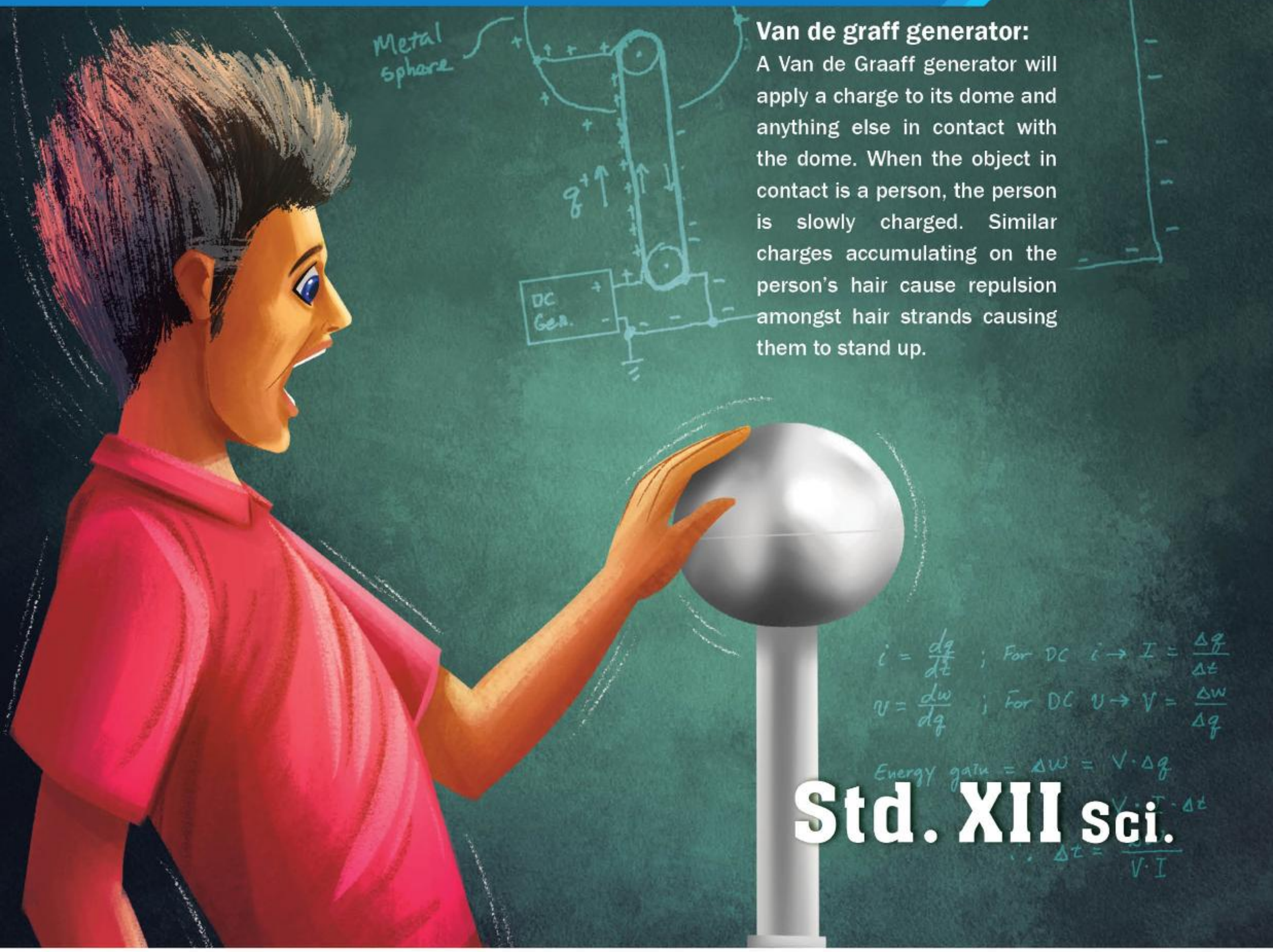
PERFECT

PHYSICS

Vol. II

As per the new textbook prescribed by Maharashtra State Board



Van de graff generator:
A Van de Graaff generator will apply a charge to its dome and anything else in contact with the dome. When the object in contact is a person, the person is slowly charged. Similar charges accumulating on the person's hair cause repulsion amongst hair strands causing them to stand up.

Std. XII Sci.

Target Publications® Pvt. Ltd.

Written as per the latest textbook prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

PERFECT

PHYSICS (Vol. II)

Std. XII Sci

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PREFACE

Perfect Physics XII, Vol. II is intended for every Maharashtra State Board aspirant of Std. XII, Science. The scope, sequence, and level of the book are designed to match the new textbook of Maharashtra State board.

At a crucial juncture of cracking a career defining board examination, we wanted to create a book that not just develops the necessary knowledge, tools and skills required to excel in the examination in students but also enables them to appreciate the beauty of subject and piques their curiosity.

We believe the students need meaningful content presented in a way that is easy to read and understand rather than being mired down with facts and information. They do much better when they understand why Physics is relevant to their everyday lives.

Comprehension of Physics eventuates naturally when subject is studied systematically with sincere and dedicated efforts.

Core of Physics lies in its concepts. To begin with, students should read a concept, contemplate upon its essence and attempt to produce the same in their own words. Students should then attempt theoretical questions based on that concept to gauge the level of understanding achieved.

To quote Albert Einstein, **"If you can't explain it simply, you don't understand it yourself."**

Though Physics is communicated in English, it is expressed in Mathematics. Hence, it is essential to befriend formulae and derivations. These should be learnt and memorized. Once Physical mathematics of concept is ingrained, solved numericals should be studied, starting from simple problems to difficult by escalating level of complexity gradually. Students are required to practise numericals and ascertain their command on problem solving. Calculations at this stage must be done using log table keeping in mind that calculators are not allowed in Board Exams. **When it comes to problems in Physics nothing makes students perfect like practice!**

Frequent revisions of concepts and numericals, help in imbibing the topic learnt and therefore should be allotted definite time.

A test on the chapter studied should be taken to check one's range of preparation.

Amongst building concepts, advancing into numbers and equations, it is essential to ponder underlying implications of subject. Students should read from references, visit authentic websites, watch relevant fascinating links and even experiment on their own following proper safety guidelines.

As famous hat detective Sherlock Holmes has pointed, **people see, they do not observe**. By becoming attentive to their surroundings, students can easily perceive how Physics has touched entire spectrum of life. The very realization is catalyst enough for students to admire and further dive into this compelling subject.

Our **Perfect Physics** adheres to our vision and achieves several goals: **building concepts**, **developing competence to solve numericals, recapitulation, self-study, self-assessment** and **student engagement**—all while encouraging students toward cognitive thinking.

FeaturFeatures of the book presented below will explicate more about the same!

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.
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KEY FEATURES

Reading between the lines

Reading between the lines provides elaboration or missing fragments of concept which is essential for complete understanding of the concept.

NCERT Corner

NCERT Corner covers information from NCERT textbook relevant to topic.

Connections

Connections enable students to interlink concepts covered in different chapters.

QR Codes

QR code provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity
ii. The Latest Board Question Papers

Enrich Your Knowledge

Enrich Your Knowledge presents fascinating information about the concept covered.

GG-Gyan Guru

Gyan Guru illustrates real life applications or examples related to the concept discussed.

Apply Your Knowledge

Apply Your Knowledge includes challenging questions.

Quick Review

Quick review includes table / flow chart to summarize the key points in chapter.

Important Formulae

Important Formulae includes all of the key formulae in the chapter.

Competitive Corner

Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main), NEET (ODISHA), MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

PAPER PATTERN

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

Section A: **(18 Marks)**

This section will contain Multiple Choice Questions and Very Short Answer (VSA) type of questions.
There will be 10 MCQs and 8 VSA type of questions, each carrying one mark.
Students will have to attempt all these questions.

Section B: **(16 Marks)**

This section will contain 12 Short Answer (SA-I) type of questions, each carrying 2 marks.
Students will have to attempt any 8 questions.

Section C: **(24 Marks)**

This section will contain 12 Short Answer (SA-II) type of questions, each carrying 3 marks.
Students will have to attempt any 8 questions.

Section D: **(12 Marks)**

This section will contain 5 Long Answer (LA) type of questions, each carrying 4 marks.
Students will have to attempt any 3 questions.

Distribution of Marks According to the Type of Questions

Type of Questions		
MCQ	1 Mark each	10 Marks
VSA	1 Mark each	8 Marks
SA - I	2 Marks each	16 Marks
SA - II	3 Marks each	24 Marks
LA	4 Marks each	12 Marks

Percentage wise distribution of marks	
Theory	63%
Numerical	37%

CONTENTS

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04**]**

Note:
1. * mark represents Textual question.
2. # mark represents Intext question.
3. + mark represents Textual examples.
4. symbol represents textual questions that need external reference for an answer.

11 Magnetic Materials

Contents and Concepts

11.1 Introduction

Q.1. Can you recall? *(Textbook page no. 251)*

i. What are magnetic lines of force?

Ans: The magnetic field around a magnet is shown by lines going from one end of the magnet to the other. These lines are named as magnetic lines of force.

ii. Why magnetic monopoles do not exist?

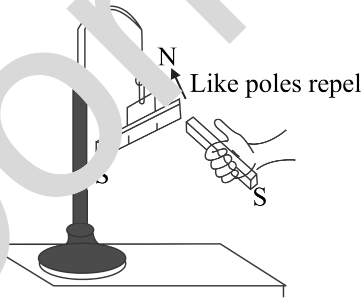
Ans: When a magnet is divided into two parts, each part forms a magnet with two poles. Thus, two independent magnets are obtained upon division. It means that the two poles of a magnet cannot be separated from each other. Hence, magnetic monopoles do not exist.

iii. Which materials are used in making magnetic compass needle?

Ans: Magnetite (lodestone or leading stone) are used in making magnetic compass needle.

Q.2. Activity. *(Textbook page no. 251)*

You have already studied in earlier classes that a short bar magnet suspended freely always aligns in North South direction (as shown in figure below). Now if you try to forcefully move and bring it in the direction along East West and leave it free, you will observe that the magnet starts turning about the axis of suspension. Do you know from where does the torque which is necessary for rotational motion come from?



Short bar magnet suspended freely with an inextensible string

Ans:

i. The forces exerted on the poles of the bar magnet due to magnetic field are along different directions.

ii. These forces form a couple. This couple provides the necessary torque required for rotational motion.

Q.3. Try This. *(Textbook page no. 251)*

Now we will extend the above experiment further by bringing another short bar magnet near to the freely suspended magnet.

Observe the change when the like and unlike poles of the two magnets are brought near each other. Draw conclusion. Does the suspended magnet rotate continuously or rotate through certain angle and remain stable?

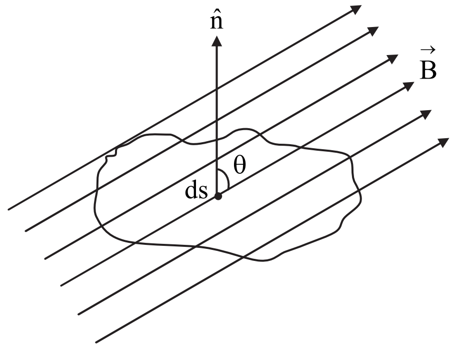
Ans:

i. **Conclusions drawn from the experiment:**
   a. like poles repel each other
   b. unlike poles attract each other.

ii. The suspended magnet rotates through a certain angle and then becomes stationary.

NCERT Corner

Magnetism and Gauss' Law



The magnetic flux through a small area is given by, $d\phi = Bds$

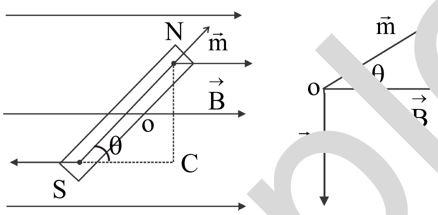
The total flux is given by, $\phi = \sum Bds = 0$

This is analogous to Gauss' law of electrostatics which states, $\sum Eds = \frac{q}{\varepsilon_0}$

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

Q.4. Derive an expression for the potential energy of a bar magnet placed in a uniform magnetic field.

Ans:



Magnet kept in a Uniform Magnetic field

i. Consider a bar magnet of moment $\vec{m}$ held at an angle θ with the direction of a uniform magnetic field $\vec{B}$. The magnitude of the torque acting on the dipole is,

$\tau = mB \sin\theta$ ….(1)

ii. This torque tends to align the dipole in the direction of the field. Work has to be done in rotating the dipole against the action of the torque. This work done is stored as potential energy of the dipole.

iii. If dW is the amount of work done in rotating the dipole from θ_1 to θ_2, the potential energy is given as,

$$U_m = \int_{\theta_1}^{\theta_2} dW = \int_{\theta_1}^{\theta_2} \tau(\theta) d\theta = \int_{\theta_1}^{\theta_2} mB\sin\theta\, d\theta$$

$$= -mB[\cos\theta]_{\theta_1}^{\theta_2}$$

∴ $U_m = -mB(\cos\theta_2 - \cos\theta_1)$ ….(2)

iv. Taking $\theta_1 = 90°$ and $\theta_2 = \theta$, then

$U_m = -mB(\cos\theta - \cos 90°)$

∴ $U_m = -mB\cos\theta$ ….(3)

This is the expression for the potential energy of a bar magnet placed in a uniform magnetic field

Special Cases:

a. When θ = 0°,

$U_m = -mB\cos\theta = -mB\cos(0) = -mB$

The bar magnet is aligned along the magnetic field ($\vec{m}$ and $\vec{B}$ are parallel), it is in stable equilibrium and has minimum potential energy.

b. When θ = 180°,

$U_m = -mB\cos\theta = -mB\cos(180) = mB$

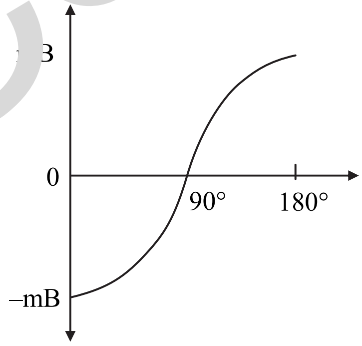
$\vec{m}$ and $\vec{B}$ are antiparallel. The bar magnet is in the most unstable state and has maximum potential energy.

c. When θ = 90°,

$U_m = -mB\cos\theta = -mB\cos(90) = 0$

The bar magnet is perpendicular to the direction of magnetic field and has zero potential energy.

Graph:



Potential Energy v/s angular position of the magnet

Reading between the lines

Explanation for point (iv):

Similar to other potential energies, there is a freedom in choosing the angle where the potential energy U is taken as zero. A natural choice is to take $\theta = \frac{\pi}{2} = 90°$ *as per the special case C.*

Q.5. Derive an expression for the time period of angular oscillations of a bar magnet.

Ans:

i. Consider a bar magnet of magnetic moment m and moment of inertia I, suspended freely using an extensible spring.

ii. The restoring torque in the string acts opposite to the deflecting torque. Thus, the magnet rotates through an angle and gradually becomes stationary.

iii. In equilibrium, both the torques balances.

$\therefore \quad \tau = I\dfrac{d^2\theta}{dt^2}$ ….(1)

Where, $\dfrac{d^2\theta}{dt^2}$ = angular acceleration of the magnet.

iv. Let the magnet be rotated in a direction opposite to the direction in which the torque is acting on the magnet. A restoring torque is produced acting on the magnet in the opposite direction and is given as,

$\tau = -mB \sin\theta$ ….(2)

v. Comparing equation (1) and (2), we get,

$I\dfrac{d^2\theta}{dt^2} = -\,mB\sin\theta$

For small values of angular displacement θ, $\sin\theta \approx \theta$.

$\therefore \quad I\dfrac{d^2\theta}{dt^2} = -\,mB\,\theta$

$\therefore \quad \dfrac{d^2\theta}{dt^2} = -\left(\dfrac{mB}{I}\right)\theta$ ….(3)

vi. The differential equation of linear S.H.M. is given as,

$\dfrac{d^2x}{dt^2} = -\omega^2 x$ ….(4)

vii. Comparing equation (3) and (4), we have,

$\omega^2 = \dfrac{mB}{I}$

$\therefore \quad \omega = \sqrt{\dfrac{mB}{I}}$ ….(5)

viii. The time period of angular oscillations of the bar magnet is,

$T = \dfrac{2\pi}{\omega}$

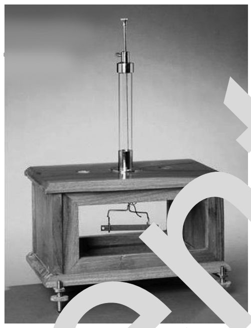
$\therefore \quad T = 2\pi\sqrt{\dfrac{I}{mB}}$

This is the expression for time period of angular oscillations of the bar magnet.

Connections

You have studied in detail about simple harmonic motion in Chapter 5 – Oscillations of Part - I.

Enrich Your Knowledge



Vibration Magnetometer is used for the comparison of magnetic moments and magnetic field. This device works on the principle, that whenever a freely suspended magnet in a uniform magnetic field, is disturbed from its equilibrium positions, it starts vibrating about its mean position. It can be used to determine horizontal component of Earth's magnetic field.

Q.6. Observe and discuss. *(Textbook page no. 253)*
What is a North pole or South pole of a bar magnet?

Ans: To determine the north pole and south pole of a bar magnet:

i. Draw a circular loop on a plane glass plate and take the direction of current in clockwise directions.

ii. Place on it a wire loop having clockwise current flowing through it.

iii. According to right hand rule, the top surface will behave as a south pole.

iv. Turn the glass to see the same loop through the other surface of glass.

v. Due to turning, it is seen that the direction of current is in anticlockwise direction and the loop side surface behaves like north pole.

Reading between the lines

Explanation for point (v):
In reality, there is no change in the direction of current.

Solved Examples

Q.7. A couple of moment 25×10^{-2} Nm acts on a magnet suspended in a uniform magnetic field of induction 0.5 Wb/m^2 when making an angle of 30° with the field. Find the magnetic moment of the magnet.

Solution:

Given: $\tau = 25 \times 10^{-2}$ Nm, $B = 0.5$ Wb/m^2, $\theta = 30°$

To find: Magnetic moment (M)

Formula: $\tau = mB \sin\theta$

Calculation: From formula,

$\therefore \quad m = \dfrac{\tau}{B\sin\theta} = \dfrac{25\times10^{-2}}{0.5\times\left(\dfrac{1}{2}\right)}$

$\therefore \quad m =$ **1 Am²**

Ans: The magnetic moment of the magnet is **1 Am²**.

Q.8. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.25 T experiences a torque of magnitude equal to 4.5 × 10⁻² J. What is the magnitude of magnetic moment of the magnet? (NCERT)

Solution:

Given: $\tau = 4.5 \times 10^{-2}$ J, $\theta = 30°$, B = 0.25 T

To find: Magnetic moment (m)

Formula: $m = \dfrac{\tau}{B\sin\theta}$

Calculation: From formula,

$m = \dfrac{4.5\times10^{-2}}{0.25\times\sin 30°} = \dfrac{4.5\times10^{-2}}{0.25\times\left(\dfrac{1}{2}\right)}$

$\therefore \quad m =$ **$0.36\ JT^{-1}$**

Ans: The magnitude of the magnetic moment of the short bar magnet is **$0.36\ JT^{-1}$**.

Q.9. A bar magnet of moment 7.5 Am² experiences a torque of 1.5 × 10⁻⁴ Nm, when placed inclined at 30° in a uniform magnetic field. Find the magnetic induction of the field.

Solution:

Given: $m = 7.5\ Am^2$, $\tau = 1.5 \times 10^{-4}$ Nm, $\theta = 30°$

To find: Magnetic induction (B)

Formula: $\tau = mB\sin\theta$

Calculation:

From formula,

$B = \dfrac{\tau}{m\sin\theta} = \dfrac{1.5\times10^{-4}}{7.5\times\sin 30} = \dfrac{1.5\times10^{-4}}{7.5\times0.5}$

$\therefore \quad B = 0.4 \times 10^{-4} = 4 \times 10^{-5}$ T

Ans: The magnetic induction of the field is **4×10^{-5} T**.

***Q.10. A short bar magnet is placed in an external magnetic field of 700 gauss. When its axis makes an angle of 30° with the external magnetic field, it experiences a torque of 0.014 Nm. Find the magnetic moment of the magnet, and the work done in moving it from most stable to most unstable position.**

Solution:

Given: $B = 700\text{ gauss} = 700 \times 10^{-4}\text{ T} = 7 \times 10^{-2}$ T, $\tau = 0.014$ Nm, $\theta = 30°$,

To find:
i. Magnetic moment of the magnet (m)
ii. Work done in moving it from its most stable to most unstable position (w).

Formulae:
i. $|\tau| = mB\sin\theta$
ii. $|W| = mB(\cos\theta_1 - \cos\theta_2)$

Calculation: From formula (i),

$0.014 = m \times 7 \times 10^{-2} \times \sin 30°$

$\therefore \quad m = \dfrac{14\times10^{-3}\times2}{7\times10^{-2}}$

$\therefore \quad m = 4 \times 10^{-1} =$ **0.4 Am²**

We know that, most stable position of magnet is when $\theta = 0°$ and most unstable position of magnet is when $\theta = 180°$

From formula (ii),

$W = 0.4 \times 7 \times 10^{-2} \times [\cos 0° - \cos 180°]$

$= 2.8 \times 10^{-2} \times [1 - (-1)]$

$= 2.8 \times 10^{-2} \times [2]$

$= 5.6 \times 10^{-2}$

= **0.056 J**

Ans: i. Magnetic moment of the magnet is **0.4 Am²**.

ii. Required work done is **0.056 J.**

[Note: *Answers calculated above are in accordance with textual methods of calculation.]*

***Q.11. The work done for rotating a magnet with magnetic dipole moment m, through 90° from its magnetic meridian is n times the work done to rotate it through 60°. Find the value of n.**

Solution:

We know that, magnet is parallel to magnetic meridian. Therefore, $\theta_1 = 0°$ and $\cos\theta_1 = 1$

Work done for rotating a magnet with magnetic dipole moment m, through 90° from its magnetic meridian $= mB(1 - \cos\theta)$

$= mB(1 - \cos 90°)$

$= mB$

Work done for rotating it through 60° from its magnetic meridian $= mB(1 - \cos 60°)$

$= mB\left(1 - \dfrac{1}{2}\right)$

$= \dfrac{mB}{2}$

Given,

$W_{90°} = nW_{60°}$

$\therefore \quad mB = n \times \dfrac{mB}{2}$

$\therefore \quad n = 2$

Ans: The value of n is **2**.

Q.12. The work done in turning a magnet of magnetic moment 'm' by an angle of 90° from the magnetic meridian, is n times the corresponding work done to turn it through an angle of 45°. What is the value of n?

Solution:

Given: $W_{90°} = nW_{45°}$

For turning 90°,

Work done, $W_{90°} = mB(\cos 0° - \cos 90°)$

$= mB(1 - 0) = mB$

Page no. **142** to **157** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

xi. The solenoid current is now reduced. H reduces resulting in reduction of B along the path de. This means domain structure is present but the direction of magnetization is reversed.

xii. Further increase in the current, gives the curve efa. On reaching point a, one loop is complete. This loop is called hysteresis loop and the process of taking magnetic material through the loop once is called hysteresis cycle.

Enrich Your Knowledge

Hysteresis curve is similar to stress hysteresis studied in mechanical properties of solid. Area inside the loop gives the energy dissipated during deformation of the material.
Hysteresis curve provides information of magnetic history of the sample to be studied.

Q.62. Use you brain power. *(Textbook page no. 262)*
What does the area inside the curve B – H (hysteresis curve) indicate?

Ans:

i. Area with the BH loop represents energy dissipated per unit volume in the material.

ii. In other words, area inside the curve B – H (hysteresis curve) indicates the amount of energy lost in applying the external magnetic field.

***Q.63. What does the hysteresis loop represents?**

Ans: The hysteresis curve represents the relation between magnetic induction $\vec{B}$ (or intensity of magnetization $\vec{I}$) of a ferromagnetic material with magnetizing force or magnetic intensity $\vec{H}$

11.7 Permanent Magnet and Electromagnet

Q.64. Write a note on Electromagnets. Also state their uses.

Ans:

i. Soft iron having large permeability (>1000) and small amount of retaining magnetization, is used to make electromagnets.

ii. A soft iron rod (or rod of a soft ferromagnetic material) is placed in a solenoid core.

iii. On passing current through the solenoid, the magnetic field associated with solenoid increases thousand folds.

iv. When the current through the solenoid is switched off, the associated magnetic field effectively becomes zero.

Uses of Electromagnets:

i. Electromagnets are used in electric bells, loud speakers, circuit breakers, and also in research laboratories.

ii. Giant electromagnets are used in cranes to lift heavy loads made of iron.

iii. Superconducting magnets are used to prepare very high magnetic fields of the order of a few tesla.

iv. Such magnets are used in NMR (Nuclear Magnetic Resonance) spectroscopy.

***Q.65. Which property of soft iron makes it useful for preparing electromagnet?**

Ans:

i. Soft iron has large value of permeability (>1000).

ii. Soft iron has small amount of retaining magnetization. Hence it is said to have high susceptibility but low retentivity.

iii. These properties of soft iron make it useful for preparing electromagnet.

Q.66. Explain one application of electromagnet.

Ans: Electromagnets are used in transformers which are electrical devices which converts low alternating voltage at high current to high alternating voltage at low current and vice-versa.

Explanation: *For detailed explanation of the transformer, students can refer Ch.12, Electromagnetic Induction Q.72.*

Q.67. Write a note on permanent magnets.

Ans:

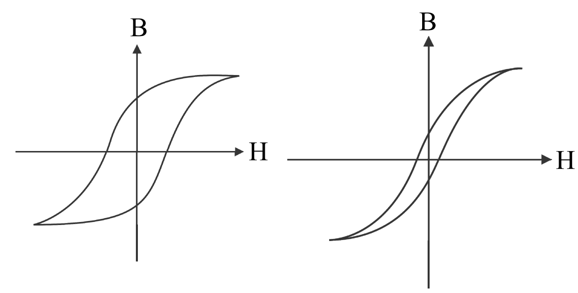
i. Permanent magnets are prepared by using a hard ferromagnetic rod.

ii. When the current is switched on, magnetic field of solenoid magnetises the rod.

iii. Due to the property of the hard ferromagnetic material to retain the magnetization to larger extent, the material remains magnetised even after switching off the current through the solenoid.

Enrich Your Knowledge

What is soft magnetic material?
Soft ferromagnetic materials can be easily magnetized and demagnetized.



Hard magnetic material **Soft magnetic material**

Soft magnetic materials and hard magnetic materials:

- That ferromagnetic materials have been divided into two types:

i. Soft magnetic materials, which have low retentivity, low corecivity and low hysteresis loss. Soft iron, mu metal and stalloy are some of the examples of these materials, used primarily for electromagnets, cores of transformers, motors and generators.

ii. Hard magnetic materials, which have high coercivity and large hysteresis loss. Steel, alnico, alcomax and ticonal are some of the examples of these materials, which have been used for making permanent magnets of electric metres and loud speakers etc.

***Q.68. What should be retentivity and coercivity of permanent magnet?**

Ans:

i. A permanent magnet should have high retentivity in order to retain the magnetization to a larger extent. i.e., remain magnetized in the absence of magnetising field.

ii. A permanent magnet should have high coercivity so as to not get demagnetised easily.

11.8 Magnetic Shielding

Q.69. Explain magnetic shielding and state its uses.

Ans:

i. 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.

ii. For a closed structure of this material spherical shell of iron kept in magnetic field, very few lines of force pass through the enclosed space.

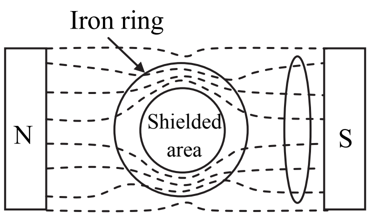
iii. Most of the lines will be crowded into the iron shell. This effect is known as magnetic shielding.

iv. The instrument to be protected from magnetic field is completely surrounded by a soft ferromagnetic substance.

Uses:

i. Magnetic shielding is used in spaceships.

ii. Some scientific experiments require the experiments to be protected from magnetic field. In the laboratory a case made up of soft ferromagnetic material helps in shielding the high magnetic fields of magnets.



Magnetic shielding

Enrich Your Knowledge

There are different types of shielding like electrical and acoustic shielding apart from magnetic shielding. Electrical insulator functions as an electrical barrier or shield and comes in a wide array of materials. Normally the electrical wires used in our households are also shielded. In case of audio recording it is necessary to reduce other stray sound which may interfere with the sound to be recorded. So the recording studios are sound insulated using acoustic material.

Q.70. If any magnetic material is kept inside a U shaped tube and two poles of a strong magnets are brought near one of its end, then discuss the behaviour of material if it is
i. Diamagnetic ii. Paramagnetic

Ans: i. The level of a diamagnetic liquid in U tube is depressed, in the limb which is between the poles of a strong magnet. Diamagnetic material shows a movement from stronger magnetic field to weaker magnetic field. This property implies that whereas a magnet attracts metals like iron, it would repel a diamagnetic substance like copper.

ii. The level of a paramagnetic liquid in U tube is raised in the limb which is between the poles of a strong magnet. It implies that paramagnetic substances get weakly attracted to a magnet.

Q.71. Show that permeability of perfectly diamagnetic substance is zero.

Ans: For a perfectly diamagnetic substance,

$B = \mu_0(H + M) = 0$

$\therefore$ $M = -H$

Therefore, $\chi = \frac{M}{H} = -1$

Also, $\mu_r = 1 + \chi = 1 - 1 = 0$

$\therefore$ $\mu = \mu_0\mu_r = \text{zero}$

Q.72. Internet my friend. *(Textbook page no. 263)*

1. https://physics.info/magnetism/

[Students can use link given above as reference and collect information about Magnetic Materials.]

Quick Review

Magnetic Materials

Properties

Magnetization
- Ratio of magnetic moment to the volume of the material is called magnetization.

Magnetic intensity
- Ratio of the strength of magnetising field to the permeability of free space is called as magnetic intensity.

Magnetic permeability, Relative magnetic permeability or susceptibility of a substance
- $\mu = \mu_0(1 + \chi)$
- $\mu = \mu_0\mu_r$

  where,

  μ = magnetic permeability

  μ_r = relative magnetic permeability.

Magnetic moment of electron revolving around nucleus
- $m_{orb} = \left(\frac{e}{2m_e}\right)L$

  Where,

  me = electron of mass

  e = charge e revolving in a circular orbit

  $L = m_evr$
- gyromagnetic ratio $= \frac{e}{2m_e}$

Bohr Magneton
- $B.M. = \frac{eh}{4\pi m_e}$
- B.M value is 9.274×10^{-24} Am^2

Magnetic dipole

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

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

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

Case 1: $\theta = 0°$, $U_m = -mB$
- The bar magnet is in stable equilibrium and has minimum potential

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.

Types

Diamagnetism

Paramagnetism

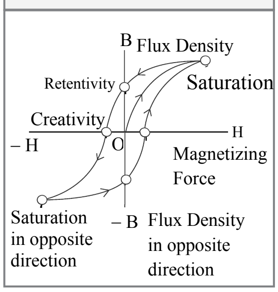
Ferromagnetism

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. This effect known as magnetic shielding.

Curie temperature
- Temperature at which a ferromagnetic material transforms into a paramagnetic substance is called Curie temperature (T_c) of that material.

Permanent Magnet
- Permanent magnets are prepared by using a hard ferromagnetic rod.

Electromagnet
- Soft iron having large permeability (>1000) and small amount of retaining magnetization, is used to make electromagnets.

Hysteresis


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

4. **For a revolving electron:**

i. Magnetic moment, $m_{orb} = \frac{evr}{2} = \frac{eL}{2m_e}$
   where, L = angular momentum

ii. $I = \frac{e}{T} = ef = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$

5. **Gyromagnetic ratio:** $\frac{m_{orb}}{L} = \frac{e}{2m_e}$

6. **Bohr magneton:** $\frac{eh}{4\pi m_e}$

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

8. **Magnetization:**

i. $M = \frac{m_{net}}{V}$

ii. $M = \frac{CB_{ext}}{T}$
   where, C = Curie constant

9. **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 $B_M = \mu_0 M$

10. **Magnetic susceptibility:** $\chi = \frac{M}{H} = \frac{B - B_0}{B_0}$

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

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

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

Exercise

11.1 Introduction

1. How is the torque necessary for the rotational motion of a freely suspended bar magnet formed?

Ans: *Refer Q.2*

11.2 Torque acting on a magnetic dipole in a uniform magnetic field

2. Derive an expression for the potential energy of a bar magnet placed in a uniform magnetic field.

Ans: *Refer Q.4*

3. Show that the time period of angular oscillations of the bar magnet is given as
   $T = 2\pi\sqrt{\frac{I}{mB}}$

Ans: *Refer Q.5*

11.3 Origin of Magnetism in Materials

4. 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.

Ans: *Refer Q.17*

5. Define the term gyromagnetic ratio.

Ans: *Refer Q.18*

6. Write a note on Bohr Magneton.

Ans: *Refer Q.19*

11.4 Magnetisation and Magnetic Intensity

7. What do you mean by magnetization? State its SI unit and dimensions.

Ans: *Refer Q.26*

8. Show that, $H = \frac{B}{\mu_0} - M$.
   where, H = magnetic field intensity of a substance
   μ_0 = permeability of free space,
   M= magnetization of a substance.

Ans: *Refer Q.27*

9. 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.28*

10. A current of 3 A flows through a plane circular coil of radius 4 cm and having 20 number of turns. It is placed in magnetic field of intensity 0.5 Wb/m^2. Find dipole moment of the coil.

Ans: 0.3 Am^2

11. 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

12. 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

11.5 Magnetic Properties of Materials

13. With the help of paired electron orbit theory, explain diamagnetism.
Ans: *Refer Q.45*

14. State properties of diamagnetic material.
Ans: *Refer Q.46*

15. Give reason why the rod of a diamagnetic material when suspended freely aligns itself in the direction perpendicular to the direction of external magnetic field.
Ans: *Refer Q.47*

16. Draw the diagrams showing the dipole moments in paramagnetic substance when external magnetic field is
(a) absent (b) strong.
Ans: *Refer Q.49 [figure (a) and figure (c) only].*

17. State Curie law for paramagnetic material. Using the law, derive relation between magnetic susceptibility and temperature.
Ans: *Refer Q.52*

18. Discuss ferromagnetism on the basis of domain theory.
Ans: *Refer Q.53*

19. How ferromagnetic substances are affected by heat?
Ans: *Refer Q.54*

20. 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}

21. 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

22. 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.
Ans: 2.36×10^3, 2.361×10^3

11.6 Hysteresis

23. Explain hysteresis cycle for ferromagnetic material.
Ans: *Refer Q.61*

11.7 Permanent Magnet and Electromagnet

24. What are electromagnets? State any two uses.
Ans: *Refer Q.64*

25. What are permanent magnets?
Ans: *Refer Q.67*

11.8 Magnetic Shielding

26. What do you mean by magnetic shielding? State its applications.
Ans: *Refer Q.69*

Multiple Choice Questions

*1. A rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely. Its period of oscillation is T′, the ratio of T′ / T is.
(A) $\frac{1}{2\sqrt{2}}$ (B) $\frac{1}{2}$
(C) 2 (D) $\frac{1}{4}$

2. 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 (1/4) of its initial value, then its period of oscillation is
(A) $\sqrt{2}$T (B) 2T
(C) $\frac{T}{2\sqrt{2}}$ (D) $2\sqrt{2}$ T

3. The orbital speed of an electron orbiting around the nucleus in a circular orbit of radius r is v. Then the magnetic dipole moment of the electron will be
(A) evr (B) $\frac{evr}{2}$
(C) $\frac{ev}{2r}$ (D) $\frac{vr}{2e}$

4. An electron in an atom revolves around the nucleus in an orbit of radius 0.7 Å. Calculate the equivalent magnetic moment, if the frequency of revolution of electron is 2×10^{10} MHz.
(A) 4.92×10^{-23} Am^2
(B) 4.92×10^{-24} Am^2
(C) 5.21×10^{-23} Am^2
(D) 5.21×10^{-24} Am^2

5. Bohr magneton is
(A) magnetic induction of electron when it is revolving in the first Bohr orbit.
(B) magnetic moment of electron when it is revolving in the first Bohr orbit.
(C) angular momentum of electron when revolving in the first Bohr orbit.
(D) angular momentum of electron when revolving in last Bohr orbit.

6. 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

7. If a diamagnetic material is placed in a magnetic field, the flux density inside the material compared to that outside will be
(A) slightly less (B) slightly more
(C) very much more (D) same

8. 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.

9. Paramagnetism is _______.
(A) an orientation effect
(B) distortion effect
(C) both orientation and distortion effects
(D) neither orientation effect nor distortion effect

10. S.I. unit of magnetic dipole moment is _______.
(A) A/m^3 (B) Am^{-2}
(C) Am^2 (D) $A - m$

11. Which of the following materials is repelled by an external magnetic field?
(A) Iron (B) Cobalt
(C) Steel (D) Copper

12. A non-magnetic material when brought near a powerful magnet, it gets repelled. The material is _______.
(A) paramagnetic (B) ferromagnetic
(C) non-magnetic (D) diamagnetic

*13. Which of the following statements is correct for diamagnetic materials?
(A) $\mu_r < 1$
(B) χ is negative and low
(C) χ does not depend on temperature
(D) All of above

14. Which of the following groups are diamagnetic?
(A) Hydrogen, oxygen, argon
(B) Oxygen, copper, silver
(C) Hydrogen, argon, copper
(D) Lead, copper, bismuth

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

16. In a ferromagnetic material, range of magnetic susceptibility is
(A) 10^2 to 10^3 (B) 10^{20} to 10^{40}
(C) -10^{-3} to -10^{-5} (D) 0 to 10^{-3}

17. The magnetic moment is not represented by
(A) accelerated charge.
(B) stationary charge.
(C) retarded charge.
(D) charge moving with constant velocity.

18. If a magnetic material moves from stronger to weaker parts of a magnetic field, then it is known as _______.
(A) diamagnetic (B) paramagnetic
(C) ferromagnetic (D) anti-ferromagnetic

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

20. Some atoms have permanent magnetic dipole moments and others do not. The correct reason for the same is
(A) If magnetic moments are paired, the dipole moment becomes zero.
(B) It depends on the number of inner electrons.
(C) It depends on the nuclear properties of the atom.
(D) When magnetic moments are not paired, the dipole moment becomes zero.

*21. A magnetising field of 360 Am^{-1} produces a magnetic flux density (B) = 0.6 T in a ferromagnetic material. What is its permeability in Tm A^{-1}?
(A) $\frac{1}{300}$ (B) 300
(C) $\frac{1}{600}$ (D) 600

22. If the relative permeability of iron is 2000, its absolute permeability in SI unit is
(A) $8\pi \times 10^{-4}$ T m/A
(B) $80\pi \times 10^{-4}$ T m/A
(C) $\frac{800}{\pi}$ T m/A
(D) $\frac{5\times10^9}{\pi}$ T m/A

23. Which of the following is incorrect relation?

(A) $\chi = \dfrac{M_Z}{H}$ (B) $B = \mu_0 (1 + \chi)H$

(C) $\mu_0 = \mu (1 + \chi)$ (D) $\mu_r = 1 + \chi$

24. Which of following is not a unit of the intensity of magnetization?

(A) $A\ m^{-1}$ (B) $J\ T^{-1}m^{-3}$

(C) $N\ T^{-1}m^{-2}$ (D) $A\ T^{-1}m^{-2}$

*25. Soft iron is used to make the core of transformer because of its

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

*26. Intensity of magnetic field of the earth at the point inside a hollow iron box is.

(A) less than that outside
(B) more than that outside
(C) same as that outside
(D) zero

Answers to Multiple Choice Questions

1.	(B)	2.	(D)	3.	(B)	4.	(A)
5.	(B)	6.	(C)	7.	(A)	8.	(D)
9.	(A)	10.	(C)	11.	(D)	12.	(D)
13.	(D)	14.	(D)	15.	(B)	16.	(A)
17.	(B)	18.	(A)	19.	(C)	20.	[illegible]
21.	(C)	22.	(A)	23.	(C)	24.	(D)
25.	(A)	26.	(A)				

Hints to Multiple Choice Questions

1. $T = 2\pi\sqrt{\dfrac{I}{mB}}$

Where, $I = \dfrac{\text{mass} \times l^2}{12}$

m = pole strength (x) × length

When pole is broken into two equal halves,

Magnetic dipole moment $= \dfrac{x \times l}{2} = \dfrac{m}{2}$ ….(1)

$\therefore\ I' = \dfrac{\text{mass}' \times l'^2}{12} = \dfrac{(\text{mass}/2)(l/2)^2}{12}$

$= \dfrac{\text{mass} \times l^2}{12 \times 8} = \dfrac{I}{8}$ ….(2)

$\therefore\ T' = 2\pi\sqrt{\dfrac{I'}{m'B}}$

$\therefore\ \dfrac{T'}{T} = \sqrt{\dfrac{I'}{m'} \times \dfrac{m}{I}} = \sqrt{\dfrac{I'}{I} \times \dfrac{m}{m'}}$

$\therefore\ \dfrac{T'}{T} = \sqrt{\dfrac{1}{8} \times \dfrac{2}{1}} = \dfrac{1}{2}$

2. Period of oscillation for a magnet, $T = 2\pi\sqrt{\dfrac{I}{mB}}$

where, $I = \dfrac{M_1L^2}{12}$ (M_1 = mass of the magnet),

m = pole strength (x) × length(2L) and B is uniform magnetic field in which magnet is oscillating.

When the length is doubled, pole strength is reduced to $\left(\dfrac{1}{4}\right)^{th}$, period of oscillation of magnet becomes, $T' = 2\pi\sqrt{\dfrac{I'}{m'B}}$

Where, $I' = \dfrac{M_1(2L)^2}{12}$ and

$m' = \left(\dfrac{\text{pole strength}}{4}\right) \times 2 \times (2L)$

$\therefore\ \dfrac{T'}{T} = \sqrt{\dfrac{I'}{m'} \times \dfrac{m}{I}} = \sqrt{\dfrac{I'}{I} \times \dfrac{m}{m'}} = \sqrt{8}$

$\therefore\ T' = 2\sqrt{2}\ T$

3. Magnetic dipole moment,

$M = IA$

$= \dfrac{e}{T} \times \pi r^2$

$= \dfrac{e}{\left(\dfrac{2\pi r}{v}\right)} \times \pi r^2$ ….$\left[\because T = \dfrac{2\pi r}{v}\right]$

$\therefore\ M = \dfrac{evr}{2}$

4. $i = \dfrac{1}{T}\ e = \nu e$

From formula,

$M = \nu eA = \nu e\pi r^2$

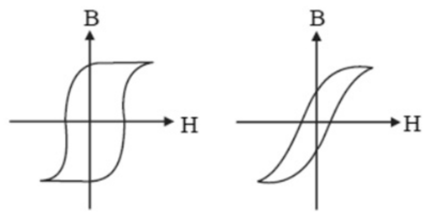
$= 2 \times 10^{16} \times 1.6 \times 10^{-19} \times 3.14 \times (0.7 \times 10^{-10})^2$

$\therefore\ M = 4.92 \times 10^{-23}\ Am^2$

21. $\mu = \dfrac{B}{H} = \dfrac{0.6}{360} = \dfrac{1}{600}\ TmA^{-1}$

Competitive Corner

1. Hysteresis loops for two magnetic materials A and B are given below: **[JEE (Main) 2016]**



(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.

2. 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 **[NEET P-II 2016]**

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

Hint: W = – mB (cos 60° – cos 0°)

$= -\,mB\left(\frac{1}{9}-1\right)=\frac{1}{2}\ mB$

∴ mB = 2 W

Torque required τ = mB sin θ = 2W sin 60°

∴ $\tau = 2W\left(\frac{\sqrt{3}}{2}\right)=\sqrt{3}\ W$

3. The magnetic moment of electron due to orbital motion is proportional to (n = principal quantum numbers) **[MHT CET 2017]**

(A) $\frac{1}{n^2}$ (B) $\frac{1}{n}$
(C) n^2 **(D) n**

Hint: The magnetic moment of the revolving electron is given by, $m_{orb} = \frac{neh}{4\pi m} = n\left(\frac{eh}{4\pi m}\right)$

Thus, $m_{orb} \propto n$ (the principal quantum number)

4. 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 **[NEET (UG) 2018]**

(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.

Hint: Diamagnetic material is repelled by magnetic field. This magnetic field is set up by switching on the current source. Hence, the energy to perform the required work is provided by the current source.

5. An electron revolving in 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 **[MHT CET 2020]**

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

Hint: Magnetic moment,
M = IA

$= \frac{e}{T}\cdot A$ $\ldots\left(\because I=\frac{q}{T}=\frac{e}{T}\right)$

$= e\,\nu\,A$ $\ldots\left(\because \nu=\frac{1}{T}\right)$

∴ $M \propto \nu$
∴ New magnetic moment = 2M

6. The magnetic moment produced in a samaple of 2 gram is 8×10^{-7} A/m². If its density is 4 g/cm³, then the magnetisation of the sample is **[MHT CET 2020]**

(A) [illegible] (B) [illegible] (C) 1.8 **(D) 1.6**

Hint: Given: Mass = 2×10^{-3} kg,
Magnetic moment = 8×10^{-7} A/m²
density = 4×10^3 kg/m³

Magnetization = $\frac{\text{Magnetic moment}}{\text{Volume}}$

$= \frac{\text{Magnetic moment}}{\text{mass/density}}$

$= \frac{8\times10^{-7}\times4\times10^{3}}{2\times10^{-3}} = 16 \times 10^{-1} = 1.6$

7. A wire of length L metre carrying a current of ampere is bent in the form of circle. Its magnetic moment is **[NEET (UG) P-II 2020]**

(A) $\frac{IL^2}{4\pi}$ Am² (B) $\frac{IL^2}{4}$ Am²
(C) $\frac{I\pi L^2}{4}$ Am² (D) $\frac{2IL^2}{\pi}$ Am²

Hint: Length of wire, L = 2πR

Radius of loop, $R = \frac{L}{2\pi}$

Magnetic moment, M = IA = I (πR²)

$= I \times \pi \times \frac{L^2}{4\pi^2}$

$= \frac{IL^2}{4\pi}$ Am²

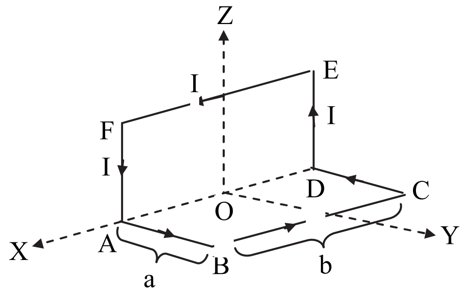
8. An iron rod of susceptibility 599 is subjected to a magnetising field of 1200 A m⁻¹. The permeability of the material of the rod is: **[NEET (UG) P-I 2020]**

($\mu_0 = 4\pi \times 10^{-7}$ T m A⁻¹)
(A) 8.0×10^{-5} T m A⁻¹
(B) $2.4\pi \times 10^{-5}$ T m A⁻¹
(C) $2.4\pi \times 10^{-7}$ T m A⁻¹
(D) $2.4\pi \times 10^{-4}$ T m A⁻¹

Hint: Relative permeability, $\mu_r = 1 + \chi$
$= 1 + 599 = 600$

Magnetic permeability,
$\mu = \mu_r\mu_0 = 600 \times 4\pi \times 10^{-7}$
$= 2.4\pi \times 10^{-4}\ \text{TmA}^{-1}$

6. A wire carrying current I is bent in the shape ABCDEFA as shown, where rectangle ABCDA and ADEFA are perpendicular to each other. If the sides of the rectangles are of lengths a and b, then the magnitude and direction of magnetic moment of the loop ABCDEFA is:
[JEE (Main) Sept 2020]



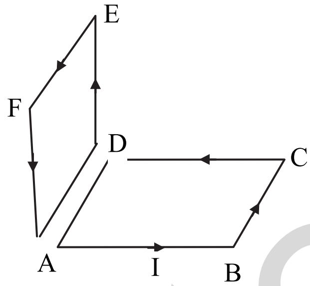
(A) $\sqrt{2}\,abI$, along $\left(\dfrac{\hat{j}}{\sqrt{5}} + \dfrac{2\hat{k}}{\sqrt{5}}\right)$

(B) abI, along $\left(\dfrac{\hat{j}}{\sqrt{5}} + \dfrac{2\hat{k}}{\sqrt{5}}\right)$

(C) $\boldsymbol{\sqrt{2}\,abI}$**, along** $\left(\dfrac{\hat{j}}{\sqrt{2}} + \dfrac{\hat{k}}{\sqrt{2}}\right)$

(D) abI, along $\left(\dfrac{\hat{j}}{\sqrt{2}} + \dfrac{\hat{k}}{\sqrt{2}}\right)$

Hint: Magnetic moment of loop ABCDA
$\overrightarrow{M_1} = Iab\hat{k}$



Magnetic moment of loop ADEFA
$\overrightarrow{M_2} = Iab\hat{j}$

Net magnetic moment
$\overrightarrow{M_{net}} = \overrightarrow{M_1} + \overrightarrow{M_2}$

$\overrightarrow{M_{net}} = Iab(\hat{j} + \hat{k})$

Magnitude of magnetic moment,
$|M_{net}| = \sqrt{2}\,Iab$

Direction of magnetic moment
$= \dfrac{(\hat{j} + \hat{k})}{\sqrt{2}}$

i.e., along $\dfrac{\hat{j}}{\sqrt{2}} + \dfrac{\hat{k}}{\sqrt{2}}$

Time: 1 Hour 30 Min **TOPIC TEST** **Total Marks: 25**

SECTION A

Q.1. Select and write the correct answer: **[04]**

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

ii. 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

iii. The correct relation between B, H and M is
(A) $B = \mu_0 (M + H)$ (B) $B = \mu_0 M - H$
(C) $B = \dfrac{\mu_0 M}{H}$ (D) $B = \mu_0 M \times \mu_0 H$

iv. A magnet placed perpendicular to a uniform field of strength 7×10^{-4} Wb/m^2 experiences a couple of moment 14×10^{-5} Nm. The magnetic moment of the magnet will be
(A) 0.8 Am^2 (B) 0.6 Am^2 (C) 0.4 Am^2 (D) 0.2 Am^2

Q.2. Answer the following: **[03]**

i. What is gyromagnetic ratio?

ii. Define magnetization. State its S.I. unit.

iii. If gyromagnetic ratio of the electron revolving in a circular orbit of hydrogen atom is 8.8×10^{10} C kg^{-1}, then what would be the mass of the electron? (Given: charge of the electron = 1.6×10^{-19} C.)

SECTION B

Attempt any Four: **[08]**

Q.3. Write a note on paramagnetic materials on the basis of atomic structure

Q.4. Establish the relation between permeability and susceptibility of a substance.

Q.5. A rod is subjected to a magnetising field of 1000 A/m. The susceptibility of the rod is 650. Find its permeability.

Q.6. State any four properties of diamagnetic substances.

Q.7. The magnetic moment of a magnet of dimensions 6 cm × 3 cm × 1.5 cm is 4 Am^2. Calculate the intensity of magnetization.

Q.8. Derive the quantity for Bohr Magneton and also state its value.

SECTION C

Attempt any Two: **[06]**

Q.9. Obtain and expression for orbital magnetic moment of an electron rotating about the nucleus in an atom. Derive an expression for the magnetic dipole moment of a revolving electron.

Q.10. The magnetic field B and the magnetic intensity H in a material are found to be 1.6 T and 1200 A/m respectively. Calculate the relative permeability 'μ_r' and the susceptibility 'χ' of the material.

Q.11. Write a note on Electromagnets. State its uses

SECTION D

Attempt any One: **[04]**

Q.12. Explain the behaviour of a ferromagnetic material in an external magnetic field with the help of a hysteresis cycle.

Q.13. i. Derive an expression for the potential energy of a bar magnet placed in a uniform magnetic field.

ii. A bar magnet of moment of inertia of 400 g cm^2 makes 10 oscillations per minute in a horizontal plane. What is its magnetic moment, if the horizontal component of earth's magnetic field is 0.4 gauss?

*Download the answers of the Topic Test by scanning the given **Q.R. Code.***

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