🌟 MAGNETISM & MATTER – FULL STUDY GUIDE (CLASS 12)

🎯 ***Fun + Visual + Exam-ready + Easy-to-understand***

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1. THEORY IN SIMPLE WORDS (WITH VISUALS)

⭐ 1.1 What is Magnetism?

Magnetism = a property of materials where they can **attract or repel** other magnetic materials (like iron, nickel, cobalt).

Visual:

```
N ———— S
Opposite poles attract
Like poles repel
```

⭐ 1.2 Earth's Magnetism

Earth behaves like a **giant bar magnet** with a magnetic field around it.

Key points:

- **Geographic North ≠ Magnetic North**
- Magnetic south pole near geographic north
- Magnetic north pole near geographic south

Visual:

```
Geographic N
   ↑
Magnetic S
```

⭐ 1.3 Magnetic Field Lines

- Always go **from North → South** outside a magnet
- Do not intersect
- Crowded = strong field

⭐ 1.4 Magnetic Dipole

Every magnet has a **North pole** and **South pole**.

Magnetic dipole moment:

$$\vec{M} = m \cdot 2l$$

(m = pole strength, 2l = length)

⭐ 1.5 Magnetization (M)

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M = magnetic moment / volume
```

Shows how strongly a material is magnetized.

⭐ 1.6 Magnetic Intensity (H)

External magnetizing field applied to a material.

$$\vec{B} = \mu_0(\vec{H} + \vec{M})$$

⭐ 1.7 Types of Magnetic Materials

(A) Diamagnetic

- Weakly repelled
- Susceptibility $\chi < 0$
- Example: copper, gold

(B) Paramagnetic

- Weakly attracted
- $\chi > 0$ (small positive)
- Example: aluminum, oxygen

(C) Ferromagnetic

- Strongly attracted
- $\chi >> 0$ (large positive)
- Example: iron, cobalt, nickel

Visual Memory:

```
DIA → Dislike magnets (repelled)
PARA → Partially like magnets (weak attraction)
```

```
FERRO → Full attraction (strong)
```

⭐ 1.8 Curie's Law

For paramagnetic materials:

$$\chi = \frac{C}{T}$$

Susceptibility decreases when temperature increases.

⭐ 1.9 Permanent Magnets vs Electromagnets

Feature	Permanent Magnet	Electromagnet
Magnetism	Always	Only with current
Strength	Fixed	Adjustable
Example	Bar magnet	Crane magnet

⭐ 1.10 Hysteresis

Describes how a ferromagnetic material retains magnetism.

Key terms:

- Retentivity
- Coercivity
- Hysteresis loop area → energy loss

Visual:

```
Loop shape: S-shaped magnetic memory curve
```

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2. KEY CONCEPTS & FORMULAS TABLE

Concept	Formula	Memory Trick
Dipole moment	$M = m \times 2l$	"Pole × distance"

Concept	Formula	Memory Trick
Magnetic intensity	$B = \mu_0(H + M)$	H + M = Total
Susceptibility	$M = \chi H$	χ connects M & H
Curie's law	$\chi = C/T$	↑Temp → ↓χ
Torque on magnet	$\tau = MB \sin\theta$	Same as electric dipole

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🌈 Mnemonics

- **DIA → Dislike** (repelled)
- **PARA → Partial like**
- **FERRO → Fiercely attracted**
- **NS Rule:** "Field OUT from N, INTO S."

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3. SOLVED NUMERICAL PROBLEMS

⭐ Type 1: Magnetic Dipole Moment

Q: A magnet has pole strength $m = 4\,A\cdot m$ and distance between poles = 10 cm.
Find magnetic dipole moment.

$$M = m(2l) = 4 \times 0.1 = 0.4\,A\cdot m^2$$

⭐ Type 2: Curie's Law Problem

Q: χ = 0.01 at 300 K. Find χ at 600 K.

Curie's law:

$$\chi \propto 1/T$$

$$\chi_2 = \chi_1 \frac{T_1}{T_2}$$

$$\chi_2 = 0.01 \times \frac{300}{600} = 0.005$$

⭐ Type 3: Torque on a Bar Magnet

Q: A magnet of moment $0.5\,A\cdot m^2$ is placed in a field of 0.2 T at 90°.
Find torque.

$$\tau = MB\sin\theta = 0.5 \times 0.2 \times 1 = 0.1\ N\cdot m$$

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4. PREVIOUS YEARS' BOARD QUESTIONS (SOLVED)

(Based on CBSE trends from 2016–2024)

✔ Q1

Define magnetic declination and inclination.
(VERY frequently asked)

✔ Q2

Explain diamagnetic, paramagnetic, ferromagnetic with examples.

✔ Q3

Draw hysteresis loop and label coercivity & retentivity.

✔ Q4

State and explain Curie's law of magnetism.
(3 marks)

✔ Q5

Derive torque on a bar magnet in a magnetic field.

✔ Q6

Explain why the earth behaves like a magnet.
(2 marks)

✔ Q7 (Numerical)

Find magnetic dipole moment / torque / susceptibility using formula.

5. QUICK REVISION NOTES (1–2 PAGES)

⭐ Earth's Magnetism

- Earth has magnetic field like a giant bar magnet
- Magnetic axis ≠ geographic axis
- Declination = angle between magnetic & geographic meridian
- Inclination = angle between B and horizontal

⭐ Magnetization (M)

$$M = \frac{\text{magnetic moment}}{\text{volume}}$$

⭐ Magnetic Susceptibility (χ)

$$M = \chi H$$

⭐ Materials

Diamagnetic

- χ negative
- Weakly repelled
- Examples: Cu, Au

Paramagnetic

- χ small positive
- Weak attraction
- Examples: Al, O_2

Ferromagnetic

- χ very large
- Domains aligned
- Examples: Fe, Co, Ni

⭐ Hysteresis

- Loop shows magnetism memory
- Retentivity: remaining magnetism after removing field
- Coercivity: field required to demagnetize
- Energy loss = area of loop

⭐ Magnets in fields

- Torque → $MB \sin\theta$
- Potential energy → $-MB \cos\theta$

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6. PREDICTED / LIKELY QUESTIONS (2025 Boards)

Short Answer

- Define declination, inclination.
- What are magnetic materials?
- Write Curie's law.
- Distinguish between diamagnetic & paramagnetic.
- What is hysteresis?

Long Answer

- Explain earth's magnetism.
- Draw and explain hysteresis loop.
- Explain properties of ferromagnets.

Numericals

- Magnetic moment
- Torque on magnet
- Curie's law calculations

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7. EXAM TIPS & TRICKS

✔ Tip 1: Draw diagrams neatly

Earth's field lines → easy marks.

✔ Tip 2: Learn materials examples

Often asked as 1-mark MCQs.

✔ Tip 3: Don't confuse these:

- **Declination ≠ Inclination**

- **Susceptibility (χ) ≠ Permeability (μ)**

✔ Tip 4: Hysteresis Loop Trick

Right side → strong field
Top curve → retained magnetism
Left curve → coercive force

✔ Tip 5: For numerical

Convert **cm → m**, **mT → T**, **A·m → SI units**.

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8. VISUAL & KID-FRIENDLY MEMORY TOOLS

🎨 Magnetic Materials Visual

```
DIA  →  ↓ (weak repulsion)
PARA →  ↑ (weak attraction)
FERRO → ↑↑↑ (strong attraction)
```

🎨 Earth's Magnet Visual

```
Actual Magnetic South ≈ Geographic North
(They attract!)
```

🎨 Hysteresis Loop

```
Loop = magnetic memory
Big loop = more energy loss
```

🎨 Dipole

```
N ── S
Moment → from S to N
```