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Magnetism and Matter — CBSE Class 12 Physics Chapter Test

FREE CHAPTER TEST · CLASS XII · PHYSICS (042) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case study based questions of 4 marks each, with four sub-parts of 1 mark.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of calculators is not allowed. You may use: $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Physics (042) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Magnetism and Matter · **Topics:** Bar magnet and magnetic dipole · Torque and potential energy in a uniform field · Gauss's law for magnetism · Magnetisation, magnetic intensity and susceptibility · Diamagnetism, paramagnetism and ferromagnetism · Curie's law

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. A bar magnet of magnetic moment 2.0 A m^2 makes an angle of 30° with a uniform magnetic field of 0.25 T. The torque on it is 1

(A) 0.50 N m (B) 0.25 N m

(C) 0.43 N m (D) 0.125 N m

2. The magnetic susceptibility of a diamagnetic substance is 1

(A) small and positive (B) large and positive

(C) small and negative (D) zero

3. The magnetic field lines of a bar magnet 1

(A) start at the N pole and end at the S pole (B) cross each other near the poles

(C) exist only outside the magnet (D) form continuous closed loops

4. A magnetic dipole of moment 1.5 A m^2 is in a uniform field of 0.20 T. The work needed to turn it from its stable position ($\theta = 0°$) to $\theta = 180°$ is 1

(A) 0.60 J (B) 0.30 J

(C) zero (D) 1.2 J

5. A long solenoid with 2000 turns per metre carries a current of 0.25 A. Its core has relative permeability 500. The magnetic field inside is about 1

(A) 6.3×10^{-4} T (B) 3.1 T

(C) 0.31 T (D) 0.031 T

6. Which of the following is ferromagnetic? 1

(A) Copper (B) Nickel

(C) Aluminium (D) Bismuth

7. **Assertion (A) :** The magnetic field lines of a bar magnet form closed loops. 1

Reason (R) : Inside a bar magnet the magnetic field lines run from its N pole to its S pole.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

8. **Assertion (A) :** A ferromagnetic material becomes paramagnetic when heated above a certain temperature. 1

Reason (R) : At high temperature, thermal agitation destroys the alignment of the magnetic moments within the domains.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. A circular coil of 100 turns and radius 5.0 cm carries a current of 2.0 A. Find its magnetic dipole moment. In which direction does it point? 2

10. (a) A bar magnet of magnetic moment 0.80 A m^2 is placed along a uniform magnetic field of 0.50 T. Find (i) the work done in turning it through 60° from this position and (ii) the torque on it in the new position. 2

OR

(b) Find the magnetic field due to a short bar magnet of magnetic moment 0.40 A m^2 at a distance of 20 cm from its centre (i) on its axis and (ii) on its equatorial line.

11. A long solenoid has 1000 turns per metre and carries a current of 1.5 A. Its core has relative permeability 800. Find the magnetic intensity H and the magnetic field B inside the core. 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. (a) Derive the expression for the potential energy of a magnetic dipole of moment m in a uniform magnetic field B. Hence find the work needed to turn a dipole of moment 2.5 A m^2 from its stable to its unstable equilibrium in a field of 0.40 T. 3

OR

(b) A circular coil of 50 turns and radius 4.0 cm carries a current of 0.50 A in a uniform magnetic field of 0.20 T. Find (i) its magnetic moment, (ii) the largest torque on it and (iii) the work needed to turn it from its stable to its unstable equilibrium.

13. A short bar magnet of magnetic moment 0.40 A m^2 is placed in a uniform external magnetic field of 1.0 $\times 10^{-5}$ T, with its magnetic moment pointing opposite to the field. (i) Find the distance from its centre, on its axis, where the resultant field is zero. (ii) What is the torque on the magnet? (iii) Is the magnet in stable equilibrium? 3

14. (i) Why is a paramagnetic substance weakly attracted by a magnet? 3

(ii) Why does the susceptibility of a diamagnetic substance not depend on temperature?

(iii) A superconductor is a perfect diamagnet. What is its susceptibility, and what happens to magnetic field lines near it?

SECTION D

This section comprises 1 case study based question of 4 marks, with four sub-parts of 1 mark each.

15. A student brings three small rods X, Y and Z of different materials, one at a time, near one pole of a strong electromagnet, where the field is non-uniform. Rod X moves weakly towards the pole, rod Y is pulled strongly towards it and rod Z moves weakly away from it.

(I) X, Y and Z are respectively

(A) diamagnetic, paramagnetic, ferromagnetic (B) paramagnetic, ferromagnetic, diamagnetic (C) ferromagnetic, paramagnetic, diamagnetic (D) paramagnetic, diamagnetic, ferromagnetic [1]

(II) The relative permeability of Z is

(A) much greater than 1 (B) slightly greater than 1 (C) zero (D) slightly less than 1 [1]

(III) When Y is heated above its Curie temperature, it becomes

(A) diamagnetic (B) more strongly ferromagnetic (C) paramagnetic (D) a superconductor [1]

(IV) If X is cooled, its magnetic susceptibility

(A) increases (B) decreases (C) does not change (D) becomes negative [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) Define magnetisation M, magnetic intensity H and magnetic susceptibility χ. Show that $B = \mu_0\mu_r H$, where $\mu_r = 1 + \chi$. 5

(ii) A solenoid of 500 turns per metre carries a current of 2.0 A. With a core inside it, the magnetic field in the core is 1.0 T. Find H, M and χ of the core.

OR

(b) (i) State Gauss's law for magnetism. How does it differ from Gauss's law in electrostatics, and why?

(ii) Distinguish between diamagnetic, paramagnetic and ferromagnetic substances on any three points.

17. (a) (i) Show that a bar magnet of magnetic moment m and moment of inertia I, slightly disturbed from its stable position in a uniform magnetic field B, performs simple harmonic motion, and find its period. 5

(ii) A magnet of moment of inertia 4.0×10^{-6} kg m^2 and magnetic moment 0.050 A m^2 oscillates in a uniform field of 0.020 T. Find its period. By what factor must the field change to double the frequency?

OR

(b) (i) Explain ferromagnetism on the basis of domains. What happens to a ferromagnetic substance above its Curie temperature?

(ii) A paramagnetic salt has susceptibility 2.8×10^{-4} at 280 K. Find its susceptibility at 350 K, and the temperature at which it would be 5.6×10^{-4}.

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(B)	(C)	(D)	(A)	(C)	(B)	(C)	(A)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (B). $\tau = mB \sin\theta = 2.0 \times 0.25 \times \sin 30° = 0.25$ N m.

Q2. Answer (C). Diamagnetic substances are magnetised weakly opposite to the field: χ is small and negative ($-1 \le \chi < 0$).

Q3. Answer (D). There are no magnetic monopoles: the lines continue inside the magnet from S to N and form closed loops.

Q4. Answer (A). $W = U(180°) - U(0°) = mB - (-mB) = 2mB = 2 \times 1.5 \times 0.20 = 0.60$ J.

Q5. Answer (C). $B = \mu_0\mu_r nI = 4\pi \times 10^{-7} \times 500 \times 2000 \times 0.25 \approx 0.31$ T.

Q6. Answer (B). Nickel (like iron and cobalt) is ferromagnetic; aluminium is paramagnetic, copper and bismuth are diamagnetic.

Q7. Answer (C). A is true (Gauss's law for magnetism: no monopoles). R is false: inside the magnet the lines run from S to N. Answer (C).

Q8. Answer (A). Above the Curie temperature the domain alignment is destroyed by thermal agitation, which is exactly why the material turns paramagnetic. Answer (A).

Q9. (2 marks) Answer: ≈ 1.57 A m², along the axis (right-hand rule).
$m = NIA = 100 \times 2.0 \times \pi(0.050)^2 \approx 1.57$ A m². [1]
It points along the axis of the coil, given by the right-hand rule: fingers curled along the current, the thumb gives m. [1]

Q10. (2 marks) Answer: (a) 0.20 J; ≈ 0.35 N m; (b) 1.0×10^{-5} T; 0.50×10^{-5} T.
(a) (i) $W = mB(\cos 0° - \cos 60°) = 0.80 \times 0.50 \times 0.5 = 0.20$ J. [1]
(ii) $\tau = mB \sin 60° = 0.80 \times 0.50 \times 0.866 \approx 0.35$ N m. [1]
OR (b) Axial: $B = (\mu_0/4\pi)(2m/r^3) = 10^{-7} \times 2 \times 0.40/(0.20)^3 = 1.0 \times 10^{-5}$ T. [1]
Equatorial: $B = (\mu_0/4\pi)(m/r^3) = 0.50 \times 10^{-5}$ T, i.e. half the axial value (and directed opposite to m). [1]

Q11. (2 marks) Answer: $H = 1500$ A m^{-1}; $B \approx 1.5$ T.
$H = nI = 1000 \times 1.5 = 1500$ A m^{-1} (does not depend on the core). [1]
$B = \mu_0\mu_r H = 4\pi \times 10^{-7} \times 800 \times 1500 \approx 1.5$ T. [1]

Q12. (3 marks) Answer: (a) $U = -m \cdot B$; 2.0 J; (b) ≈ 0.126 A m²; $\approx 2.5 \times 10^{-2}$ N m; $\approx 5.0 \times 10^{-2}$ J.
(a) Torque $\tau = mB \sin\theta$ tends to decrease θ. Work done in turning slowly from θ_0 to θ: $W = \int mB \sin\theta \, d\theta = mB(\cos\theta_0 - \cos\theta)$. [1]
Choosing $U = 0$ at $\theta = 90°$: $U(\theta) = -mB\cos\theta = -m \cdot B$. [1]
$W = U(180°) - U(0°) = 2mB = 2 \times 2.5 \times 0.40 = 2.0$ J. [1]
OR (b) (i) $m = NIA = 50 \times 0.50 \times \pi(0.040)^2 \approx 0.126$ A m². [1]
(ii) $\tau_{max} = mB \approx 0.126 \times 0.20 \approx 2.5 \times 10^{-2}$ N m. [1]
(iii) $W = 2mB \approx 5.0 \times 10^{-2}$ J. [1]

Q13. (3 marks) Answer: (i) 0.20 m; (ii) zero; (iii) unstable.

(i) On the axis the magnet's field $(\mu_0/4\pi)(2m/r^3)$ points along m, i.e. opposite to the external field. Zero when $(\mu_0/4\pi)(2m/r^3) = B$: $r^3 = 10^{-7} \times 0.80/1.0 \times 10^{-5} = 8.0 \times 10^{-3}$ m³, r = 0.20 m. [1]

(ii) $\theta = 180°$, so $\tau = mB \sin 180° = 0$. [1]

(iii) No. $U = -mB \cos 180° = +mB$ is the largest possible energy: a small turn lowers U, so it is unstable equilibrium. [1]

Q14. (3 marks) Answer: (iii) $\chi = -1$; field expelled (Meissner effect).

(i) Its atoms have permanent magnetic moments; a field partly aligns them along B, so the substance is magnetised along B and moves towards the stronger field (thermal agitation keeps the alignment small). [1]

(ii) Diamagnetism comes from moments induced opposite to the field in every atom, not from aligning permanent moments, so thermal agitation has nothing to disturb. [1]

(iii) $\chi = -1$ ($\mu_r = 0$): the field lines are completely expelled from it (Meissner effect). [1]

Q15. (4 marks) Answer: (I) B; (II) D; (III) C; (IV) A.

(I) (B) Weak attraction: paramagnetic; strong attraction: ferromagnetic; weak repulsion: diamagnetic. [1]

(II) (D) Diamagnetic: χ slightly negative, so $\mu_r = 1 + \chi$ is slightly less than 1. [1]

(III) (C) Above the Curie temperature a ferromagnet turns paramagnetic. [1]

(IV) (A) Curie's law $\chi = C/T$: cooling increases χ. [1]

Q16. (5 marks) Answer: (a) H = 1000 A m⁻¹, M ≈ 7.95 × 10⁵ A m⁻¹, $\chi \approx 795$; (b) $\oint B \cdot dS = 0$.

(a) (i) M = net magnetic moment per unit volume; H is defined by $B = \mu_0(H + M)$; $\chi = M/H$ (dimensionless). [1½]

$B = \mu_0(H + \chi H) = \mu_0(1 + \chi)H = \mu_0\mu_r H$ with $\mu_r = 1 + \chi$. [1½]

(ii) $H = nI = 500 \times 2.0 = 1000$ A m⁻¹. $M = B/\mu_0 - H = 1.0/(4\pi \times 10^{-7}) - 1000 \approx 7.95 \times 10^5$ A m⁻¹. $\chi = M/H \approx 795$. [2]

OR (b) (i) $\oint B \cdot dS = 0$ over any closed surface: as many magnetic field lines leave a closed surface as enter it. [1] In electrostatics $\oint E \cdot dS = q/\varepsilon_0$ can be non-zero because isolated charges exist; the magnetic flux is always zero because there are no isolated magnetic poles (monopoles). [1]

(ii) Any three, e.g. [3]:

- χ: diamagnetic small negative; paramagnetic small positive; ferromagnetic large positive.
- μ_r: slightly less than 1; slightly more than 1; much greater than 1.
- In a non-uniform field: moves weakly to the weaker region; moves weakly to the stronger region; pulled strongly to the stronger region.
- Temperature: diamagnetism independent; paramagnetic $\chi \propto 1/T$; ferromagnetism lost above the Curie temperature.

Q17. (5 marks) Answer: (a) $T = 2\pi\sqrt{(I/mB)}$; ≈ 0.40 s; 4 times; (b) 2.24×10^{-4}; 140 K.

(a) (i) Restoring torque $-mB \sin\theta \approx -mB\theta$ for small θ, so $I\, d^2\theta/dt^2 = -mB\theta$. [1] This is SHM with $\omega^2 = mB/I$: $T = 2\pi\sqrt{(I/mB)}$. [2]

(ii) $T = 2\pi\sqrt{(4.0 \times 10^{-6}/(0.050 \times 0.020))} = 2\pi\sqrt{(4.0 \times 10^{-3})} \approx 0.40$ s. [1] Frequency $\propto \sqrt{B}$, so B must become 4 times as large. [1]

OR (b) (i) A ferromagnet contains domains, each fully magnetised (moments aligned) but pointing in random directions, so the net M is zero. [1] In a field, domains along B grow and the others turn, giving a large M along B. [1] Above the Curie temperature T_C, thermal agitation destroys the alignment and the substance becomes paramagnetic. [1]

(ii) Curie's law $\chi = C/T$: $\chi(350\text{ K}) = 2.8 \times 10^{-4} \times 280/350 = 2.24 \times 10^{-4}$. [1] $\chi = 5.6 \times 10^{-4}$ (doubled) at $T = 280/2 = 140$ K. [1]

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: energies by integrating the torque, the neutral point by solving for zero field, the oscillation period by stepping the equation of motion in time.