

Magnetism and Matter — CBSE Pattern Test 2

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

Test 2 — 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)

- The SI unit of magnetic moment is
 - $\text{A}\cdot\text{m}^2$
 - A/m
 - $\text{A}\cdot\text{m}$
 - $\text{T}\cdot\text{m}^2$
- The potential energy of a magnetic dipole in a magnetic field is
 - $-\mathbf{M}\cdot\mathbf{B}$
 - $+\mathbf{M}\cdot\mathbf{B}$
 - $\mathbf{M} \times \mathbf{B}$
 - $\mathbf{M}\mathbf{B}^2$
- The angle between the earth's total magnetic field and the horizontal is called the
 - angle of dip (inclination)
 - angle of declination
 - magnetic latitude
 - magnetic azimuth
- At the magnetic poles, the angle of dip is
 - 90°
 - 0°
 - 45°
 - 60°
- Diamagnetic materials have a
 - small negative susceptibility
 - large positive susceptibility
 - zero susceptibility
 - large negative susceptibility
- Soft iron has a
 - narrow hysteresis loop
 - wide hysteresis loop
 - zero loop area
 - square loop
- The torque on a magnetic dipole is maximum when the dipole is
 - perpendicular to $\mathbf{B}$

- (B) parallel to B
 - (C) antiparallel to B
 - (D) at 45° to B
8. The relative permeability of a diamagnetic material is
- (A) slightly less than 1
 - (B) much greater than 1
 - (C) exactly 1
 - (D) slightly more than 1
9. Define magnetic susceptibility.
10. What does the area of a hysteresis loop represent?

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

11. Compare the axial and equatorial magnetic fields of a short bar magnet at the same distance.
12. A bar magnet of moment $3 \text{ A}\cdot\text{m}^2$ is placed perpendicular to a field of 0.2 T . Find the torque on it.
13. Give one example each of a diamagnetic, a paramagnetic and a ferromagnetic material.
14. Define hysteresis.

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

15. Derive the expression for the magnetic field on the equatorial line of a bar magnet.
16. Derive the expression for the potential energy of a magnetic dipole and state the equilibrium conditions.
17. Explain the classification of magnetic materials on the basis of susceptibility, with examples.
18. Explain hysteresis, define retentivity and coercivity, and state the materials for a transformer core and a permanent magnet.

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

19. Define magnetic dipole moment. Derive the torque on a magnetic dipole in a uniform magnetic field, and hence derive its potential energy. State the conditions for stable and unstable equilibrium.
20. Define the elements of the earth's magnetism. Derive the relations between the total field, its horizontal and vertical components and the angle of dip, and explain magnetic declination.

Answer Key (Marking Scheme)

- Q1 — (A) $\text{A}\cdot\text{m}^2$. Q2 — (A) $-\mathbf{M}\cdot\mathbf{B}$. Q3 — (A) angle of dip (inclination). Q4 — (A) 90° .
- Q5 — (A) small negative susceptibility. Q6 — (A) narrow hysteresis loop. Q7 — (A) perpendicular to B. Q8 — (A) slightly less than 1.
- Q9 — $\chi = M/H$, the magnetisation per unit magnetising field.
- Q10 — The energy lost per unit volume per cycle.
- Q11 — Axial field = twice the equatorial field.
- Q12 — $\tau = MB \sin 90^\circ = 3 \times 0.2 = 0.6 \text{ N}\cdot\text{m}$.
- Q13 — Diamagnetic: bismuth; paramagnetic: aluminium; ferromagnetic: iron.
- Q14 — The lag of magnetisation behind the magnetising field in a ferromagnetic material.
- Q15 — Resolve the fields of the two poles perpendicular to the equator; the resultant is $B = \mu_0 M / 4\pi r^3$.

Q16 — $U = -MB \cos\theta$; minimum (stable) at $\theta = 0^\circ$ and maximum (unstable) at $\theta = 180^\circ$.

Q17 — See notes: χ small negative (dia), small positive (para), large positive (ferro); $\mu_r < 1, > 1, \infty$ respectively.

Q18 — Hysteresis = lag of B behind H ; retentivity = remnant B ; coercivity = reverse field for $B = 0$; transformer core = soft iron (narrow loop); permanent magnet = steel/alnico (wide loop).

Q19 — $M = m \times 2l$ (S to N). The couple of the two pole forces gives $\tau = MB \sin\theta = M \times B$, and $U = -MB \cos\theta$; stable at $\theta = 0^\circ$, unstable at $\theta = 180^\circ$.

Q20 — Declination, dip and horizontal component; $B_H = B \cos\delta$, $B_V = B \sin\delta$, $B = \sqrt{B_H^2 + B_V^2}$, $\tan\delta = B_V/B_H$; declination is the angle between the magnetic and geographic meridians.