SAMPLE CONTENT

Precise

PHYSICS - II

STD. XII Sci.

Exposure Meter

It is a device which works on the principle of photoelectric effect. It is used by photographers to determine the correct time of exposure for the photograph.

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Written as per the revised syllabus prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune.

Precise
Physics – II
STD. XII Sci.

Salient Features

- Concise coverage of syllabus in Question Answer Format.
- Covers answers to all Textual Questions and Intext Questions.
- Includes Solved and Practice Numericals.
- Includes Solved Board Questions from 2013 to 2018.
- Includes Board Question Papers of 2017 and 2018.
- Exercise, Multiple Choice Questions and Topic test at the end of each chapter for effective preparation.

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Preface

In the case of good books, the point is not how many of them you can get through, but rather how many can get through to you.

"Std. XII Sci. : PRECISE PHYSICS – II" is a compact yet complete guide designed to boost students' confidence and prepare them to face the conspicuous Std. XII final exam.
This book is specifically aimed at Maharashtra Board students. The content of the book is framed in accordance with Maharashtra State board syllabus and collates each and every important concept in question and answer format.
This book has been developed on certain key features as detailed below:

- **Question and Answer** are represented in **Tabular** format wherever needed to correlate between two concepts. **Stepwise explanation** for specific questions makes it easier to understand.
- **Solved Examples** provide step-wise solution to various numerical problems. This helps students to understand the application of different concepts and formulae.
- **Solutions to Board Questions** along with marking scheme (wherever relevant) have been included.
- **Notes** cover additional bits of relevant information about discussed topic.
- **Formulae** are provided in every chapter which are the main tools to tackle numericals.
- **Exercise** helps the students to gain insight on the various levels of theory and numercial-based questions.
- **Board Questions** section contains questions of past board question papers which fall under the new syllabus.
- **Multiple Choice Questions** and **Topic Test** assess the students on their range of preparation and the amount of knowledge of each topic.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

Yours faithfully,
Publisher

Edition: Second

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PAPER PATTERN

- There will be one single paper of 70 Marks in Physics.
- Duration of the paper will be 3 hours.

Section A: **(8 Marks)**

This section will contain Multiple Choice Questions and Very Short Answer(VSA) type of questions.

There will be 4 MCQs and 4 VSA type of questions, each carrying one mark.

Students will have to attempt all these questions.

Section B: **(14 Marks)**

This section will contain 7 Short Answer (SA-I) type of questions, each carrying 2 marks.

Internal choice is provided for only one question.

Section C: **(33 Marks)**

This section will contain 11 Short Answer (SA-II) type of questions, each carrying 3 marks.

Internal choice is provided for only one question.

Section D: **(15 Marks)**

This section will contain 3 Long Answer (LA) type of questions, each carrying 5 marks.

Internal choice is provided for each question.

Distribution of Marks According to Type of Questions

Type of Questions		
MCQ	1 Mark each	4 Marks
VSA	1 Mark each	4 Marks
SA I	2 Marks each	14 Marks
SA II	3 Marks each	33 Marks
LA	5 Marks each	15 Marks

SAMPLE CONTENT

Index

Note: All the Textual questions are represented by * mark
All the Intext questions are represented by # mark

SAMPLE CONTENT

15 Magnetism

Subtopics

15.0 Introduction

Q.1. State the properties of a magnet.

Ans: Properties of a magnet:

i. When a magnet is suspended freely, it comes to rest in the north-south direction. This property is called directive property of magnet.

ii. When a magnet is dipped in iron fillings, they cling to the magnet. This property is called attractive property of magnet.

iii. If a bar magnet is cut into pieces, each piece, however small it may be, is still a magnetic dipole, i.e., Magnetic monopoles do not exist.

15.1 Circular current loop as a magnetic dipole

***Q.2. Show that current loop produces a magnetic field and behaves like a magnetic dipole.**

Ans: i. The magnetic induction at a point at a distance 'x' from the centre of circular loop of a radius 'R' carrying a steady current 'I' is $B = \dfrac{\mu_0 I R^2}{2\left(x^2 + R^2\right)^{3/2}}$ and its direction is along the axis, given by the right hand thumb rule.

ii. For x >> R, $B = \dfrac{\mu_0 I R^2}{2x^3}$

iii. Area of the loop, $A = \pi R^2$

$$\therefore \quad B = \frac{\mu_0 I A}{2\pi x^3} \qquad \ldots.[\because R^2 = \frac{A}{\pi}]$$

$$B = \frac{\mu_0 M}{2\pi x^3} \qquad \ldots.[\because M = IA]$$

$$B = \frac{\mu_0}{4\pi}\frac{2M}{x^3} \qquad \ldots.(1)$$

iv. This expression is very similar to the expression obtained for electric field due to the electric dipole as

$$E = \frac{1}{4\pi\varepsilon_0}\frac{2p}{x^3} \qquad \ldots.(2)$$

where, x is the distance of the point from the centre of the dipole.

v. Comparing equations (1) and (2), μ_0 is analogous to $\dfrac{1}{\varepsilon_0}$.

Magnetic dipole moment 'M' is analogous to electrostatic dipole moment 'p' and magnetic field is analogous to electrostatic field.

vi. When placed in external magnetic field, a current loop produces a magnetic field and behaves like a magnetic dipole. It experiences a torque given by,

$$\vec{\tau} = \vec{M} \times \vec{B}$$

SAMPLE CONTENT

Solved Examples

Q.3. A circular coil of 300 turns and average area $5 \times 10^{-3} m^2$ carries a current of 15 A. Calculate the magnitude of magnetic moment associated with the coil. [Mar 15]

Solution:

Given: n = 300, A = 5×10^{-3} m^2, I = 15 A

To find: Magnetic moment of the coil (M)

Formula: M = nIA ***[½ Mark]***

Calculation: Using formula,

$M = 300 \times 15 \times 5 \times 10^{-3}$ ***[½ Mark]***

$= \mathbf{22.5\ Am^2}$

Ans: The magnitude of magnetic moment associated with coil is **22.5 Am^2**. ***[1 Mark]***

***Q.4. A circular coil of 300 turns and diameter 14 cm carries a current of 15 A. What is the magnitude of magnetic moment associated with the coil?**

Solution:

Given: n = 300, d = 14 cm,

r = 7 cm = 7×10^{-2} m, I = 15 A

To find: Magnetic moment of the coil (M)

Formula: M = nIA

Calculation: From formula,

$M = nI\pi r^2 = 300 \times 15 \times \pi \times (7 \times 10^{-2})^2$

$\therefore$ M = **69.24 Am^2**

Ans: The magnetic moment of the coil is **69.24 Am^2**.

Q.5. A circular coil of 250 turns and diameter 18 cm carries a current of 12 A. What is the magnitude of magnetic moment associated with the coil? [Mar 13]

Solution:

Given: n = 250, d = 18 cm,

r = 9 cm = 9×10^{-2} m, I = 12 A

To find: Magnetic moment of the coil (M)

Formula: M = nIA ***[½ Mark]***

Calculation: From formula,

$M = nI\pi r^2$

$= 250 \times 12 \times 3.14 \times (9 \times 10^{-2})^2$ ***[½ Mark]***

$\therefore$ M = **76.3 Am^2**

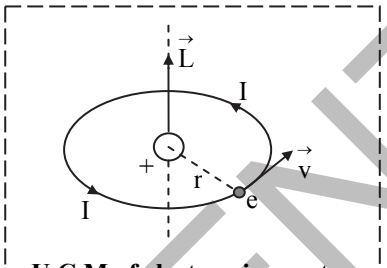
Ans: The magnetic moment of the coil is **76.3 Am^2**. ***[1 Mark]***

15.2 Magnetic dipole moment of revolving electron

***Q.6. Derive an expression for the magnetic dipole moment of a revolving electron.**

Ans: Expression for magnetic dipole moment:

i. Consider an electron of mass m_e and charge e revolving in a circular orbit of radius r around the positive nucleus in anticlockwise direction, leading to a clockwise current.



U.C.M of electron in an atom

ii. The angular momentum of an electron due to its orbital motion is given by,

$L_0 = m_e vr$ ….(1)

iii. For the sense of orbital motion of electron shown in the figure, the angular momentum vector $\vec{L}$ acts along normal to the plane of the electron orbit and in upward direction.

iv. Suppose that the period of orbital motion of the electron is T. Then the electron crosses any point on its orbit after every T seconds or 1/T times in one second.

v. Magnitude of circulating current is given by, $I = e\left(\frac{1}{T}\right)$

But, $T = \frac{2\pi r}{v}$

$\therefore \quad I = e\left(\frac{1}{2\pi r / v}\right) = \frac{ev}{2\pi r}$

vi. The magnetic dipole moment associated with circulating current is given by,

$M_0 = IA = \frac{ev}{2\pi r} \times \pi r^2$

[$\because$ Area of current loop, $A = \pi r^2$]

$\therefore \quad M_0 = \frac{evr}{2}$ ….(2)

vii. Multiplying and dividing the R.H.S of equation (2) by m_e, $M_0 = \frac{e}{2m_e} \times m_e vr$

$\therefore \quad M_0 = \frac{eL_0}{2m_e}$ ….(3)

viii. In vector notation, $\vec{M}_0 = -\left(\frac{e}{2m_e}\right)\vec{L}_0$

The negative sign indicates that the orbital angular momentum of electron is opposite to the orbital magnetic moment.

SAMPLE CONTENT

Q.7. What is gyromagnetic ratio?

Ans: i. *The ratio of magnetic dipole moment with angular momentum of revolving electron is called the gyromagnetic ratio.*

ii. Gyromagnetic ratio is given by,

$$\frac{M_0}{L_0} = \frac{e}{2m_e} = 8.8 \times 10^{10}\ \text{C/kg} = \text{constant}$$

Solved Examples

***Q.8. An electron in an atom revolves around the nucleus in an orbit of radius 0.5 Å. Calculate the equivalent magnetic moment if the frequency of revolution of electron is 10^{10} MHz.**

Solution:

Given: $r = 0.5\ \text{Å} = 0.5 \times 10^{-10}$ m,
$f = 10^{10}$ MHz $= 10^{10} \times 10^{6} = 10^{16}$ Hz

To find: Magnetic moment (M)

Formula: M = IA

Calculation: Since, $I = \frac{1}{T}\ e = fe$

From formula,

$M = feA = fe\pi r^2$

$= 10^{16} \times 1.6 \times 10^{-19} \times \pi \times (0.5 \times 10^{-10})^2$

$= 1.6 \times \pi \times 0.25 \times 10^{-23}$

$\therefore$ $M = \mathbf{1.256 \times 10^{-23}\ Am^2}$

Ans: The equivalent magnetic moment is $\mathbf{1.256 \times 10^{-23}\ Am^2}$.

Q.9. An electron in an atom revolves around the nucleus in an orbit of radius 0.53 Å. If the frequency of revolution of an electron is 9×10^9 MHz, calculate the orbital angular momentum.
[Given : Charge on an electron = 1.6×10^{-19} C; Gyromagnetic ratio = 8.8×10^{10} C/kg; $\pi = 3.142$] [Mar 17]

Solution:

Given: $r = 0.53\ \text{Å} = 0.53 \times 10^{-10}$ m,
$f = 9 \times 10^9$ MHz $= 9 \times 10^{15}$ Hz

To find: Angular momentum (L_0)

Formula: $L_0 = \frac{M_0}{\text{gyromagnetic ratio}}$ ***[½ Mark]***

Calculation: M = IA ***[½ Mark]***

Since, $I = \frac{1}{T}\ e = fe$

From formula,

$M = feA = fe\pi r^2$ ***[½ Mark]***

$= 9 \times 10^{15} \times 1.6 \times 10^{-19} \times \pi \times (0.53 \times 10^{-10})^2$

$= 1.6 \times \pi \times 0.25 \times 10^{-23}$

$\therefore$ $M = 1.270 \times 10^{-23}\ Am^2$

Using formula,

$L_0 = \frac{1.270 \times 10^{-23}}{8.8 \times 10^{10}}$ ***[½ Mark]***

$\therefore$ $L_0 = 0.1443 \times 10^{-33}\ kgm^2/s$

Ans: The orbital angular momentum of the electron is $\mathbf{0.1443 \times 10^{-33}\ kgm^2/s}$. ***[1 Mark]***

15.3 Magnetization and magnetic intensity

Table 15.0	
Magnetization	i. *The net magnetic dipole moment per unit volume, in the magnetic material is called as magnetization.* It is denoted by $\vec{M}_Z$. If magnetic specimen of volume 'V' acquires net magnetic dipole moment 'M_{net}' due to the magnetising field, then $\vec{M}_Z = \frac{M_{net}}{V}$ ii. Unit: $\mathbf{Am^{-1}}$ iii. Dimensions: $\mathbf{[M^0L^{-1}T^0I^1]}$
Magnetic intensity	i. *The ratio of the strength of magnetising field to the permeability of free space is called as magnetic intensity.* The strength of magnetic field at a point can be given in terms of vector quantity called as magnetic intensity (H). Magnetic intensity is a quantity used in describing magnetic phenomenon in terms of their magnetic field. $H = \frac{B_0}{\mu_0}$ or $\mathbf{B_0 = \mu_0 H}$ ii. Unit: SI unit of magnetic intensity is $\mathbf{Am^{-1}}$. iii. Dimensions: $\mathbf{[M^0L^{-1}T^0I^1]}$

SAMPLE CONTENT

Magnetic susceptibility	*The ratio of magnitude of intensity of magnetization to that of magnetic intensity is called as magnetic susceptibility.* It is given by $\chi = \frac{M_Z}{H}$.
Magnetic permeability	*The ratio of the magnitude of total field inside the material to that of intensity of magnetising field is called magnetic permeability.* i.e., $\mu = \frac{B}{H}$ It measures the degree to which a magnetic material can be penetrated by the magnetising field. Unit: **H/m** or **Wb/Am** Dimensions: $[M^1L^1T^{-2}I^{-2}]$
Relative permeability	*The ratio of magnetic permeability of the material (μ) and magnetic permeability of free space (μ_0) is called relative permeability.* $\mu_r = \frac{B}{B_0}$ $\mu_r = \frac{\mu H}{\mu_0 H} = \frac{\mu}{\mu_0}$ It has no units and dimensions.

Q.10. State Curie's law.

Ans: Curie's law:

Magnetization of a paramagnetic sample is directly proportional to the external magnetic field and inversely proportional to the absolute temperature.

Mathematically,

$M_Z \propto B_{ext}$ and $M_Z \propto \frac{1}{T}$

$\therefore \quad M_Z \propto \frac{B_{ext}}{T}$

$\therefore \quad M_Z = C \times \frac{B_{ext}}{T}$

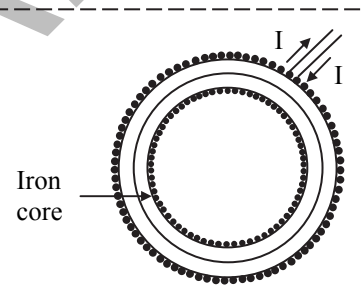
where, C is called Curie constant.

Above equation represents Curie's law for magnetization.

***Q.11. Discuss magnetization of a ferromagnetic material with the help of toroid ring.**

Ans: Magnetization of a ferromagnetic material by toroid (Rowland) ring:

i. The magnetization of a ferromagnetic material such as iron can be studied using Rowland ring. Rowland ring is similar in shape of the toroid as shown in the figure.



Toroid with an iron core (Rowland ring)

ii. The material is formed into a thin toroidal core of circular cross section. A toroidal coil having 'n' turns per unit length is wrapped around the core and carries current 'I'.

iii. The coil is long solenoid bent into a circle. If iron core was not present, the magnitude of the magnetic field inside the coil would be, $B_0 = \mu_0 nI$, where μ_0 is the permeability of vacuum.

iv. If iron core was present, the magnetic field $\vec{B}$ inside the coil is greater than $\vec{B}_0$.

Magnitude of this field,

$B = B_0 + B_M$ ….(1)

Where, B_M is the magnetic field contributed by the iron core.

v. Additional field B_M is directly proportional to the magnetization M_Z of the iron.

$\therefore \quad B_M = \mu_0 M_Z$ ….(2)

vi. Also, $B_0 = \mu_0 H$ ….(3)

where H = nI

From equations (1), (2) and (3),

$B = \mu_0 (H + M_Z)$

Q.12. Establish the relation between permeability and susceptibility of a substance.

Ans: Relation between permeability and susceptibility:

i. When magnetic material is placed in a magnetising field for its magnetization, the field inside the magnetic material is the resultant of the magnetising field B_0 and the induced field B_M.

$\therefore \quad B = B_0 + B_M$

SAMPLE CONTENT

ii. Since, $B_0 = \mu_0 H$ and $B_M = \mu_0 M_Z$

$\therefore \quad B = \mu_0\left(H + M_Z\right) = \mu_0 H\left(1 + \frac{M_Z}{H}\right)$

$\therefore \quad \frac{B}{H} = \mu_0\left(1 + \frac{M_Z}{H}\right)$

iii. $\frac{B}{H} = \mu_0 (1 + \chi) \quad \ldots\left[\because \frac{M_Z}{H} = \chi\right]$

Also, $\frac{B}{H} = \mu$

$\therefore \quad \mu = \mu_0 (1 + \chi)$

$\therefore \quad \frac{\mu}{\mu_0} = 1 + \chi$

$\therefore \quad \mu_r = 1 + \chi \quad \ldots\left[\because \frac{\mu}{\mu_0} = \mu_r\right]$

Solved Examples

Q.13. The magnetic moment of a magnet of dimensions 5 cm × 2.5 cm × 1.25 cm is 3 Am^2. Calculate the intensity of magnetization. [Oct 14]

Solution:

Given: $l = 5$ cm $= 5 \times 10^{-2}$ m,
b = 2.5 cm $= 2.5 \times 10^{-2}$ m,
h = 1.25 cm $= 1.25 \times 10^{-2}$ m,
$M_{net} = 3$ Am^2

To find: Intensity of magnetization (M_Z)

Formula: $M_Z = \frac{M_{net}}{V}$ ***[½ Mark]***

Calculation: Using formula,

$M_Z = \frac{M_{net}}{l \times b \times h} \quad \ldots[\because V = l \times b \times h]$

$= \frac{3}{5 \times 10^{-2} \times 2.5 \times 10^{-2} \times 1.25 \times 10^{-2}}$ ***[½ Mark]***

$= 0.192 \times 10^6$

$= \mathbf{1.92 \times 10^5}$ **A/m**

Ans: The intensity of magnetization is **1.92 × 10^5 A/m.** ***[1 Mark]***

Q.14. Find the magnetization of a bar magnet of length 10 cm and cross-sectional area 4 cm^2, if the magnetic moment is 2 Am^2. [July 17]

Solution:

Given: $M_{net} = 2$ Am^2, $l = 10$ cm $= 10 \times 10^{-2}$ m,
area of cross section = 4 cm^2 = 4×10^{-4} m^2

To find: Magnetization (M_Z)

Formula: $M_Z = \frac{M_{net}}{V}$ ***[½ Mark]***

Calculation: Since, V = l × cross sectional area
$= (10 \times 10^{-2} \times 4 \times 10^{-4})$
$= 4 \times 10^{-5}$ m^3

From formula,

$M_Z = \frac{2}{4 \times 10^{-5}}$ ***[½ Mark]***

$\therefore \quad M_Z =$ **50000 A/m**

Ans: The intensity of Magnetization is **50000 A/m**. ***[1 Mark]***

***Q.15. A bar magnet made of steel has magnetic moment of 2.5 Am^2 and a mass of 6.6 × 10^{-3} kg. If the density of steel is 7.9 × 10^3 kg/m^3, find the intensity of magnetization of the magnet.**

Solution:

Given: $M_{net} = 2.5$ Am^2, m = 6.6×10^{-3} kg,
$\rho = 7.9 \times 10^3$ kg/m^3

To find: Intensity of Magnetization (M_Z)

Formula: $M_Z = \frac{M_{net}}{V}$

Calculation: Since, $\rho = \frac{m}{V}$

$\therefore \quad V = \frac{m}{\rho} = \frac{6.6 \times 10^{-3}}{7.9 \times 10^3} = 8.354 \times 10^{-7}$

From formula,

$M_Z = \frac{2.5}{8.354 \times 10^{-7}}$

$\therefore \quad M_Z =$ **3 × 10^{6}A/m**

Ans: The intensity of Magnetization is **3 × 10^6 A/m**.

Q.16. An iron rod of area of cross-section 0·1m^2 is subjected to a magnetising field of 1000 A/m. Calculate the magnetic permeability of the iron rod.
[Magnetic susceptibility of iron = 59·9, magnetic permeability of vacuum = 4π × 10^{-7} S. I. unit] [Oct 15]

Solution:

Given: H= 1000 A/m, $\chi = 59.9$,
$\mu_0 = 4\pi \times 10^{-7}$ S.I. unit

To find: Permeability (μ)

Formula: $\mu = \mu_0 (1 + \chi)$ ***[½ Mark]***

Calculation: From formula,

$\mu = 4\pi \times 10^{-7} (1 + 59.9)$

$= 4 \times 3.142 \times 10^{-7} \times 60.9$ ***[½ Mark]***

$\therefore \quad \mu =$ **7.654 × 10^{-5} Hm^{-1}**

Ans: The magnetic permeability of the iron rod is **7.654 × 10^{-5} Hm^{-1}**. ***[1 Mark]***

SAMPLE CONTENT

Q.17. The magnetic susceptibility of annealed iron at saturation is 4224. Find the permeability of annealed iron at saturation. ($\mu_0 = 4\pi \times 10^{-7}$ SI unit). [Oct 13]

Solution:

Given: $\chi = 4224$

To find: Permeability (μ)

Formula: $\mu = \mu_0 (1 + \chi)$ ***[½ Mark]***

Calculation: From formula,

$\mu = 4\pi \times 10^{-7} (1 + 4224)$ ***[½ Mark]***

$= \mathbf{5.31 \times 10^{-3}}$ **T m/A**

Ans: The permeability of annealed iron at saturation is $\mathbf{5.31 \times 10^{-3}}$ **T m/A**. ***[1 Mark]***

***Q.18. The susceptibility of annealed iron at saturation is 5500. Find the permeability of annealed iron at saturation.**

Solution:

Given: $\chi = 5500$

To find: Permeability (μ)

Formula: $\mu = \mu_0 (1 + \chi)$

Calculation: From formula,

$\mu = 4\pi \times 10^{-7} (1 + 5500)$

$\therefore$ $\mu = \mathbf{6.9 \times 10^{-3}}$ **Hm^{-1}**

Ans: The permeability of annealed iron at saturation is $\mathbf{6.9 \times 10^{-3}}$ **Hm^{-1}**.

***Q.19. Find the percent increase in the magnetic field B when the space within a current carrying toroid is filled with aluminium. The susceptibility of aluminium is 2.1×10^{-5}.**

Solution:

The magnetic field inside the toroid in the absence of aluminium = $B_0 = \mu_0 H$

When filled with aluminium, $B = \mu_0 (1 + \chi) H$

The increase in the field = $B - B_0 = \mu_0 \chi H$

The percent increase in the magnetic field

$$= \frac{B - B_0}{B_0} \times 100$$

$$= \frac{\mu_0 \chi H \times 100}{\mu_0 H}$$

$= \chi \times 100$

$= 2.1 \times 10^{-5} \times 100$

$= \mathbf{2.1 \times 10^{-3}}$

Ans: The percent increase in magnetic field is $\mathbf{2.1 \times 10^{-3}}$.

Q.20. The maximum value of permeability of a metal (77% Ni, 16% Fe, 5% Cu, 2% Cr) is 0.126 T mA^{-1}. Find the maximum relative permeability and susceptibility.

Solution:

Given: $\mu = 0.126$ T mA^{-1}

To find: Relative permeability (μ_r), Susceptibility (χ)

Formulae: i. $\mu_r = \dfrac{\mu}{\mu_0}$

ii. $\mu_r = 1 + \chi$

Calculation: From formula (i),

$$\mu_r = \frac{0.126}{4\pi \times 10^{-7}} = \mathbf{1.0 \times 10^5}$$

From formula (ii),

$\chi = \mu_r - 1$

$\chi = 1.0 \times 10^5 - 1$

$\therefore$ $\chi = \mathbf{99.99 \times 10^3}$

Ans: i. The relative permeability is $\mathbf{1.0 \times 10^5}$.

ii. The susceptibility is $\mathbf{99.99 \times 10^3}$.

***Q.21. The magnetic field B and the magnetic intensity H in a material are found to be 1.6 T and 1000 A/m respectively. Calculate the relative permeability 'μ_r' and the susceptibility 'χ' of the material.**

Solution:

Given: B = 1.6 T, H = 1000 A/m

To find: Relative permeability (μ_r), Susceptibility (χ)

Formulae: i. $\mu_r = \dfrac{\mu}{\mu_0}$

ii. $\mu_r = 1 + \chi$

Calculation: Since, $\mu = \dfrac{B}{H}$

$$\mu = \frac{1.6}{1000}$$

$= 1.6 \times 10^{-3}$ T mA^{-1}

From formula (i),

$$\mu_r = \frac{1.6 \times 10^{-3}}{4\pi \times 10^{-7}}$$

$\therefore$ $\mu_r = \mathbf{1.274 \times 10^3}$

From formula (ii),

$\chi = \mu_r - 1$

$= 1.274 \times 10^3 - 1$

$\therefore$ $\chi = \mathbf{1273}$

Ans: The relative permeability is $\mathbf{1.274 \times 10^3}$ and susceptibility is **1273**.

SAMPLE CONTENT

15.4 Diamagnetism, paramagnetism and ferromagnetism on the basis of domain theory

***Q.22. Discuss the classification of materials based on their behaviour in magnetic field.**

Ans:

Diamagnetic materials	Paramagnetic materials	Ferromagnetic materials
i. These substances, when placed in magnetic field are feebly magnetised in a direction opposite to that of the magnetising field. ii. When a diamagnetic substance is placed inside an external magnetic field, the magnetic field inside the diamagnetic is found to be slightly less than the external magnetic field. iii. When a diamagnetic sample is placed inside a non-uniform magnetic field, it tends to move from stronger part to the weaker part of the magnetic field. iv. The behaviour of a diamagnetic substance is independent of temperature. Further, a diamagnetic substance has the nature similar to that of a dielectric having non-polar atoms.	i. These substances, when placed in a magnetic field are feebly magnetised in the direction of the magnetising field. ii. When a paramagnetic substance is placed inside an external magnetic field, the magnetic field inside the paramagnetic is found to be slightly greater than the external magnetic field. iii. A paramagnetic substance tends to move from weaker part of the magnetic field to stronger part, when placed in a non-uniform magnetic field. iv. The behaviour of a paramagnetic is temperature dependent also, the paramagnetic effects are perceptible only with a strong magnetic field. The nature of a paramagnetic is similar to that of a dielectric having polar atoms.	i. These substances, when placed in a magnetic field are strongly magnetised, in the direction of the magnetising field. ii. When a ferromagnetic substance is placed inside a magnetic field, the field inside the ferromagnetic substance gets greatly enhanced. iii. As a result, when a ferromagnetic is placed in a non-uniform magnetic field, it quickly moves from weaker part to stronger part of the magnetic field. Thus, the ferromagnetic effects are perceptible even in the presence of a weak magnetic field. iv. The ferromagnetic behaviour of a substance becomes temperature dependent above certain temperature, which is characteristic of that substance.

***Q.23. Explain origin of diamagnetism on the basis of its atomic structure.**

Ans: Diamagnetic substances:

i. *Substances which are weakly repelled by a magnet are called diamagnetic substances.*

ii. In diamagnetic substance, magnetic dipole moments of all the electrons in an atom cancel each other. Thus resulting magnetic moment of the atom is zero.
eg: air, bismuth, copper, gold, water, alcohol, hydrogen, zinc, diamond, salt, nitrogen, magnesium, silver, mercury etc.

iii. When diamagnetic materials are kept in an external magnetic field then those electrons whose orbital magnetic moments are in the same direction as that of the external magnetic field slow down and those electrons whose orbital magnetic moments are in the opposite direction to that of the external magnetic field speeds up.

iv. Thus, a magnetic moment is developed in the direction opposite to that of applied external magnetic field. As a result, the diamagnetic substance is repelled by the applied field and sets itself at right angles to the direction of the field when suspended freely in magnetic field.

v. The superconductors are perfect example of diamagnetism. The phenomenon of perfect diamagnetism in superconductors is called Meissner effect.

Note

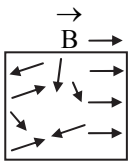
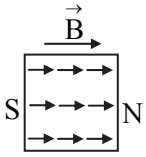
1. When a diamagnetic substance is placed near a magnet, its atoms acquire a small magnetic dipole moment in the direction opposite to that of the external magnetic field.
2. As a result, the diamagnetic substance moves from stronger part to weaker part of the magnetic field.
3. Hence, diamagnetic substances are feebly repelled by a magnet.

SAMPLE CONTENT

***Q.24. Explain origin of paramagnetism on the basis of its atomic structure.**

Ans:

Paramagnetic substances	
Introduction	i. *Substances which are weakly attracted by a magnet are called paramagnetic substances.* ii. In paramagnetic substances, the magnetic dipole moments of all the electrons do not cancel out, resulting in some dipole moment for an atom so that each atom of paramagnetic substance is equivalent to tiny magnetic dipole, called atomic magnets. iii. In the absence of external magnetic field, the dipole moments of the atoms are randomly oriented and hence the net dipole moment of the substance is zero. **eg:** Aluminium, tungsten, niobium, calcium, lithium, platinum, oxygen, chromium, sodium, manganese, copper chloride etc.
Origin of paramagnetism	For the atom of a paramagnetic substance, the orbital motion and spin motion of the electrons is such that, the resultant magnetic dipole moment of the atom is non-zero. Each atom behaves as a tiny dipole called as atomic dipole. The phenomenon can be explained in following ways.

Behaviour of paramagnetic substances		
Absence of external magnetic field	**Effect of weak external field**	**Effect of strong external field**
A specimen of a paramagnet is kept at a place where there is no external magnetic field. Due to thermal vibration, atomic dipoles have random orientation and the specimen as a whole does not posses a net dipole moment. Though each atom is a tiny magnet, the specimen as a whole does not behave as a magnet. Thus the specimen is in unmagnetised state as shown in figure (a).	The specimen placed in a weak external magnetic field $\vec{B}$ is as shown in figure (b). Partial alignment of the atomic dipoles takes place. A complete alignment is prevented due to thermal vibration. The specimen has acquired a net dipole moment $\vec{M}$.	The specimen placed in a strong external magnetic field $\vec{B}$ is as shown in figure (c). Inspite of thermal vibrations, a complete alignment of atomic dipoles along the external field takes place. The specimen is said to be saturated and possesses maximum net magnetic dipole moment $\vec{M}$. The net magnetic dipole moment is parallel to $\vec{B}$. Hence the specimen shows a tendency to move from weaker field to stronger field. The alignment of atomic dipoles is temporary. When the external magnetic field is switched off, immediately the alignment is disturbed by thermal vibration and specimen gets demagnetized. Hence, permanent magnets cannot be made out of paramagnetic substances. The tendency of alignment is greater in stronger magnetic field at low temperature.
 **Figure (a): Absence of external field**	 **Figure (b): Weak external magnetic field**	 **Figure (c): Strong external magnetic field**

Note

1. The magnetic moment of each atom of a paramagnetic substance is slightly greater than zero.
2. The permeability of paramagnetic substance is slightly greater than one.

Table 15.1 Ferromagnetic substances	
Introduction	*Substances which are strongly attracted by a magnet are called ferromagnetic substances.* **eg:** Iron, nickel, cobalt, gadolinium, dysprosium and their alloys.
Domain theory	i. Ferromagnetism can be explained on the basis of domain theory proposed by Weiss. ii. A ferromagnetic material contains a large number of small regions or domains. iii. Even in the absence of magnetic field millions of atomic magnets form a group.

SAMPLE CONTENT

iv. The region in which all magnetic moments are aligned in the same direction are known as domains.
v. Magnetic dipole moments of all the atoms in one domain are aligned in the same direction. Each domain thus behaves as a resultant magnetic dipole moment.
vi. The domains have irregular shape and large magnetic dipole moment.
vii. Due to strong exchange coupling between neighbouring atoms in domain, all the dipoles have magnetic dipole moments in the same direction.

Ferromagnetism on the basis of domain theory

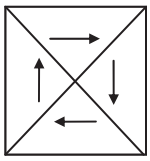
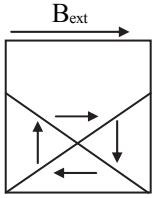
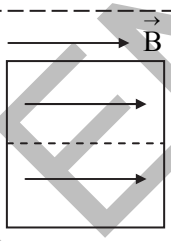
Absence of external magnetic field	Effect of weak magnetic field	Effect of strong magnetic field
 **Figure (a) Unmagnetised state**	 **Figure (b) Weak magnetic field**	 **Figure (c) Strong magnetic field**
In the absence of any external magnetic field, the different domains are oriented at random so that the magnetic fields of the domains cancel each other and do not show any magnetic (effect) properties, as shown in figure (a).	When the external applied magnetic field is weak, the individual atomic magnets tend to align their dipole moments parallel to the direction of the field, as shown in figure (b). The domain wall shifts in the direction of applied field. With the removal of the external magnetic field, the boundaries return to their original positions and the material loses its magnetism.	When the external applied magnetic field is strong as shown in figure (c), the dipole moments of non-aligned domains abruptly rotate in the direction of the applied field. Removal of external field does not set the domain boundaries back to their original position, and the material gets the magnetic property permanently.

Table 15.2 Properties

Properties of diamagnetic substances	Properties of paramagnetic substances	Properties of ferromagnetic substances
i. If a thin rod of a diamagnetic material is suspended freely in an external uniform magnetic field, it comes to rest with its length perpendicular to the direction of the field. ii. These materials when placed in an external non-uniform magnetic field tend to move from the stronger part of the field to the weaker part of the field. iii. In the absence of external magnetic field, the net magnetic moment of diamagnetic substances is zero. iv. Diamagnetic substances lose their magnetism on removal of external magnetic field. v. If a watch-glass containing a small quantity of a diamagnetic liquid is placed on two dissimilar magnetic poles, the liquid shows a depression in the middle.	i. If a thin rod of a paramagnetic material is freely suspended in a uniform magnetic field, it comes to rest with its length parallel to the direction of the field. ii. These materials when placed in an external non-uniform magnetic field, tend to move from the weaker part to the stronger part of the field. iii. In the absence of external magnetic field, the dipole moments of the atoms are randomly oriented and hence the net dipole moment of the substance is zero. iv. When paramagnetic substance is kept in an external magnetic field, the tiny atomic magnets tend to align parallel to the applied field and show magnetic effects. As soon as the external field is removed, the atomic magnets again get randomly oriented and the substance loses its magnetism.	i. These materials when placed in an external uniform magnetic field get strongly magnetised in the direction of the external magnetic field. ii. These materials when placed in an external non-uniform magnetic field, tend to move from the weaker part to the stronger part of the field. iii. All the atoms of the ferromagnetic materials have a resultant magnetic moment even in the absence of external magnetic field. iv. When a thin rod of a ferromagnetic substance is kept between two conical pole pieces of an electromagnet, it comes to rest with its axis parallel to the magnetic induction between the two poles.

SAMPLE CONTENT

vi. If a magnetic field is applied to diamagnetic liquid in one arm of U-tube, the liquid level in that arm is lowered. vii. If a diamagnetic gas is introduced between the pole-pieces of a magnet, it spreads at right angles to the magnetic field.	v. If a watch-glass containing a small quantity of a paramagnetic liquid is placed on two dissimilar magnetic poles, the liquid shows an elevation in the middle. vi. If a magnetic field is applied to paramagnetic liquid in one arm of U-tube the liquid level rises in that arm. vii. If a paramagnetic gas is introduced between the pole pieces of a magnet, it spreads in the direction of the field. viii. The susceptibility of paramagnetic substance is small but positive. It depends on the temperature of the substance. The susceptibility is inversely proportional to absolute temperature $\left(\chi \propto \frac{1}{T}\right)$.	v. Ferromagnets remain magnetised even after the removal of the magnetizing field. vi. The susceptibility is positive and very high.

***Q.25. Distinguish between diamagnetic substance and paramagnetic substance. [July 17]**

Ans:

No.	Diamagnetic substance	Paramagnetic substance
i.	In an external magnetic field, a substance gets weakly magnetised in the direction opposite to that of the field.	In an external magnetic field, a paramagnetic substance gets weakly magnetised in the same direction as that of the field.
ii.	When placed in a non-uniform magnetic field, it tends to move from the stronger to the weaker part of the field.	When placed in a non-uniform magnetic field, it tends to move from the weaker to the stronger part of the field.
iii.	It is weakly repelled by a magnet.	It is weakly attracted by a magnet.
iv.	Magnetic moment of every atom of a diamagnetic substance is zero.	Every atom of a paramagnetic substance is a magnetic dipole having a certain resultant magnetic moment.
v.	When a rod of diamagnetic substance is suspended in a uniform magnetic field, it comes to rest with its length perpendicular to the direction of the field.	When a rod of paramagnetic substance is suspended in a uniform magnetic field, it comes to rest with its length parallel to the direction of the field.
vi.	There is no effect of temperature on diamagnetic substance.	There is effect of temperature on paramagnetic substance.

*[Any two points – **1 Mark each**]*

Q.26. Distinguish between 'paramagnetic' and 'ferromagnetic' substances. [Mar 16]

Ans:

No.	Paramagnetic substance	Ferromagnetic substance
i.	It is weakly attracted by a magnet.	It is strongly attracted by a magnet.
ii.	When kept in a non-uniform magnetic field, it shows moderate tendency to move from weaker to the stronger part of the field.	When kept in a non-uniform magnetic field, it shows strong tendency to move from weaker to the stronger part of the field.
iii.	When kept in an external magnetic field it becomes weakly magnetised, and the direction of magnetic moment acquired will be same as that of the field.	When kept in an external magnetic field it becomes strongly magnetised, and the direction of magnetic moment acquired will be same as that of the field.

SAMPLE CONTENT

iv.	When the external magnetic field is removed, the paramagnetic substance loses its magnetism.	When the external magnetic field is removed, the ferromagnetic substance retains magnetism permanently.
v.	They cannot be converted into ferromagnetic substances.	When heated above curie temperature, they become paramagnetic substances.
vi.	Every atom has some magnetic dipole moment but resultant dipole moment is zero.	The resultant magnetic dipole moment is greater.
vii.	They can be temporarily magnetised in external magnetic field.	They can be permanently magnetised.

*[Any two points – **1 Mark each**]*

***Q.27. Distinguish between diamagnetic and ferromagnetic substances.**

Ans:

No.	Diamagnetic Substance	Ferromagnetic Substance
i.	They are weakly repelled by magnet.	They are strongly attracted by magnet.
ii.	If a thin rod of diamagnetic substance is freely suspended in uniform magnetic field, it comes to rest slowly with its length perpendicular to the direction of magnetic field.	If a thin rod of ferromagnetic substance is freely suspended in a uniform magnetic field, it comes quickly to rest with its length parallel to the direction of the field.
iii.	When placed in non uniform magnetic field, they show a moderate tendency to move from the stronger to the weaker part of the field.	When placed in non uniform magnetic field, they show a strong tendency to move from the weaker to the stronger part of the field.
iv.	In the absence of external magnetic field, the resultant magnetic moment of each atom is zero.	The resultant magnetic moment of each atom of a ferromagnetic substance is much greater than zero.
v.	There is no effect of temperature on diamagnetic substance.	There is effect of temperature on ferromagnetic substance.
vi.	They cannot be permanently magnetised.	They can be permanently magnetised.

15.5 Curie temperature

***Q.28. What is Curie temperature? What happens above the Curie temperature? [July 18]**

Ans: i. *The temperature at which the domain structure is destroyed and a ferromagnetic substance loses its magnetism is called Curie temperature.*

ii. Above the Curie temperature, a ferromagnetic substance is converted into paramagnetic substance. The Curie temperature is different for different substances.

Q.29. What is the effect of heat on a ferromagnetic substance?

Ans: i. With increase in the temperature, the thermal vibrations of the atoms in the given ferromagnetic substance is increased and as a result, the inter atomic coupling becomes weak.

ii. At a higher temperature, the exchange coupling between the atomic magnets in each domain breaks completely and all the atomic dipoles get randomly oriented, destroying the domain structure.

iii. Hence above the Curie temperature ferromagnetic substance is converted into a paramagnetic substance.

Solved Examples

Miscellaneous

***Q.30. The susceptibility of magnesium at 300 K is 1.2×10^{-5}. At what temperature will the susceptibility increase to 1.8×10^{-5}? [July 16]**

Solution:

Given: $\chi_1 = 1.2\times10^{-5}$, $T_1 = 300$ K, $\chi_2 = 1.8\times10^{-5}$

To find: Required temperature (T_2)

Formula: χT = constant

Calculation: From formula,

$$\chi_1 T_1 = \chi_2 T_2 \quad \textit{[½ Mark]}$$

$$\therefore \quad T_2 = \frac{\chi_1 T_1}{\chi_2} = \frac{1.2\times10^{-5}\times300}{1.8\times10^{-5}} \quad \textit{[½ Mark]}$$

$$\therefore \quad T_2 = \mathbf{200\ K}$$

Ans: The required temperature is **200 K.** *[1 Mark]*

Q.31. The susceptibility of magnesium at 300 K is 2.4×10^{-5}. At what temperature will the susceptibility increase to 3.6×10^{-5}? [Mar 14]

SAMPLE CONTENT

Solution:

Given: $\chi_1 = 2.4\times10^{-5}$, $T_1 = 300$ K, $\chi_2 = 3.6\times10^{-5}$

To find: Required temperature (T_2)

Formula: χT = constant

Calculation: From formula,

$\chi_1 T_1 = \chi_2 T_2$ ***[½ Mark]***

$\therefore \quad T_2 = \frac{\chi_1 T_1}{\chi_2} = \frac{2.4\times10^{-5}\times300}{3.6\times10^{-5}}$ ***[½ Mark]***

$= \frac{2\times300}{3}$

= **200 K**

Ans: The temperature at which the susceptibility will increase is **200 K**. ***[1 Mark]***

Q.32. The susceptibility of magnesium at 200 K is 1.8×10^{-5}. At what temperature will the susceptibility decrease by 6×10^{-6}? [Mar 16]

Solution:

Given: $\chi_1 = 1.8 \times 10^{-5}$, $T_1 = 200$ K,

$\chi_1 - \chi_2 = 6 \times 10^{-6}$

$\Rightarrow \chi_2 = 1.8 \times 10^{-5} - 0.6 \times 10^{-5}$

$= 1.2 \times 10^{-5}$

To find: Required temperature (T_2)

Formula: χT = constant

Calculation: From formula,

$\chi_1 T_1 = \chi_2 T_2$

$\therefore \quad T_2 = \frac{\chi_1 T_1}{\chi_2}$ ***[½ Mark]***

$= \frac{1.8\times10^{-5}\times200}{1.2\times10^{-5}}$ ***[½ Mark]***

$\therefore \quad T_2$ = **300 K**

Ans: The required temperature is **300 K.** ***[1 Mark]***

Formulae

1. **Magnetic moment of current loop or a solenoid:**
   i. $M = IA$ (for single turn)
   ii. $M = nIA$ (for n turns)

2. **Magnetic induction due to current loop:**
   $B = \frac{\mu_0}{4\pi} \times \frac{2M}{x^3}$

3. **Torque:** $\tau = MB \sin\theta$

4. **For a revolving electron:**
   i. Magnetic moment, $M_0 = \frac{evr}{2} = \frac{eL_0}{2m_e}$
   where, L_0 = angular momentum
   ii. $I = \frac{e}{T} = ef = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$

5. **Magnetic intensity:** $H = \frac{B_0}{\mu_0}$

6. **Magnetization:**
   i. $M_Z = \frac{M_{net}}{V}$ ii. $M_Z = \frac{CB_{ext}}{T}$
   where, C = Curie constant

7. **Magnetic field due to iron core in toroid:**
   $B = \mu_0 (H + M_Z) = B_0 + B_M = \mu_0 \mu_r H = \mu H$
   where, $B_0 = \mu_0 H$ and $B_M = \mu_0 M_Z$

8. **Magnetic susceptibility:** $\chi_m = \frac{M_Z}{H} = \frac{B - B_0}{B_0}$

9. **Magnetic permeability:** $\mu = \frac{B}{H}$

10. **Relation between permeability and susceptibility:** $\mu = \mu_0(1 + \chi_m)$

11. **Relative permeability:** $\mu_r = \frac{\mu}{\mu_0} = 1 + \chi_m$

Exercise

One Mark Questions

1. What is gyromagnetic ratio?
Ans: *Refer Q.7*

2. State Curie's law.
Ans: *Refer Q.10*

3. Define the term magnetic permeability.
Ans: *Refer table 15.0. (Magnetic permeability)*

Two Marks Questions

1. What are directive and attractive properties of magnet?
Ans: *Refer Q.1 (i), (ii)*

2. Show that, $\mu = \mu_0(1 + \chi)$
where, μ = permeability of a substance,
μ_0 = permeability of free space,
χ = susceptibility of a substance.
Ans: *Refer Q.12*

3. Write a note on diamagnetic material.
Ans: *Refer Q.22. (Diamagnetic materials)*

4. Write a note on ferromagnetic material.
Ans: *Refer Q.22. (Ferromagnetic materials)*

5. How ferromagnetic substances are affected by heat?
Ans: *Refer Q.29*

SAMPLE CONTENT

6. What is
   i. Magnetization and
   ii. Magnetic intensity? **[Oct 13]**

   OR

   Define Magnetization and magnetic intensity. **[Mar 15]**

Ans: *Refer table 15.0*
*[Definitions – **1 Mark each**]*

7. *In a hydrogen atom, an electron of charge 'e' revolves in an orbit of radius 'r' with speed 'v'. Prove that the magnetic moment associated with the electron is given by $\frac{evr}{2}$.

   OR

   Show that the orbital magnetic dipole moment of a revolving electron is $\frac{evr}{2}$. **[Mar 14]**

   OR

   In a hydrogen atom, an electron carrying charge 'e' revolves in an orbit of radius 'r' with speed 'v'. Obtain an expression for the magnitude of magnetic moment of a revolving electron. **[Oct 14]**

Ans: *Refer Q.6*
*[Expression for time period T – ½ **Mark**, Expression for circulating current I – ½ **Mark**, Formula of magnetic dipole moment M_0 – ½ **Mark**, Final expression for M_0 – ½ **Mark**]*

8. Draw the diagrams showing the dipole moments in paramagnetic substance when external magnetic field is
   (a) absent
   (b) strong. **[July 16]**

Ans: *Refer Q. 24 [figure (a) and figure (c) only]*
*[Diagrams – **1 Mark each**]*

9. Define magnetization. State its formula and S.I. unit. **[Mar 13]**

Ans: *Refer table 15.0 (Magnetization)*
*[Definition – **1 Mark,** formula – ½ **Mark,** units – ½ **Marks**]*

10. Define magnetization. Write its SI unit and dimensions. **[Mar 18]**

Ans: *Refer table 15.0 (Magnetization)*

*11. Explain magnetic intensity.

Ans: *Refer table 15.0 (Magnetic intensity)*

12. Give any 'two' points of differences between diamagnetic and ferromagnetic substances. **[Oct 15]**

Ans: *Refer Q.27*
*[Any two points – **1 Mark each**]*

13. In a hydrogen atom, an electron revolves with a frequency of 6.8×10^9 megahertz in an orbit of diameter 1.06 Å. Calculate the equivalent magnetic moment.

Ans: 9.6×10^{-24} Am^2

14. The moment of magnet (15 cm × 2 cm × 1 cm) is 1.2 Am^2. What is its intensity of Magnetization?

Ans: 4×10^4 A m^{-1}

15. In hydrogen atom, the electron is making 6.6×10^{15} rev/sec around the nucleus in an orbit of radius 0.528 Å. Find the magnetic moment (Am^2).

Ans: 9.24×10^{-24} Am^2

16. A current of 3 A flows through a plane circular coil of radius 4 cm and having 20 number of turns. Find dipole moment of the coil.

Ans: 0.3 Am^2

Three Marks Questions

1. Discuss magnetization of a ferromagnetic material with the help of toroid with an iron core.

Ans: *Refer Q.11*

2. What are diamagnetic substances? Explain its origin on the basis of its atomic structure.

Ans: *Refer Q.23*

3. State any six properties of ferromagnetic substances.

Ans: *Refer table 15.2. (Properties of ferromagnetic substances)*

4. Write a note on domain theory.

Ans: *Refer 15.1.(Domain theory)*

*5. Explain ferromagnetism on the basis of domain theory. **[Mar 13 old course]**

Ans: *Refer table 15.1(Ferromagnetism on the basis of domain theory)*
*[Diagram – ½ **Mark each,** Explanation – ½ **Mark each**]*

6. The magnetic field B and the magnetic intensity H in a material are found to be 0.3 T and 400 A/m respectively. Calculate the relative permeability 'μ_r' and the susceptibility 'χ' of the material.

Ans: 597, 596

Five Marks Questions

1. What are paramagnetic substances? Explain its origin on the basis of its atomic structure.

Ans: *Refer Q.24*

SAMPLE CONTENT

2. i. Define magnetic susceptibility and relative permeability. **[2 M]**

Ans: *Refer table 15.0*

ii. The magnetic field B and the magnetic intensity H in a material are found to be 2.67 and 900 A/m respectively. Calculate the relative permeability μ_r and the susceptibility χ of the material. **[3 M]**

Ans: 2.36×10^3, 2.361×10^3

Board questions

Theory:

1. What is Curie temperature and what happens above Curie temperature? **[Mar 97]**
2. Explain ferromagnetism on the basis of domain theory. **[Mar 99]**
3. Explain ferromagnetism on the basis of domain theory. State any two points of difference between ferromagnetic and paramagnetic substances. **[Oct 2000]**
4. Explain ferromagnetism on the basis of domain theory. What is Curie temperature? **[Oct 06]**

Multiple Choice Questions

1. An example of diamagnetic substance is _____.
   (A) iron (B) copper
   (C) aluminium (D) nickel
2. A magnetising field of 2×10^3 ampere/m produces a magnetic flux density of 8π tesla in an iron rod. The relative permeability of the rod will be
   (A) 10^2 (B) 10^0 (C) 10^4 (D) 10^1
3. Diamagnetism is _____.
   (A) an orientation effect
   (B) a distortion effect
   (C) both orientation and distortion effects
   (D) mutual induction-effect
4. A copper rod is suspended in a non-homogeneous magnetic field region. The rod when in equilibrium will align itself
   (A) in the direction in which it was originally suspended.
   (B) in the region where the magnetic field is strongest.
   (C) in the region where the magnetic field is weakest and perpendicular to the direction of the magnetic field.
   (D) in the region where the magnetic field is weakest and parallel to the direction of the magnetic field there.
5. S.I. unit of magnetic dipole moment is _____. **[Mar 13 old course]**
   (A) A/m^3 (B) Am^{-2}
   (C) Am^2 (D) A – m
6. To protect the machine of a watch from external magnetic field, its box should be made of _____.
   (A) paramagnetic material
   (B) diamagnetic material
   (C) ferromagnetic material
   (D) non-magnetic material
7. Which of the following materials is repelled by an external magnetic field?
   (A) Iron (B) Cobalt
   (C) Steel (D) Copper
8. Which of the following groups are diamagnetic?
   (A) Hydrogen, oxygen, argon
   (B) Oxygen, copper, silver
   (C) Hydrogen, argon, copper
   (D) Argon, copper, silver
9. Iron shows its ferromagnetic property at _____.
   (A) temperatures below 770 °C
   (B) temperatures above 770 °C
   (C) all temperatures
   (D) normal temperature
10. Which of the following is a paramagnetic group?
    (A) Manganese, aluminum, oxygen
    (B) Water, oxygen, aluminium
    (C) Copper, manganese, aluminium
    (D) Aluminium, copper, water
11. Which of the following is a paramagnetic substance?
    (A) Air (B) Water
    (C) Oxygen (D) Copper
12. The cause of ferromagnetism is _____.
    (A) orbital motion of electrons
    (B) spin motion of electrons
    (C) permanent dipole moment
    (D) neither spin motion nor orbital motion.
13. When a small magnet is aligned with a non-uniform magnetic field, it will
    (A) remain at rest.
    (B) rotate but will not move.
    (C) move from high field region to low field region.
    (D) move from low field region to high field region.

SAMPLE CONTENT

14. In paramagnetic substances, the atom has _____.
    (A) no magnetic moment
    (B) torque
    (C) magnetic moment
    (D) domain

15. A circular loop is carrying current and is said to be equivalent to a magnetic dipole. Then, a point on the axis of the loop lies in its
    (A) end-on position.
    (B) broad side-on position.
    (C) both end-on and broad side-on positions.
    (D) none of the above.

16. If a watch-glass containing a small quantity of water is placed on two dissimilar magnetic poles, then water _____. **[Mar 17]**
    (A) shows a depression in the middle.
    (B) shows an elevation in the middle.
    (C) surface remains horizontal.
    (D) evaporates immediately.

Answers to Multiple Choice Questions

1.	(B)	2.	(C)	3.	(B)	4.	(D)
5.	(C)	6.	(C)	7.	(D)	8.	(D)
9.	(A)	10.	(A)	11.	(C)	12.	(C)
13.	(D)	14.	(C)	15.	(A)	16.	(A)

TOPIC TEST

Total : 25 Marks

Section A (1 × 5 = 5 Marks)

Choose the correct alternative.

1. Above Curie temperature, the ferromagnetic materials get converted into _____ material.
   (A) diamagnetic (B) non-magnetic
   (C) paramagnetic (D) ferrimagnetic

2. Which of the following substance has negative and very large value of permeability?
   (A) Ferromagnetic (B) Paramagnetic
   (C) Diamagnetic (D) None of these

3. Property possessed only by ferromagnetic substance is _____.
   (A) attracting magnetic substance
   (B) hysteresis
   (C) susceptibility independent of temperature
   (D) directional property

Answer the following.

1. What is gyromagnetic ratio?
2. What is Curie temperature?

Section B (2 × 3 = 6 Marks)

1. Write a note on paramagnetic materials.
2. Establish the relation between permeability and susceptibility of a substance.
3. A rod is subjected to a magnetising field of 10000 A/m. The susceptibility of the rod is 650. Find its permeability.

OR

3. The magnetic moment of a magnet of dimensions 6 cm × 3 cm × 1.5 cm is 4 Am^2. Calculate its magnetization.

Section C (3 × 3 = 9 Marks)

1. State any six properties of paramagnetic substances.
2. The magnetic field B and the magnetic intensity H in a material are found to be 0.5 T and 350 A/m respectively. Calculate the relative permeability 'μ_r' and the susceptibility 'χ' of the material.
3. Differentiate between diamagnetic substance and paramagnetic substance.

OR

3. Differentiate between diamagnetic substances and ferromagnetic substances.

Section D (5 × 1 = 5 Marks)

1. What are ferromagnetic substances? Explain its origin on the basis of domain theory.

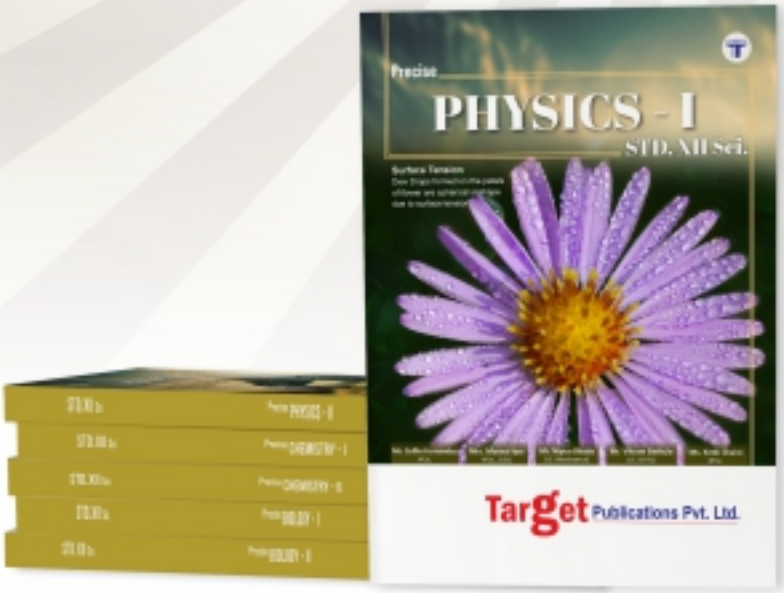
OR

1. i. Show that current loop behaves like a magnetic dipole. **[3 M]**
   ii. Calculate magnetic moment associated with a circular coil having 200 turns and diameter 20 cm carrying a current of 20 A in it. **[2 M]**

SAMPLE CONTENT

Std. XII

Precise Science



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- Precise Chemistry - I
- Precise Chemistry - II
- Precise Biology - I
- Precise Biology - II

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