Chapter 5

Magnetism and Matter

Solutions

SECTION - A

Objective Type Questions

(Bar Magnet)

1. A wire of length L m carrying a current I A, is bent in the form of a circle. The magnetic moment is

(1) $\frac{4\pi I}{L^2}$ (2) $\frac{2IL^2}{\pi}$ (3) $\frac{IL^2}{\pi}$ (4) $\frac{IL^2}{4\pi}$

Sol. Answer (4)

$l = 2\pi r$

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

$M = I\pi\left(\frac{L}{2\pi}\right)^2 \Rightarrow M = \frac{IL^2}{4\pi}$

2. Bohr magneton is given by (symbols have their usual meanings)

(1) $\frac{4\pi m_e}{eh^2}$ (2) $\frac{4\pi m_e}{eh}$ (3) $\frac{eh^2}{4\pi m_e}$ (4) $\frac{eh}{4\pi m_e}$

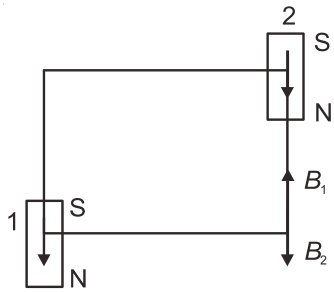
Sol. Answer (4)

$B_m = \frac{eh}{4\pi m}$

3. Two short bar magnets of magnetic moments 'M' each are arranged at the opposite corners of a square of side 'd', such that their centres coincide with the corners and their axes are parallel to one side of the square. If the like poles are in the same direction, the magnetic induction at any of the other corners of the square is

(1) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$ (2) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$ (3) $\frac{\mu_0}{2\pi}\frac{M}{d^3}$ (4) $\frac{\mu_0}{2\pi}\frac{2M}{d^3}$

Sol. Answer (1)

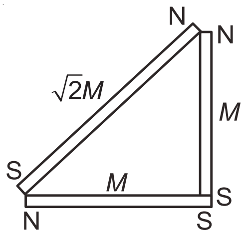


$$B_{net} = B_2 - B_1$$

$$= \frac{\mu_0}{4\pi}\left(\frac{2M}{d^3}\right) - \frac{\mu_0}{4\pi}\left(\frac{M}{d^3}\right)$$

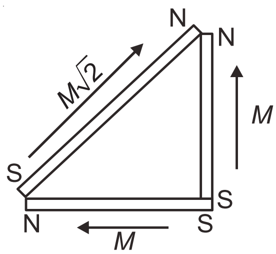
$$= \frac{\mu_0}{4\pi}\frac{M}{d^3}$$

4. The magnetic moment of the arrangement shown in the figure is



(1) Zero (2) $2\sqrt{2}M$ (3) $2M$ (4) M

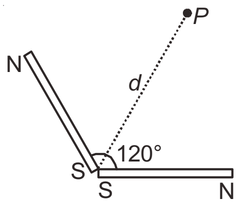
Sol. Answer (3)



Resultant of these three dipole moments will be

$$M_{net} = \sqrt{\left(M\sqrt{2}\right)^2 + \left(M\sqrt{2}\right)^2} = 2M$$

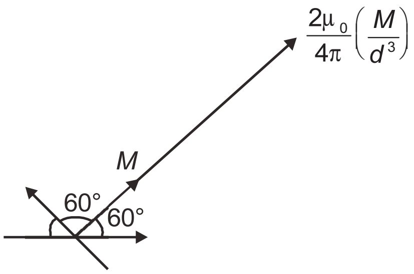
5. Two identical short bar magnets are placed at 120° as shown in the figure. The magnetic moment of each magnet is M. Then the magnetic field at the point P on the angle bisector is given by



(1) $\frac{\mu_0}{4\pi}.\frac{M}{d^3}$ (2) $\frac{\mu_0}{4\pi}.\frac{2M}{d^3}$ (3) $\frac{\mu_0}{4\pi}.\frac{2\sqrt{2}M}{d^3}$ (4) Zero

Sol. Answer (2)

Since two equal vectors M are inclined at 120°, their resultant will also be M and along its angular bisector. So point P is on axial line of resultant moment M.



$$B_{net} = \frac{2\mu_0 M}{4\pi d^3}$$

6. Two small bar magnets are placed in a line at certain distance d apart. If the length of each magnet is negligible compared to d, the force between them will be inversely proportional to

(1) d^2 (2) d (3) d^3 (4) d^4

Sol. Answer (4)

$$F \propto \frac{\mu_0}{4\pi}\frac{M_1M_2}{d^4}$$

so $F \propto \frac{1}{d^4}$

(Bar Magnet in a Magnetic Field, Magnetism and Gauss's Law)

7. The work done in turning a magnet of magnetic moment M by an angle of 90° from the magnetic meridian is n times the corresponding work done to turn it through an angle of 60°. The value of n is

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

Sol. Answer (1)

$$U_1 = -MB\cos 0^\circ$$

$$U_2 = -MB\cos 90^\circ$$

$$U_3 = -MB\cos 60^\circ$$

$$U_2 - U_1 = MB$$

$$U_3 - U_1 = \frac{MB}{2} \Rightarrow n = 2$$

8. A magnetic needle oscillates in a horizontal plane with a period T at a place where the angle of dip is 60°. When the same needle is made to oscillate in a vertical plane coinciding with the magnetic meridian, its period will be

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

Sol. Answer (1)

$$T = 2\pi\sqrt{\frac{I}{MB\cos 60^\circ}} \Rightarrow \frac{T'}{T} = \sqrt{\cos 60^\circ}$$

$$T' = 2\pi\sqrt{\frac{I}{MB}} \Rightarrow \frac{T'}{T} = \frac{1}{\sqrt{2}} \Rightarrow T' = \frac{T}{\sqrt{2}}$$

9. Two different magnets are tied together and allowed to vibrate in a horizontal plane. When their like poles are joined, time period of oscillation is 5 s and with unlike poles joined, time period of oscillation is 15 s. The ratio of their magnetic moments is

(1) 5 : 4 (2) 1 : 3 (3) 3 : 1 (4) 2 : 5

Sol. Answer (1)

$$5 = 2\pi\sqrt{\frac{I}{M_1 + M_2}}$$

$$15 = 2\pi\sqrt{\frac{I}{M_1 - M_2}} \Rightarrow \frac{1}{3} = \sqrt{\frac{M_1 - M_2}{M_1 + M_2}}$$

$$\frac{M_1 - M_2}{M_1 + M_2} = \frac{1}{9}$$

$$\frac{M_1}{M_2} = \frac{10}{8} = \frac{5}{4}$$

10. A tangent galvanometer has 80 turns of wire. The internal and external diameters of the coil are 19 cm and 21 cm respectively. The reduction factor of the galvanometer at a place where H = 0.32 oersted will be (1 oersted = 80 A/m)

(1) 0.0064 (2) 0.64 (3) 0.064 (4) None of these

Sol. Answer (3)

Reduction factor = $\dfrac{2RB_h}{\mu_0 N} = \dfrac{2 \times 0.1 \times 0.32 \times 80}{80} = 0.064$

11. If the number of turns and radius of cross section of the coil of a tangent galvanometer are doubled, then the reduction factor K will become

(1) K (2) $2K$ (3) $4K$ (4) $\frac{K}{4}$

Sol. Answer (1)

$$K = \frac{2RB_H}{\mu_0 N}$$

$$\therefore \quad K \propto= \frac{R}{N} \text{ and } K' \propto= \frac{2R}{2N} = K$$

12. The work done in rotating a bar magnet of magnetic moment M from its unstable equilibrium position to its stable equilibrium position in a uniform magnetic field B is

(1) $2MB$ (2) MB

(3) $-MB$ (4) $-2MB$

Sol. Answer (4)

$U_i = MB$

$U_f = -MB$

$\Delta U = -2MB$

13. A magnetic needle of negligible breadth and thickness compared to its length, oscillates in a horizontal plane with a period T. The period of oscillation of each part obtained on breaking the magnet into n equal parts perpendicular to the length is

(1) $\frac{T}{n}$ (2) T (3) Tn (4) $\frac{1}{Tn}$

Sol. Answer (1)

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$T' = 2\pi\sqrt{\frac{\frac{I}{n^3}}{\frac{M}{n}B}} = \frac{2\pi}{n}\sqrt{\frac{I}{MB}}$$

$$T' = \frac{T}{n}$$

(Earth's Magnetism)

14. At a certain place, vertical component of earth's magnetic field is $\sqrt{3}$ times the horizontal component of earth's magnetic field. If a magnetic needle is suspended freely in air then it will incline

(1) 30° below horizontal (2) 60° below horizontal (3) 30° above horizontal (4) 45° above horizontal

Sol. Answer (2)

$$B_V = \sqrt{3}B_H$$

$$\frac{B_V}{B_H} = \sqrt{3} = \tan\theta$$

$\theta = 60°$

15. The values of the apparent angles of dip in two planes at right angles to each other are 45° and 30° respectively. The true value of angle of dip at the place is

(1) $\cot^{-1}(1)$ (2) $\cot^{-1}(2)$ (3) $\cot^{-1}(3)$ (4) $\cot^{-1}(4)$

Sol. Answer (2)

$$\cot^2\phi = \cot^2 45° + \cot^2 30°$$

$\cot^2\phi = 1 + 3$

$\cot\phi = 2 \quad \Rightarrow \phi = \cot^{-1}(2)$

16. A magnet is placed horizontally on ground with its north pole towards the magnetic north pole of the earth. The neutral point is obtained

(1) Along the axis of the magnet

(2) On the magnetic east-west line through the centre of the magnet

(3) In only east side of the magnet

(4) In only west side of the magnet

Sol. Answer (2)

17. The value of horizontal component of earth's magnetic field at a place is 0.35×10^{-4} T. If the angle of dip is 60°, the value of vertical component of earth's magnetic field is nearly

(1) 0.1×10^{-4} T (2) 0.2×10^{-4} T (3) 0.4×10^{-4} T (4) 0.61×10^{-4} T

Sol. Answer (4)

$B_V = B_H \tan\delta$

$B_H = (0.35 \times 10^{-4})\sqrt{3}$

$B_H = 0.61 \times 10^{-4}$ T

18. The period of oscillation of a magnet of a vibration magnetometer is 2.45 s at one place and 4.9 s at the other. The ratio of the horizontal component of earth magnetic field at the two places is

(1) 1 : 4 (2) 1 : 2 (3) 2 : 1 (4) 4 : 1

Sol. Answer (4)

$$2.45 = 2\pi\sqrt{\frac{I}{MB_{H_1}}}$$

$$4.9 = 2\pi\sqrt{\frac{I}{MB_{H_2}}}$$

Dividing both the equations

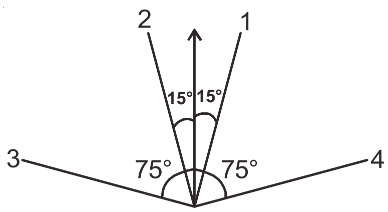
$$\frac{2.45}{4.9} = \sqrt{\frac{B_{H_2}}{B_{H_1}}} \Rightarrow \frac{B_{H_1}}{B_{H_2}} = 4:1$$

19. If ϕ is latitude and δ is dip at a place then

(1) $\tan\phi = \dfrac{\tan\delta}{2}$ (2) $\tan\delta = \dfrac{\tan\phi}{2}$ (3) $\tan\delta = \dfrac{1}{\tan\phi}$ (4) $\tan^2\phi + \tan^2\delta = 1$

Sol. Answer (1)

20. If declination at a place is known to be 15° E. And a compass needle points as shown, then geographic north is represented by the direction numbered.



(1) 1 (2) 2 (3) 3 (4) 4

Sol. Answer (2)

Geographic north will be 15° west of the direction in which the magnetic needle is pointing.

21. A dip circle lies initially in the magnetic meridian, it shows an angle of dip δ at a place. The dip circle is rotated through an angle α in the horizontal plane and then it shows an angle of dip δ'. Hence $\dfrac{\tan\delta'}{\tan\delta}$ is

(1) $\cos\alpha$ (2) $1/\sin\alpha$ (3) $1/\tan\alpha$ (4) $1/\cos\alpha$

Sol. Answer (4)

$$\tan\delta' = \frac{\tan\delta}{\cos\alpha}$$

$$\frac{\tan\delta'}{\tan\delta} = \frac{1}{\cos\alpha}.$$

22. If a dip circle is placed in a vertical plane at an angle of 30° to the magnetic meridian, the dip needle makes an angle of 45° with the horizontal. The real dip at that place is

(1) $\tan^{-1}(\sqrt{3}/2)$ (2) $\tan^{-1}(\sqrt{3})$ (3) $\tan^{-1}(\sqrt{3}/\sqrt{2})$ (4) $\tan^{-1}(2/\sqrt{3})$

Sol. Answer (1)

$$\tan 45^\circ = \frac{\tan\delta}{\cos 30^\circ}$$

$$1 = \frac{2\tan\delta}{\sqrt{3}}$$

$$\tan\delta = \frac{\sqrt{3}}{2} \Rightarrow \delta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

23. If ϕ_1 and ϕ_2 are the angles of dip in two vertical planes at right angles to each other and ϕ is the true angle of dip then

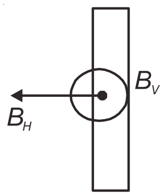
(1) $\cot^2\phi = \cot^2\phi_1 + \cot^2\phi_2$ (2) $\tan^2\phi = \tan^2\phi_1 + \tan^2\phi_2$ (3) $\cot\phi = \cot\phi_1 + \cot\phi_2$ (4) $\tan\phi = \tan\phi_1 + \tan\phi_2$

Sol. Answer (1)

24. Time period of oscillations of a magnet of magnetic moment M and moment of inertia I in a vertical plane perpendicular to the magnetic meridian at a place where earth's horizontal and vertical component of magnetic field are B_H and B_V respectively is

(1) $T = 2\pi\sqrt{\frac{I}{M(B_V^2+B_H^2)^{1/2}}}$ (2) $T = 2\pi\sqrt{\frac{I}{MB_V}}$ (3) $T = 2\pi\sqrt{\frac{I}{MB_H}}$ (4) Infinite

Sol. Answer (2)



$$T = 2\pi\sqrt{\frac{I}{MB_v}}$$

25. A magnet is suspended in such a way that it oscillates in the horizontal plane. It makes 20 oscillations per minute at a place where dip angle is 30° and 15 oscillations per minute at a place where dip angle is 60°. Ratio of the total earth's magnetic field at the two places is

(1) $3\sqrt{3}:8$ (2) $16:9\sqrt{3}$ (3) $4:9$ (4) $2\sqrt{3}:9$

Sol. Answer (2)

$$\frac{1}{20} = 2\pi\sqrt{\frac{I}{MB_1\cos 30^\circ}}$$

$$\frac{1}{15} = 2\pi\sqrt{\frac{I}{MB_2\cos 60^\circ}}$$

$$\left(\frac{3}{4}\right)^2 = \frac{B_2}{B_1\sqrt{3}} \Rightarrow \frac{B_1}{B_2} = \frac{16}{9\sqrt{3}}$$

26. The time period of a vibration magnetometer is T_0. Its magnet is replaced by another magnet whose moment of inertia is 3 times and magnetic moment is $\left(\frac{1}{3}\right)$ of the initial magnet. The time period now will be

(1) $3T_0$ (2) $\frac{T_0}{\sqrt{3}}$ (3) T_0 (4) $\frac{T_0}{3}$

Sol. Answer (1)

27. The length of a magnet is very large as compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnetic is cut perpendicular to its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be

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

Sol. Answer (2)

(Tangent law)

28. Two short magnets have equal pole strength but one is twice as long as the other. The shorter magnet is placed at 20 cm in tanA position from the compass needle. The longer magnet must be placed on the other side of the magnetometer for no deflection at a distance equal to

(1) $20(2)^{1/3}$ cm (2) $20(2)^{2/3}$ cm (3) 40 cm (4) 20 cm

Sol. Answer (1)

29. The needle of a deflection galvanometer shows a deflection of 60° due to a short bar magnet at a certain distance in tanA position. If the distance is doubled, then the deflection will be

(1) $\tan^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (2) $\tan^{-1}\left(\frac{\sqrt{3}}{8}\right)$ (3) $\tan^{-1}\left(\frac{\sqrt{3}}{5}\right)$ (4) None of these

Sol. Answer (2)

30. The magnetic needle of tangent galvanometer is deflected at an angle 30° due to a magnet. The horizontal component of earth's magnetic field is 0.34×10^{-4} T along the plane of the coil. Then the magnetic intensity will be

(1) 1.96×10^{5} T (2) 1.96×10^{4} T (3) 1.96×10^{-4} T (4) 1.96×10^{-5} T

Sol. Answer (4)

31. The certain amount of current when flowing in a properly set tangent galvanometer, produces a deflection of 45°. If the current is reduced by a factor of $\sqrt{3}$, the deflection would

(1) Decrease by 30° (2) Decrease by 15° (3) Increase by 15° (4) Increase by 30°

Sol. Answer (2)

32. The deflection magnetometer is most sensitive when the deflection θ is

(1) Nearly 0° (2) Nearly 30° (3) Nearly 45° (4) Nearly 90°

Sol. Answer (3)

33. Two short magnets having magnetic moments in the ratio 27 : 8, when placed on opposite sides of a deflection magnetometer it shows no deflection. If the distance of the weaker magnet is 0.12 m from the centre of the deflection magnetometer, the distance of the stronger magnet from the centre is

34. If number of turns and radius of cross-section of the coil of a tangent galvanometer are doubled. The reduction factor k will be

(1) k (2) $2k$ (3) $4k$ (4) $\frac{k}{4}$

Sol. Answer (1)

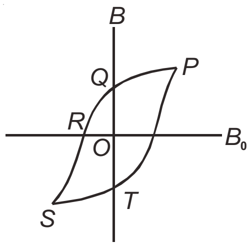
35. Two tangent galvanometer A and B are identical except in their number of turns. They are connected in series on passing a current through them, defections of 60° and 30° are produced. The ratio of number of turns in A and B is

(1) 1 : 3 (2) 3 : 1 (3) 1 : 2 (4) 2 : 1

Sol. Answer (2)

(Magnetisation and magnetic Intensity, Magnetic properties of Materials)

36. The figure illustrates how B, the flux density, inside a sample of ferromagnetic material varies with external magnetic field B_0. For the sample to be suitable for making a permanent magnet



(1) OQ should be large, OR should be small (2) OQ and OR both should be large

(3) OQ should be small and OR should be large (4) OQ and OR both should be small

Sol. Answer (2)

37. Soft iron is used in many parts of electrical machines for

(1) Low hysteresis loss and low permeability (2) Low hysteresis loss and high permeability

(3) High hysteresis loss and low permeability (4) High hysteresis loss and high permeability

Sol. Answer (2)

38. Magnetic susceptibility for a diamagnetic substance is

(1) Large and positive (2) Large and negative (3) Small and positive (4) Small and negative

Sol. Answer (4)

39. Area of B-H curve measures the energy loss

(1) By the specimen (2) Per unit volume of the specimen

(3) Per unit volume per cycle of the specimen (4) Per cycle of the specimen

Sol. Answer (3)

40. The unit of magnetic susceptibility is

(1) weber (2) weber per metre (3) henry (4) Dimensionless

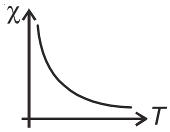
Sol. Answer (4)

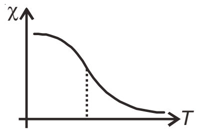
41. One weber is equal to

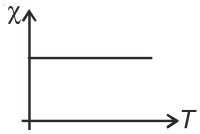
(1) 10^2 maxwell (2) 10^4 maxwell (3) 10^6 maxwell (4) 10^8 maxwell

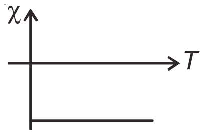
Sol. Answer (4)

42. The variation of magnetic susceptibility (χ) with absolute temperature (T) for a ferromagnetic material is

(1) 

(2) 

(3) 

(4) 

Sol. Answer (2)

SECTION - B

Previous Years Questions

1. At a point A on the earth's surface the angle of dip, $\delta = +25°$. At a point B on the earth's surface the angle of dip, $\delta = –25°$. We can interpret that: **[NEET-2019]**

(1) A and B are both located in the northern hemisphere.

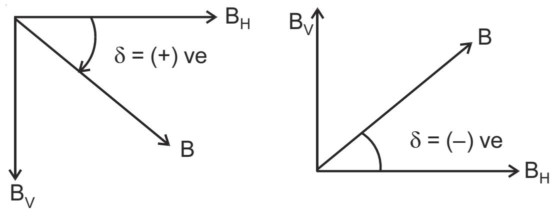
(2) A is located in the southern hemisphere and B is located in the northern hemisphere.

(3) A is located in the northern hemisphere and B is located in the southern hemisphere.

(4) A and B are both located in the southern hemisphere.

Sol. Answer (3)

Angle of dip is the angle between earth's resultant magnetic field from horizontal. Dip is zero at equator and positive in northern hemisphere.



In southern hemisphere dip angle is considered as negative.

2. A 250-Turn rectangular coil of length 2.1 cm and width 1.25 cm carries a current of 85 μA and subjected to a magnetic field of strength 0.85 T. Work done for rotating the coil by 180° against the torque is **[NEET-2017]**

(1) 9.1 μJ (2) 4.55 μJ (3) 2.3 μJ (4) 1.15 μJ

Sol. Answer (1)

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

When it is rotated by angle 180º then

$W = 2MB$

$W = 2(NIA)B$

$= 2 \times 250 \times 85 \times 10^{-6}[1.25 \times 2.1 \times 10^{-4}] \times 85 \times 10^{-2}$

$= 9.1\ \mu J$

$_2$ be the apparent angles of dip observed in two vertical planes at right angles to each other, then the true angle of dip θ is given by **[NEET-2017]**

(1) $\cot^2\theta = \cot^2\theta_1 + \cot^2\theta_2$

(2) $\tan^2\theta = \tan^2\theta_1 + \tan^2\theta_2$

(3) $\cot^2\theta = \cot^2\theta_1 - \cot^2\theta_2$

(4) $\tan^2\theta = \tan^2\theta_1 - \tan^2\theta_2$

Sol. Answer (1)

$\cot^2\theta = \cot^2\theta_1 + \cot^2\theta_2$

4. A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60° is W. Now the torque required to keep the magnet in this new position is

[NEET-(Phase-2)-2016]

(1) $\dfrac{W}{\sqrt{3}}$

(2) $\sqrt{3}W$

(3) $\dfrac{\sqrt{3}W}{2}$

(4) $\dfrac{2W}{\sqrt{3}}$

Sol. Answer (2)

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

$W = PE(\cos 0 - \cos 60°)$

$= \dfrac{PE}{2}$

$\Rightarrow\ PE = 2W$

$\tau = PE\sin\theta$

$= 2W\sin 60°$

$= \sqrt{3}W$

5. The magnetic susceptibility is negative for **[NEET-2016]**

(1) Paramagnetic and ferromagnetic materials

(2) Diamagnetic material only

(3) Paramagnetic material only

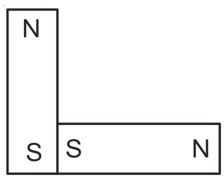
(4) Ferromagnetic material only

Sol. Answer (2)

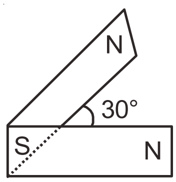
Susceptibility of diamagnetic substance is negative.

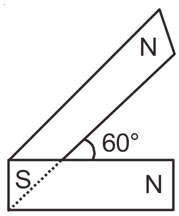
Susceptibility of para and ferromagnetic substance is positive.

6. Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnetic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment ? **[AIPMT-2014]**

a.


b.


c.


d.


(1) (a)

(2) (b)

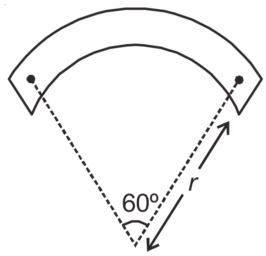
(3) (c)

(4) (d)

Sol. Answer (3)

Resultant dipole moment = $\sqrt{M^2 + M^2 + 2M^2\cos\theta}$

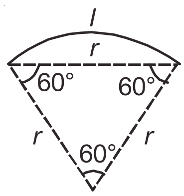
7. A bar magnet of length l and magnetic dipole moment M is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be **[NEET-2013]**



(1) $\frac{3}{\pi}M$ (2) $\frac{2}{\pi}M$ (3) $\frac{M}{2}$ (4) M

Sol. Answer (1)

$\frac{\pi}{3} = \frac{l}{r}$



$l = \frac{r\pi}{3}$

or $r = \frac{3l}{\pi}$

$M = ml$

$M' = mr$

$= M\left(\frac{3l}{\pi}\right) = \frac{3M}{\pi}$

8. A compass needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It

[AIPMT (Prelims)-2012)

(1) Will stay in north-south direction only
(2) Will stay in east-west direction only
(3) Will become rigid showing no movement
(4) Will stary in any position

Sol. Answer (4)

Because here earth's magnetic field has vertical component only.

9. A magnetic needle suspended parallel to a magnetic field requires $\sqrt{3}$ J of work to turn it through 60°. The torque needed to maintain the needle in this position will be **[AIPMT (Mains)-2012]**

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

Sol. Answer (2)

$W = \frac{MB}{2}$

$\sqrt{3} = \frac{MB}{2} \Rightarrow MB = 2\sqrt{3}$

$$\tau = MB\sin 60^\circ$$

$$\tau = MB\frac{\sqrt{3}}{2}$$

$$\tau = 2\sqrt{3}\,\frac{\sqrt{3}}{2} = 3\text{ J}$$

10. There are four light-weight-rod samples, *A, B, C, D* separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted

    i) *A* is feebly repelled ii) *B* is feebly attracted

    iii) *C* is strongly attracted iv) *D* remains unaffected

    Which one of the following is true? **[AIPMT (Prelims)-2011]**

    (1) *A* is of a non-magnetic material

    (2) *B* is of a paramagnetic material

    (3) *C* is of a diamagnetic material

    (4) *D* is of a ferromagnetic material

Sol. Answer (2)

11. A short bar magnet of magnetic moment 0.4 J T^{-1} is placed in a uniform magnetic field of 0.16 T. The magnet is in stable equilibrium when the potential energy is **[AIPMT (Mains)-2011]**

    (1) – 0.082 J (2) 0.064 J (3) – 0.064 J (4) Zero

Sol. Answer (3)

$$U = -\vec{M}.\vec{B}$$

$$= -(0.4)(0.16)$$

$$= -0.064\text{ J}$$

12. Electromagnets are made of soft iron because soft iron has **[AIPMT (Prelims)-2010]**

    (1) High retentivity and low coercive force

    (2) Low retentivity and high coercive force

    (3) High retentivity and high coercive force

    (4) Low retentivity and low coercive force

Sol. Answer (4)

13. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 s in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be: **[AIPMT (Prelims)-2010]**

    (1) 4 s (2) 1 s (3) 2 s (4) 3 s

Sol. Answer (1)

$$\frac{T_2}{T_2} = \sqrt{\frac{B_1}{B_2}} \qquad \text{or, } \frac{T_2}{2} = \sqrt{\frac{24}{(24-18)}} \qquad \text{or, } T_2 = 4\text{ s}$$

14. A closely wound solenoid of 2000 turns and area of cross-section 1.5×10^{-4} m^2 carries a current of 2.0 A. It is suspended through its centre and perpendicular to its length, allowing it to turn in a horizontal plane in a uniform magnetic field 5×10^{-2} T making an angle of 30° with the axis of the solenoid. The torque on the solenoid will be **[AIPMT (Mains)-2010]**

(1) 3×10^{-3} N m (2) 1.5×10^{-3} N m (3) 1.5×10^{-2} N m (4) 3×10^{-2} N m

Sol. Answer (3)

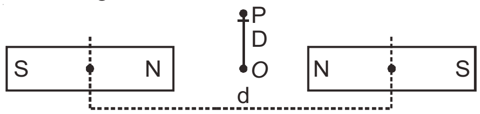
15. The magnetic moment of a diamagnetic atom is **[AIPMT (Mains)-2010]**

(1) Much greater than one (2) 1

(3) Between zero and one (4) Equal to zero

Sol. Answer (4)

16. Two identical bar magnets are fixed with their centres at a distance *d* apart. A stationary charge *Q* is placed at *P* in between the gap of the two magnets at a distance *D* from the centre *O* as shown in the figure



The force on the charge *Q* is **[AIPMT (Mains)-2010]**

(1) Zero (2) Directed along *OP*

(3) Directed along *PO* (4) Directed perpendicular to the plane of paper

Sol. Answer (1)

If charge is stationary then

Using $F_m = q(\vec{v} \times \vec{B})$

as $v = 0$, $F_m = 0$

17. A thin ring of radius *R* meter has charge *q* coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of *f* revolutions/s. The value of magnetic induction in Wb/m^2 at the centre of the ring is **[AIPMT (Prelims)-2010]**

(1) $\frac{\mu_0 qf}{2\pi R}$ (2) $\frac{\mu_0 q}{2\pi fR}$ (3) $\frac{\mu_0 q}{2fR}$ (4) $\frac{\mu_0 qf}{2R}$

Sol. Answer (4)

18. A bar magnet having a magnetic moment of 2×10^4 J T^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is **[AIPMT (Prelims)-2009]**

(1) 12 J (2) 6 J (3) 2 J (4) 0.6 J

Sol. Answer (2)

19. If a diamagnetic substance is brought near the north or the south pole of a bar magnet, it is **[AIPMT (Prelims)-2009]**

(1) Repelled by the north pole and attracted by the south pole

(2) Attracted by the north pole and repelled by the south pole

(3) Attracted by both the poles

(4) Repelled by both the poles

Sol. Answer (4)

20. Curie temperature is the temperature above which **[AIPMT (Prelims)-2008]**

(1) Ferromagnetic material becomes diamagnetic material

(2) Ferromagnetic material becomes paramagnetic material

(3) Paramagnetic material becomes diamagnetic material

(4) Paramagnetic material becomes ferromagnetic material

Sol. Answer (2)

21. Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show **[AIPMT (Prelims)-2007]**

(1) Diamagnetism (2) Paramagnetism (3) Anti ferromagnetism (4) No magnetic property

Sol. Answer (2)

22. Above Curie temperature **[AIPMT (Prelims)-2006]**

(1) A ferromagnetic substance becomes paramagnetic

(2) A paramagnetic substance becomes diamagnetic

(3) A diamagnetic substance becomes paramagnetic

(4) A paramagnetic substance becomes ferromagnetic

Sol. Answer (1)

23. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material are denoted by μ_d, μ_p and μ_f respectively, then **[AIPMT (Prelims)-2005]**

(1) $\mu_d \neq 0$ and $\mu_f \neq 0$ (2) $\mu_p = 0$ and $\mu_f \neq 0$ (3) $\mu_d = 0$ and $\mu_p \neq 0$ (4) $\mu_d \neq 0$ and $\mu_p = 0$

Sol. Answer (3)

24. A bar magnet having a magnetic moment of 2×10^4 J T^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is

(1) 2 J (2) 0.6 J (3) 12 J (4) 6 J

Sol. Answer (4)

$$W = \frac{MB}{2} = \frac{2\times10^4 \times 6\times10^{-4}}{2} = 6 \text{ J}$$

25. A bar magnet of magnetic moment $\vec{M}$, is placed in a magnetic field of induction $\vec{B}$, The torque exerted on it is

(1) $\vec{M}\times\vec{B}$ (2) $-\vec{M}\cdot\vec{B}$ (3) $\vec{M}\cdot\vec{B}$ (4) $\vec{B}\times\vec{M}$

Sol. Answer (1)

$$\tau = \vec{M}\times\vec{B}$$

26. Tangent galvanometer is used to measure

(1) Potential difference (2) Current (3) Resistance (4) Charge

Sol. Answer (2)

27. The work done in turning a magnet of magnetic moment M by an angle of 90° from the magnetic meridian is n times the corresponding work done to turn it through an angle of 60°. The value of n is

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

Sol. Answer (1)

$$W_{0\to 90} = nW_{0\to 60}$$

$$MB = \frac{nMB}{2}$$

$n = 2$

28. Due to earth's magnetic field, the charged cosmic rays particles

(1) Can never reach the pole

(2) Can never reach the equator

(3) Require greater kinetic energy to reach the equator than pole

(4) Require less kinetic energy to reach the equator than pole

Sol. Answer (2)

They will move in helical path while trapped in earth's magnetic field and will eventually move towards poles.

29. For protecting a sensitive equipment from the external magnetic field, it should be

(1) Surrounded with fine copper sheet

(2) Placed inside an iron can

(3) Wrapped with insulation around it when passing current through it

(4) Placed inside an aluminium can

Sol. Answer (2)

Because stationary magnetic field is zero inside soft ring.

30. Two bar magnets having same geometry with magnetic moments M and $2M$, are firstly placed in such a way that their similar poles are same side then its time period of oscillation is T_1. Now the polarity of one of the magnet is reversed then time period of oscillation is T_2, then

(1) $T_1 < T_2$ (2) $T_1 = T_2$

(3) $T_1 > T_2$ (4) $T_2 = \infty$

Sol. Answer (1)

$$T_1 = 2\pi\sqrt{\frac{I}{3MB}}$$

$$T_2 = 2\pi\sqrt{\frac{I}{MB}}$$

$$\frac{T_1}{T_2} = \frac{1}{\sqrt{3}} \Rightarrow T_2 = T_1\sqrt{3} \Rightarrow T_2 > T_1$$

31. According to Curie's law, the magnetic susceptibility of a substance at an absolute temperature T is proportional to

(1) $\frac{1}{T}$ (2) T (3) $\frac{1}{T^2}$ (4) T^2

Sol. Answer (1)

$$\chi_m \propto \frac{1}{T}$$

32. A diamagnetic material in a magnetic field moves

(1) From stronger to the weaker parts of the field

(2) From weaker to the stronger parts of the field

(3) Perpendicular to the field

(4) In none of the above directions

Sol. Answer (1)

33. A current loop in a magnetic field

(1) Can be in equilibrium in one orientation

(2) Can be in equilibrium in two orientations, both the equilibrium states are unstable

(3) Can be in equilibrium in two orientations, one stable while the other is unstable

(4) Experience a torque whether the field is uniform or non-uniform in all orientations

Sol. Answer (3)

34. An iron nail near a bar magnet experiences

(1) Only torque (2) Torque and force of attraction

(3) Only force (4) Torque and force of repulsion

Sol. Answer (2)

Field is non-uniform.

SECTION - C

Assertion-Reason Type Questions

1. A : If a bar magnet is cut into two equal halves then magnetic dipole moment of each part is half that of the original magnet.

R : Magnetic dipole moment is the product of pole strength and magnetic length.

Sol. Answer (1)

2. A : A magnetized needle in a uniform magnetic field experiences a torque but no net force, however, an iron nail near a bar magnet experiences a force of attraction as well as torque.

R : Bar magnet creates non-uniform magnetic field.

Sol. Answer (1)

3. A : Every magnetic configuration need not have a north pole and south pole.

R : North pole, south pole exists only if the source of the field has net magnetic dipole moment.

Sol. Answer (1)

4. A : If different ends of two identical looking iron bars are brought closer and they always attract each other then one of the bars is not magnetized.

R : Repulsion is the sure check of presence of magnetization of both the bars.

Sol. Answer (1)

5. A : The magnetic field lines also represent the lines of force on a moving charged particle at every point.

R : Force on a moving charge acts parallel to the magnetic field.

Sol. Answer (4)

6. A : Magnetic field lines can be entirely confined within the core of a toroid.

R : Magnetic field lines cannot be entirely confined within the core of a straight solenoid.

Sol. Answer (2)

7. A : A bar magnet does not exert a torque on itself due to its own field.

R : One element of a current-carrying non-straight wire exert a force on another element of the same wire.

Sol. Answer (2)

8. A : A system can have magnetic moments even though its net charge is zero.

R : Magnetic moment is created by charges in motion.

Sol. Answer (1)

9. A : The earth's magnetic field not only varies from point to point in space, it also changes with time.

R : The earth's core is known to contain iron yet geologists do not regard this as a source of the earth's magnetism.

Sol. Answer (2)

10. A : The earth may have been reversed the direction of its field several times during its history of 4 to 5 billion years.

R : Earth's magnetic field gets weakly 'recorded' in certain rocks during solidification.

Sol. Answer (1)

11. A : The earth's field departs from its dipole shape substantially at large distances (greater than about 30,000 km).

R : At large distances, the field gets modified due to the field of ions in motion in the ionosphere which is sensitive to extra-terrestrial disturbances such as, the solar wind.

Sol. Answer (1)

12. A : Paramagnetic sample displays greater magnetisation (for the same magnetizing field) when cooled.

R : The tendency to disrupt the alignment of dipoles (with the magnetising field) arising from random thermal motion is reduced at lower temperatures.

Sol. Answer (1)

13. A : Diamagnetism is almost independent of temperature.

R : The induced dipole moment in a diamagnetic sample is always opposite to the magnetising field irrespective of what the internal motion of the atom is.

Sol. Answer (1)

14. A : If a toroid uses bismuth for its core, then the field in the core will be slightly less than when the core is empty.

R : Bismuth is paramagnetic.

Sol. Answer (3)

15. A : Permeability of a ferromagnetic material is independent of the magnetising field.

R : Permeability is given by the area under a hysteresis loop.

Sol. Answer (4)

16. A : The maximum possible magnetization of a paramagnetic sample is of the same order of magnitude as the magnetization of a ferromagnet.

R : Saturation of paramagnetic substances requires impractically high magnetising fields.

Sol. Answer (1)

17. A : A system displaying a hysteresis loop such as a ferromagnet, is a device for storing memory.

R : Magnetisation of a ferromagnet is not a single valued function of the magnetising field rather it depends both on the field and also on history of magnetization.

Sol. Answer (1)

18. A : Ceramics (specially treated barium iron oxides) also called **ferrites** are used for coating magnetic tapes in a cassette player, or for building 'memory stores' in a modern computer.

R : A certain region of space surrounded by soft iron rings is approximately shielded from magnetic fields.

Sol. Answer (2)

19. A : Magnetic field lines are continuous and form closed loops.

R : Magnetic monopoles do not exist.

Sol. Answer (1)

20. A : Superconductors are perfect diamagnetic.

R : Superconductors are perfect conductors.

Sol. Answer (2)

21. A : Superconducting magnets are gainfully exploited in running magnetically levitated superfast trains.

R : Superconductors are diamagnetic substances which get repelled by strong external magnetic field.

Sol. Answer (1)

22. A : Diamagnetism is exhibited by all the substances.

R : Diamagnetism is due to paired electrons.

Sol. Answer (1)

23. A : Above curie-point a ferromagnetic substance behaves as a paramagnetic substance.

R : Magnetic susceptibility of a diamagnetic substance increases with rise in temperature.

Sol. Answer (3)

24. A : Earth's magnetism protects us from many of the harmful cosmic rays.

R : Earth's magnetism is due to a large permanent magnet inside earth.

Sol. Answer (3)

25. A : In a diamagnetic substance each atom has a non-zero dipole moment but due to thermal agitation the individual dipoles remain randomly oriented and, therefore, the net dipole moment in any finite volume of the substance remains zero.

R : On increasing the temperature the magnetism inside a permanent magnet increases.

Sol. Answer (4)

26. A : The magnetic field lines have a tendency to avoid entering the body of a frog.

R : The body of a frog is diamagnetic in nature.

Sol. Answer (1)

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