4
Chapter

Exploring Magnets

We'll cover the following key points:

- Magnetic and Non-magnetic Materials
- Magnetic Poles and Interactions
- Navigation with Magnets
- Magnetic Wonders

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Learning Outcomes

By the end of this chapter, students will be able to:

- Understand the properties of magnets and their role in daily life.
- Differentiate between magnetic and non-magnetic materials.
- Explore magnetic poles, attraction, and repulsion.
- Discover practical uses of magnets in navigation, technology, and more.
- Conduct experiments to analyze magnet interactions and solve real-world problems.

Guidelines for Teachers

The educator can introduce this topic by demonstrating the unique properties of magnets, such as attracting iron objects and identifying magnetic poles. Simple experiments like using magnets to pick up materials or showcasing how compasses work can engage students and make the learning process interactive. Facilitating discussions and encouraging students to observe magnetic and non-magnetic materials in their environment will deepen their understanding. The educator should aim to foster curiosity and critical thinking by integrating fun activities, such as building simple magnetic tools or exploring magnetic forces with everyday objects.

NCF Curricular Goals and Competencies

This chapter aligns with the following curricular goals and competencies:

CG-4 (C 4.1, 4.2, and 4.3) investigates the properties of magnets, their interactions, and their practical uses in daily life through scientific exploration.

Introduction

Magnets are fascinating objects that exhibit unique properties, such as attracting certain materials and repelling others. They play an essential role in everyday life, from guiding compasses to powering advanced technologies. Magnets possess two poles, north and south, which interact to create forces of attraction and repulsion. By understanding the behavior of magnetic materials and how magnets find directions, we can uncover their practical applications and scientific principles. Exploring magnets allows us to appreciate the invisible yet powerful force of magnetism that shapes the world around us.

In History...

The history of magnets dates back over 2,000 years, beginning with the discovery of naturally occurring magnetic stones called lodestones in ancient Greece and China. These stones were composed of magnetite, a naturally magnetized mineral. The earliest documented use of magnets was for navigation in ancient China, where compasses were developed around the 11th century. In the 17th century, English scientist William Gilbert conducted detailed studies on magnetism and proposed that Earth itself acts like a giant magnet

Magnetic and Non-magnetic Materials

Aarav and Maya are playing with toys in the park.

Materials around us can be classified based on their interaction with magnets into magnetic and non-magnetic types. Magnetic materials, such as iron and nickel, are attracted to magnets, while non-magnetic materials, like wood and plastic, are not. Understanding this distinction helps us identify materials that can be used in applications involving magnetism, from building electric motors to creating magnetic storage devices.

Discovery of Magnet

The discovery of magnets is often linked to a shepherd named "Magnes" from the region of Magnesia (Greece). According to legend, while tending his sheep and goats in the mountains, Magnes found his metal-tipped staff drawn to a large black rock. This rock was later identified as a natural magnet. These magnetic stones, known as **magnetite**, were likely named after either Magnesia or Magnes himself. When suspended freely, pieces of magnetite aligned along the north-south axis, proving useful for navigation and earning the name "**lodestone**."

Materials can be divided into two categories: magnetic and non-magnetic, based on their response to a magnet's pull.

1. Magnetic Materials:

These are substances that are strongly drawn towards a magnet.

Examples: Iron, steel, nickel, and cobalt

2. Non-Magnetic Materials:

These are substances that do not respond to a magnet's attraction.

Examples: Wood, aluminum, copper, rubber, stone, and sand

Magnetic Materials

Non-Magnetic Materials

KEYWORDS

Magnetite: A naturally occurring iron oxide mineral (Fe_3O_4) that is strongly magnetic and widely used in industrial applications.

Lodestone: A naturally magnetized piece of magnetite, historically used as a compass due to its ability to align with Earth's magnetic field

Natural and Artificial Magnets

Magnets can be categorized into two main types based on how they occur: **Natural magnets and Artificial magnets.** Below is a comprehensive explanation of their properties, differences, and examples.

Natural Magnets

Definition:

Natural magnets are materials that occur naturally in the environment and possess the ability to attract iron and other magnetic substances.

Example:

Lodestone (magnetite) is a commonly known natural magnet.

Characteristics:

Weaker Strength: Natural magnets generally have a weaker **magnetic strength** compared to artificial magnets.

Unaltered by Humans: These magnets are formed naturally without any human intervention.

Artificial Magnets

Definition:

Artificial magnets are those that are created by humans using materials that can be **magnetized** easily, such as iron, cobalt, and nickel.

Characteristics:

Stronger Magnetic Force: They are typically more powerful than natural magnets due to the ability to control their design and magnetic strength.

Customizable: Artificial magnets can be manufactured in a wide range of shapes, sizes, and strengths to suit various applications.

Common Materials Used:

Iron, Cobalt, and Nickel are the most widely used materials in the creation of artificial magnets because they exhibit excellent magnetic properties.

KEYWORDS

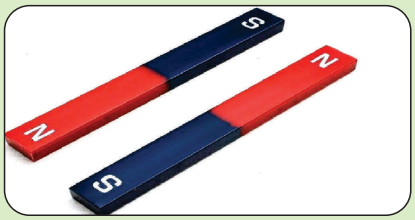
Magnetic Strength: Magnetic strength refers to the ability of a magnet to attract objects made of iron or steel. It shows how strong the magnetic force of the magnet is.

Magnetized: An object is said to be magnetized when it becomes a magnet itself, either temporarily or permanently, and can attract or repel other magnetic materials.

Shapes of Artificial Magnets

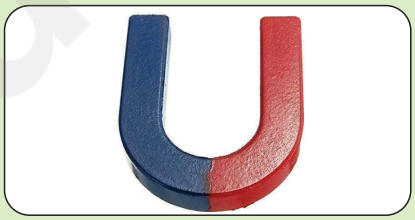
Artificial magnets come in different forms to serve specific purposes. The commonly manufactured shapes include:

1. **Rectangular Bar Magnet:**
   - Shaped like a flat rectangular bar.
   - Commonly used in physics experiments and as fridge magnets.

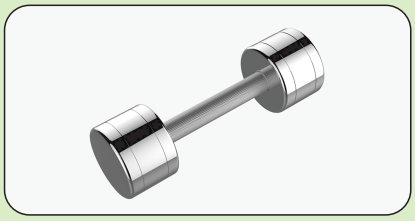


2. **Cylindrical Magnet:**
   - Cylindrical in shape.
   - Frequently used in medical devices, electric motors, and industrial applications.

3. **U-Shaped Magnet (Horseshoe Magnet):**
   - Designed to resemble the shape of a horseshoe or the letter "U."
   - Known for providing concentrated magnetic force at the poles, making them useful for lifting heavy objects or in electromagnets.



4. **Dumbbell-Shaped Magnet:**
   - Features two magnetic ends connected by a slim bar.
   - Often used in scientific demonstrations to study the properties of magnets.



Key Differences Between Natural and Artificial Magnets

Feature	Natural Magnets	Artificial Magnets
Source	Found in nature (e.g., lodestone).	Made by humans using magnetic materials.
Magnetic Strength	Relatively weak.	Stronger and customizable.
Durability	Less durable and not easy to modify.	Durable and can be shaped or tailored easily.
Applications	Limited practical applications.	Widely used in industries, electronics, and experiments.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Apply Concept in Context

Apply

- Provide two examples of materials that can exhibit both magnetic and non-magnetic properties under specific conditions.
- How does the magnetic property of a material relate to its composition or structure?

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Examine Further

Analyse

- Research examples of how industries use magnetic materials for specific purposes.
- What are the key physical properties that help distinguish magnetic materials from non-magnetic materials?
- List some examples of materials that are used in extreme conditions, such as high temperatures or underwater, due to their magnetic or non-magnetic properties.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking, Research, Problem-solving.

Self-Assessment Questions

Evaluate

- Define magnetism and explain its importance in technology.
- Differentiate between magnetic and non-magnetic materials with examples.
- Give examples of naturally magnetic materials and synthetic magnetic materials.
- List two differences between permanent magnets and temporary magnets.
- Which devices in your home use magnets, and how do they work?

Skills Covered: : Evaluation, Logical thinking

Creative Insight

Create

List ten objects from your surroundings and categorize them based on their magnetic or non-magnetic properties. Present this information creatively in a table or chart with columns for material type and usage.

Skills Covered: Creativity, Critical and logical thinking, Brainstorming, Observation, Organization

Magnetic Poles and Interactions

Aarav and Maya are playing with magnets in their living room.

When a bar magnet is moved over materials like iron filings or other magnetic substances, you'll notice that these materials tend to cling mostly to the ends of the magnet. These two ends, where the magnetic force is the strongest, are referred to as the magnetic poles of the magnet.

Identification of Poles

1. The end of the magnet that points toward the **geographical north** is called the **south pole**.
2. The end of the magnet that points toward the **geographical south** is called the **north pole**.

This behavior can be observed clearly when a magnet is allowed to hang freely, ensuring its alignment with Earth's magnetic field.

Unbreakable Pairing of Magnetic Poles

Magnets are unique in that their poles always exist in pairs. If a magnet is broken into smaller pieces, each piece automatically forms its own north pole and south pole. This phenomenon ensures that no matter how small the fragment, it will have both poles.

Magnetic Strength and Its Distribution

The magnetic force of a magnet is not uniform across its surface:

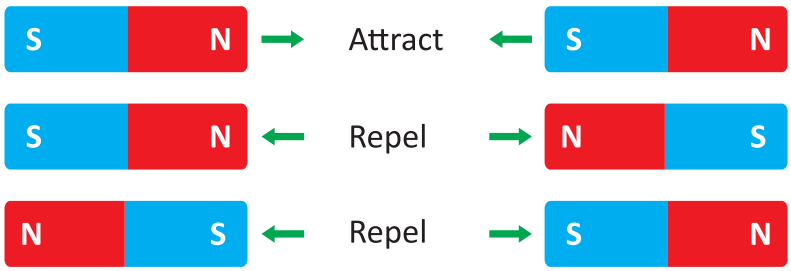
- Maximum strength is concentrated at the poles.
- Minimum strength is found at the center of the magnet.

This unique distribution of force explains why materials like iron filings tend to cluster at the ends rather than the middle of the magnet.

Interaction Between Magnets: Attraction and Repulsion

Magnets exhibit fascinating interactions with each other based on the type of poles they present:

- Like poles (e.g., north-north or south-south) repel each other.
- Opposite poles (e.g., north-south or south-north) attract each other.



Let's recall what we know

Apply Concept in Real-Life Context

Apply

- Provide two examples of objects or phenomena where magnetic poles interact (e.g., attracting or repelling).
- How do the magnetic interactions between poles apply to practical uses in daily life or technology?

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Examine Further

Analyse

- Research examples of how magnetic fields are used in transportation systems like maglev trains.
- List some applications of magnetic poles in devices used in extreme conditions (e.g., in outer space or deep-sea environments).

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Self-Assessment Questions

Evaluate

- Define magnetic poles and explain their role in magnetic interactions.
- Give examples of materials that are magnetic and non-magnetic.
- List two differences between the behavior of like poles and unlike poles.

Skills Covered: Evaluation, Logical thinking

Creative Insight

Create

List ten objects in your surroundings that use magnetism in some way (e.g., fridge magnets, speakers, motors). Categorize these objects based on their magnetic type (natural/temporary/permanent) and their function (attract/repel/store energy). Also, classify their use in terms of interaction type (static or dynamic). Present this information in a creative chart or table for the class.

Skills Covered: Creativity, Critical and logical thinking, Brainstorming

SCAN TO ACCESS

Take a Task

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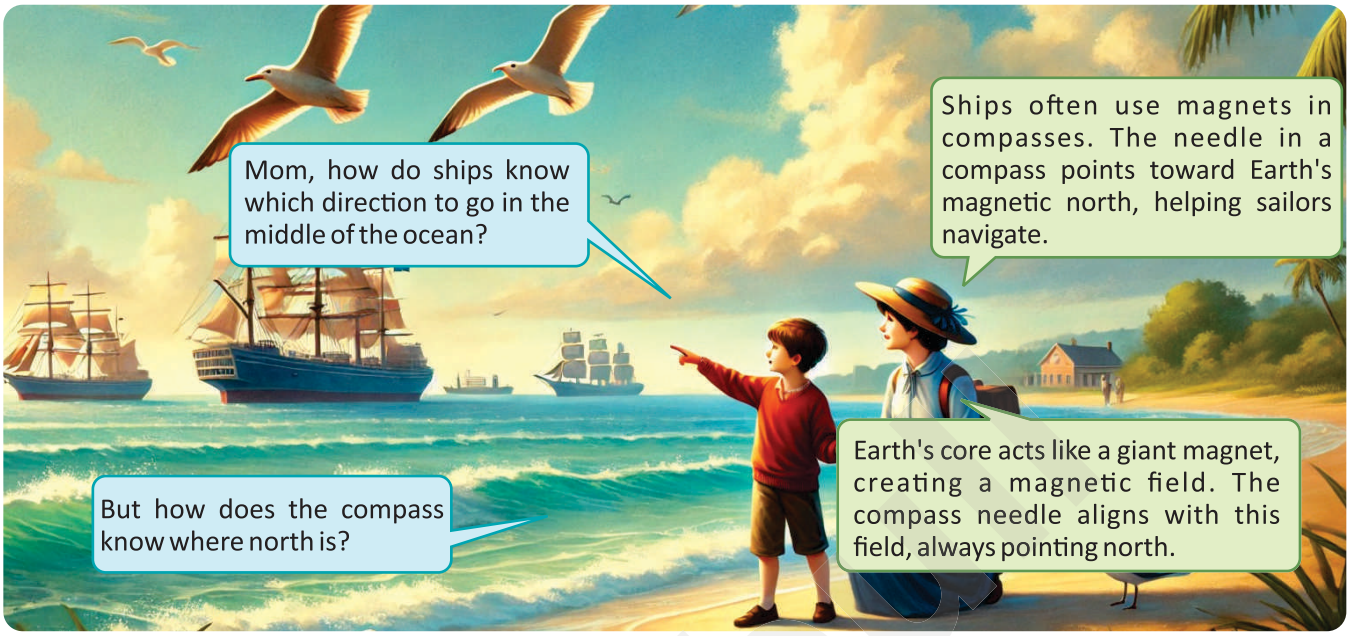
Bloom's Taxonomy

Navigation with Magnets

Aarav and Maya are by a beach, observing ships and seagulls.



Navigation with Magnets

Magnets have been used for navigation for thousands of years. Sailors, travelers, and explorers relied on magnets to find directions long before modern navigation tools were invented. This section explains how magnets are used for navigation and why they are important.

The Compass: A Magnet for Navigation

The compass is a simple tool used for navigation that uses the properties of magnets.

Parts of a Compass:

- A magnetic needle that can rotate freely.
- A dial with directions marked: North (N), South (S), East (E), and West (W).
- A housing to protect the needle.

How a Compass Works:

- The magnetic needle inside the compass aligns itself with Earth's magnetic field.
- The end of the needle that points towards the Earth's magnetic north is marked as N (North).

Advantages of Using Magnets for Navigation

- **Global Use:** Works anywhere on Earth as long as the magnetic field is present.
- **Durability:** Compasses are durable and can function in harsh environments like deserts, mountains, and oceans.
- **Accurate:** Provides an accurate sense of direction without the need for advanced technology.

Fun Facts About Magnets and Navigation

- Birds, turtles, and some fish use Earth's magnetic field to navigate during migration, just like humans use a compass!
- The magnetic poles of the Earth are not fixed; they slowly move over time. This phenomenon is called magnetic pole shift.
- Magnetic compasses were critical for great explorations, like Columbus's voyage to the Americas.

Let's recall what we know

SCAN TO ACCESS

Take a Task

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Bloom's Taxonomy

Apply Concept in Real-Life Context

Apply

- Provide two examples of devices or tools that use magnets for navigation and explain how they work.
- How do magnets help in determining direction, and why is this method reliable in most environments?

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Examine Further

Analyse

- Research examples of animals that use Earth's magnetic field for navigation.
- What are the key features of a compass that make it effective for navigation? Explain its working principle.
- List some examples of real-world situations where navigation using magnets is critical, such as maritime or aviation contexts.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking, Research

Self-Assessment Questions

Evaluate

- Define magnetic navigation and explain its significance in human history.
- List two advantages of using magnets over other navigation methods.
- How do animals detect and use magnetic fields for migration or movement?

Skills Covered: Evaluation, Logical thinking

Creative Insight

Create

- List some devices or tools which use natural phenomena that involve magnetic navigation.
- Present this information in a creative chart or table for a class project.

Skills Covered: Creativity, Critical and logical thinking, Brainstorming, Observation, Organization

Magnetic Wonders

Aarav and Maya are in a science museum, standing near an exhibit on magnets.

Magnets are everywhere, and their invisible yet powerful force, known as magnetism, is one of nature's most incredible phenomena. They can attract and repel, hold things in place, and create energy that drives machines and technology. The wonders of magnets extend beyond what we see—making them both mysterious and magical.

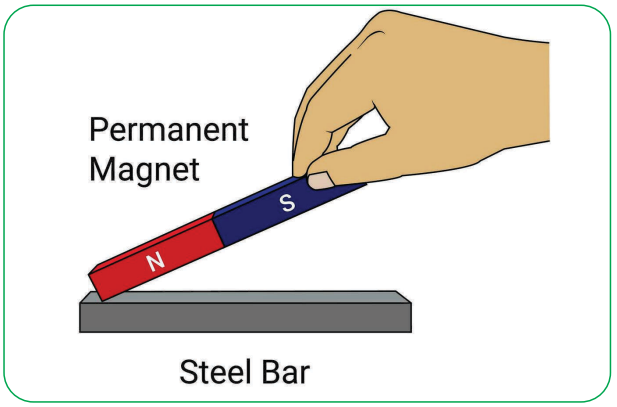
The process of turning an ordinary piece of metal, such as iron or steel, into a magnet is known as magnetisation. This transformation allows the metal to acquire magnetic properties, enabling it to attract other magnetic materials.. This involves placing an iron piece near a strong magnet and exposing it repeatedly. Over time, the magnetic field of the magnet induces magnetism in the iron, converting it into a magnet.

One simple method of magnetisation is the single-touch method, where a magnet is rubbed over the metal in a single, consistent direction. This movement aligns the particles inside the metal, gradually turning it into a magnet. These processes are essential for creating magnets that can be used in various applications, from scientific experiments to practical tools and devices in daily life.

Single-Touch Method

To magnetise an iron piece using the single-touch method, follow these steps:

- Take an iron piece (e.g., a rod) of length AB and place it on a flat surface, such as a table.
- Using a bar magnet, stroke the iron piece with one pole of the magnet in a single direction only.



- Start at point A on the iron piece and move the magnet along its entire length to the opposite end, B, without lifting the magnet.
- Once you reach point B, lift the magnet and return it to the starting point (A) with the same pole of the magnet.
- Repeat this process about 30 to 40 times, ensuring the strokes are consistent and in the same direction.

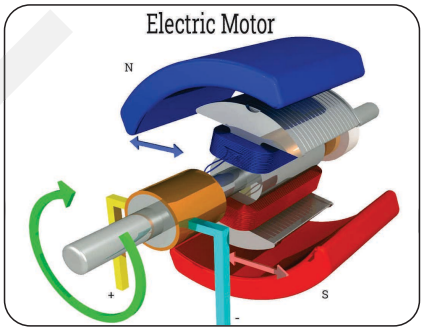
To check if the iron piece has been magnetised, bring a small iron object, like a nail or a pin, close to it. If the object is attracted to the iron piece, it is now magnetised. If no attraction is observed, repeat the procedure until the iron piece becomes magnetised.

Uses of Magnets

Magnets are widely used in various applications beyond navigation. Here are some common examples of their uses:

Refrigerator Doors: Magnets are used to ensure the doors close tightly, keeping the contents fresh.

ATM and Credit Cards: Magnetic strips on these cards store important information securely.



- **Speakers, Headphones, and Microphones:** Magnets play a crucial role in producing and transmitting sound.
- **Electric Motors:** Found in devices like fans, coolers, and vehicles, magnets help generate power in electric motors.
- **Dunkyards:** Magnets are used to efficiently lift and sort iron and steel materials.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Apply Concept in Real-Life Context

Apply

- Identify two daily-use devices that rely on magnets for their operation and explain how the magnets contribute to their functionality.
- How does the strength of a magnet affect its ability to hold or attract objects? Provide examples to illustrate your answer.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Examine Further

Analyse

- Research how magnets are used in transportation systems like trains or vehicles.
- What are the key differences between permanent magnets and electromagnets, and how does each type suit specific applications?
- List examples of industries that rely heavily on magnets and describe one specific use in each industry.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking, Research

Self-Assessment Questions

Evaluate

- Define magnetism and explain its role in electronic devices.
- Give examples of objects with magnetic strips used in everyday life.
- List two differences between the single-touch method and other magnetisation methods.
- Which types of magnets are used in electric motors and why?

Skills Covered: Evaluation, Logical thinking

Creative Insight

Create

Activity: Create a table listing ten objects in your home or surroundings that use magnets. Categorize these objects based on the type of magnet (permanent/electromagnet) and their use (e.g., storage, sound, energy, etc.).

Skills Covered: Creativity, Critical and logical thinking, Brainstorming, Observation, Organization

SUMMARY

1. Magnetic and Non-Magnetic Materials

The chapter explains how materials are classified as **magnetic** (those attracted to magnets, such as iron, nickel, and cobalt) or **non-magnetic** (those that do not interact with magnets, such as wood, plastic, and rubber). This distinction helps us understand why some objects respond to magnetic forces while others do not.

2. Magnetic Poles and Interactions

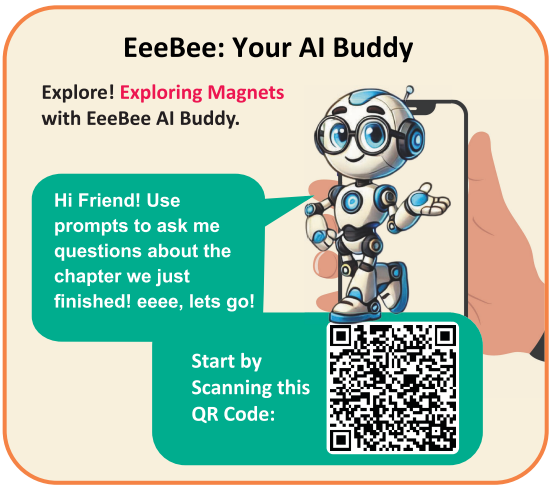
Students learn about the **poles of a magnet**—the north and south poles—where the magnetic force is strongest. The chapter explains the principle of magnetic interaction: **like poles repel,** while **opposite poles attract**. It also emphasizes the fact that magnetic poles always exist in pairs, even if a magnet is broken into smaller pieces.

3. Navigation with Magnets

The chapter highlights the role of magnets in navigation. It explains how a freely suspended magnet always aligns itself in the **north-south direction**, helping people find directions using compasses. The concept of Earth's magnetic field and its influence on magnetized objects is also introduced, showing how magnets have been used for navigation for centuries.

4. Magnetic Wonders

This section explores the various applications of magnets in everyday life and technology. Magnets are used in refrigerator doors, ATM cards, speakers, electric motors, and even in junkyards to lift heavy iron materials. The chapter also introduces students to the idea of magnetisation, where ordinary materials like iron can be turned into magnets using methods such as the **single-touch method and magnetic induction**.



EXERCISE

That turn curiosity into confidence—let's begin!

Gap Analyzer™
Take a Test

A. Choose the correct answer.

1. Which of the following materials is magnetic?
   (a) Plastic ☐ (b) Wood ☐
   (c) Iron ☐ (d) Rubber ☐
2. What happens when like poles of two magnets are brought close to each other?
   (a) They attract ☐ (b) They repel ☐
   (c) They lose their managetism ☐ (d) Nothing happens ☐
3. What tool uses magnets to find directions?
   (a) Telescope ☐ (b) Compass ☐
   (c) Microscope ☐ (d) Barometer ☐
4. The Earth's magnetic field causes a freely suspended magnet to align itself in which direction?
   (a) East-West ☐ (b) North-South ☐
   (c) Up-Down ☐ (d) South-East ☐
5. Which of the following is an example of using magnets in everyday life?
   (a) Growing crops ☐ (b) Storing data in ATM cards ☐
   (c) Building Houses ☐ (d) Painting walls ☐

B. Fill in the blanks.

- Materials that do not interact with magnets are called _____.
- The north pole of a magnet always points towards the _____.
- A freely suspended magnet aligns itself in the _____ direction.
- Like poles of a magnet _____, while opposite poles _____.
- Magnets are used in electric motors to generate _____.

C. Write True or False.

1. Magnets attract all kinds of materials. _____
2. A compass is used to find directions with the help of a magnet. _____
3. Like poles of a magnet attract each other. _____
4. Magnetic materials like iron are attracted to a magnet. _____
5. The poles of a magnet can exist independently if a magnet is broken. _____

D. Define the following terms.

1. Magnetic materials
2. Non-magnetic materials
3. Magnetic poles
4. Magnetic induction
5. Compass

E. Match the columns.

Column A	Column B
1. Magnetic materials	(a) Rubber and wood
2. Non-magnetic materials	(b) Points North-South
3. Magnetic poles	(C) Strongest magnetic force
4. Compass	(d) Iron and steel
5. Like poles	(e) Repel each other

F. Give reasons for the following statements.

1. Magnetic poles always exist in pairs.
2. Non-magnetic materials do not interact with magnets.
3. A compass always points in the north-south direction.
4. Opposite poles of a magnet attract each other.
5. Magnets are useful in everyday applications like electric motors and ATM cards.

G. Answer in brief.

1. What are magnetic and non-magnetic materials?
2. How does a compass work for navigation?
3. Why do the poles of a magnet have the strongest magnetic force?
4. Explain the concept of attraction and repulsion in magnets.
5. Why do broken magnets always form new poles?

H. Answer in detail.

1. Explain the difference between magnetic and non-magnetic materials with examples.
2. Describe the interactions between magnetic poles with suitable illustrations.
3. How does the Earth's magnetic field help in navigation?
4. Discuss the various uses of magnets in daily life and industries.
5. How can an ordinary piece of iron be turned into a magnet? Explain the process.

NEP Corner

Know about NEP 2020

Blended Learning Models

Schools and institutions are encouraged to adopt hybrid teaching models, combining traditional methods with online education for better engagement.

Skill-based Activity

Activity Time

STEM

Curious Minds at Work

Observe your surroundings and identify one object that uses a magnet. Write a question about how the magnet's properties (e.g., attraction, poles, strength) help the object function. Using the scientific method, describe the steps you would take to answer your question.

Skills Covered: Critical and logical thinking, Brainstorming, Analytical thinking, Problem-solving, Curiosity, Observation, Decision-making skills

Wonders of Magnetism

Art

Identify and sketch a creative representation of a magnetic interaction, such as attraction or repulsion. Write a short description explaining the role of magnetic poles and how they cause this interaction. Present your work to the class.

Skills Covered: Creativity, Critical and logical thinking, Applicative thinking

Poles in Action

Group Activity

In groups, explore how magnetic poles interact with one another. Create a chart categorizing the outcomes (e.g., attraction, repulsion, neutral effects) based on different configurations of poles. Present your findings with examples of practical uses.

Skills Covered: Critical and logical thinking, Brainstorming, Teamwork, Communication, Applicative thinking, Decision-making skills

Technology in Focus

Case to Investigate

Explore and research how magnets are used in navigation tools like compasses or advanced technologies like GPS systems. Write a short report on how these tools rely on magnetism for direction-finding and positioning.

Skills Covered: Critical and logical thinking, Brainstorming, Research, Applicative thinking

Sustainability Spotlight

Aligning with SDGs

Research a program or initiative that uses magnetic technology for sustainable purposes, such as waste sorting in recycling plants. Highlight its key features and how it aligns with sustainable development goals. Present your findings to the class.

Aligned with: SDG 12 – Responsible Consumption and Production, SDG 13 – Climate Action

Skills Covered: Critical and logical thinking, Brainstorming, Research, Problem-solving, Ethics

Mapping Magnetism

Integrated Learning

Using the Internet, create a map showing regions where magnetic navigation has historically been important (e.g., early maritime routes). Explain how these regions benefited from magnetic tools like compasses and how geography influenced their use.

Integrated Learning: History and Geography

Skills Covered: Critical and logical thinking, Brainstorming, Analytical thinking, Applicative thinking