CBSE Class 12 Physics Notes Chapter 5: Here are the notes for CBSE Class 12 Physics Chapter 5 Magnetism and Matter. This chapter explains the magnetic properties of materials and their response to external magnetic fields.

It covers the concepts of magnetic susceptibility, magnetization, and the types of magnetic materials such as diamagnetic, paramagnetic, and ferromagnetic substances. These notes provide a detailed understanding of how matter interacts with magnetic fields and the fundamental principles governing these interactions.

CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter Overview

These notes are prepared by the subject experts of Physics Wallah provides a detailed overview of CBSE Class 12 Physics Chapter 5 Magnetism and Matter. It covers key topics such as magnetic susceptibility, magnetization, and the classification of materials into diamagnetic, paramagnetic and ferromagnetic types.

The notes also explain important phenomena like hysteresis and the behavior of materials in magnetic fields. This detailed overview helps students grasp the core principles of magnetism and their applications in various materials.

CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter PDF

The PDF link for CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter is available below. The notes cover important topics like hysteresis and the classification of materials into diamagnetic, paramagnetic, and ferromagnetic types.

Access the PDF to explore detailed explanations and illustrations that will enhance your understanding of magnetism and its effects on various substances.

CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter PDF

CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter

Here we have provided CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter-

Magnetic Field and Force

The magnetic field is a region around a magnet where materials or charged particles experience a magnetic force. This force can either attract or repel the charged particles depending on their relative positions. The magnetic field is generated by moving charges, such as currents in wires, and its strength and direction determine how strongly it influences other charges within its reach.

The force experienced by a charged particle in a magnetic field depends on the charge's velocity, the magnetic field strength, and the angle between the particle's velocity and the field direction. This interaction between the magnetic field and moving charges is fundamental to various physical phenomena and applications.

Now, consider a positive charge q moving in a uniform magnetic field $\overrightarrow{B}$, with a velocity $\overrightarrow{v}$.

Let the angle between $\overrightarrow{v}$ and $\overrightarrow{B}$ be θ.

$\overrightarrow{F} = qBv \sin\theta = 180^\circ$

$\overrightarrow{F_B} = q\left(\vec{v} \times \vec{B}\right)$

$If\ \theta = 90^\circ,\ then\ sin\,\theta = 1$

$v\ cos\,\theta\ (= v_1)$

$v = 0$

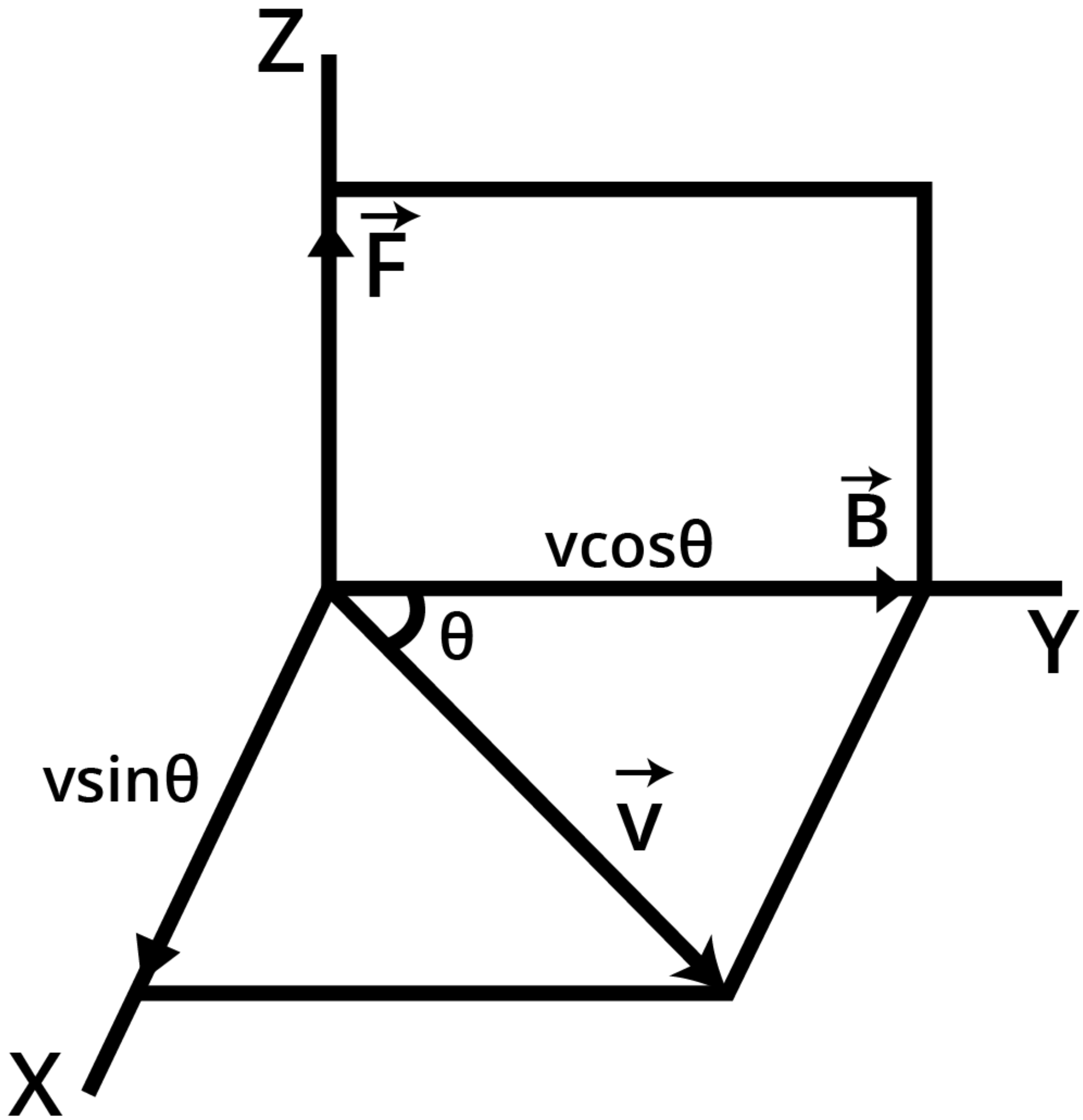

Z
$\vec{F}$
vcosθ
$\vec{B}$
Y
θ
vsinθ
$\vec{v}$
X

Diagram Showing the Direction Of Force, Magnetic Field and Motion of Charged Particles.

i. The magnitude of force F experienced by the moving charge is directly proportional to the magnitude of the charge i.e. $F \propto q$

ii. The magnitude of force F is directly proportional to the component of velocity acting perpendicular to the direction of the magnetic field, i.e. $F \propto v \sin\theta$

iii. The magnitude of force F is directly proportional to the magnitude of the magnetic field applied i.e., $F \propto B$ Combining the above factors, we get $F \propto qBv\sin\theta$ or $F = kqBv\sin\theta$ where k is a constant of proportionality. Its value is found to be one i.e. $k = 1$.

$$\overrightarrow{F} = qBv\sin\theta \quad ...(1)$$

$$\overrightarrow{F} = \overrightarrow{q}(\overrightarrow{v} \times \overrightarrow{B}) \quad ...(2)$$

The direction of $\overrightarrow{F}$ is same as the direction of $(\overrightarrow{v} \times \overrightarrow{B})$, which is perpendicular to the plane containing $\overrightarrow{v}$ and $\overrightarrow{B}$. Its direction is given by Right-handed-Screw Rule or Right-Hand Rule.

If $\overrightarrow{v}$ and $\overrightarrow{B}$ are in the plane of the paper, then according to Right-Hand Rule, the direction of $\overrightarrow{F}$ on the positively charged particle will be perpendicular to the plane of paper upwards as shown in the figure and on the negatively charged particle will be perpendicular to the plane of paper downwards as shown in the figure.

Definition of $\overrightarrow{B}$:

$$If\ v = 1,\ q = 1\ and\ sin\,\theta = 1\ or\ \theta = 90^\circ,\ then\ from\ (1),\ F = 1 \times 1 \times B \times 1 = B.$$

The force experienced by a unit charge travelling with a unit velocity perpendicular to the direction of magnetic field induction at a place in the magnetic field is equal to the force experienced by a unit charge moving with a unit velocity perpendicular to the direction of magnetic field induction at that moment in time.

Special Cases:

Case-1 :

$If\ \theta = 0^\circ\ or\ 180^\circ,\ then\ sin\,\theta = 0.$

∴ From (1),

$F = qv\,B\ (0) = 0.$

That means, a charged particle moving along or opposite to the direction of magnetic field, does not experience any force.

Case-2 :

$If\ v = 0$, then

$F = 0.$

That means, if a charged particle is at **rest** in a magnetic field, it experiences no force.

Case-3 :

$If\ \theta = 90^\circ,\ then\ sin\,\theta = 1$, then

$\overrightarrow{F} = qBv$

Note, **SI** unit of $\overrightarrow{B}$ is tesla (T) or $Weber/(metre)^2$ i.e. (Wb/m^2) or $Ns\ C^{--1}\ m^{--1}$.

Therefore, the magnetic field inducted at a point is said to be one tesla, if a charge of one coulomb while moving at right angle to a magnetic field, with a velocity of $1\ ms^{--1}$experiences a force of $1N$, at that point.

$$\text{Dimensions of B} = \frac{\text{MLT}^{-2}}{\text{AT}\left(\text{LT}^{-1}\right)} = \text{MA}^{-1}\text{T}^{-2}]$$

Lorentz Force

The Lorentz force is the force exerted on a charged particle moving through a region where both electric and magnetic fields are present. This force is a combination of the electric force and the magnetic force acting on the particle.

Force Due to Magnetic Field. If the charged particle is moving in a magnetic field $\overrightarrow{B}$, with a velocity $\overrightarrow{v}$ it experiences a force given by:- $\overrightarrow{F_B} = \overrightarrow{q}\,(\overrightarrow{v} \times \overrightarrow{B})$ ...(6)

The direction of this force is in the direction of $(\overrightarrow{v} \times \overrightarrow{B})$ i.e. perpendicular to the plane containing $\overrightarrow{v}$ and $\overrightarrow{B}$ and is directed as given by **Right hand screw rule**.

The total force experienced by the charged particle Due to both the electric and magnetic fields will be given by:-

$$\overrightarrow{F_e} + \overrightarrow{F_m} = q\vec{E} + q\left(\vec{v} \times \vec{B}\right) = q\left(\vec{E} + \left(\vec{v} \times \vec{B}\right)\right)$$

Special Cases:-

Case I:

When $\overrightarrow{v}$, $\overrightarrow{E}$ and $\overrightarrow{B}$, all the three are collinear.

The magnetic force on the charged particle is zero since it is travelling parallel or antiparallel to the fields.

The electric force on the charged particle will produce acceleration $\vec{a} = \frac{q\vec{E}}{\mathrm{m}}$ along the direction of electrical field. As a result, there will be a change in the speed of charged particles along the direction of the field.

So there will be no change in the direction of motion of the charged particle but, the speed, velocity, momentum and kinetic energy of charged particle will change.

Case II:

When $\overrightarrow{v}$, $\overrightarrow{E}$ and $\overrightarrow{B}$ are mutually perpendicular to each other.

If $\overrightarrow{E}$ and $\overrightarrow{B}$ are such that $\vec{F} = \overrightarrow{F_e} + \overrightarrow{F_m} = 0$, then acceleration in the particle, $\vec{a} = \frac{\vec{F}}{m} = 0$. That means the particle will pass through the fields without any change in its velocity. Here

$F_e = F_m$ so $\mathrm{qE} = \mathrm{q} \vee \mathrm{B}$ or

$\mathrm{v} = \mathrm{E}/\mathrm{B}$.

Motion of a Charged Particle in a Uniform Magnetic Field

When a charged particle moves through a uniform magnetic field, it experiences a force that causes its trajectory to bend into a circular or spiral path. This behavior is due to the Lorentz force, which acts perpendicular to both the velocity of the particle and the magnetic field.

Diagram Showing the Circular Path Described By A Charged Particle in A Uniform Magnetic Field.

The magnetic field is depicted perpendicular to the plane of the paper, pointing inwards, and the particle is travelling in that plane. When the particle is at locations A, C, and D, the magnetic force on the particle will be directed along with AO, CO, and DO, respectively, i.e., towards the circular path's centre O.

The force F on the charged particle due to magnetic field provides the required centripetal force = $\frac{mv^2}{r}$ necessary for motion along a circular path of radius r.

$$\therefore \quad \mathrm{Bqv_2} = \frac{mv_2{}^2}{r} \text{ or } \mathrm{v_2} = \frac{\mathrm{Bqr}}{\mathrm{m}}$$

$$\text{or} \quad v\sin\theta = \mathrm{Bqr/m} \quad \text{....(2)}$$

The angular velocity of rotation of the particle in magnetic field will be:-

$$\omega = \frac{\mathrm{V}\sin\theta}{\mathrm{r}} = \frac{\mathrm{Bqr}}{\mathrm{mr}} = \frac{\mathrm{Bq}}{\mathrm{m}}$$

The frequency of rotation of the particle in magnetic field will be:-

$$\mathrm{v} = \frac{\omega}{2\pi} = \frac{\mathrm{Bq}}{2\pi\mathrm{m}} \quad \text{...(3)}$$

The time period of revolution of the particle in the magnetic field will be:-

$$\mathrm{T} = \frac{1}{\mathrm{V}} = \frac{2\pi\mathrm{m}}{\mathrm{Bq}} \quad \text{...(4)}$$

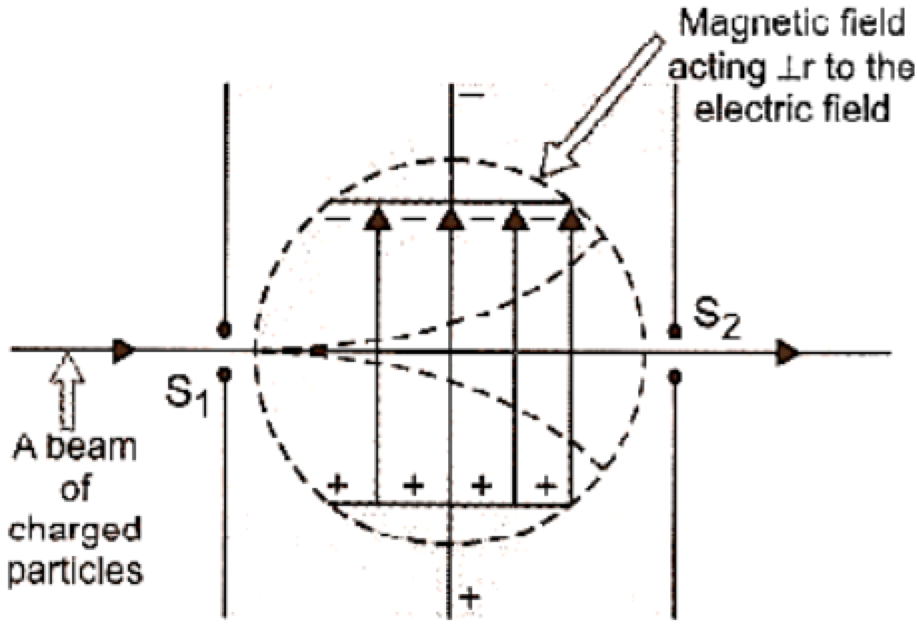
We can see from (3) and (4) that v and T are independent of the particle's velocity v. It indicates that at a given position, all charged particles with the same particular charge (mass/charge) but moving at different velocities will complete their circular trajectories at the same time due to component velocities perpendicular to the magnetic fields.

For component velocity $v\ cos\ \theta\ (=\ v_1\ )$ there will be no force on the charged particle in the magnetic field, because the angle between v_1 and $\vec{B}$ is zero. As a result, the charged particle moves at a constant speed v cos in the direction of the magnetic field.

Motion in Combined Electron and Magnetic Fields

Velocity Filter

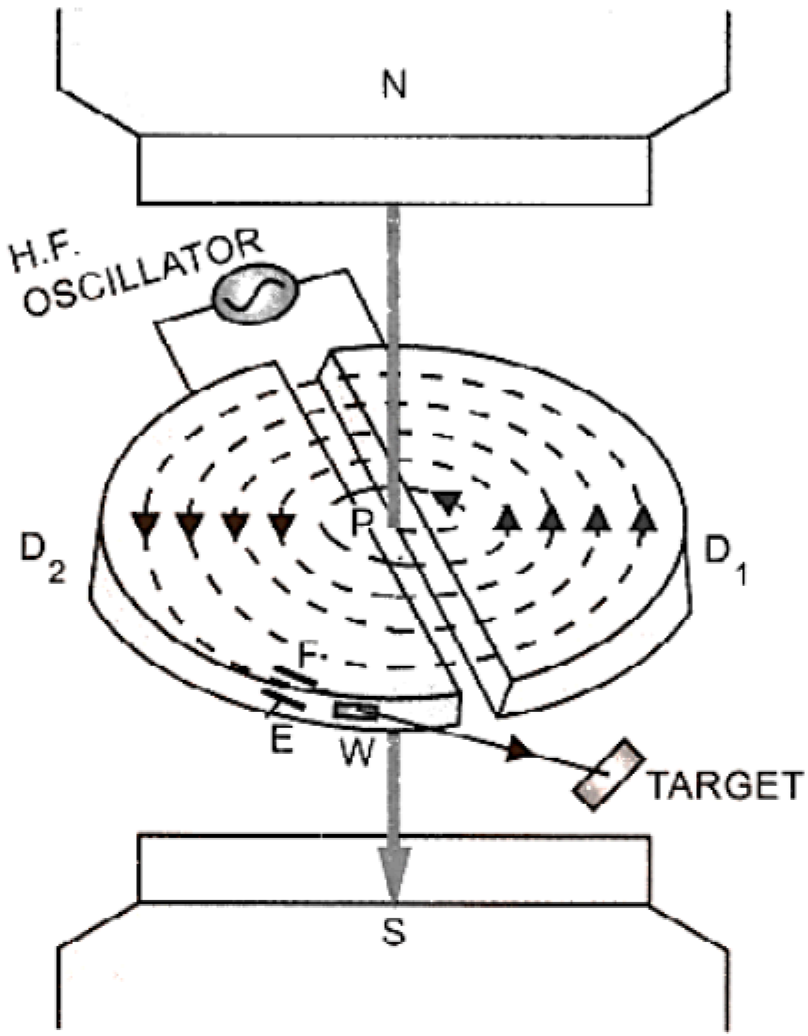
A velocity filter is a device that uses crossed electric and magnetic fields to select particles based on their velocity, irrespective of their mass or charge. It is designed to allow only those particles with a specific velocity to pass through, while others are deflected.



Force on a Current-Carrying Conductor Placed in a Magnetic Field

Consider a straight cylindrical conductor PQ of length l, area of cross-section A, carrying current I placed in a uniform magnetic field of induction, B. Let the conductor be placed along the X-axis and the magnetic field be acting in X plane making an angle θ with X-axis.

Suppose the current I flows through the conductor from the end P to Q figure. Since the current in a conductor is due to motion of electrons, therefore, electrons are moving from the end Q to P.



How Are Magnetic Materials Classified?

Magnetic materials are classified based on their magnetic properties and how they respond to an external magnetic field. Here's a simple explanation of the three main types:

Diamagnetic Materials:

- **Magnetic Susceptibility (χ)**: Negative and very small.
- **Behavior**: Diamagnetic materials create an induced magnetic field opposite to the direction of the applied external magnetic field. They are weakly repelled by magnetic fields.
- **Examples**: Bismuth, copper, and graphite.
- **Characteristics**: These materials do not retain any magnetic properties once the external magnetic field is removed.

Paramagnetic Materials:

- **Magnetic Susceptibility (χ)**: Positive and small.
- **Behavior**: Paramagnetic materials have a weak and temporary magnetic attraction to an external magnetic field. The magnetic moments align with the external field but only while the field is applied.
- **Examples**: Aluminum, platinum, and certain metal ions.
- **Characteristics**: The alignment of magnetic moments in paramagnetic materials is relatively weak and disappears when the external field is removed.

Ferromagnetic Materials:

- **Magnetic Susceptibility (χ)**: Large and positive.
- **Behavior**: Ferromagnetic materials have a strong magnetic attraction and can retain magnetic properties even after the external magnetic field is removed. They exhibit spontaneous magnetization, meaning their magnetic moments align in the same direction even without an external field.
- **Examples**: Iron, nickel, and cobalt.
- **Characteristics**: These materials have high magnetic permeability and can be permanently magnetized, forming strong magnetic domains.

Permanent Magnets

Permanent magnets are materials that, when magnetized, retain their magnetic properties for a long time, even after the external magnetic field is removed. These magnets are made from ferromagnetic materials, such as iron, cobalt, or nickel, which have strong magnetic properties and can sustain their magnetization.

Benefits of CBSE Class 12 Physics Notes Chapter 5 Magnetism and Matter

- **Clear Conceptual Understanding**: The notes provide a thorough explanation of fundamental concepts related to magnetism and matter including the types of magnetic materials, magnetic fields, and forces. This clarity helps students build a solid foundation in understanding magnetic phenomena.
- **Simplified Explanations**: Complex topics such as the behavior of magnetic materials and the principles of magnetism are broken down into simpler terms. This makes it easier for students to grasp difficult concepts and apply them to problems.
- **Preparation for Exams**: By covering essential topics and providing practice problems, the notes help students prepare effectively for their exams.
- **Comprehensive Coverage**: The notes cover all critical aspects of the chapter ensuring that students are well-prepared for both theoretical questions and practical applications. This comprehensive approach supports thorough learning and review.