SAMPLE CONTENT

TRIUMPH

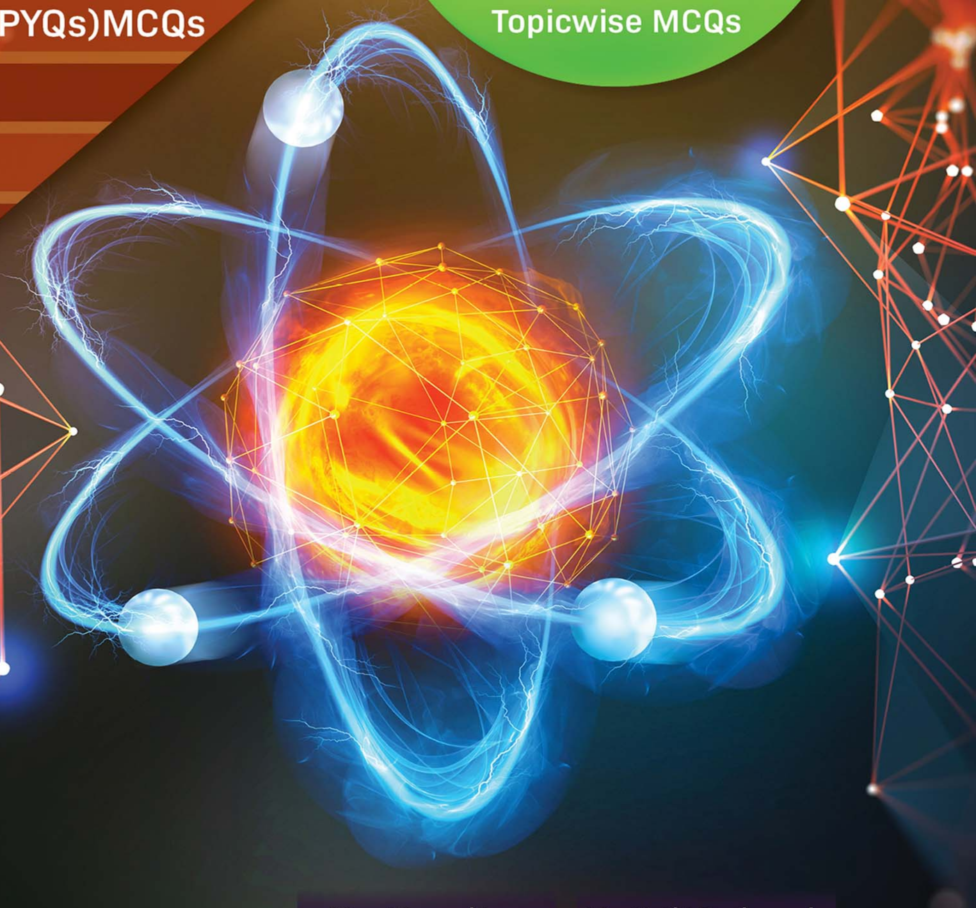
MHT-CET

PHYSICS

BASED ON STD. XI & XII SYLLABUS OF MHT-CET

7054 MCQs
Chapterwise and Topicwise MCQs

- Previous Years' Questions (PYQs)MCQs
- Segregated into 3 levels
- Model Question Papers
- Evaluation Tests
- Quick Review
- Smart Keys



Includes **Authentic Questions** From Latest **MHT-CET Examination**

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Target Publications® Pvt. Ltd.

Written in accordance with the latest MHT-CET Paper Pattern prescribed by State Common Entrance Test Cell, Maharashtra State

TRIUMPH

MHT-CET PHYSICS

7054 MCQS

Based on the latest Syllabus of MHT-CET

Salient Features

- Includes chapters of Std. XII and relevant chapters of Std. XI as per the latest MHT-CET Syllabus
- Includes '7054' MCQs
- Quick Review and exhaustive subtopic wise coverage of MCQs
- Compilation of all 'Important Formulae' & 'Fundamental Constants' in relevant chapters
- Solved Previous Years' MHT-CET questions till 2023
- Evaluation Test for each chapter
- Two Model Question Papers with answer keys (Solutions provided through Q.R. codes)
- Two Question Papers & Answer Keys of MHT-CET 2023 (Solutions provided through Q.R. codes)
- Includes **Smart Keys** (Key Notes For Good Practice, Shortcuts, Mindbenders, Caution, Thinking Hatke)
- 'Real-world applications' in each chapter
- Special inclusion: 'The physics of ….' to engage students in scientific enquiry.
- Video/pdf links via QR codes for boosting conceptual retention
- Answer keys for all the chapters and Evaluation Tests at the end of book
- *Solutions to MCQs and Evaluation Test can be accessed through Q.R. code given at the end of each chapter*

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PREFACE

"Don't follow your dreams; chase them!" A quote by Richard Dumbrill is perhaps the most pertinent for one who is aiming to crack entrance examinations held after Standard XII. We are aware of the aggressive competition a student appearing for such career-defining examinations experiences and hence wanted to create books that develop the necessary knowledge, tools, and skills required to excel in these examinations.

For the syllabus of **MHT-CET**, 80% of the weightage is given to the syllabus for XIIth standard while only 20% is given to the syllabus for XIth standard (with inclusion of only selected topics).

We believe that although the syllabus for Std. XII and XI and MHT-CET is aligned, the outlook for studying the subject should be altered based on the nature of the examination. To score well in the MHT-CET, a student has to be not just good with the concepts but also quick to complete the test successfully. Such ingenuity can be developed through sincere learning and dedicated practice.

As a first step to MCQ solving, students should start with elementary questions. Once momentum is gained, complex MCQs with a higher level of difficulty should be practised. Such holistic preparation is the key to succeeding in the examination!

Target's **Triumph MHT-CET Physics** book has been designed to achieve the above objectives. Beginning with basic MCQs, the book proceeds to develop competence to solve complex MCQs. It offers ample practice of recent questions from MHT-CET examinations. It also includes solutions (via QR codes) that provide explanations to help students learn how to solve the MCQs.

The sections of **Quick Review, Formulae, Fundamental Constants** and **MCQs (Classical, Critical, Concept Fusion, Previous Years' MHT-CET Questions, Evaluation Test)** form the backbone of every chapter and ensure adequate revision.

To optimise learning efficiency, multiple study techniques are included in every chapter in the form of **Smart Keys** *(Key Notes For Good Practice, Shortcuts, Mindbenders, Caution, Thinking Hatke)*.

The two **Model Question Papers** given at the end of the book are specially prepared to gauge the student's preparedness to appear for the MHT-CET examination. Two **MHT-CET 2023 Question Papers** have been provided to offer students a glimpse of the complexity of the questions asked in the examination.

All the features of this book pave the way for a student to excel in the examination. The features are designed keeping the following elements in mind: Time management, easy memorization or revision, and non-conventional yet simple methods for MCQ solving. The features of the book presented on the next page will explain more about them!

We hope the book benefits the learner as we have envisioned.

Publisher
Edition: Second

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.

Please write to us on: mail@targetpublications.org

FEATURES

Quick Review

Quick Review includes tables/charts to summarize the key points of important concepts in the chapter.
This is our attempt to help students to reinforce key concepts.

Formulae & Fundamental Constants

Formulae & Fundamental Constants cover all of the key formulae and constants in the chapter.
This is our attempt to make tools of formulae and constants accessible for students while solving problems and revising at last minute at a glance.

Sub-topic wise Segregation

Every section is **segregated sub-topic wise.**
This is our attempt to cater to individualistic pace and preferences of studying a chapter in students and enable easy assimilation of questions based on the specific concept.

Classical Thinking

Classical Thinking section encompasses straight forward questions including knowledge based questions.
This is our attempt to revise chapter in its basic form and warm up students to deal with complex MCQs.

Critical Thinking

Critical Thinking section encompasses challenging questions which test understanding, rational thinking and application skills of students.
This is our attempt to take students from beginner to proficient level in smooth steps.

Concept Fusion

Concept Fusion section encompasses whose solutions require knowledge of concepts covered in different sub-topics of same chapter or from different chapters.
This is our attempt to develop cognitive thinking in the students essential to solve questions involving fusion of multiple key concepts.

MHT-CET Previous Years' Questions

MHT-CET Previous Years' Questions section encompasses questions from MHT-CET examinations.
This is our attempt to give students practice of MHT-CET questions and advance them to acquire knack essential to solve such questions.

Continued…

FEATURES

Evaluation Test

Evaluation Test encompasses questions based on concepts covered in the entire chapter.
This is our attempt to allow self-assessment of the chapter

Smart Keys

Smart Keys comprise a set of remarkable study techniques contrived to benefit students.
This is our attempt to promote quick, innovative, and divergent thinking as well as enable the students to perceive the underlying depth and implications of concepts.

Key Notes For Good Practice

Key Notes For Good Practice consolidate critical information, useful facts and tips about the key concepts.

Shortcuts

Shortcuts incorporate important theoretical or formula based short tricks, beneficial in solving MCQs.

Mindbenders

Mindbenders present thought provoking snippets of concepts.

Caution

Caution apprises students about mistakes often made while solving MCQs.

Thinking Hatke

Thinking Hatke reveals quick witted approach to crack the specific question.

The physics of .....

The physics of ..... illustrates real life applications or examples related to the concept discussed.
This is our attempt to link learning to the life and make the students conscious of how Physics has touched entire spectrum of life.

QR Code

QR Code includes
- Video/pdf links for boosting conceptual retention
- Solutions to MCQs and Evaluation Test for each chapter
- Solutions to Model Question Papers I and II
- Solutions to MHT-CET 2023 Question Papers

MHT-CET PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject	Approximate No. of Multiple Choice Questions (MCQs) based on		Mark(s) Per Question	Total Marks
		Std. XI	Std. XII		
Paper I	Mathematics	10	40	2	100
Paper II	Physics	10	40	1	100
	Chemistry	10	40		
Paper III	Biology	20	80	1	100

- Questions will be set on
  i. the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by Maharashtra Bureau of Textbook Production and curriculum Research, Pune, and
  ii. chapters / units from Std. XI curriculum as mentioned below:

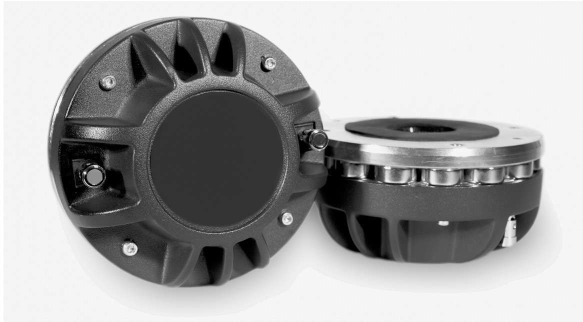
Sr. No.	Subject	Chapters / Units of Std. XI
1	Physics	Motion in a plane, Laws of motion, Gravitation, Thermal properties of matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter: Gaseous and Liquid States, Basic Principles of Organic Chemistry, Adsorption and Colloids, Hydrocarbons
3	Mathematics	Trigonometry - II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and osmoregulation

CONTENTS

Chapter

11

Magnetic Materials



NdFeB magnets

Neodymium or neodymium-iron-boron (NdFeB) magnets, are powerful permanent magnets made from an alloy of neodymium, iron, and boron. They are characterized by their extremely high magnetic field strength in a small volume. NdFeB magnets are manufactured by the process of powder metallurgy. This involves a complex sequence of steps encompassing raw material preparation, mixing, sintering and magnetization. Neodymium magnets are used in motors, loudspeakers, headphones, magnetic couplings and magnetic resonance imaging (MRI) machines.

Chapter Outline

Key Notes For Good Practice

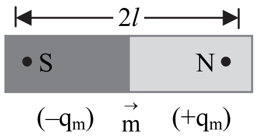
- *Intensity of magnetisation (M) is produced in materials due to spin motion of electrons.*
- *Universal property of substance is diamagnetism.*
- *Diamagnetism originates from the magnetic moment associated with orbital motion of electrons.*
- *All substances should exhibit diamagnetism. In paramagnetic or ferromagnetic substances, diamagnetic property is neutralised by large intrinsic dipole moment which provides stronger properties.*
- *Depending upon the structure and type of ferromagnetic material, the volume of magnetic domain varies from 10^{-18} to 10^{-12} m^3 and each domain contains 10^{17} to 10^{21} atoms.*
- *The minimum temperature at which the domain structure of ferromagnetic substance collapses completely and it is converted into paramagnetic substance is called as Curie temperature.*
- *Ferromagnetic substances do not obey Curie's law.*
- *The magnetic form of an element i.e., paramagnetic or diamagnetic can be determined by its electronic configuration. If the atom of element shows unpaired electrons, then the substance is paramagnetic. If the atom of element shows paired electrons, it is diamagnetic.*
- *Atoms which have paired electrons have zero magnetic moment.*
- *Ferromagnetic properties are due to partially filled sub-shells.*
- *If the body is diamagnetic, intensity of magnetisation (M) and magnetic field intensity (H) will be in opposite direction.*
- *If a body is a paramagnetic substance, intensity of magnetisation (M) and magnetic field intensity (H) will be in the same direction.*

Quick Review

Magnetic dipole moment:

Magnetic Dipole Moment ⇒ It represents the strength of a magnet.

$\vec{m} = q_m \left(2\vec{l}\right)$



Torque acting on a magnetic dipole in a uniform magnetic field	• $\tau = mB \sin\theta$

- The torque tends to align the magnetic dipole moment vector with the magnetic field vector.
- This torque is responsible for various phenomena, like the behavior of compass needles aligning with Earth's magnetic field, the operation of electric motors based on the interaction between a magnetic field and current-carrying wires

Magnetic potential energy in a uniform magnetic field	• $U_m = -mB \cos\theta$

Case 1 $\theta = 0°, U_m = -mB$	• The bar magnet is in stable equilibrium and has minimum potential energy.
Case 2 $\theta = 180°, U_m = mB$	• The bar magnet is in the most unstable state and has maximum potential energy.
Case 3 $\theta = 90°, U_m = 0$	• The bar magnet is perpendicular to the direction of magnetic field and has zero potential energy.

Time period of angular oscillation	• $T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{I}{mB}}$

Types of Magnetic Materials:

Types of Magnetic Materials

Diamagnetic

Substances which when placed in a magnetic field, are feebly magnetised in a direction opposite to that of the magnetising field are called diamagnetic substances.

Paramagnetic

Substances which when placed in a magnetic field are feebly magnetised in the direction of the magnetising field are called paramagnetic substances.

Ferromagnetic

Substances which when placed in a magnetising field are strongly magnetised in the direction of the magnetising field are called ferromagnetic substances.

➢ Properties of Magnetic Material:

Properties

Magnetization

The ratio of magnetic moment to the volume of the material is called magnetization.

Magnetic permeability (μ)

The ratio of the magnitude of total field inside the material to that of intensity of magnetising field is called magnetic permeability.

Magnetic susceptibility (χ)

The ratio of magnitude of intensity of magnetization to that of magnetic intensity is called as magnetic susceptibility.

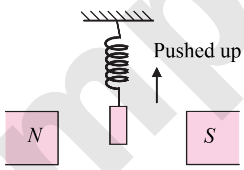
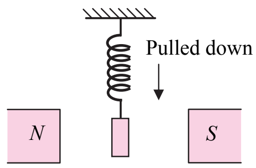
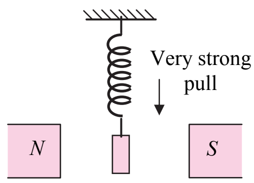
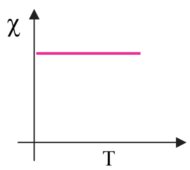
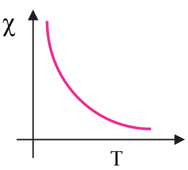
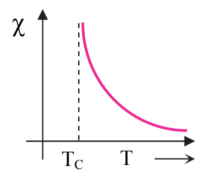
Magnetic intensity

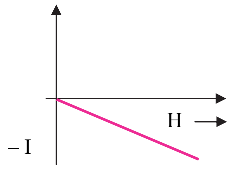
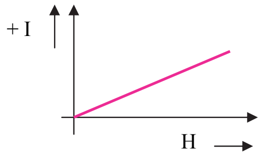
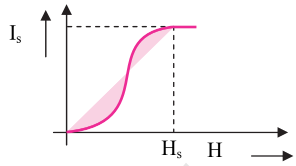
The ratio of the strength of magnetising field to the permeability of free space is called as magnetic intensity.
It is a quantity used to describe a magnetic phenomenon in terms of the magnetic field.

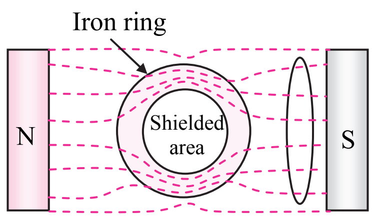
Relative permeability (μ_r)

The ratio of magnetic permeability of the material (μ) and magnetic permeability of free space (μ_0) is called relative permeability.

➢ Properties of Dia-, Para- and Ferro-magnetic substances:

Property	Diamagnetic substances	Paramagnetic substances	Ferromagnetic substances
Cause and Explanation of magnetism	Orbital motion of electrons	Spin motion of electrons	Formation of domains
Behaviour in a non-uniform magnetic field	They are repelled in external magnetic field hence move from high to low field region. 	These are feebly attracted in an external magnetic field they move from low to high field region hence slightly attracted. 	They easily move from low to high field region hence strongly attracted. 
State of magnetisation	Feebly magnetised in a opposite direction.	Feebly magnetised in same direction.	Strongly magnetised in same direction.
Substance placed inside a Magnetising field (H) OR The value of magnetic induction B	$B < B_0$ (where, B_0 is the magnetic induction in vacuum = $\mu_0 H$)	$B > B_0$	$B >> B_0$
Magnetic susceptibility χ	Low and negative $\lvert \chi \rvert \approx 1$	Low and positive $\chi \approx 1$	Positive and high $\chi \approx 10^2$
Dependence of χ on temperature	Independent of temperature (except *Bi* at low temperature). 	On cooling, these get converted to ferromagnetic materials at Curie temperature. 	These get converted into paramagnetic materials at Curie temperature. 

Relative permeability (μ_r)	$\mu_r < 1$ (as B is less than H.)	$\mu_r > 1$ (as B is slightly greater than H.)	$\mu_r >> 1$, of the order of 10^2
Intensity of magnetisation (I)	I and H are in opposite direction, value can be negative.	I and H are in same direction, value is low (positive).	I is in the direction of H and value is very high (positive).
I-H curves			
Magnetic moment (m)	Very low (≈ 0)	Very low but not zero	Very high
Examples	Cu, Ag, Au, Zn, Bi, Sb, NaCl, H_2O, air, diamond etc.	Al, Mn, Pt, Na, $CuCl_2$, O_2 and crown glass.	Fe, Co, Ni, Cd, Fe_3O_4 etc.

Ferromagnetism	
Curie temperature	• Curie's Law: $\frac{I}{H} = \frac{C}{T}$ or $\chi = \frac{C}{T}$ i.e., the magnetic susceptibility of paramagnetic material is inversely proportional to its absolute temperature. • *The minimum temperature at which the domain structure of ferromagnetic substance collapses completely and it is converted into paramagnetic substance is called as Curie temperature.* • Above Curie temperature, ferromagnetic substances lose their magnetic property.
Magnetic Shielding	• When a soft ferromagnetic material is kept in a uniform magnetic field, large number of magnetic lines crowd up inside the material leaving a few outside. • For a closed structure, like an iron ring, kept in magnetic field, very few lines of force pass through the enclosed space. This effect is known as magnetic shielding.  **Magnetic shielding**
Hysteresis	• *The lag of intensity of magnetisation (I) or magnetic induction (B) behind the magnetising field (H) during the process of magnetisation and demagnetisation of a magnetic material is called hysteresis.* • Exhibited only by ferromagnetic substances. • Area of I - H curve over a complete cycle is proportional to the net energy absorbed per unit volume.
Electromagnet	• The properties of the material of electromagnet are as follows: a. Low retentivity b. High value of saturation magnetisation c. Low coercivity d. The hysteresis loss of the material should be small e. High permeability and susceptibility • Soft iron is a suitable material for electromagnets

Permanent magnet	• *Substances which at room temperature retain their ferromagnetic property for a long period of time are called permanent magnets.* • The important requirement of the magnetic material are: a. High retentivity b. High coercivity c. Immunity to loss of magnetisation by alternating fields d. Negligible effect due to change in temperature e. The hysteresis loss of material of permanent magnet is immaterial in case of permanent magnets as they are never put through cycle of magnetisation. • Suitable material include steel, cobalt, alnico, ticonol, vicalloy etc.

Formulae

1. Torque acting on magnetic dipole:
$\tau = m\,B\,\sin\theta$

2. Potential energy of a bar magnet placed in a uniform magnetic field:
$U = -mB\cos\theta$

3. The small work done in rotating a bar magnet by an angle $d\theta$ (dipole moment is $\vec{m}$) will be:
$d\vec{W} = \tau \cdot d\theta$
$\int_0^w dW = \int_{\theta_1}^{\theta_2} \tau \cdot d\theta \quad \Rightarrow w = \int_{\theta_1}^{\theta_2} (m\,B\sin\theta)\,d\theta$
$= mB(\cos\theta_1 - \cos\theta_2)$

4. Time period of angular oscillations of a bar magnet:
$T = 2\pi\sqrt{\dfrac{I}{mB}}$

5. For a revolving electron:
i. Magnetic moment, $m_{orb} = \dfrac{evr}{2} = \dfrac{eL}{2m_e}$
where, L = angular momentum
ii. $I = \dfrac{e}{T} = ef = \dfrac{e}{2\pi r/v} = \dfrac{ev}{2\pi r}$

6. Gyromagnetic ratio: $\dfrac{m_{orb}}{L} = \dfrac{e}{2m_e}$

7. Bohr magneton: $\dfrac{eh}{4\pi m_e}$

8. Magnetic intensity: $H = \dfrac{B_0}{\mu_0}$

9. Magnetization:
i. $M = \dfrac{m_{net}}{V}$ ii. $M = \dfrac{CB_{ext}}{T}$
where, C = Curie constant

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

11. Magnetic susceptibility:
$\chi = \dfrac{M}{H} = \dfrac{B - B_0}{B_0}$

12. Magnetic permeability: $\mu = \dfrac{B}{H}$

13. Relation between permeability and susceptibility:
$\mu = \mu_0(1 + \chi)$

14. Relative permeability:
$\mu_r = \dfrac{\mu}{\mu_0} = 1 + \chi$

Fundamental Constants in This Chapter

1.	Bohr Magneton (μ_B)	9.274×10^{-24} A/m^2 or J/T
2.	Gyromagnetic ratio of electron	8.8×10^{10} C/kg or 1.76×10^{11} rad /sT
3.	Magnetic moment of an electron (m_{orb})	-9.28×10^{-24} J/T
4.	Boltzmann constant (k_B)	1.38×10^{-23} J/K
5.	Magnetic permeability of vacuum (μ_0)	1.26×10^{-6} N/A^2 or $4\pi \times 10^{-7}$ Hm^{-1}

Shortcuts

1. If a rectangular bar magnet is cut in n equal parts then time period of each part will be $\frac{1}{\sqrt{n}}$ times that of complete magnet $\left(\text{i.e., } T' = \frac{T}{\sqrt{n}}\right)$ while for short magnet $T' = \frac{T}{n}$. If nothing is said then bar magnet is treated as short magnet.
2. If the body is paramagnetic, B will be slightly greater than H. Therefore, μ will be slightly greater than 1.
3. For diamagnetic substance, B will be less than H. Therefore, μ will be less than 1.

Mindbenders

1. Diamagnetic substances can be compared to non-polar dielectrics and paramagnetic substances can be compared to polar dielectrics.
2. The existence and domains and their motion in applied magnetic field can be observed under a microscope, after sprinkling a liquid suspension of powdered ferromagnetic substance.

Classical Thinking

11.2 Torque Acting on a Magnetic Dipole in a Uniform Magnetic Field

1. In a uniform magnetic field, a bar magnet will experience
   (A) only force.
   (B) only torque.
   (C) both force and torque.
   (D) no force, no torque.

2. A bar magnet of magnetic moment $\vec{M}$ is placed in a magnetic field of induction $\vec{B}$. The torque exerted on it is
   (A) $\vec{M}\cdot\vec{B}$ (B) $-\vec{M}\cdot\vec{B}$
   (C) $\vec{M}\times\vec{B}$ (D) $\vec{B}\times\vec{M}$

3. There is no couple acting when two bar magnets are placed coaxially separated by a distance because
   (A) there are no forces on the poles.
   (B) the forces are parallel and their lines of action do not coincide.
   (C) the forces are perpendicular to each other.
   (D) the forces act along the same line.

4. The energy possessed by a magnetic dipole when placed along the direction the field is
   (A) maximum. (B) minimum.
   (C) zero. (D) unaffected.

5. The ratio of torque acting on a magnet of magnetic moment 'M' placed in uniform magnetic field when angle between $\vec{M}$ and $\vec{B}$ are 90° and 0° respectively is
   (A) 1 (B) 0 (C) ∞ (D) $\frac{1}{2}$

6. If the magnitude of torque is equal to the magnetic dipole moment and the axis of magnet is perpendicular to the field then the magnitude of magnetic induction is
   (A) 1 gauss (B) 1 Wb/m^2
   (C) 10^4 gauss (D) both (B) and (C)

11.3 Origin of Magnetism in Materials

1. In a hydrogen atom, an electron of charge 'e' revolves in a orbit of radius 'r' with speed 'v'. Then magnetic moment associated with electron is
   (A) evr (B) $\frac{evr}{3}$
   (C) 2evr (D) $\frac{evr}{2}$

2. If an electron of charge (–e) and mass m_e revolves around the nucleus of an atom having magnetic moment M_0, then angular momentum of electron is
   (A) $L_0 = \frac{M_0 e}{2m_e}$ (B) $L_0 = \frac{e}{2M_0 m_e}$
   (C) $L_0 = \frac{2M_0 m_e}{e}$ (D) $L_0 = \frac{2e}{M_0 m_e}$

3. Which of the following represents correct formula for circulating current?
(A) $I = \frac{2\pi r}{v}$ (B) $I = \frac{ev}{2\pi r}$
(C) $I = \frac{\pi rv}{2e}$ (D) $I = \frac{\pi rev}{2}$

4. If M_0 and L_0 denote the orbital angular moment and the angular momentum of the electron due to its orbital motion, then the gyromagnetic ratio is given by
(A) $\frac{L_0}{M_0}$ (B) $\frac{M_0}{L_0}$ (C) L_0M_0 (D) $\sqrt{\frac{M_0}{L_0}}$

5. The S.I. unit of gyromagnetic ratio is
(A) Cm (B) C kg
(C) $C\ kg^{-1}$ (D) $kg\ C^{-1}$

11.4 Magnetization and Magnetic Intensity

1. The magnetic susceptibility is given by
(A) $\chi = \frac{1}{H}$ (B) $\chi = \frac{B}{H}$
(C) $\chi = \frac{M_{net}}{V}$ (D) $\chi = \frac{M_z}{H}$

2. SI Unit of Magnetization is
(A) $\frac{A^2}{m}$ (B) $\frac{A}{m}$
(C) A^2m^2 (D) $\frac{A}{m^2}$

3. Relative permittivity and permeability of a material are ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?
(A) $\varepsilon_r = 1.5, \mu_r = 0.5$ (B) $\varepsilon_r = 0.5, \mu_r = 0.5$
(C) $\varepsilon_r = 1.5, \mu_r = 1.5$ (D) $\varepsilon_r = 0.5, \mu_r = 1.5$

4. Magnetization of a sample is
(A) volume of sample per unit magnetic moment.
(B) net magnetic moment per unit volume.
(C) ratio of magnetic moment and pole strength.
(D) ratio of pole strength to magnetic moment.

5. Magnetic material can be easily magnetized if magnetic susceptibility is
(A) very high and positive.
(B) very low and negative.
(C) very low and positive.
(D) very high and negative.

6. Which of the following is not correct about relative magnetic permeability (μ_r)?
(A) It is a dimensionless quantity.
(B) For vacuum its value is one.
(C) For ferromagnetic materials, $\mu_r << 1$
(D) For paramagnetic materials $\mu_r > 1$.

11.5 Magnetic Properties of Materials

1. The cause of paramagnetism is
(A) electrons.
(B) Unpaired electron and spin motion of electrons.
(C) paired electrons.
(D) orbital motion of electrons.

2. If a paramagnetic substance is placed in a non-uniform magnetic field, then it will move from
(A) weaker to stronger part
(B) remains stable
(C) stronger to weaker field
(D) perpendicular to field

3. A paramagnetic liquid is filled in a glass U tube of which one limb is placed between the pole pieces of an electromagnet. When the field is switched on, the liquid in the limb, which is in the field, will
(A) rise.
(B) fall.
(C) remain stationary.
(D) initially rise and then fall.

4. Susceptibility of a paramagnetic substance
(A) increases with increase in temperature.
(B) decreases with increase in temperature.
(C) remains same at any temperature.
(D) first increases then decreases with increase in temperature.

5. A permanent magnet can be made from which one of the following substances?
(A) Soft iron (B) Paramagnetic
(C) Diamagnetic (D) Ferromagnetic

6. Water is
(A) diamagnetic (B) paramagnetic
(C) ferromagnetic (D) None of these

7. Indicate the group containing only diamagnetic substances.
(A) Ar, Al, Ag, Ni, Co, Na, Cu
(B) Fe, Co, Ni, Gd, Fe_3O_4
(C) Al, Mn, Pt, Na, O_2, $CuCl_2$, Crown glass
(D) Air, Mercury, Antimony, NaCl, Au

8. An example of a diamagnetic substance is
(A) Aluminium (B) Copper
(C) Iron (D) Nickel

9. Permeability of diamagnetic materials are
(A) zero
(B) less than unity
(C) equal to unity
(D) greater than unity

10. If a diamagnetic liquid is placed in a watch glass on the pole pieces of a magnet, then the liquid will accumulate at
(A) centre.
(B) at some places between end and centre.
(C) ends.
(D) one third of its end.

11. When a gas is introduced between the pole-pieces of a magnet, it spreads at right angles to the magnetic field. The gas is
(A) paramagnetic (B) ferromagnetic
(C) diamagnetic (D) non-magnetic

12. Most of the substances show which of the following types of magnetism?
(A) Paramagnetism
(B) Ferromagnetism
(C) Diamagnetism
(D) Both diamagnetism and ferromagnetism

13. If a substance moves from the stronger to the weaker parts of a non-uniform magnetic field, then it is known as ______.
(A) paramagnetic (B) diamagnetic
(C) ferromagnetic (D) antiparamagnetic

14. A small piece of unmagnetised substance gets repelled, when it is brought near a powerful magnet. The substance can be _______.
(A) diamagnetic (B) ferromagnetic
(C) non-magnetic (D) paramagnetic

15. Which of the following is ferromagnetic?
(A) Quartz (B) Bismuth
(C) Nickel (D) Aluminium

16. When a ferromagnetic material is placed in a strong external magnetic field, its domain size
(A) increases.
(B) decreases.
(C) remains same.
(D) does not depend upon the strength of field.

17. Domain formation is a necessary feature of
(A) non magnetics (B) paramagnetics
(C) diamagnetics (D) ferromagnetics

18. Magnetic permeability of ferromagnetic substance is
(A) always zero.
(B) minimum.
(C) maximum.
(D) less than paramagnetic substance and more than diamagnetic substance.

19. Susceptibility of ferromagnetic substance is
(A) large and positive
(B) large and negative
(C) small and negative
(D) small and positive

20. Among the following for which, the magnetic susceptibility does not depend on the temperature?
(A) Diamagnetism (B) Paramagnetism
(C) Ferromagnetism (D) Ferrite

21. The substances which are strongly attracted by the magnet are _______.
(A) diamagnetic (B) paramagnetic
(C) ferromagnetic (D) electromagnetic

22. Iron is ferromagnetic _______.
(A) above 770 °C (B) below 770 °C
(C) at all temperature (D) above 1100 °C

23. Ferromagnetic substances have their properties due to
(A) filled inner sub-shells.
(B) vacant inner sub-shells.
(C) partially filled inner sub-shells.
(D) all the sub-shells equally filled.

24. Ferromagnetic substances have
(A) very high permeability and very high susceptibility.
(B) very high permeability and very low susceptibility.
(C) very low permeability and very low susceptibility.
(D) very low permeability and very high susceptibility.

25. A susceptibility of a certain magnetic material is 400. What is the class of the magnetic material?
(A) Diamagnetic (B) Paramagnetic
(C) Ferromagnetic (D) Ferroelectric

26. In the unmagnetised state of a ferromagnetic substance, all the domains in it are
(A) parallel to each other.
(B) perpendicular to each other.
(C) randomly oriented in all directions.
(D) anti parallel to each other.

27. Susceptibility of ferromagnetic substance is
(A) > 1 (B) < 1
(C) 0 (D) 1

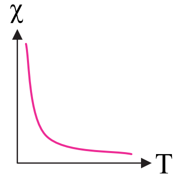
28. The magnetic susceptibility is negative for
(A) Ferromagnetic material only
(B) Paramagnetic and ferromagnetic materials
(C) Diamagnetic material only
(D) Paramagnetic material only

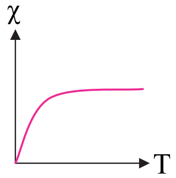
29. Maximum magnetization of a paramagnetic and ferromagnetic sample
(A) is of the same order.
(B) is smaller for para and larger for ferro.
(C) is smaller for ferro and larger for para.
(D) cannot be predicted.

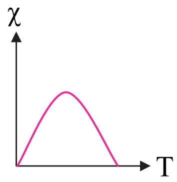
30. When a magnetic substance is heated, then
(A) it becomes a strong magnet.
(B) it losses its magnetism.
(C) it does not affect the magnetism.
(D) its susceptibility increases.

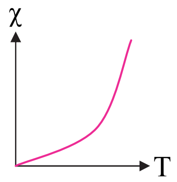
31. According to Curie's law,
(A) $\chi \propto (T - T_c)$ (B) $\chi \propto \frac{1}{T - T_c}$
(C) $\chi \propto \frac{1}{T}$ (D) $\chi \propto T$

32. Point out the best representation of relation between magnetic susceptibility (χ) and temperature (T) for a paramagnetic material.

(A)


(B)


(C)


(D)


33. Curie-Weiss law is obeyed by cobalt at a temperature
(A) Below Curie temperature
(B) At Curie temperature only
(C) Above Curie temperature
(D) At all temperatures

11.6 Hysteresis

1. The property possessed by only ferromagnetic substance is _________.
(A) hysteresis
(B) susceptibility
(C) directional property
(D) compressibility

2. In the hysteresis cycle, the value of H needed to make the intensity of magnetisation zero is called
(A) retentivity
(B) coercive force
(C) Lorentz force
(D) none of the above

3. The hard ferromagnetic material is characterised by
(A) narrow hysteresis loop.
(B) fat hysteresis loop.
(C) high mechanical hardness, all over.
(D) mechanically hard surface.

4. Hysteresis is the phenomenon of lagging of
(A) I behind B.
(B) B behind I.
(C) I and B behind H.
(D) H behind I.
Where, I is intensity of magnetisation, H is magnetic field intensity and B is magnetic field.

5. Which of the following is represented by the area enclosed by a hysteresis loop (B – H curve)?
(A) Permeability.
(B) Retentivity.
(C) Heat energy lost per unit volume in the sample.
(D) Susceptibility.

11.7 Permanent Magnet and Electromagnet

1. Which of the following is most suitable for the core of electromagnets?
(A) Soft iron
(B) Steel
(C) Copper-nickel alloy
(D) Air

2. Soft iron is used for making electromagnet because it
(A) has low retentivity.
(B) has low coercivity.
(C) small hysteresis loss.
(D) all of these.

3. Permanent magnets are the substanes having the property of
(A) ferromagnetism at room temperature for a long period of time.
(B) paramagnetism at room temperature for a long period of time.
(C) anti ferromagnetism at room temperature for a long period of time.
(D) diamagnetism at room temperatrue for a long period of time.

4. Strength of electromagnet can be increased by
(A) decreasing current in the coil.
(B) decreasing number of turns.
(C) using core of high permeability.
(D) using core of low permeability.

5. A permanent magnet
(A) attracts all substances.
(B) attracts only magnetic substances.
(C) attracts magnetic substances and repels all non-magnetic substances.
(D) attracts non-magnetic substances and repels magnetic substances.

Critical Thinking

11.2 Torque Acting on a Magnetic Dipole in a Uniform Magnetic Field

1. Rate of change of torque τ with deflection θ is maximum for a magnet suspended freely in a uniform magnetic field of induction B, when

(A) $\theta = 0°$ (B) $\theta = 45°$
(C) $\theta = 60°$ (D) $\theta = 90°$

2. A bar magnet is held perpendicular to a uniform magnetic field. If the couple acting on the magnet is to be halved by rotating it, then the angle by which it is to be rotated is

(A) 30° (B) 45°
(C) 60° (D) 90°

3. A magnetic dipole of moment 2.5 Am^2 is free to rotate in a horizontal plane. The work done in rotating the magnet slowly from a direction parallel to the field to a direction 60° from the field is $(B_H = 3 \times 10^{-5}$ T).

(A) 50 μJ (B) 100 μJ
(C) 175 μJ (D) 37.5 μJ

4 A bar magnet of magnetic moment 20 J/T lies aligned with the direction of a uniform magnetic field of 0.25 T. The amount of work required to turn the magnet so as to align its magnetic moment normal to the field direction is

(A) 0.10 J (B) 0.5 J
(C) 0.3 J (D) 5.0 J

5. A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60° is W. Now the torque required to keep the magnet in this new position is

(A) $\frac{2W}{\sqrt{3}}$ (B) $\frac{W}{\sqrt{3}}$
(C) $\sqrt{3}W$ (D) $\frac{\sqrt{3}W}{2}$

6. A magnetic needle has a magnetic moment of 5×10^{-2} Am^2 and moment of inertia 8×10^{-6} kgm^2. It has a period of oscillation of 2 s in a magnetic field. The magnitude of magnetic field is approximately

(A) 3.2×10^{-4} T (B) 1.6×10^{-3} T
(C) 0.8×10^{-3} T (D) 0.4×10^{-4} T

7. A closely wound solenoid of 2000 turns and area of cross-section 1.5×10^{-4} m^2 carries a current of 2.0 A. It is suspended through its centre and perpendicular to its length, allowing it to turn in a horizontal plane in a uniform magnetic field 5×10^{-2} tesla making an angle of 30^o with the axis of the solenoid. The torque on the solenoid will be

(A) 3×10^{-3} N-m (B) 1.5×10^{-3} N-m
(C) 1.5×10^{-2} N-m (D) 3×10^{-2} N-m

8. If there is no torsion in the suspension thread, then the time period of a magnet executing SHM is

(A) $T = 2\pi\sqrt{\frac{I}{MB}}$ (B) $T = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$
(C) $T = 2\pi\sqrt{\frac{MB}{I}}$ (D) $T = \frac{1}{2\pi}\sqrt{\frac{I}{MB}}$

9. A bar magnet is oscillating in the earth's magnetic field with time period T. If its mass is increased four times then its time period will be

(A) 4T (B) 2T (C) T (D) T/2

10. A thin bar magnet oscillates with a time period T. If it is cut into two equal pieces along its axis, time period of oscillation of each piece is

(A) T (B) 2T (C) $\frac{T}{2}$ (D) $\frac{T}{4}$

11. A magnetic needle of magnetic moment 6.7×10^{-2} Am^2 and moment of inertia 7.5×10^{-6} kg m^2 is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is

(A) 6.98 s (B) 8.76 s
(C) 6.65 s (D) 8.89 s

12. A magnetic dipole of magnetic moment 6×10^{-2} Am^2 and moment of inertia 12×10^{-6} kgm^2 performs oscillations in a magnetic field of 2×10^{-2} T. The time taken by the dipole to complete 20 oscillations is ($\pi = 3$)

(A) 18 s (B) 6 s (C) 36 s (D) 12 s

13. The period of oscillation of a thin magnet at a place is T. When it is stretched to double its length and its pole strength is reduced to $\frac{1}{4}$ of its initial value, then its period of oscillation is

(A) 2T (B) $\sqrt{2}$T
(C) $\frac{T}{2\sqrt{2}}$ (D) $2\sqrt{2}$ T

14. At a certain place a magnet makes 30 oscillations per minute. At another place where the magnetic field is doubled its time period will be

(A) $\sqrt{2}$ s (B) 2 s (C) 4 s (D) $\frac{1}{2}$ s

11.3 Origin of Magnetism in Materials

1. Dimensions of gyromagnetic ratio are ________.
   (A) $[L^1 M^0 T^1 I^1]$ (B) $[L^{-1} M^0 T^1 I^1]$
   (C) $[L^0 M^{-1} T^1 I^1]$ (D) $[L^1 M^0 T^0 I^{-1}]$

2. The angle made by orbital angular momentum of electron with the direction of the orbital magnetic moment is ________.
   (A) 180° (B) 90° (C) 120° (D) 60°

3. An electron revolving in a circular orbit of radius 'r' with velocity 'v' and frequency ν has orbital magnetic moment 'M'. If the frequency of revolution is doubled then the new magnetic moment will be
   (A) $\frac{M}{4}$ (B) $\frac{M}{2}$
   (C) 2M (D) M

4. If the angular momentum of an electron is $\vec{J}$ then the magnitude of the magnetic moment will be
   (A) $\frac{eJ}{m}$ (B) $\frac{eJ}{2m}$
   (C) eJ 2m (D) $\frac{2m}{eJ}$

5. Gyromagnetic ratio of the electron revolving in a circular orbit of hydrogen atom is 8.8×10^{10} C kg^{-1}. What is the mass of the electron? (Given charge of the electron $= 1.6 \times 10^{-19}$ C.)
   (A) 1×10^{-29} kg (B) 0.1×10^{-29} kg
   (C) 1.1×10^{-29} kg (D) $\frac{1}{11} \times 10^{-29}$ kg

6. The electron in the hydrogen atom is moving with a speed of 2.5×10^6 m/s in an orbit of radius 0.5 Å. Magnetic moment of the revolving electron is
   (A) 10^{-20} Am^2 (B) 2×10^{-21} Am^2
   (C) 10^{-23} Am^2 (D) 3×10^{-19} Am^2

7. The electron in the hydrogen atom revolves around the nucleus in an orbit of radius 0.5 Å. What is the equivalent magnetic moment, if the frequency of revolution of the electron is 10^{10} MHz?
   (A) 0.8×10^{-23} Am^2
   (B) 1.1×10^{-22} Am^2
   (C) 1.256×10^{-23} Am^2
   (D) 1.256×10^{-28} Am^2

11.4 Magnetization and magnetic intensity

1. Dimensions of magnetization are
   (A) $[M^0L^{-1}T^0I^1]$ (B) $[M^1L^1T^0I^{-1}]$
   (C) $[M^1L^{-1}T^{-1}I^{-1}]$ (D) $[M^{-1}L^0T^0I^{-1}]$

2. For an isotropic medium B, μ, H and M_z are related as (where B, μ_0, H and M_z have their usual meaning in the context of magnetic material)
   (A) $(B - M_z) = \mu_0 H$ (B) $M = \mu_0(H + M_z)$
   (C) $H = \mu_0(H + M_z)$ (D) $B = \mu_0(H + M_z)$

3. Relative permeability of nickel is 600, then its magnetic susceptibility will be
   (A) 600×10^7 (B) 600×10^{-7}
   (C) 601 (D) 599

4. **Assertion:** Susceptibility is defined as the ratio of intensity of magnetisation I to magnetic intensity H.
   Reason: Greater the value of susceptibility, smaller the value of intensity of magnetisation I.
   (A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion
   (B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion
   (C) Assertion is True, Reason is False
   (D) Assertion is False but, Reason is True.

5. The permeability of a metal is 0.1256 TmA^{-1}. What is its relative permeability?
   (A) 10^4 (B) 10^5
   (C) 2×10^6 (D) 3×10^5

6. Relative permeability of iron is 5500, then its magnetic susceptibility will be
   (A) 5500×10^7 (B) 5500×10^{-7}
   (C) 5501 (D) 5499

7. What is the magnetization of a bar magnet having length 6 cm and area of cross section 5 cm^2? (M = 1 Am^2)
   (A) 1.2×10^{-4} A/m (B) 3.3×10^4 A/m
   (C) 1.25×10^{-4} A/m (D) 3.3×10^{-4} A/m

8. The space within a current carrying toroid is filled with tungsten of susceptibility 6.8×10^{-5}. The percentage increase in the magnetic field B is
   (A) 6.8×10^{-3} (B) 68×10^{-3}
   (C) 6.08×10^{-4} (D) 68×10^5

9. A magnet of magnetic moment 3 Am^2 weighs 75 g. The density of the material of the magnet is 7500 kg/m^3. What is the magnetization?
   (A) 4×10^5 A/m (B) 3×10^5 A/m
   (C) 6×10^6 A/m (D) 2.5×10^5 A/m

10. A bar magnet has coercivity 4×10^3 Am^{-1}. It is desired to demagnetise it by inserting it inside a solenoid 12 cm long and having 60 turns. The current that should be sent through the solenoid is
    (A) 2 A (B) 4 A (C) 6 A (D) 8 A

11. Coercivity of a magnet where the ferromagnet gets completely demagnetized is 3×10^3 Am^{-1}. The minimum current required to be passed in a solenoid having 1000 turns per metre, so that the magnet gets completely demagnetized when placed inside the solenoid is
(A) 3 A (B) 30 mA
(C) 6 A (D) 60 mA

12. A solenoid has core of a material with relative permeability 500 and its windings carry a current of 1 A. The number of turns of the solenoid is 500 per metre. The magnetization of the material is nearly
(A) 2.5×10^3 Am^{-1} (B) 2.5×10^5 Am^{-1}
(C) 2.0×10^3 Am^{-1} (D) 2.0×10^5 Am^{-1}

13. An iron rod of cross sectional area 4 sq.cm is placed with its length parallel to a magnetic field of intensity 1200 A/m. The flux through the rod is 40×10^{-4} Wb. The permeability of the rod is
(A) 8.3×10^{-5} Wb/Am
(B) 8.3×10^{-4} Wb/Am
(C) 8.3×10^{-6} Wb/Am
(D) 8.3×10^{-3} Wb/Am

14. A magnetizing field of 5000 A/m produces a magnetic flux of 4×10^{-5} weber in an iron rod of cross sectional area 0.4 cm^2. The permeability of the rod in Wb/Am is
(A) 1×10^{-3} (B) 2×10^{-4}
(C) 3×10^{-5} (D) 4×10^{-6}

15. A magnetising field of 1500 A/m produces a flux of 2.4×10^{-5} weber in a bar of iron of cross-sectional area 0.5 cm^2. The relative permeability and susceptibility of the iron bar used are respectively.
(A) 255; 254 (B) 300; 350
(C) 254; 255 (D) 400; 590

11.5 Magnetic Properties of Materials

1. Magnetic permeability is maximum for
(A) diamagnetic substance
(B) paramagnetic substance
(C) ferromagnetic substance
(D) all of these

2. If a magnetic substance is kept in a magnetic field, then which of the following is thrown out?
(A) Paramagnetic (B) Ferromagnetic
(C) Diamagnetic (D) Antiferromagnetic

3. If a diamagnetic substance is brought near north or south pole of a bar magnet, it is
(A) attracted by the poles.
(B) repelled by the poles.
(C) repelled by the north pole and attracted by the south pole.
(D) attracted by the north pole and repelled by the south pole.

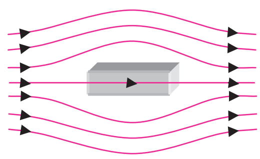
4. Which of the following statements are true about the magnetic susceptibility χ_m of paramagnetic substance?
(A) Value of χ_m is directly proportional to the absolute temperature of the sample.
(B) χ_m is positive at all temperatures.
(C) χ_m is negative at all temperatures.
(D) χ_m does not depend on the temperature of the sample.

5. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material are denoted by μ_d, μ_p and μ_f respectively, then
(A) $\mu_d \neq 0$ and $\mu_f \neq 0$
(B) $\mu_p = 0$ and $\mu_f \neq 0$
(C) $\mu_d = 0$ and $\mu_p \neq 0$
(D) $\mu_d \neq 0$ and $\mu_p = 0$

6. **Assertion:** Paramagnetism and ferromagnetism are associated with orbital motion of electrons.
Reason: In ferromagnetics, the magnetic effect is increased due to the formation of domains.
(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion
(C) Assertion is True, Reason is False
(D) Assertion is False but, Reason is True.

7. A ferromagnetic material is heated above its Curie temperature. Which one is a correct statement?
(A) Ferromagnetic domains are perfectly arranged.
(B) Ferromagnetic domains become random.
(C) Ferromagnetic domains are not influenced.
(D) Ferromagnetic material changes itself into diamagnetic material.

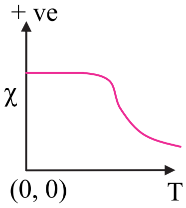
8. The given figure represents a material which is
(A) paramagnetic
(B) diamagnetic
(C) ferromagnetic
(D) none of these



9. **Assertion:** The susceptibility of diamagnetic materials does not depend upon temperature.
Reason: Every atom of a diamagnetic material is not a complete magnet in itself.
(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion
(C) Assertion is True, Reason is False
(D) Assertion is False but, Reason is True.

10. There are four light-weight-rod samples, A, B, C, D separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted.
i. A is feebly repelled
ii. B is feebly attracted
iii. C is strongly attracted
iv. D remains unaffected
Which one of the following is true?
(A) A is of a non-magnetic material.
(B) B is of a paramagnetic material.
(C) C is of a diamagnetic material.
(D) D is of a ferromagnetic material.

11. The variation of magnetic susceptibility (χ) with absolute temperature T for a ferromagnetic substance is represented by which graph.

(A)


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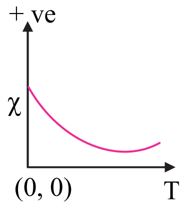

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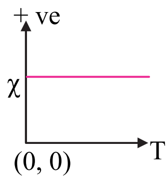

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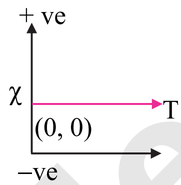
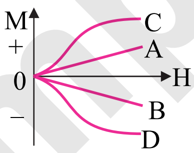
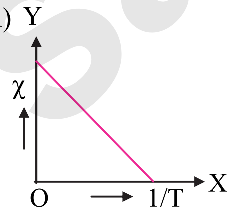


12. The most appropriate magnetization M versus magnetising field H curve for a paramagnetic substance is
(A) A
(B) B
(C) C
(D) D



13. The graph between χ and 1/T for paramagnetic material will be represented by

(A)


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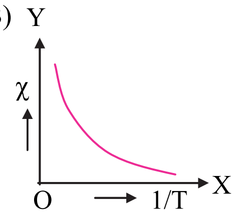

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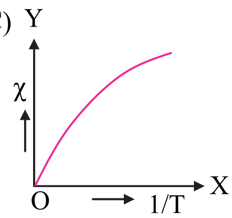
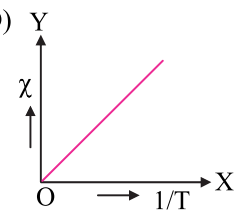
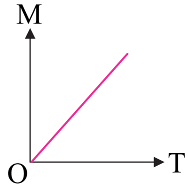
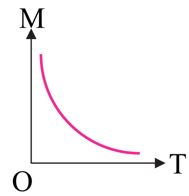
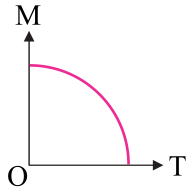


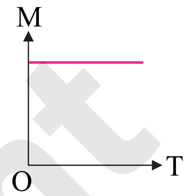
(D)


14. A curve between saturation magnetization and temperature of a ferromagnetic sample is

(A)


(B)


(C)


(D)


15. A domain in a ferromagnetic substance is in the form of a cube of side length 1 μm. If it contains 8×10^{10} atoms and each atomic dipole has a dipole moment of 9×10^{-24} A m^2, then magnetization of the domain is
(A) 7.2×10^5 A m^{-1} (B) 7.2×10^3 A m^{-1}
(C) 7.2×10^9 A m^{-1} (D) 7.3×10^{12} A m^{-1}

16. χ_1 and χ_2 are susceptibility of a paramagnetic material at temperatures T_1 K and T_2 K respectively, then
(A) $\chi_1 = \chi_2$ (B) $\chi_1 T_1 = \chi_2 T_2$
(C) $\chi_1 T_2 = \chi_2 T_1$ (D) $\chi_1 \sqrt{T_1} = \chi_2 \sqrt{T_2}$

17. The susceptibility of a magnetic material is χ at 127 °C. At what temperature will its susceptibility be reduced to half of its original value?
(A) 327 °C (B) 427 °C
(C) 527 °C (D) 627 °C

18. The magnetic susceptibility of a paramagnetic material is 1.0×10^{-5} at 27 °C temperature. Then, at what temperature its magnetic susceptibility would be 1.5×10^{-5}?
(A) 18 °C (B) 200 °C
(C) –73 °C (D) –18 °C

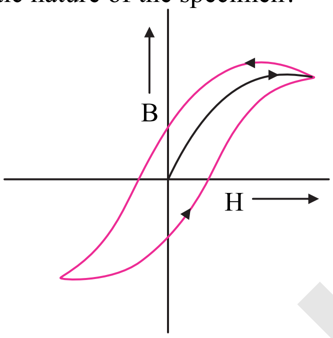
19. The susceptibility of a paramagnetic substance was found for different temperatures and a graph of χ against $\frac{1}{T}$ was plotted. From the graph, it was found that when χ = 0.5, $\frac{1}{T} = 5 \times 10^{-3}$/K. What is the curie constant for the substance?
(A) 50 K (B) 75 K
(C) 100 K (D) 125 K

11.6 Hysteresis

1. Which of the following statements in incorrect about hysteresis?
(A) This effect is common to all ferromagnetic substances.
(B) The hysteresis loop area is proportional to the thermal energy developed per unit volume of the material.
(C) The hysteresis loop area is independent of the thermal energy developed per unit volume of the material.
(D) The shape of the hysteresis loop is characteristic of the material.

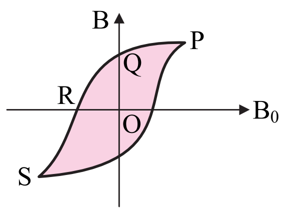
2. The use of study of hysteresis curve for a given material is to estimate the
(A) voltage loss (B) hysteresis loss
(C) current loss (D) power loss

3. The B – H curve for a certain specimen is schematically shown in the diagram below. Which one of the following is the correct magnetic nature of the specimen?



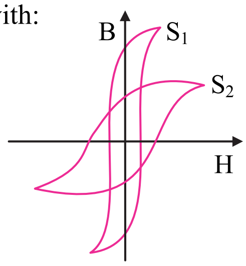
(A) Diamagnetic, and not ferromagnetic or paramagnetic
(B) Ferromagnetic and not diamagnetic or paramagnetic
(C) Paramagnetic, and not diamagnetic or ferromagnetic
(D) Applicable to all the three types of magnetism mentioned above.

4. The figure illustrates how B, the flux density inside a sample of unmagnetised ferromagnetic material varies with B_0, the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet



(A) OQ should be large, OR should be small.
(B) OQ and OR should both be large.
(C) OQ should be small and OR should be large.
(D) OQ and OR should both be small.

5. The B-H curves S_1 and S_2 in the adjoining figure are associated with:



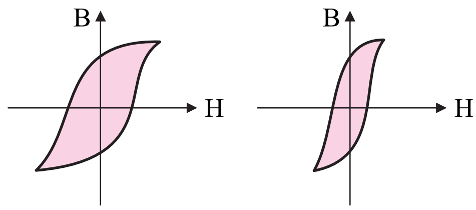
(A) a diamagnetic and paramagnetic substances respectively.
(B) a paramagnetic and ferromagnetic substances respectively.
(C) soft iron and steel respectively.
(D) steel and soft iron respectively.

11.7 Permanent Magnet and Electromagnet

1. The materials suitable for making electromagnets should have
(A) high retentivity and high coercivity.
(B) low retentivity and low coercivity.
(C) high retentivity and low coercivity.
(D) low retentivity and high coercivity.

2. The material of permanent magnet has
(A) high retentivity, low coercivity.
(B) low retentivity, high coercivity.
(C) low retentivity, low coercivity.
(D) high retentivity, high coercivity.

3. Hysteresis loops for two magnetic materials A and B are given below:



(A) (B)

These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use:
(A) A for electromagnets and B for electric generators.
(B) A for transformers and B for electric generators.
(C) B for electromagnets and transformers.
(D) A for electric generators and transformers.

4. In a permanent magnet at room temperature
(A) domains are partially aligned.
(B) magnetic moment of each molecule is zero.
(C) domains are all perfectly aligned.
(D) the individual molecules have non-zero magnetic moment which are all perfectly aligned.

5. The value of hysteresis loss of the material used as electromagnets should be ________.
(A) large (B) zero
(C) small (D) negative

6. The property of retentivity of a material is useful in the construction of
(A) transformers.
(B) electromagnets.
(C) permanent magnets.
(D) non-magnetic substances.

11.8 Magnetic Shielding

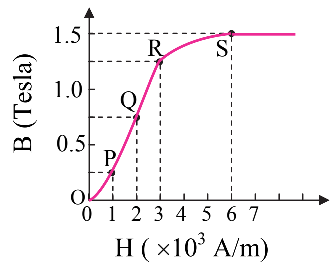
1. **Assertion:** To protect any instrument from external magnetic field, it is put inside an iron box.
Reason: Iron is a magnetic substance.
(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion
(C) Assertion is True, Reason is False
(D) Assertion is False but, Reason is True.

Concept Fusion

1. A thin diamagnetic rod is placed vertically between the poles of an electromagnet. When the current in the electromagnet is switched ON, then the diamagnetic rod is pushed up, out of the horizontal magnetic field. Hence the rod gains gravitational potential energy. The work required to do this comes from
(A) the current source
(B) the magnetic field
(C) the lattice structure of the material of the rod
(D) the induced electric field due to the changing magnetic field

2. Two small bar magnets are placed in a line with like poles facing each other at a certain distance d apart. If the length of each magnet is negligible as compared to d, the force between them will be inversely proportional to
(A) d (B) d^2
(C) $\frac{1}{d^2}$ (D) d^4

3. The basic magnetization curve for a ferromagnetic material is shown in figure. Then, the value of relative permeability is highest for the point
(A) P
(B) Q
(C) R
(D) S



MHT-CET Previous Years' Questions

1. The ratio of magnetic dipole moment of an electron of charge 'e' and mass 'm' in Bohr's orbit in hydrogen atom to its angular momentum is **[2014]**
(A) $\frac{e}{m}$ (B) $\frac{m}{e}$
(C) $\frac{2m}{e}$ (D) $\frac{e}{2m}$

2. Electromagnets are made of soft iron because soft iron has **[2014]**
(A) high susceptibility and low retentivity.
(B) low susceptibility and high retentivity.
(C) low susceptibility and low retentivity.
(D) high susceptibility and high retentivity.

3. For diamagnetic materials, magnetic susceptibility is **[2015]**
(A) small and negative.
(B) small and positive.
(C) large and negative.
(D) large and positive.

4. The magnetic field (B) inside a long solenoid having 'n' turns per unit length and carrying current 'I' when iron core is kept in it is (μ_0 = permeability of vacuum, χ = magnetic susceptibility) **[2016]**
(A) $\mu_0 nI (1 - \chi)$ (B) $\mu_0 nI \chi$
(C) $\mu_0 nI^2 (1 + \chi)$ (D) $\mu_0 nI (1 + \chi)$

5. An iron rod is placed parallel to magnetic field of intensity 2000 A/m. The magnetic flux through the rod is 6×10^{-4} Wb and its cross-sectional area is 3 cm^2. The magnetic permeability of the rod in Wb/A–m is **[2016]**
(A) 10^{-1} (B) 10^{-2}
(C) 10^{-3} (D) 10^{-4}

6. The magnetic moment of electron due to orbital motion is proportional to
(n = principal quantum numbers) **[2017]**
(A) $\frac{1}{n^2}$ (B) $\frac{1}{n}$ (C) n^2 (D) n

7. A bar magnet has length 3 cm, cross-sectional area 2 cm^2 and magnetic moment 3 Am^2. The intensity of magnetisation of bar magnet is **[2017]**
(A) 2×10^5 A/m (B) 3×10^5 A/m
(C) 4×10^5 A/m (D) 5×10^5 A/m

8. If M_Z = magnetization of a paramagnetic sample, B = external magnetic field, T = absolute temperature, C = curie constant then according to Curie's law in magnetism, the correct relation is **[2018]**
(A) $M_Z = \frac{T}{CB}$ (B) $M_Z = \frac{CB}{T}$
(C) $C = \frac{M_Z B}{T}$ (D) $C = \frac{T^2}{M_Z B}$

9. Magnetic susceptibility for a paramagnetic and diamagnetic materials is respectively **[2018]**
(A) small, positive and small, positive
(B) large, positive and small, negative
(C) small, positive and small, negative
(D) large, negative and large, positive

10. The magnetic susceptibility of paramagnetic substance is 3×10^{-4}. It is placed in magnetising field of 4×10^4 A/m. The intensity of magnetisation will be **[2019]**
(A) 12×10^8 A/m (B) 12 A/m
(C) 3.24 A/m (D) 4.3×10^8 A/m

11. The magnetization of bar magnet of length 5 cm, cross sectional area 2 cm^2 and net magnetic moment 1 Am^2 is **[2019]**
(A) 2×10^5 A/m (B) 3×10^5 A/m
(C) 1×10^5 A/m (D) 4×10^5 A/m

12. If a circular coil of radius 3 cm having 10 turns carries a current 0.2 A, then magnetic moment of the coil is **[2019]**
(A) 5.65×10^{-3} Am^2 (B) 6.56×10^{-3} Am^2
(C) 4×10^{-3} Am^2 (D) 3.5×10^{-3} Am^2

13. The magnetic susceptibility of a paramagnetic material at −73 °C is 0.0075 and its value at −173 °C will be **[2020]**
(A) 0.015 (B) 0.0045
(C) 0.0075 (D) 0.0030

14. A charge q is circulating with constant speed v in a semicircular loop of wire of radius R. The magnetic moment of this loop is **[2020]**
(A) qvR (B) $\frac{\pi Rqv}{2(\pi+2)}$
(C) $\frac{qvR}{3}$ (D) $\frac{qv\pi R}{\pi+2}$

15. There are three needles 'N_1', 'N_2' and 'N_3' made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. When a magnet is brought close to them, then it will **[2020]**
(A) attract N_1 strongly, N_2 and N_3 weakly.
(B) attract N_1 strongly and N_2 weakly, repel N_3 weakly.
(C) attract N_2 strongly, N_1 and N_3 weakly.
(D) attract N_1 strongly, repel N_2 and N_3 weakly.

16. A current carrying circular coil of area 'A' produces magnetic field 'B' at the centre. The magnetic moment of the coil is (μ_0 = permeability of free space) **[2020]**
(A) $\frac{2B\sqrt{A^3}}{\mu_0\sqrt{\pi}}$ (B) $\frac{2BA}{\mu_0}$
(C) $\frac{BA^3}{2\pi\mu_0}$ (D) $\frac{B\sqrt{A^3}}{4\pi\mu_0}$

17. In an atom, electron of charge (–e) performs U.C.M. around a stationary positively charged nucleus, with period of revolution 'T'. If 'r' is the radius of the orbit of the electron and 'v' is the orbital velocity, then the circulating current (I) is proportional to **[2020]**
(A) $e^1r^{-1}v^{-1}$ (B) $e^1v^1r^{-1}$
(C) $v^1r^1e^{-1}$ (D) $e^1r^1v^{-1}$

18. A torque of 1.732×10^{-5} Nm is required to hold a magnet at 90° with the horizontal component of earth's magnetic field. The torque required to hold it at 60° will be $\left[\sin\frac{\pi}{2} = 1, \sin\frac{\pi}{3} = \frac{\sqrt{3}}{2}\right]$
$\left[\sqrt{3} = 1.732\right]$ **[2020]**
(A) 0.5×10^{-5} Nm (B) 1×10^{-5} Nm
(C) 1.5×10^{-5} Nm (D) 1.732×10^{-5} Nm

19. The susceptibility of tungsten is 6.8×10^{-5} at temperature 300 K. The susceptibility at temperature 400 K is **[2020]**
(A) 4.8×10^{-5} (B) 6.8×10^{-5}
(C) 3.4×10^{-5} (D) 5.1×10^{-5}

20. The magnetic moment produced in a sample of 2 gram is 8×10^{-7} Am^2. If its density is 4 g/cm^3, then the magnetization of the sample is **[2020]**
(A) 1.6 (B) 1.8
(C) 1.4 (D) 1.2

21. A domain in a ferromagnetic substance is in the form of cube of side 1 μm. If it contains 8×10^{10} atoms and each atomic dipole has dipole moment of 9×10^{-24} Am^2, then the magnetization of the domain is **[2020]**

(A) 7.2×10^5 Am^{-1} (B) 7.2×10^3 Am^{-1}
(C) 7.2×10^9 Am^{-1} (D) 7.2×10^{12} Am^{-1}

22. The relation between magnetic moment 'M' of revolving electron and principal quantum number 'n' is **[2021]**

(A) $M \propto \frac{1}{n}$ (B) $M \propto n$
(C) $M \propto n^2$ (D) $M \propto n^3$

23. A magnetizing field of 1000 A/m produces a magnetic flux of 2.4×10^{-5} Wb in an iron bar of cross-sectional area 0.3 cm^2. The magnetic permeability of the iron bar in SI unit is **[2022]**

(A) 5×10^{-4} (B) 4×10^{-4}
(C) 2.5×10^{-4} (D) 8×10^{-4}

24. A metal wire is of length l and magnetic moment M. What is the new magnetic moment if it is bent in L-shape? **[2022]**

(A) $\frac{M}{2}$ (B) $\frac{M}{\sqrt{2}}$ (C) 2M (D) M

25. The region inside a current carrying toroid is filled with a material having susceptibility χ. The percentage increase in the magnetic field in the presence of the material, over that without it is **[2022]**

(A) $\chi \times 10^5$ (B) $\chi \times 10^4$
(C) $\chi \times 10^2$ (D) $\chi \times 10^{-2}$

26. A magnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T and magnetic intensity of 60×10^3 A/m. Its magnetic susceptibility is nearly **[2022]**

(A) 4.3×10^{-2} (B) 3.3×10^{-2}
(C) 3.3×10^{-4} (D) 2.3×10^{-2}

27. According to Curie's law in magnetism, the correct relation is (M = magnetization in paramagnetic sample, B = applied magnetic field, T = absolute temperature of the material, C = curie's constant) **[2023]**

(A) $M = \frac{T}{CB}$ (B) $M = \frac{CB}{T}$
(C) $C = \frac{MB}{T}$ (D) $C = \frac{T^2}{MB}$

28. An electron of charge 'e' and mass 'm' is revolving which has orbital magnetic moment 'M'. Its angular momentum is given by **[2023]**

(A) $\frac{Mm}{e}$ (B) $\frac{2Mm}{e}$
(C) $\frac{Me}{m}$ (D) $\frac{m}{Me}$

29. The materials suitable for making electromagnets should have **[2023]**

(A) high retentivity and high coercivity
(B) low retentivity and low coercivity
(C) high retentivity and low coercivity
(D) low retentivity and high coercivity

30. A thin rod of length L has magnetic moment M when magnetised. If rod is bent in a semicircular arc what is magnetic moment in new shape? **[2023]**

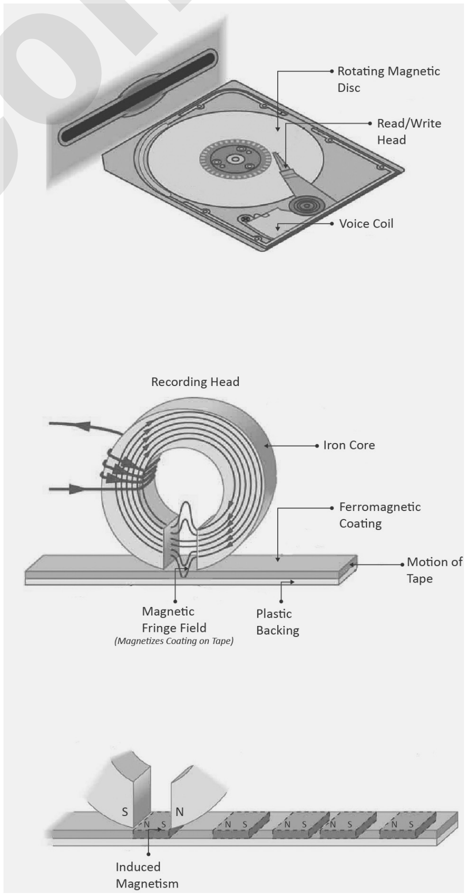
(A) $\frac{M}{L}$ (B) $\frac{M}{\pi}$ (C) $\frac{M}{2\pi}$ (D) $\frac{2M}{\pi}$

31. In the hysteresis cycle, the value of magnetizing force (H) needed to make intensity of magnetization (B) as zero is called as **[2023]**

(A) retentivity (B) coercivity
(C) domain value (D) saturation

The physics of …..

Magnetic tape recording ….



The magnetic fringe field of the recording head penetrates the magnetic coating on the tape and causes the coating to become magnetized. What mechanism allows this to happen?

The answer is at the end of this chapter.

Evaluation Test

1. A cylindrical rod magnet having length of 4 cm and a diameter of 1.2 cm has a uniform magnetization of 4.20×10^3A/m^3. Its magnetic dipole moment is
(A) 1.9×10^{-2} J/T (B) 3.8×10^{-2} J/T
(C) 5.7×10^{-2} J/T (D) 7.6×10^{-2} J/T

2. **Assertion:** Intensity of magnetization is directly proportional to susceptibility.
Reason: Susceptibility is defined as the ratio of magnetic intensity (H) to the intensity of magnetization (I).
(A) If both assertion and reason are true and reason is the correct explanation of assertion
(B) If both assertion and reason are true but reason is not be correct explanation of assertion
(C) If assertion is true but reason is false
(D) If assertion is false but reason is true

3. A magnetic dipole of moment 4.5 Am^2 is free to rotate in a horizontal plane. The work done in rotating the magnet slowly from a direction parallel to the field to a direction 60° from the field is $(B_H = 2 \times 10^{-5}\ T)$.
(A) 50 μJ (B) 100 μJ
(C) 175 μJ (D) 45 μJ

4. A bar of diamagnetic substance is placed in a magnetic field with its length making angle θ with the direction of the magnetic field. How will the bar behave?
(A) It will align itself parallel to the magnetic field
(B) It will align itself perpendicular to the magnetic field
(C) It will not show any change
(D) Its behaviour cannot be predicted

5. A solenoid has a core of a material having relative permeability 350. The windings of the solenoid are insulated from the core and carry a current of 1 A. If the number of turns is 500 per metre, the magnetization is
(A) 1.8×10^5 Am^{-1} (B) 3.6×10^5 Am^{-1}
(C) 5.4×10^5 Am^{-1} (D) 7.2×10^5 Am^{-1}

6. A bar magnet of magnetic moment 200 A-m^2 is suspended in a magnetic field of intensity 0.25 N/A-m. The couple required to deflect it through 30° is
(A) 50 N-m (B) 25 N-m
(C) 20 N-m (D) 15 N-m

7. The space within a current carrying toroid is filled with tungsten of susceptibility 4.6×10^{-5}. The percentage increase in the magnetic field is
(A) 2.3×10^{-3} (B) 4.6×10^{-3}
(C) 6.9×10^{-3} (D) 9.2×10^{-3}

8. A toroid has 1500 turns and the inner and outer radii of its core 6 cm and 8 cm respectively. The magnetic field in the core for a current of 0.5 A is 2 T. The relative permeability of core is
(A) 156.3 (B) 662.2
(C) 931.5 (D) 1863

9. An iron rod of 0.1 cm^2 cross-sectional area is subjected to a magnetising field of 800 A/m. If the susceptibility of iron is 599, then magnetic flux produced in the rod is
(A) 0.6×10^{-5} Wb (B) 6×10^{-5} Wb
(C) 1.12×10^{-5} Wb (D) 2.24×10^{-5} Wb

10. A bar magnet having coercivity 4×10^3 Am^{-1} is demagnetised by inserting it inside a solenoid 10 cm long and having 50 turns. The current that should be sent through the solenoid is
(A) 1 A (B) 4 A
(C) 8 A (D) 16 A

11. Select the correct option:
i. Susceptibility of a diamagnetic substance is high and negative.
ii. In paramagnetic substance, the intrinsic magnetic moment is not zero.
iii. When a paramagnetic substance is heated, it becomes ferromagnetic.
iv. Spin exchange interaction is present in the absence of external magnetic field.
(A) (i) and (iii) (B) (iii) and (iv)
(C) (ii) and (iii) (D) (ii) and (iv)

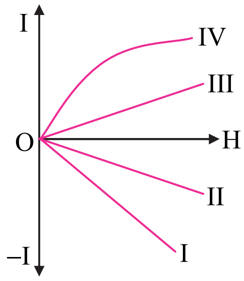
12. An iron rod of volume 10^{-4} m^3 and relative permeability 900 is placed inside a long solenoid wound with 6 turns/cm. If a current of 0.4 A is passed through the solenoid, the magnetic moment of the rod is
(A) 0.216 Am^2 (B) 2.16 Am^2
(C) 21.6 Am^2 (D) 2.16×10^{-2} Am^2

13. A magnetic needle of magnetic moment 4.6×10^{-2} Am^2 and moment of inertia 5.5×10^{-6} kgm^2 is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is
(A) 6.98 s (B) 8.76 s
(C) 6.87 s (D) 8.89 s

14. What is the magnetization of a bar magnet having length 4 cm and area of cross section 6 cm^2? (M = 1 Am^2)

(A) 1.2×10^{-4} A/m (B) 4.2×10^{4} A/m
(C) 1.25×10^{-4} A/m (D) 4.2×10^{-4} A/m

15. The most appropriate I-H curve for a paramagnetic substance is



(A) I (B) II
(C) III (D) IV

The Answer to Physics of…..

Magnetic tape recording

The process of magnetic tape recording is based on induced magnetism. The weak electrical signal from a microphone is fed to an amplifier where it is amplified. The current from the output of the amplifier is then sent to the recording head which is a coil of wire wrapped around an iron core. The iron core has the approximate shape of a horseshoe with a small gap between the two ends. The ferromagnetic iron substantially enhances the magnetic field produced by the current in the wire.

When there is a current in the coil, the recording head becomes an electromagnet with a north pole at one end and a south pole at the other end. The magnetic field lines pass through the iron core and cross the gap. Within the gap, the lines are directed from the north pole to the south pole. Some of the field lines in the gap "bow outward", the bowed region of magnetic field being called the fringe field. The fringe field penetrates the magnetic coating on the tape and induces magnetism in the coating. This induced magnetism is retained when the tape leaves the vicinity of the recording head and thus, provides a means for storing audio information. Audio information is stored because at any instant in time the way in which the tape is magnetized depends on the amount and direction of current in the recording head. The current, in turn, depends on the sound picked up by the microphone, so that changes in the sound that occur from moment to moment are preserved as changes in the tape's magnetism.

Answer Key of the chapter: *Magnetic Materials* & Evaluation Test is given at the end of the book.

Solutions to the relevant questions of this chapter & Evaluation Test can be accessed by scanning the adjacent QR code in ***Quill - The Padhai App.***