

Magnetism and Matter — CBSE Pattern Test 1

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Magnetism and Matter · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.
 (2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.
 (3) For MCQ questions choose the single correct option; for VSA answers write a single line.
 (4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

1. The magnetic moment of a bar magnet of pole strength m and magnetic length $2l$ is
 - (A) $m \times 2l$
 - (B) $m + 2l$
 - (C) $m/2l$
 - (D) $2l/m$
2. The magnetic field on the equatorial line of a short bar magnet at distance r is
 - (A) $\mu_0 M / 4\pi r^3$
 - (B) $\mu_0 2M / 4\pi r^3$
 - (C) $\mu_0 M / 4\pi r^2$
 - (D) $\mu_0 2M / 4\pi r^2$
3. The torque on a magnetic dipole in a uniform magnetic field B is
 - (A) $M \times B$
 - (B) $M \cdot B$
 - (C) B/M
 - (D) MB^2
4. A magnetic dipole is in stable equilibrium when
 - (A) M is parallel to B
 - (B) M is perpendicular to B
 - (C) M is antiparallel to B
 - (D) M is at 45° to B
5. The angle between the magnetic meridian and the geographic meridian is called the
 - (A) angle of declination
 - (B) angle of dip
 - (C) magnetic moment
 - (D) magnetic susceptibility
6. A material with a small positive susceptibility is
 - (A) paramagnetic
 - (B) diamagnetic
 - (C) ferromagnetic
 - (D) non-magnetic
7. The area of a hysteresis loop measures the
 - (A) energy loss per unit volume per cycle

- (B) magnetic moment
 - (C) susceptibility
 - (D) permeability
8. For a permanent magnet, the material should have
- (A) a wide hysteresis loop and high retentivity
 - (B) a narrow hysteresis loop
 - (C) low coercivity
 - (D) zero retentivity
9. Define magnetic dipole moment.
10. Define angle of dip.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. A bar magnet of moment $2 \text{ A}\cdot\text{m}^2$ is placed at 30° to a field of 0.5 T . Find the torque on it.
12. At a place $B_H = 0.4 \text{ G}$ and the angle of dip is 30° . Find the total field.
13. Define magnetic susceptibility and give its sign for a diamagnetic material.
14. Compare the axial and equatorial magnetic fields of a short bar magnet at the same distance.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Derive the expression for the magnetic field on the axial line of a bar magnet.
16. Derive the expression for the torque on a magnetic dipole in a uniform magnetic field.
17. Define the elements of the earth's magnetism and derive $\tan \delta = B_V/B_H$.
18. Explain hysteresis with the help of a B-H curve and define retentivity and coercivity.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Derive the expressions for the magnetic field on the axial and equatorial lines of a short bar magnet, and hence derive the torque on a magnetic dipole placed in a uniform magnetic field.
20. Classify magnetic materials as diamagnetic, paramagnetic and ferromagnetic on the basis of susceptibility and permeability, giving examples, and state the material best suited for a transformer core and for a permanent magnet with reasons.

Answer Key (Marking Scheme)

- Q1 — (A) $m \times 2l$. Q2 — (A) $\mu_0 M / 4\pi r^3$. Q3 — (A) $M \times B$. Q4 — (A) M is parallel to B .
- Q5 — (A) angle of declination. Q6 — (A) paramagnetic. Q7 — (A) energy loss per unit volume per cycle. Q8 — (A) a wide hysteresis loop and high retentivity.
- Q9 — $M = m \times 2l$, a vector along the magnet from S to N pole; SI unit $\text{A}\cdot\text{m}^2$.
- Q10 — The angle between the earth's total field and the horizontal.
- Q11 — $\tau = MB \sin\theta = 2 \times 0.5 \times \sin 30^\circ = 0.5 \text{ N}\cdot\text{m}$.
- Q12 — $B = B_H / \cos\delta = 0.4 / \cos 30^\circ \approx 0.46 \text{ G}$.
- Q13 — $\chi = M/H$; for a diamagnetic material χ is small and negative.
- Q14 — Axial field is twice the equatorial field at the same distance.
- Q15 — Resolve the fields of the two poles along the axis; for a short magnet the result is $B = \mu_0 2M / 4\pi r^3$.

Q16 — The two poles experience equal and opposite forces; the couple gives $\tau = MB \sin\theta = M \times B$.

Q17 — $B_H = B \cos\delta$, $B_V = B \sin\delta$; dividing gives $\tan\delta = B_V/B_H$.

Q18 — The B-H curve lags the field; the loop area is the loss per unit volume per cycle; retentivity is the remnant B at $H = 0$ and coercivity is the reverse field needed to demagnetise.

Q19 — Axial: $B = \mu_0 2M/4\pi r^3$ (along M); equatorial: $B = \mu_0 M/4\pi r^3$ (opposite M); torque $\tau = MB \sin\theta$.

Q20 — Diamagnetic: χ small negative, $\mu_r < 1$; paramagnetic: χ small positive, $\mu_r > 1$; ferromagnetic: χ large positive, $\mu_r \gg 1$. Transformer core: soft iron (narrow loop, low loss); permanent magnet: steel/alnico (wide loop, high retentivity and coercivity).