DCAM classes
Dynamic Classes for Academic Mastery

magnetism and matter very important questions

2 Marks Question

1. A small compass needle of magnetic moment M and moment of inertia I is free to oscillate in a magnetic field B. It is slightly disturbed from its equilibrium position and then released. Show that it executes simple harmonic motion. Hence, write the expression for its time period.

3 Marks Questions

2. Prove that the magnetic moment of the electron revolving around a nucleus in an orbit of radius r with orbital speed v is equal to $evr/2$. Hence using Bohr's postulate of quantisation of angular momentum, deduce the expression for the magnetic moment of hydrogen atom in the ground state.

3. (a) State Gauss's law for magnetism. Explain its significance.
   (b) Write the four important properties of the magnetic field lines due to a bar magnet.

4. A bar magnet of magnetic moment 6 J/T is aligned at 60° with a uniform external magnetic field of 0.44 T. Calculate (a) the work done in turning the magnet to align its magnetic moment (i) normal to the magnetic field, (ii) opposite to the magnetic field and (b) the torque on the magnet in the final orientation in case (ii).

1 Mark Questions

1. The magnetic susceptibility of magnesium at 300K is 1.2×10^{-5}. At what temperature will its magnetic susceptibility become 1.44×10^{-5}?
2. The magnetic susceptibility of χ of a given material is -0.5. Identify the magnetic material.
3. At a place, the horizontal component of earth's magnetic field is **B** and angle of dip is 60°. What is the value of horizontal component of the earth's magnetic field at equator?
4. In what way is the behaviour of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?
5. Relative permeability of a material $\mu_r = 0.5$. Identify the nature of the magnetic material and write its relation of magnetic susceptibility.
6. What are permanent magnets? Give one example.
7. Where on the surface of earth is the vertical component of earth's magnetic field zero?
8. The horizontal component of the earth's magnetic field at a place is B and angle of dip is 60°. What is the value of vertical component of the earth's magnetic field?

9. What is the angle of dip at a place where the horizontal and vertical components of the earth's magnetic field are equal?

10. A magnetic needle free to rotate in a vertical plane orients itself vertically at a certain place on the earth. What are the values of
    (i) horizontal component of the earth's magnetic field and
    (ii) angle of dip at this place?

11. Where on the surface of earth is the angle of dip 90°?

12. The permeability of a magnetic material is 0.9983. Name the type of magnetic material, it represents.

13. The susceptibility of a magnetic material is 1.9×10^{-5}. Name the type of magnetic material, it represents.

14. The susceptibility of a magnetic material is -4.2×10^{-6}. Name the type of magnetic material, it represents.

15. What is the characteristic property of a diamagnetic material?

2 Marks Questions

16. (i) Define the term magnetic susceptibility and write its relation in terms of relative magnetic permeability.
    (ii) Two magnetic materials A and B have relative magnetic permeabilities of 0.96 and 500. Identify the magnetic materials A and B.

17. Show diagrammatically the behaviour of magnetic field lines in the presence of
    (i) paramagnetic and
    (ii) diamagnetic substances.
    How does one explain this distinguishing feature?

18. Out of the two magnetic materials, A has relative permeability slightly greater than unity while B has less than unity. Identify the nature of the materials A and B. Will their susceptibilities be positive or negative?

19. Give two points to distinguish between a paramagnetic and diamagnetic substance.

20. (i) How is an electromagnet different from a permanent magnet?
    (ii) Write two properties of a material which makes it suitable for making electromagnet.

21. The relative magnetic permeability of a magnetic material is 800. Identify the nature of magnetic material and state its two properties.

22. (i) How does a diamagnetic material behave when it is cooled at very low temperature?
    (ii) Why does a paramagnetic sample display greater magnetisation when cooled? Explain

23. Explain the following.
    (i) Why do magnetic lines of force form continuous closed loops?
    (ii) Why are the field lines repelled (expelled) when a diamagnetic material is placed in an external uniform magnetic field?

24. A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its North tip down at 60° with the horizontal. The horizontal component of the earth's magnetic field at the place is known to be 0.4 G. Determine the magnitude of the earth's magnetic field at the place.

25. (i) Name the three elements of the Earth's magnetic field.
    (ii) Where on the surface of the Earth is the vertical component of the Earth's magnetic field zero?

26. Distinguish between diamagnetic and ferromagnetic materials in terms of
    (i) susceptibility and
    (ii) their behaviour in a non-uniform magnetic field

27. (i) Write two characteristics of a material used for making permanent magnets?

(ii) Why is core of an electromagnet made of ferromagnetic materials?

28. The horizontal component of the earth's magnetic field at a place is $\sqrt{3}$ times its vertical component there. Find the value of the angle of dip at that place. What is the ratio of the horizontal component to the total magnetic field of the earth at that place?

29. The horizontal component of the earth's magnetic field at a place equals to its vertical component there. Find the value of the angle of dip at that place.

What is the ratio of the horizontal component to the total magnetic field of the earth at that place?

30. Draw magnetic field lines when a (i) diamagnetic, (ii) paramagnetic substance is placed in an external magnetic field. Which magnetic property distinguishes this behaviour of the field lines due to the two substances?

3 Marks Questions

31. Write three points of differences between para-, dia- and ferro- magnetic materials, giving one example for each.

32. The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field.

33. A wheel with 8 metallic spokes each 50 cm long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of the earth's magnetic field. The earth's magnetic field at the place is 0.4 G and the angle of dip is 60°. Calculate the emf induced between the axle and the rim of wheel. How will the value of emf be affected, if the number of spokes were increased?

34. Three identical specimens of a magnetic materials nickel, antimony and aluminium are kept in a non-uniform magnetic field. Draw the modification in the field lines in each case. Justify your answer.

5 Marks Question

35. (i) A small compass needle of magnetic moment M is free to turn about an axis perpendicular to the direction of uniform magnetic field B. The moment of inertia of the needle about the axis is I. The needle is slightly disturbed from its stable position and then released. Prove that it executes simple harmonic motion. Hence, deduce the expression for its time period.

(ii) A compass needle free to turn in a vertical plane orients itself with its axis vertical at a certain place on the earth. Find out the values of

(a) horizontal component of the earth's magnetic field and

(b) angle of dip at the place.

Objective Questions

(For Complete Chapter)

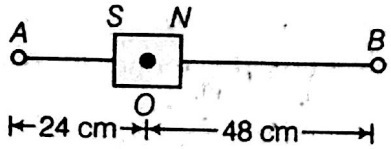
1 Mark Questions

1. A magnetic wire of dipole moment 4π Am^2 is bent in the form of semicircle. The new magnetic moment is

(a) 4π Am^2 (b) 8π Am^2

(c) 4 Am^2 (d) None of these

2. A bar magnet of length 3 cm has points A and B along its axis at distances of 24 cm and 48 cm on the opposite sides. Ratio of magnetic fields at these points will be



(a) 8 (b) $1/2\sqrt{2}$ (c) 3 (d) 4

3. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.16 T experiences a torque of magnitude 0.032 J. The magnetic moment of the bar magnet will be

(a) 0.23 JT^{-1} (b) 0.40 JT^{-1}

(c) 0.80 JT^{-1} (d) zero

4. A bar magnet is placed in the position of stable equilibrium in a uniform magnetic field of induction B. If it is rotated through an angle 180°, then the work is (M = magnetic dipole moment of bar magnet)

(a) MB (b) $2MB$ (c) $\frac{MB}{2}$ (d) zero

5. A long magnet is cut into two equal parts such that the length of each half is same as that of original magnet. If the period of original magnet is T, then the period of new magnet is

(a) T (b) $\frac{T}{2}$ (c) $\frac{T}{4}$ (d) $2T$

6. At the magnetic pole of earth, the value of angle of dip is

(a) 0° (b) 30° (c) 45° (d) 90°

7. At a given place on the earth, the angle between the magnetic meridian and the geographic meridian is called

(a) magnetic longitude

(b) magnetic declination

(c) magnetic latitude

(d) magnetic dip

8. The angle of dip at a place on the earth gives

(a) the horizontal component of the earth's magnetic field

(b) the location of geographic meridian

(c) the vertical component of the earth's field

(d) the direction of the earth's magnetic field

9. The intensity of magnetisation of a bar magnet is 5.0×10^4 Am^{-1}. The magnetic length and the area of cross-section of the magnet are 12 cm and 1 cm^2, respectively. The magnitude of magnetic moment of this bar magnet (in SI unit) is

(a) 0.6 (b) 1.3 (c) 1.24 (d) 2.4

10. Relative permeability of iron is 5500, then its magnetic susceptibility will be

(a) 5500×10^7 (b) 5500×10^{-7}

(c) 5501 (d) 5499

11. Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show

(a) paramagnetism

(b) anti-ferromagnetism

(c) no magnetic property

(d) diamagnetism

12. Ferromagnetic materials used in a transformer must have
(a) low permeability and high hysteresis loss
(b) high permeability and low hysteresis loss
(c) high permeability and high hysteresis loss
(d) low permeability and low hysteresis loss

13. Permanent magnet has properties retentivity and coercivity respectively
(a) high-high (b) low-low
(c) low-high (d) high-low

Explanations

1. *(d)* If length of wire is $2l$, then magnetic moment
$$M = m \times 2l = 4\pi \text{ A-m}^2 \quad \text{(given)}$$
As wire is bent in the form of semicircle effective distance between the ends is $2r$.
So, new dipole moment $M' = m \times 2r$
As $\pi r = 2l, r = \frac{2l}{\pi}$
So, $M' = m \times 2 \times \frac{2l}{\pi} = \frac{2}{\pi}(m \times 2l)$
$$= \frac{2}{\pi} M = \frac{2}{\pi} 4\pi = 8 \text{ Am}^2$$

2. *(a)* Magnetic field due to a bar magnet at a distance r from the centre of magnet on axial position,
$$B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{r^3}$$
$$\Rightarrow \quad \frac{B_1}{B_2} = \left(\frac{r_2}{r_1}\right)^3 = \left(\frac{48}{24}\right)^3 = 8$$

3. *(b)* Magnetic moment,
$$M = \frac{\tau}{B\sin\theta} = \frac{0.032}{0.16 \times \sin 30^\circ} = 0.40 \text{ JT}^{-1}$$

4. *(b)* We know that, $W = MB(\cos\theta_1 - \cos\theta_2)$
As $\theta_1 = 0^\circ$ and $\theta_2 = 180^\circ$
Then, $W = MB(\cos 0^\circ - \cos 180^\circ) = 2MB$

5. *(a)* Time period $T = 2\pi\sqrt{\frac{I}{MB}}$
As the magnet is cut into two equal parts along axis, then for each part $I' = \frac{I}{2}$, $M' = \frac{M}{2}$
$\therefore$ Time period of new magnet,
$$T' = \sqrt{\frac{I'}{M'B}} = \sqrt{\frac{I \times 2}{2 \times M \times B}} \Rightarrow T' = T$$

6. *(d)* At earth's magnetic poles, the angle of dip is 90°.

7. *(b)* The angle between the magnetic meridian and the geographic meridian is called magnetic declination.

8. *(d)* The angle of dip at a place on the earth gives the direction of the earth's magnetic field.

9. *(a)* We know that
Intensity of magnetisation $I = \frac{M}{V}$
where, M = magnetic moment and V = volume.
So, $M = IV$
$$= 5.0 \times 10^4 \times \frac{12}{100} \times \frac{1}{(100)^2}$$
$$= 60 \times 10^4 \times 10^{-6} = 0.6 \text{ Am}^2$$

10. *(d)* As we know that, $\mu_r = 1 + \chi_m$
$$\Rightarrow \quad 5500 = 1 + \chi_m$$
$$\Rightarrow \quad \chi_m = 5500 - 1 = 5499$$

11. *(a)* Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show a paramagnetism.

12. *(b)* Ferromagnetic materials used for transformers must have high permeability and low hysteresis loss.

13. *(a)* The materials for a permanent magnet should have high retentivity (so that the magnet is strong) and high coercivity (so that the magnetism is not wiped out by stray magnetic fields). As the material in this case is never put to cyclic changes of magnetisation, hence hysteresis is immaterial.