre is

- 1) $\frac{\mu_0}{4\pi} \left(\frac{q\omega}{r} \right)$ 2) $\frac{\mu_0}{4\pi} \left(\frac{r}{q\omega} \right)$ 3) $\frac{\mu_0}{4\pi} \left(\frac{q}{r\omega} \right)$ 4) $\frac{\mu_0}{4\pi} \left(\frac{\omega}{qr} \right)$

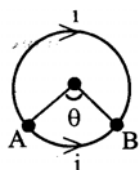
32. A long straight wire of radius 'a' carries a steady current i. The current is uniformly distributed across its cross section. The ratio of the magnetic fields at a/2 and 2a is

- 1) 1 2) 1/2 3) 1/4 4) 4

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

- 1) 50: 1 2) 1 : 50 3) 100 : 1 4) 1 : 100

34. Equal current 'i' flows in the two segments of a circular loop in the direction shown in fig. radius fo the loop is 'a'. Magnetic field at the centre of the loop is

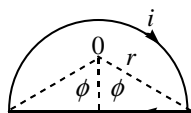


- 1) Zero 2) $\left(\frac{\pi - \theta}{\pi}\right) \frac{\mu_0 i}{2a}$ 3) $\left(\frac{2\pi - \theta}{\pi}\right) \frac{\mu_0 i}{2a}$ 4) $\left(\frac{\theta}{2\pi}\right) \frac{\mu_0 i}{2a}$

35. The field normal to the plane of a coil of 'n' turns and radius 'r' which carries a current 'i' is measured on the axis of the coil at a small distance 'h' from the centre of the coil . This is smaller than the field at the centre by the fraction.

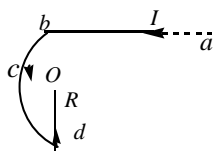
- 1) $\frac{3 h^2}{2 r^2}$ 2) $\frac{2 h^2}{3 r^2}$ 3) $\frac{3 r^2}{2 h^2}$ 4) $\frac{2 r^2}{3 h^3}$

36. The total magnetic induction at point 0 due to curved portion and straight portion in the following figure, will be



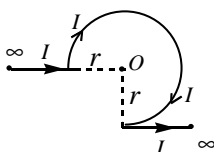
- 1) $\frac{\mu_0 i}{2\pi r} [\pi - \phi + \tan \phi]$ 2) $\frac{\mu_0 i}{2\pi r}$ 3) 0 4) $\frac{\mu_0 i}{\pi r} [\pi - \phi + \tan \phi]$

37. An infinitely long wire is bent in the form of a semicircle at the end as shown in the figure. It carries current I along $abcdo$. If radius of the semicircle be R , then the magnetic field at 'O' which is the centre of the circular part is



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

38. The magnetic induction at point 'O' in the following fig. will be



- 1) $\frac{\mu_0 I}{4r} \left[\frac{3}{2} - \frac{1}{\pi} \right] \otimes$ 2) $\frac{\mu_0 I}{4r} \left[\frac{3}{2} - \frac{1}{\pi} \right] \odot$ 3) $\frac{\mu_0 I}{4r} \left[\frac{3}{2} + \frac{1}{\pi} \right] \odot$ 4) $\frac{\mu_0 I}{4r} \left[\frac{3}{2} + \frac{1}{\pi} \right] \otimes$

KEY

- 1) 2 2) 2 3) 3 4) 3 5) 3 6) 1 7) 2 8) 1 9) 3 10) 1
- 11) 2 12) 4 13) 2 14) 2 15) 1 16) 1 17) 1 18) 3 19) 4 20) 4
- 21) 1 22) 2 23) 4 24) 1 25) 4 26) 4 27) 1 28) 3 29) 2 30) 2
- 31) 1 32) 1 33) 2 34) 2 35) 1 36) 1 37) 3 38) 2

HINTS

$$21. \int B \cdot dl = \mu_0 i$$

$$= 4\pi \times 10^{-7} \times \frac{1}{4\pi} = 10^{-7} \text{ wb/m}$$

22. At the centroid of an equilateral triangle

$$B = 18 \frac{\mu_0 i}{4\pi a} \quad B = \frac{9 \mu_0 i}{\pi a}$$

$$23. \frac{B_1}{B_2} = \frac{n_1^2}{n_2^2} \Rightarrow \frac{0.2}{B_2} = \frac{4}{16} \Rightarrow B_2 = 0.8T$$

$$24. B = \frac{\mu_0 i}{2r} = \frac{\mu_0 e}{2r T} = \frac{4 \times \pi \times 10^{-7} \times 1.6 \times 10^{-19}}{2 \times 0.5 \times 10^{-10} \times 0.16 \times 10^{-15}} = 4\pi$$

$$B = 4 \times 3.14 = 12.56 \text{ T.}$$

$$25. B = \frac{\mu_0 i}{4\pi r} (\theta) \Rightarrow B = \frac{\mu_0 i}{4\pi r} \frac{\pi}{2} \Rightarrow B = \frac{\mu_0 i}{8r}$$

$$26. B = \frac{\mu_0 i}{2r} \Rightarrow B_1 : B_2 = \frac{i_1}{r_1} : \frac{i_2}{r_2} \quad B_1 : B_2 = 1 :$$

$$27. \text{In series } B_1 : B_2 = \frac{n_1}{r_1} : \frac{n_2}{r_2} = \frac{50}{20} : \frac{100}{30}$$

$$B_1 : B_2 = 3 : 4$$

$$28. B = \frac{\mu_0 e v}{4\pi r^2} = \frac{10^{-7} \times 1.6 \times 10^{-19} \times 10^6}{(0.4 \times 10^{-10})^2} = 10$$

$$29. L = 2\pi r \Rightarrow r = \frac{L}{2\pi}$$

$$M = ni A = 1 \times i \times \pi r^2 = \frac{i L^2}{4\pi}$$

$$30. B_{net} = \sqrt{B_1^2 + B_2^2} \quad \text{but } B_1 = B_2$$

$$B_{net} = \sqrt{2}B$$

$$31. B = \frac{\mu_o i}{2r} = \frac{\mu_o q}{2r T} = \frac{\mu_o qv}{2r 2\pi r} = \frac{\mu_o}{4\pi} \left(\frac{q\omega}{r} \right)$$

$$32. B_1 = \frac{\mu_o i r}{2 g p R^2} = \frac{\mu_o i \frac{a}{2}}{2 \pi a^2} = \frac{\mu_o i}{4 \pi a}$$

$$B_2 = \frac{\mu_o i r}{2 \pi x} = \frac{\mu_o i}{2 \pi (2a)} = \frac{\mu_o i}{4 \pi a}$$

$$33. B_1 = \frac{\mu_o i}{2 \pi r} = \frac{2 \times 10^{-7} \times 2}{1 \times 10^{-2}} = 4 \times 10^{-5} T$$

$$L = 2 \pi r \Rightarrow \pi^2 = 2 \pi r \Rightarrow r = \pi / 2$$

$$B_2 = \frac{\mu_o i}{2r} = \frac{4 \pi \times 10^{-7} \times 2}{2 \times \pi / 2} = 8 \times 10^{-7} T$$

$$\frac{B_2}{B_1} = \frac{8 \times 10^{-7}}{4 \times 10^{-5}} = \frac{2}{100} = 1/50$$

$$34. B = B_1 - B_2 = \frac{\mu_o i}{4 \pi a} (2\pi - \theta) - \frac{\mu_o i}{4 \pi a} (\theta)$$

$$B = \frac{\mu_o i}{4 \pi a} (2\pi - 2\theta) = \frac{\mu_o i}{2a} \left(\frac{\pi - \theta}{\pi} \right)$$

$$35. \frac{B_c}{B_a} = \left(1 + \frac{x^2}{r^2} \right)^{3/2} = \left[1 + \frac{h^2}{r^2} \right]^{3/2} = 1 + \frac{3 h^2}{2 r^2}$$

$$\frac{B_c}{B_a} - 1 = 1 + \frac{3 h^2}{2 r^2} - 1$$

$$\frac{B_c - B_a}{B_a} = \frac{3 h^2}{2 r^2}$$

36. $x = r \cos \phi$

$$B = B_1 + B_2$$

$$B = \frac{\mu_0 i}{4\pi r} (2\pi - 2\phi) + \frac{\mu_0 i}{4\pi x} 2 \sin \phi$$

$$B = \frac{\mu_0 i}{2\pi r} (\pi - \phi) + \frac{\mu_0 i}{2\pi r} \tan \phi$$

$$B = \frac{\mu_0 i}{2\pi r} (\pi - \phi + \tan \phi)$$

37. $B = \frac{\mu_0 I}{4R} + \frac{\mu_0 I}{4\pi R}$

$$B = \frac{\mu_0 I}{4\pi R} (\pi + 1)$$

38. $B = B_1 + B_2 - B_3 = 0 + \frac{\mu_0 i}{4\pi r} \left(\frac{3\pi}{2} \right) - \frac{\mu_0 i}{4\pi r}$

$$B = \frac{\mu_0 i}{4r} \left[\frac{3}{2} - \frac{1}{\pi} \right]$$

MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD

- 1. A charged particle with charge q is moving in a uniform magnetic field. If this particle makes any angle with the magnetic field, then its path will be**
(1) circular (2) straight line (3) helical (4) parabolic
- 2. An electron is moving vertically downwards at any place. The direction of magnetic force acting on it due to horizontal component of the earth's magnetic field will be**
(1) towards east (2) towards west (3) towards north (4) towards south
- 3. Proton and α -particle enter with same velocity at 90° in a uniform magnetic field. Ratio of radius of their paths will be :**
(1) 1:2 (2) 2:1 (3) 4:1 (4) 1:4
- 4. The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to:**
(1) the charge on the particle (2) the momentum of the particle
(3) the intensity of the field (4) the energy of the particle
- 5. A proton enters in a magnetic field of strength B (Tesla) with speed v , parallel to the direction of magnetic lines of force. The force on the proton is:**
(1) evB (2) Zero (3) (4) $evB/2$
- 6. A uniform electric field and a uniform magnetic field are produced, pointed in the same direction. An electron is projected with its velocity pointed in the same direction:**
(1) The electron will turn to its left
(2) The electron will turn to its right
(3) The electron velocity will decrease in magnitude
(4) The electron velocity will increase in magnitude

12. Statement (A) : When a charged particle of charge 'q' moving with a velocity V in the magnetic field of induction B then the force acting on it is $\vec{F} = q(\vec{V} \times \vec{B})$

Statement (B): An electron is projected in a magnetic field along the lines of force then there will be no effect on the motion of the electron

- 1) A is a true B is false 2) A is false B is true 3) A and B are true 4) A and B is false

13. A charged particle with charge q enters region of constant, uniform and mutually orthogonal fields \vec{E} and \vec{B} , and comes out without any change in magnitude or direction of \vec{v} , then

- 1) $\vec{v} = \vec{E} \times \vec{B} / E^2$ 2) $\vec{v} = \vec{B} \times \vec{E} / E^2$ 3) $\vec{v} = \vec{E} \times \vec{B} / B^2$ 4) $\vec{v} = \vec{B} \times \vec{E} / B^2$

14. 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

- 1) it will turn towards right of direction of motion
2) it will turn towards left of direction of motion
3) its velocity will decrease
4) its velocity will increase

15. An electron and a proton having same momenta enter perpendicularly to a magnetic field, then

- 1) Curved path of electron and proton will be same (ignoring the sense of revolution)
2) They will move undeflected
3) Curved path of electron is more curved than that of proton
4) Path of proton is more curved

16. Two long parallel wires are separated by a distance of 8 cm carry electric currents of 3A and 5 A . The distance of null point from the conductor carrying larger current when currents are flowing in the same direction is

- 1) 3cm 2) 5cm 3) 12 cm 4) 20 cm

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

- 1) $-2F$ 2) $\frac{F}{3}$ 3) $-\frac{2F}{3}$ 4) $-\frac{F}{3}$

23. A proton of velocity $[3\hat{i}+2\hat{j}]$ m/s enters a field a magnetic induction $[3\hat{i}+2\hat{j}]$ tesla, The acceleration produced in the proton in (m/s^2) is (specific charge of proton = 0.96×10^8 C/Kg)

- 1) $2.8 \times 10^8 (2\hat{i} - 3\hat{j})$ 2) $2.88 \times 10^8 (2\hat{i} - 3\hat{j} + 2\hat{k})$
 3) $2.8 \times 10^8 (2\hat{i} + 3\hat{k})$ 4) $2.88 \times 10^8 (\hat{i} - 3\hat{j} + 2\hat{k})$

24. Two ions having equal masses, but charges in the ratio 1:2 are projected perpendicular to a uniform magnetic field with speeds in the ratio 2:3. The ratio of the radii of curvature along which the ions move, is

- 1) 4:3 2) 2:3 3) 3:2 4) 1:4

25. A proton moving in a perpendicular magnetic field 'B' possesses kinetic energy 'K'. If the magnetic field increases to '4B' and the particle is constrained to move in the path of same radius, the kinetic energy will be

- 1) K 2) 4K 3) 8K 4) 16K

KEY

1) 3 2) 2 3) 2 4) 2 5) 2 6) 4 7) 3 8) 4 9) 1 10) 4

11) 2 12) 3 13) 3 14) 3 15) 1 16) 2 17) 2 18) 2 19) 2 20) 1

21) 2 22) 3 23) 2 24) 1 25) 4

HINTS

$$16. \frac{i_1}{r-x} = \frac{i_2}{x} \Rightarrow \frac{3}{8-x} = \frac{5}{x}$$

$$3x = 40 - 5x \Rightarrow x = 5 \text{ cm}$$

$$17. r = \frac{mv}{qB} \Rightarrow r \propto mv$$

$$\text{since } r_A > r_B \Rightarrow m_A v_A > m_B v_B$$

18. Since electron is travelling along positive x - direction the magnetic field perpendicular to it

$$\vec{B} = 4\vec{j} - 3\vec{k} \Rightarrow |\vec{B}| = 5T$$

$$F = q v B \Rightarrow 1.6 \times 10^{-19} \times 2 \times 10^5 \times 5$$

$$= 1.6 \times 10^{-13} \text{ T}$$

$$19. r = \frac{mv}{qB} \quad B \text{ is constant}$$

$$r_1 : r_2 = \frac{m_1 v_1}{q_1} : \frac{m_2 v_2}{q_2} \Rightarrow \frac{1}{1} \times 2 : \frac{2}{2} \times 3 = 2 : 3$$

$$20. r = \frac{p}{qB} = \frac{\sqrt{2m k \cdot E}}{q B} \Rightarrow r \propto \frac{\sqrt{m}}{q}$$

$$r_1 : r_2 : r_3 = \frac{\sqrt{1}}{1} : \frac{\sqrt{2}}{1} : \frac{\sqrt{4}}{2} = 1 : \sqrt{2} : 1$$

$$21. F = mg \Rightarrow \frac{\mu_0 i_1 i_2 l}{2\pi r} = mg \Rightarrow \frac{\mu_0 i_1 i_2}{2\pi r} = \frac{m}{l} g$$

$$\frac{2 \times 10^{-7} \times 200 \times i_2}{2 \times 10^{-2}} = 20 \times 10^{-3} \times 9.8 \Rightarrow i_2 = 98 \text{ A}$$

$$22. \frac{F_1}{F_2} = - \frac{i_1 i_2 / r_1}{i_1^2 i_2^2 / r_2^2} = \frac{i_1 i_2}{i_1^2 2i_2} \times \frac{3d}{d} \Rightarrow F_2 = \frac{-2F}{3}$$

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

- 1) attract each other with a force of $\frac{\mu_0 i^2}{(2\pi d^2)}$ 2) repel each other with a force of $\frac{\mu_0 i^2}{(2\pi d^2)}$
3) attract each other with a force of $\frac{\mu_0 i^2}{(2\pi d)}$ 4) repel each other with a force of $\frac{\mu_0 i^2}{(2\pi d)}$

4. Two very long straight parallel wires carry steady currents I and -I. The distance between the wires is d. At a certain instant of time, a point charge 'q' is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity 'v' is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

- 1) $\frac{\mu_0 I q v}{2\pi d}$ 2) $\frac{\mu_0 I q v}{\pi d}$ 3) $\frac{2\mu_0 I q v}{\pi d}$ 4) zero

5. A current carrying circular coil, suspended freely in a uniform external magnetic field orients to a position of stable equilibrium. In this state:

- 1) The plane of coil is normal to external magnetic field
2) The plane of coil is parallel to external magnetic field
3) Flux through coil is minimum
4) Torque on coil is maximum

6. The plane of the coil of tangent galvanometer is kept parallel to magnetic meridian to

- 1) avoid the influence of earth's magnetic field
2) increase the magnetic field due to current in the coil
3) make earth's magnetic field perpendicular to that due to current in the coil
4) make readings more accurate

7. In a moving coil galvanometer a radial magnetic field is obtained with concave magnetic poles, to have
- 1) uniform magnetic field
 - 2) the plane of coil is parallel to the field in any orientation of coil
 - 3) a non-linear scale for galvanometer
 - 4) Both 1 and 2
8. A) Tangent galvanometer is a moving magnet type galvanometer
B) Tangent galvanometer works on tangent law
- 1) A is true, B is false 2) A is false, B is true 3) A & B are true 4) A & B are false
9. The restoring couple for the coil of galvanometer [suspension coil type] is provided by
- 1) the magnetic field 2) material of the coil
 - 3) twist produced in the suspension 4) current in the coil
10. A) In Tangent galvanometer the circular frame is rotated until the plane of the coil is parallel to magnetic meridian
B) In Tangent galvanometer current through it is related to deflection of needle as
- 1) A is true, B is false 2) A is false, B is true 3) A & B are true 4) A & B are false
11. In case of Tangent galvanometer
- A) The galvanometer reduction factor depends on earth's magnetic field
B) External fields have effect on T.G and therefore T.G cannot be used in mines (ATB)
- 1) A is true, B is false 2) A is false, B is true 3) A & B are true 4) A & B are false
12. The current that must flow through a galvanometer to have a deflection of 1 division on its scale is called
- 1) meter sensitivity 2) micro sensitivity 3) figure of merit 4) voltage sensitivity

13. A moving coil galvanometer can be converted into

- 1) an ammeter by connecting a high resistance in series with it
- 2) an ammeter by connecting a high resistance in parallel to it
- 3) a voltmeter by shunting a low resistance to it
- 4) a voltmeter by connecting a high resistance in series

14. The correct statement among the following is:

- 1) Ammeter is connected in series in a circuit because its resistance is generally high
- 2) Voltmeter is connected in parallel in a circuit because its resistance is generally low
- 3) Voltmeter is connected in parallel because its resistance is generally high
- 4) Ammeter is connected in parallel because its resistance is generally low

15. Statement A: The resistance of ideal ammeter is zero

Statement B: The resistance of ideal voltmeter is infinity

Choose the correct option among the following.

- | | |
|-----------------------------|---------------------------|
| 1) Only A is correct | 2) Only 'B' is correct |
| 3) Both A and B are correct | 4) Both A and B are false |

16. a) M.C.G is a highly sensitive instrument used to measure the small current of the order 10^{-9} A

b) The suspension wire in M.C.G is phosphor - bronze because it has high young's modulus and very low rigidity modulus

c) A soft iron cylinder is placed inside the coil in M.C.G to increase the intensity of the magnetic induction in between the poles

- | | | | |
|-------------------|-------------------|-------------------|-------------------------|
| 1) Only a is true | 2) only b is true | 3) only c is true | 4) a, b, c all are true |
|-------------------|-------------------|-------------------|-------------------------|

17. **Statement A: Ammeter is a low resistance galvanometer**

Statement B: Voltmeter is a high resistance galvanometer

Read the above statements and chose the correct option given below

- 1) Only A is correct 2) only B is correct 3) A and B are correct 4) A and B are false

18. **Which of the following statement (s) are true**

- i) **Moving coil galvanometer can be used in mines**
- ii) **The coil of tangent galvanometer need not be arranged in magnetic meridian.**
- iii) **The reduction factor of a tangent galvanometer varies from place to place**
- iv) **In tangent galvanometer, current is proportional to tangent of deflection**

1) i, ii and iii are correct 2) i, ii and iv are correct

3) i, ii and iv are correct 4) i, iii and iv are correct

19. **A: For a point on the axis of a circular coil carrying current, magnetic field is maximum at the centre of the coil**

R: Magnetic field is inversely proportional to the distance of point from the circular coil.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'

2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'

3) 'A' is true and 'R' is false

4) 'A' is false and 'R' is true

20. **(A): In case of M.C.G the torque on the coil is maximum in any position of the coil**

(R): In case of M.C.G the concave shaped magnetic poles render the field to be radial between them so that the plane of the coil is always perpendicular to the lines of induction even after deflection

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'

2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'

3) 'A' is true and 'R' is false

4) 'A' is false and 'R' is true

21. List - I

a) Moving coil galvanometer

b) Tangent galvanometer

c) Duddle's galvanometer

List - II

d) $i \propto \tan \theta$

e) $i \propto \theta$

f) $i \propto \theta^2$

g) $i \propto \sqrt{\theta}$

1) a - e, b - f, c - g

2) a - e, b - d, c - g

3) a - d, b - e, c - f

4) a - e, b - d, c - f

22. A rectangular loop carrying a current 'i' is placed in a uniform magnetic field B. The area enclosed by the loop is A. If there are n turns in the loop, the torque acting on the loop is given by (PMT MP 1994)

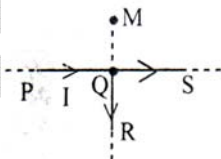
1) $ni(\vec{A} \times \vec{B})$

2) $ni(\vec{A} \cdot \vec{B})$

3) $\left(\frac{i\vec{A} \times \vec{B}}{n} \right)$

4) $\left(\frac{i\vec{A} \cdot \vec{B}}{n} \right)$

23. An infinitely long conductor PQR is bent to form a right angle as shown. A current I flows through PQR. The magnetic field due to this current at the point M is B_1 . Now another infinitely long straight conductor QS is connected to Q so that the current is I/2 in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at M is now B_2 . The ratio B_1/B_2 is given by



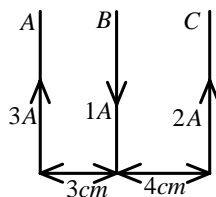
1) 1/2

2) 1

3) 2/3

4) 2

24. Figure shows three long straight and parallel conductors A, B and C carrying currents 3A, 1A and 2A respectively. A length of 0.5 m of the wire B experiences a force of :



- 1) 10^{-5} from left to right
 2) 10^{-5} from right to left
 3) $5 \times 10^{-6} N$ from L to R
 4) $5 \times 10^{-6} N$ from R to L
25. A rectangular coil of wire of 100 turns and $10 \times 15 \text{ cm}^2$ size carrying a current of 2Amp. is in a magnetic field of induction $2 \times 10^{-3} \text{ wb / m}^2$. If the normal drawn to the plane of the coil makes an angle 30° with the field, then the torque on the coil is
- 1) $3 \times 10^{-5} N - m$
 2) $3 \times 10^{-3} N - m$
 3) $3\sqrt{3} \times 10^{-5} N - m$
 4) $3\sqrt{3} \times 10^{-3} N - m$
26. A galvanometer of resistance 150 ohm is shunted such that only 1/11 of the main current flows through the galvanometer. The resistance of the shunt is,
- 1) 5 W
 2) 10 W
 3) 15 W
 4) 25 W
27. A galvanometer has coil of resistance 50Ω and shows full deflection at $100 \mu\text{A}$. The resistance to be added for the galvanometer to work as an ammeter of range 10mA is nearly
- 1) 0.5Ω in series
 2) 0.5Ω in parallel
 3) 5.0Ω in series
 4) 5.0Ω in parallel
28. When 0.005A current flows through a moving coil galvanometer, it gives fullscale deflection. It is converted into a voltmeter to read 5 Volt, using an external resistance of 975Ω . The resistance of galvanometer in ohms is
- 1) 5
 2) 10
 3) 15
 4) 25
29. A galvanometer of resistance 40Ω and current passing through it is $100 \mu\text{A}$ per division. The full scale has 50 divisions. If it is converted into an ammeter of range 2A by using a shunt, then the resistance of ammeter is
- 1) $\frac{40}{399} \Omega$
 2) $\frac{4}{399} \Omega$
 3) 0.01Ω
 4) 0.4Ω

35. A galvanometer has resistance G and Current I_g produces full scale deflection. S_1 is the value of the shunt which converts it into an ammeter of range $0 - I$ and S_2 is the value of shunt for the range $0 - 2I$. The ratio of S_1 and S_2 is

1) $\frac{1}{2} \left(\frac{I - I_g}{2I - I_g} \right)$ 2) $\frac{2I - I_g}{I - I_g}$ 3) $1/2$ 4) 2

36. A galvanometer having a resistance of 50Ω , gives a full scale deflection for a current of 0.05 A. The length in meter of a resistance wire of area of cross section $2.97 \times 10^{-2} \text{ cm}^2$ that can be used to convert the galvanometer into an ammeter which can read a maximum of 5A current is (specific resistance of the wire = $5 \times 10^{-7} \Omega - m$)

1) 9 2) 6 3) 3 4) 1.5

37. A particle of mass ' m ' and charge ' q ' moves with a constant velocity ' v ' along the positive x - direction. It enters a region containing a uniform magnetic field \vec{B} directed along the negative Z -direction, extending from $x = a$ to $x = b$. The minimum value of ' v ' required, so that the particle can just enter the region $x > b$ is

1) $\frac{qbB}{m}$ 2) $\frac{q(b-a)B}{m}$ 3) $\frac{qaB}{m}$ 4) $\frac{q(b+a)B}{2m}$

KEY

- | | | | | |
|-------|-------|-------|-------|-------|
| 1) 1 | 2) 3 | 3) 3 | 4) 4 | 5) 1 |
| 6) 3 | 7) 2 | 8) 3 | 9) 3 | 10) 3 |
| 11) 3 | 12) 3 | 13) 4 | 14) 3 | 15) 3 |
| 16) 4 | 17) 3 | 18) 4 | 19) 3 | 20) 3 |
| 21) 2 | 22) 1 | 23) 3 | 24) 4 | 25) 2 |
| 26) 3 | 27) 2 | 28) 4 | 29) 1 | 30) 3 |
| 31) 2 | 32) 2 | 33) 1 | 34) 1 | 35) 2 |
| 36) 3 | 37) 2 | | | |

HINTS

$$23. \quad B_1 = \frac{\mu_0 i}{4\pi r} \quad B_2 = \frac{\mu_0 i}{4\pi r} + \frac{\mu_0 i/2}{4\pi r} = \frac{3\mu_0 i}{8\pi r}$$

$$\frac{B_1}{B_2} = \frac{\mu_0 i}{4\pi r} \times \frac{8\pi r}{3\mu_0 i} = 2/3$$

$$24. \quad F_{net} = F_{AB} - F_{BC} = \frac{\mu_0 I}{2\pi} \left[\frac{i_1 i_2}{r_1} - \frac{i_2 i_3}{r_2} \right]$$

$$= 2 \times 10^{-7} \times 0.5 \left[\frac{3}{3 \times 10^{-2}} - \frac{2}{4 \times 10^{-2}} \right]$$

$$F_{net} = 10^{-5} \left(1 - \frac{1}{2} \right) = 5 \times 10^{-6} \text{ from left to right}$$

$$25. \quad \tilde{T} = B i A N \sin \theta = 2 \times 10^{-3} \times 2 \times 10 \times 15 \times 10^{-4} \times 100 \times \frac{1}{2}$$

$$= 3 \times 10^{-3} \text{ N-m}$$

$$26. \quad S = \frac{G}{\frac{i}{i_g} - 1} = \frac{150}{\frac{11}{1} - 1} = 15 \Omega$$

$$27. \quad S = \frac{G}{\frac{i}{i_g} - 1} = \frac{50}{\frac{10 \times 10^{-3}}{100 \times 10^{-6}} - 1} = \frac{50}{100 - 1} = 0.5 \Omega \text{ Parallel.}$$

$$28. \quad V = i_g (G + R) \Rightarrow 5 = 5 \times 10^{-3} (G + 975) \Rightarrow G = 25 \Omega$$

$$29. \quad i_g = 50 \times 100 \times 10^{-6} = 5 \times 10^{-3} \text{ A}$$

$$S = \frac{G}{\frac{i}{i_g} - 1} = \frac{40}{\frac{2}{5 \times 10^{-3}} - 1} = \frac{40}{399} \Omega$$

$$30. \quad G = 20 \Omega \quad S = \frac{12}{3} = 4 \Omega \quad i_g = 1 \text{ mA}$$

$$i = i_g \frac{(G+S)}{S} = \frac{1 \times 24}{4} = 6 \text{ mA}$$

$$31. \quad i_g = \frac{50}{20} \times 1 \mu A = \frac{5}{2} \mu A$$

$$i_g = \frac{i S}{G+S} \Rightarrow i = i_g \frac{(G+S)}{S} = \frac{5}{2} \frac{12.5}{2.5} = 12.5 \mu A$$

$$32. \quad F = mg \tan \theta$$

$$\frac{\mu_0 i^2 l}{2 \pi r} = mg \tan \theta$$

$$\frac{2 \times 10^{-7} i^2 75}{1.5} = \frac{mg 0.5 \times 10^{-2}}{l}$$

$$\frac{150 \times 10^{-7} i^2}{1.5} = 4 \times 10^{-4} \times 9.8 \times 0.5 \times 10^{-2}$$

$$i^2 = \frac{2 \times 9.8}{10} = 1.96 \Rightarrow i = 1.4 A \text{ in opposite direction}$$

$$33. \quad Bil \sin \alpha = mg \sin \theta \quad \theta = 60^\circ ; \alpha = 90 - 60 = 30^\circ$$

$$B \sqrt{3} \times 10 \times 10^{-2} \times \frac{1}{2} = 10 \times 10^{-3} \times 10 \times \frac{\sqrt{3}}{2} \quad \alpha = 90 - 60^\circ = 30$$

$$B = \pi$$

34.

$$qv(B_1 + B_2) = F$$

$$1.6 \times 10^{-19} \times 4 \times 10^5 \left(\frac{\mu_0 \times 2.5}{2\pi \times 5} + \frac{\mu_0 I}{2\pi \times 2} \right) = 3.2 \times 10^{-20}$$

$$2 \times 10^{-14} \times 2 \times 10 h - 7 \left[\frac{1}{2} + \frac{I}{2} \right] = 10^{-20}$$

$$\frac{1}{2} + \frac{I}{2} = \frac{5}{2} \Rightarrow I = 4 A$$

$$35. \quad S_1 = \frac{G}{\frac{I}{I_g} - 1} \quad S_2 = \frac{G}{\frac{2I}{I_g} - 1}$$

$$\frac{S_1}{S_2} = \frac{2I - I_g}{I - I_g}$$

$$36. S = \frac{G}{\frac{i}{ig} - 1} = \frac{50}{\frac{5}{0.05} - 1} = \frac{50}{99}$$

$$S = \frac{Pl}{A} \Rightarrow l = \frac{SA}{P}$$

$$l = \frac{50}{99} \times \frac{2.97 \times 10^{-2} \times 10^{-4}}{5 \times 10^{-7}} = 3m$$

$$37. F = ma = qv_{avg} B \Rightarrow \frac{mv^2}{2d} = q \frac{V}{2} B$$

$$V = \frac{qdB}{m} \text{ but } d = x_2 - x_1 = b - a$$

$$V = q \frac{(b-a)B}{m}$$

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