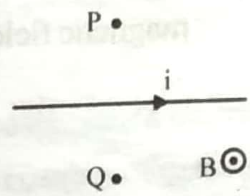
SINGLE CORRECT TYPE QUESTIONS

Biot savart law

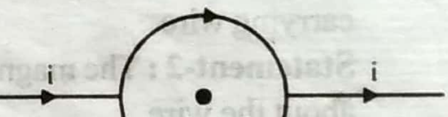
1. A long, straight wire carrying a current of 1.0 A is placed horizontally in a uniform magnetic field $B = 1.0 \times 10^{-5}$ T pointing vertically upward (figure). The magnitude of the resultant magnetic field at the points P and Q, both situated at a distance of 2.0 cm from the wire in the same horizontal plane are respectively



(A) zero, 20 μT (B) 20 μT, zero (C) zero, zero (D) 20 μT, 20 μT

2. Two parallel wires carry equal currents of 10 A along the same direction and are separated by a distance of 2.0 cm. Find the magnetic field at a point which is 2.0 cm away from each of these wires.
(A) 3.4×10^{-4} T in a direction parallel to the plane of the wires and perpendicular to the wires
(B) 1.7×10^{-4} T in a direction parallel to the plane of the wires and parallel to the wires
(C) 1.7×10^{-4} T in a direction parallel to the plane of the wires and perpendicular to the wires
(D) 3.4×10^{-4} T in a direction parallel to the plane of the wires and parallel to the wires

3. A conducting circular loop of radius a is connected to two long, straight wires. The straight wires carry a current i as shown in figure. Find the magnetic field B at the centre of the loop.

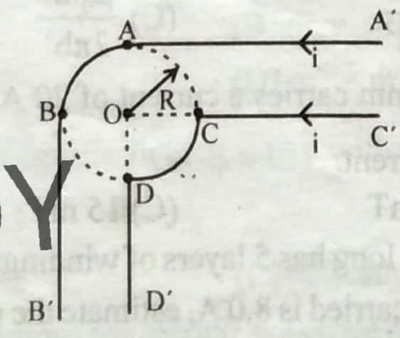


(A) zero (B) $\frac{\mu_0 I}{2a}$

(C) $\frac{\mu_0 I}{a}$ (D) $\frac{\mu_0 I}{a} + \frac{\mu_0 I}{2\pi a}$

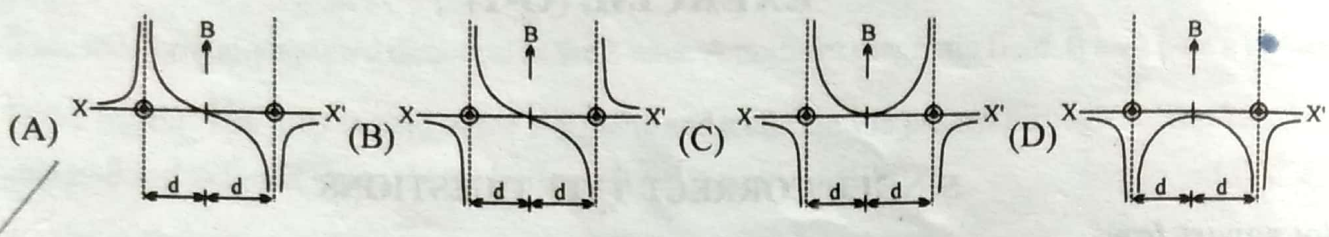
4. A piece of wire carrying a current of 6.00 A is bent in the form of a circular arc of radius 10.0 cm, and it subtends an angle of 120° at the centre. Find the magnetic field B due to this piece of wire at the centre.
(A) zero (B) 1.26×10^{-5} T (C) 5×10^{-5} T (D) 7.2×10^{-5} T

5. All straight wires are very long. Both AB and CD arc area of the same circle, both subtending right angles at the centre O. Then the magnetic field at O is

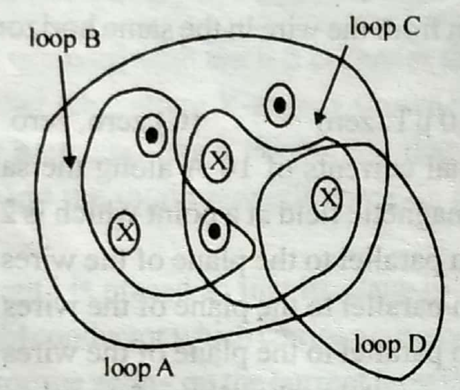


(A) $\frac{\mu_0 i}{4\pi R}$ (B) $\frac{\mu_0 i}{4\pi R}\sqrt{2}$ (C) $\frac{\mu_0 i}{2\pi R}$ (D) $\frac{\mu_0 i}{2\pi R}(\pi + 1)$

6. Two long parallel wires are at a distance 2d apart. They carry steady equal currents flowing out of the plane of the paper, as shown. The variation of the magnetic field B along the XX' is given by



7. Consider six wires coming into or out of the page, all with the same current. Rank the line integral of the magnetic field (from most positive to most negative) taken counterclockwise around each loop shown.



(A) B > C > D > A (B) B > C = D > A (C) B > A > C = D (D) C > B = D > A

8. **Statement-1 :** Ampere law can be used to find magnetic field due to finite length of a straight current carrying wire.

Statement-2 : The magnetic field due to finite length of a straight current carrying wire is symmetric about the wire.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

9. A long, cylindrical wire of radius b carries a current i distributed uniformly over its cross-section. Find the magnitude of the magnetic field at a point inside the wire at a distance a from the axis.

(A) zero (B) $\frac{\mu_0 ib}{2\pi a^2}$ (C) $\frac{\mu_0 ia^2}{2\pi b^3}$ (D) $\frac{\mu_0 ia}{2\pi b^2}$

10. A copper wire of diameter 1.6 mm carries a current of 20 A. Find the maximum magnitude of the magnetic field $\vec{B}$ due to this current.

(A) 5.0 mT (B) 10 mT (C) 15 mT (D) 15.5 mT

11. A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A. estimate the magnitude of B inside the solenoid near its centre. *(NCERT)*

(A) zero (B) $8\pi \times 10^{-3}$ T (C) $15\pi \times 10^{-3}$ T (D) $\pi \times 10^{-3}$ T

Motion of charge particle

12. A charged particle enters a non-uniform uni-directional field such that initial velocity is parallel to magnetic field, then the radius of curvature of its path is (in standard notation):

(A) mV/qB (B) 0 (C) ∞ (D) qB/mV

13. A charge particle moves in a uniform magnetic field such that initial velocity is perpendicular to the magnetic field . No other force acts on the particle .

(A) the motion is uniform rectilinear

(B) the motion can be non uniform circular motion

(C) the motion can be uniform circular motion

(D) the motion must be uniform circular motion .

14. A tightly-wound, long solenoid carries a current of 2.00 A. An electron is found to execute a uniform circular motion inside the solenoid with a frequency of 1.00×10^8 rev/s. Find the number of turns per metre in the solenoid.

(A) 500 Turns/m (B) 1020 Turns/m (C) 1232 Turns/m (D) 1420 Turns/m

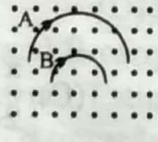
15. An electron is moving along positive x-axis. A uniform electric field exists towards negative y-axis. What should be the direction of magnetic field of suitable magnitude so that net force of electron is zero

(A) positive z- axis (B) negative z-axis (C) positive y-axis (D) negative y-axis

16. An electron having kinetic energy T is moving in a circular orbit of radius R perpendicular to a uniform magnetic induction $\vec{B}$. If kinetic energy is doubled and magnetic induction tripled, the radius will become

(A) $\frac{3R}{2}$ (B) $\sqrt{\frac{3}{2}}R$ (C) $\sqrt{\frac{2}{9}}R$ (D) $\sqrt{\frac{4}{3}}R$

17. Two particles A and B of masses m_A and m_B respectively and having the same charge are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speeds of the particles are v_A and v_B respectively and the trajectories are as shown in the figure. Then **[JEE, 2001 (Scr)]**



(A) $m_A v_A < m_B v_B$ (B) $m_A v_A > m_B v_B$

(C) $m_A < m_B$ and $v_A < v_B$ (D) $m_A = m_B$ and $v_A = v_B$

18. A charged particle moves in a magnetic field $\vec{B} = 10\hat{i}$ with initial velocity $\vec{u} = 5\hat{i} + 4\hat{j}$. The path of the particle will be

(A) straight line (B) circle (C) helical (D) none

19. An electron makes 3×10^5 revolutions per second in a circle of radius 0.5 angstrom. Find the magnetic field B at the centre of the circle.

(A) 6×10^{-10} T (B) 12×10^{-10} T (C) 18×10^{-10} T (D) 24×10^{-10} T

20. Electrons moving with different speeds enter a uniform magnetic field in a direction perpendicular to the field. They will move along circular paths.

(A) of same radius

(B) with larger radii for the faster electrons

(C) with smaller radii for the faster electrons

(D) either (B) or (C) depending on the magnitude of the magnetic field

21. In the previous question, time periods of rotation will be :

(A) same for all electrons

(B) greater for the faster electrons

(C) smaller for the faster electrons

(D) either (B) or (C) depending on the magnitude of the magnetic field

22. 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 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 :- **JEE 2002 (screening)]**

(A) q b B/m (B) q(b – a) B/m (C) q a B/m (D) q(b + a) B/2m

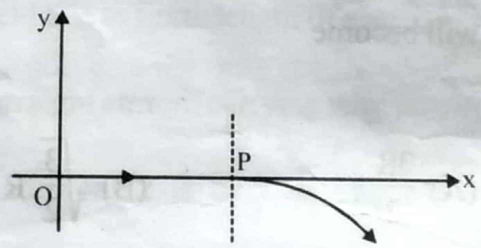
23. For a positively charged particle moving in a x – y plane initially along the x–axis, there is a sudden change in it path due to the presence of electric and/or magnetic field beyond P. The curved path is shown in the x – y plane and is found to be non–circular. Which one of the following combinations is possible? **[JEE 2004]**

(A) $\vec{E} = 0; \vec{B} = b\hat{j} + c\hat{k}$

(B) $\vec{E} = a\hat{i}; \vec{B} = c\hat{k} + a\hat{i}$

(C) $\vec{E} = 0; \vec{B} = c\hat{j} + b\hat{k}$

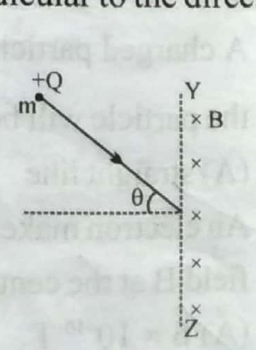
(D) $\vec{E} = a\hat{i}; \vec{B} = c\hat{k} + b\hat{j}$



24. A particle having charge of 1 C, mass 1 kg and speed 1 m/s enters a uniform magnetic field, having magnetic induction of 1 T, at an angle θ = 30° between velocity vector and magnetic induction. The pitch of its helical path is (in meters)

(A) $\frac{\sqrt{3}\pi}{2}$ (B) $\sqrt{3}\pi$ (C) $\frac{\pi}{2}$ (D) π

25. A particle with charge +Q and mass m enters a magnetic field of magnitude B, existing only to the right of the boundary YZ. The direction of the motion of the particle is perpendicular to the direction of B. Let $T = 2\pi\frac{m}{QB}$. The time spent by the particle in the field will be



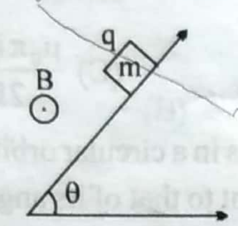
(A) Tθ (B) 2Tθ

(C) $T\left(\frac{\pi + 2\theta}{2\pi}\right)$ (D) $T\left(\frac{\pi - 2\theta}{2\pi}\right)$

26. In the previous question, if the particle has –Q charge, the time spend by the particle in the field will be :-

(A) $T\theta$ (B) $2T\theta$ (C) $T\left(\frac{\pi+2\theta}{2\pi}\right)$ (D) $T\left(\frac{\pi-2\theta}{2\pi}\right)$

27. A block of mass m & charge q is released on a long smooth inclined plane magnetic field B is constant, uniform, horizontal and parallel to surface as shown. Find the time from start when block loses contact with the surface.

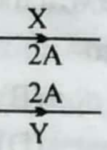


(A) $\frac{m\cos\theta}{qB}$ (B) $\frac{m\operatorname{cosec}\theta}{qB}$ (C) $\frac{m\cot\theta}{qB}$ (D) none

28. In a cyclotron, a charged particle
(A) undergoes acceleration all the time.
(B) speeds up between the dees because of the magnetic field.
(C) speeds up in a dee.
(D) slows down within a dee and speeds up between dees.

Ampere force & torque

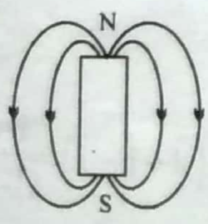
29. In given figure, X and Y are two long straight parallel conductors each carrying a current of 2 A. The force on each conductor is F newtons. When the current in each is changed to 1 A and reversed in direction, the force on each is now

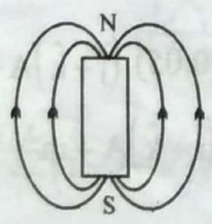


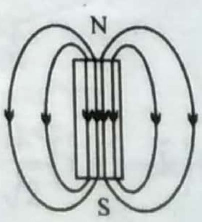
(A) F/4 and unchanged in direction (B) F/2 and reversed in direction
(C) F/2 and unchanged in direction (D) F/4 and reversed in direction

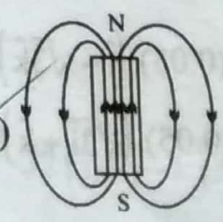
30. Two long and parallel straight wires A and B carrying currents of 8.0 A and 5.0 A in the same direction are separated by a distance of 4.0 cm. Estimate the force on a 10 cm section of wire A. ***(NCERT)***
(A) 2×10^{-5} N ; attractive force normal to B towards A.
(B) 2×10^{-5} N ; attractive force normal to A towards B.
(C) 5×10^{-5} N ; attractive force normal to A towards B.
(D) 5×10^{-5} N ; attractive force normal to B towards A.

31. The magnetic field lines due to a bar magnet are correctly shown in:- **[JEE 2002 (screening)]**

(A) 

(B) 

(C) 

(D) 

32. A wire of mass 100 g carrying a current of 2A towards increasing x is in the form of $y = x^2$ $(-2m \le x \le +2m)$. This wire is placed in a magnetic field $B = -0.02\hat{k}$ Tesla & gravity free region. The acceleration of the wire (in m/s^2) is :

(A) $-1.6\hat{j}$ (B) $-3.2\hat{j}$ (C) $1.6\hat{j}$ (D) $2.4\hat{j}$

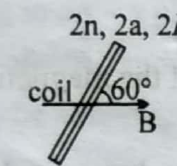
33. A circular loop of radius R carries a current I. Another circular loop of radius r(<<R) carries a current i and is placed at the centre of the larger loop. The planes of the two circles are at right angle to each other. Find the torque acting on the smaller loop.

(A) zero (B) $\frac{\mu_0 \pi i I r^2}{4R}$ (C) $\frac{\mu_0 \pi i I r^2}{2R}$ (D) $\frac{\mu_0 \pi i I r^2}{R}$

34. A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on.

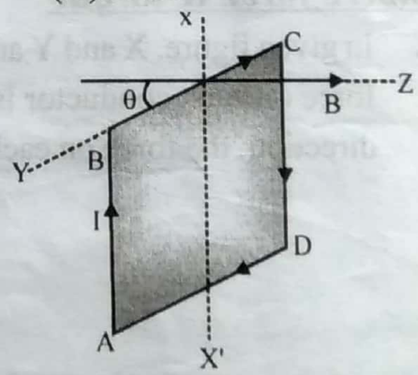
(A) ω and q (B) ω, q and m (C) q and m (D) ω and m

35. A rectangular coil PQ has 2n turns, an area 2a and carries a current 2*I*, (refer figure). The plane of the coil is at 60° to a horizontal uniform magnetic field of flux density B. The torque on the coil due to magnetic force is :-



(A) Bna*I* sin60° (B) 8Bna*I* cos60° (C) 4na*I* Bsin60° (D) none

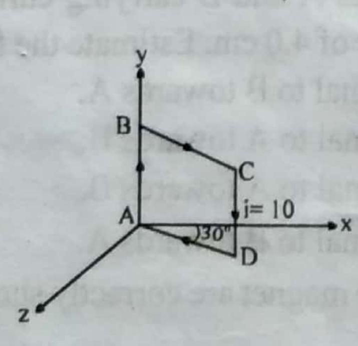
36. The square loop ABCD, carrying a current I, is placed in a uniform magnetic field B, as shown. The loop can rotate about the axis XX'. The plane of the loop makes an angle θ (θ < 90°) with the direction of B. Through what angle will the loop rotate by itself before the torque on it becomes zero–



(A) θ (B) 90° – θ

(C) 90° + θ (D) 180° – θ

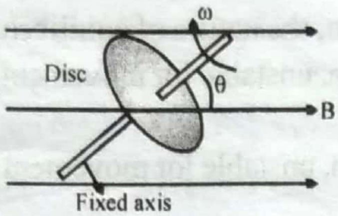
37. Figure shows a square current carrying loop ABCD of side 10 cm and current i = 10A. The magnetic moment $\vec{M}$ of the loop is



(A) $(0.05)\left(\hat{i} - \sqrt{3}\hat{k}\right)A - m^2$ (B) $(0.05)\left(\hat{j} + \hat{k}\right)A - m^2$

(C) $(0.05)\left(\sqrt{3}\hat{i} + \hat{k}\right)A - m^2$ (D) $\left(\hat{i} + \hat{k}\right)A - m^2$

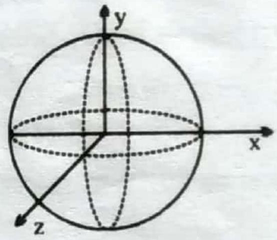
38. A disc of radius r and carrying positive charge q is rotating with an angular speed ω in a uniform magnetic field B about a fixed axis as shown in figure, such that angle made by axis of disc with magnetic field is θ. Torque applied by axis on the disc is



(A) $\frac{q\omega r^2 B\sin\theta}{2}$, clockwise (B) $\frac{q\omega r^2 B\sin\theta}{4}$, anticlockwise

(C) $\frac{q\omega r^2 B\sin\theta}{2}$, anticlockwise (D) $\frac{q\omega r^2 B\sin\theta}{4}$, clockwise

39. Three rings, each having equal radius R, are placed mutually perpendicular to each other and each having its centre at the origin of co-ordinate system. If current I is flowing through each ring then the magnitude of the magnetic field at the common centre is



(A) $\sqrt{3}\frac{\mu_0 I}{2R}$

(B) zero

(C) $\left(\sqrt{2}-1\right)\frac{\mu_0 I}{2R}$

(D) $\left(\sqrt{3}-\sqrt{2}\right)\frac{\mu_0 I}{2R}$

40. Two mutually perpendicular long conducting wire carrying currents I_1 and I_2 lie in one plane. Locus of the point at which the magnetic induction is zero, is a

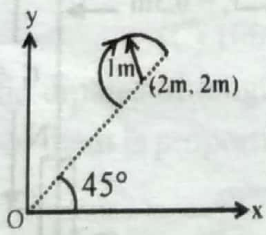
(A) circle with centre as the point of intersection of the wire.

(B) parabola with vertex as the point of intersection of the wire

(C) straight line passing through the point of intersection of the wire

(D) rectangular hyperbola

41. A uniform magnetic field $\vec{B}=\left(3\hat{i}+4\hat{j}+\hat{k}\right)$ Tesla exist in a region of space. A semicircular wire of radius 1 m carrying a current of 1A having its centre at (2,2,0) m is placed on the X-Y plane as shown. The force on the semicircular wire will be



(A) $\frac{1}{\sqrt{2}}\left(\hat{i}-\hat{j}+\hat{k}\right)N$ (B) $\sqrt{2}\left(\hat{i}-\hat{j}+\hat{k}\right)N$ (C) $\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{j}-\hat{k}\right)N$ (D) $\sqrt{2}\left(\hat{i}+\hat{j}-\hat{k}\right)N$

42. A very long wire carrying current I is fixed along x-axis. Another parallel finite wire carrying a current in the opposite direction is kept at a distance d above the wire in xy plane. The second wire is free to move parallel to itself. The options available for its small displacements are in

(i) +ve x direction (ii) +ve y direction (iii) +ve z direction

Taking gravity in negative y direction, the nature of equilibrium of second wire is

(A) stable for movement in x direction, unstable for movement in y direction, neutral for movement in z direction

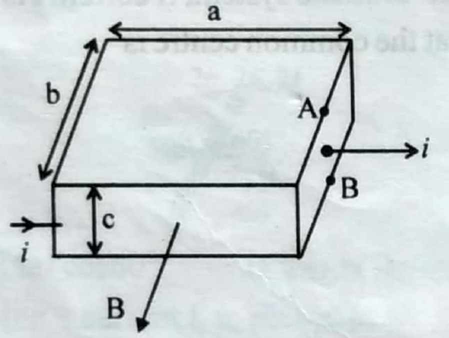
(B) stable for movement in y direction, unstable for movement in z direction, neutral for movement in x direction

(C) stable for movement in z direction, unstable for movement in y direction, neutral for movement in x direction

(D) stable for movement in y direction, unstable for movement in x direction, neutral for movement in z direction

43. A current flows through a rectangular conductor in the presence of uniform magnetic field B pointing out of the page as shown. Then the potential difference $V_B - V_A$ is equal to

(Assume charge carries in the conductor to be positively charged moving with speed v)



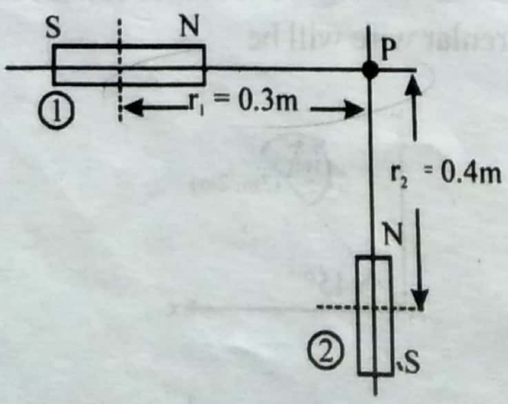
(A) Bvc (B) –Bvc (C) Bvb (D) –Bvb

44. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 divisions per milli ampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 V, the resistance in Ohm's needed to be connected in series with the coil will be- **[AIEEE-2005]**

(A) 10^3 (B) 10^5 (C) 99995 (D) 9995

SUPPLEMENT ON MAGNETIC PROPERTIES OF MATTER

45. Two short magnets of magnetic moment $2Am^2$ and $5Am^2$ respectively are placed along two lines drawn at right angle to each other on the sheet of paper as shown in the figure. What is the magnetic field at the point of intersection of their axis:



(A) 2.15×10^{-5} T (B) 215×10^{-5} T (C) 2.15×10^{-4} T (D) 21.5×10^{-5} T

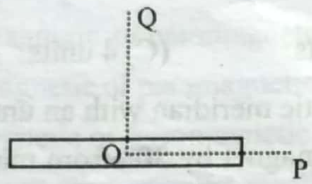
46. A steel wire of length L has a magnetic moment M. It is then bent into a semi-circular are; the new magnetic moment will be :

(A) M (B) $2M/\pi$ (C) M/L (D) $M \times L$

47. Two bar magnets of the same mass, same length and breadth but having magnetic moments M and 2M are joined together north pole to north pole and suspended by a string . The time period of assembly in a magnetic field of strength H is 3 seconds. If now the polarity of one of the magnets is reversed and the combination is again made to oscillate in the same field, the time of oscillations is :

(A) $\sqrt{3}$ sec (B) $3\sqrt{3}$ sec (C) 3 sec (D) 6 sec

48. When magnetic field at P and Q is same then OP/OQ = ?



(A) $\sqrt[3]{2}$ (B) $\frac{1}{\sqrt[3]{2}}$ (C) $2\sqrt{2}$ (D) $\frac{3}{2\sqrt{2}}$

49. Similar pole each of pole strength m are placed at a distance of 1, 2,4, 8, ...meters from the origin on the x-axis. Where do you place a similar pole n the other side of the origin so that the origin becomes a neutral point :-

(A) 0.5 m (B) 0.5774 m (C) 0.86 m (D) 1m

50. Two identical poles each of pole strength 4×10^{-3} amp-m placed at the two corners of an equilateral triangle of side 20 cm. The magnetic field at the third corner is :-

(A) $\sqrt{3}\times10^{-8}$ N/amp-m (B) $\frac{\sqrt{3}}{4}\times 10^{-8}$N/amp-m

(C) zero (D) 10^{-8} N/amp-m

51. The magnetic field at a point on the axis of a dipole is 20 Wb/m^2 Northwards. What will be the magnetic induction at the point if the dipole be rotated anticlockwise by 90° :-

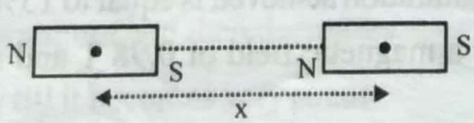
(A) 10 Wb/m^2 Eastwards (B) 10 Web/m^2 Southwards

(C) 10 Wb/m^2 Northwards (D) 20 Wb/m^2 Southwards

52. A bar magnet of magnetic moment 2A-m^2 free to rotate about a vertical axis passing through its centre. The magnet is released from rest from east-west position. Then the kinetic energy of the magnet as it takes North-South position is (horizontal component of the earth's field is 25μT and angle of declination is zero :-

(A) 25 μJ (B) 50 μJ (C) 100 μJ (D) 125 μJ

53. The mid points of two small magnetic dipoles of length d in end-on positions, are separated by a distance x, (x >> d). The force between them is proportional to x^{-n} where n is :-



(A) 3 (B) 4 (C) 2 (D) 1

54. A permanent magnet has shape of a thin disc with magnetic moment along its axis the radius of the disc is 1 cm. The magnetic field due to it can be assumed to be that due to molecular current I' flowing along the rim of the disc. It $\vec{B}$ at a distance of 10 cm from it's centre on the axis is 30μT, find I' (approximately) :-

(A) 1 kA (B) 0.5 kA (C) 2.5 kA (D) 3 kA

55. The angle of dip at a place is 30° and the intensity of the vertical component of the earth's magnetic field $V = 6 \times 10^{-5}$T. The total intensity of the earth's magnetic field at this place is :

(A) 7×10^{-5} T (B) 6×10^{-5} T (C) 5×10^{-5} T (D) 12×10^{-5} T

56. The total intensity of the earth's magnetic field at the magnetic equator is 5 units. What is its value at a magnetic latitude of 37 degree?

(A) $\sqrt{73}$ units (B) $\sqrt{52}$ units (C) 4 units (D) 3 units

57. A magnet is suspended in the magnetic meridian with an untwisted wire. The upper end of wire is rotated through 180° to deflect the magnet by 30° from magnetic meridian. When the magnet is replaced by another magnet, the upper end of wire is rotated through 270° to deflect the magnet 30° from magnetic meridian. The ratio of magnetic moments of magnets is :-

(A) 1 : 5 (B) 1 : 8 (C) 5 : 8 (D) 8 : 5

58. The imagined magnet makes an angle of 11.3° with earth's axis. On the earth, there are two points where magnetic equator and geographic equator meet let the angle of dip and angle of declination at these point be θ & ϕ respectively :-

(A) $\theta = \phi = 0°$ (B) $\theta = 11.3°, \phi = 0°$ (C) $\theta = 0°, \phi = 11.3°$ (D) $\theta = \phi = 11.3°$

59. A specimen of iron of permeability 8×10^{-3} weber/ amp × metre is placed in a magnetic field of intensity 160 amp/metre. Then magnetic field in this iron is :

(A) 20×10^{3} Wb/m² (B) 1.28 Wb/m² (C) 5×10^{-5} Wb/m² (D) 0.8Wb/m²

60. Curie temperature is the temperature above which :

(A) a paramagnetic material becomes diamagnetic

(B) a ferromagnetic material becomes diamagnetic

(C) a paramagnetic material becomes ferromagnetic

(D) a ferromagnetic material becomes paramagnetic

61. If a solution of ferromagnetic material is poured into a U-tube and one arm of this is placed between the poles of a strong magnet with the meniscus in line with the field, then the level of the solution will:

(A) Rise (B) Fall

(C) Rise till the liquid comes out (D) Remain unchanged

62. A sample of paramagnetic salt contains 2.0×10^{24} atomic dipoles each of dipole moment 1.5×10^{-23} J T^{-1}. The sample is placed under a homogeneous magnetic field of 0.84T, and cooled to a temperature of 4.2K. The degree of magnetic saturation achieved is equal to 15%. What is the total dipole moment (approximate) of the sample for a magnetic field of 0.98 T and a temperature of 2.8K? (Assume Curie's law).

(A) 7.9 JT^{-1} (B) 52.5 J T^{-1} (C) 30 J T^{-1} (D) 4.6J T^{-1}