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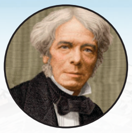


"Magnetism is one of the most mysterious and fascinating forces in nature." – Michael Faraday

Exploring Magnets

The Big Question

Imagine tiny, invisible forces pulling objects together or pushing them apart, making compass needles spin, or even helping massive trains float above tracks. What unseen power is at play in these incredible phenomena? This chapter will unveil the hidden world of magnets – discover their magical properties, how they work, and their surprising uses all around us!

Meet EeeBee.AI

Hello, curious magnet-explorers! I'm EeeBee, your AI buddy. Let's delve into magnetism—poles, forces, magnetic fields—and how they attract and repel!

Still curious? Talk to me by scanning the QR code.

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.

Science Around You

Magnets are surprisingly common in our daily lives. From holding notes on your refrigerator and securing cabinet doors to powering electric motors in fans and washing machines, their applications are vast. Understanding magnets helps us grasp how many modern technologies function, from simple toys to complex industrial machinery.

NCF Curricular Goals and Competencies

This chapter aligns with the following curricular goals and competencies:

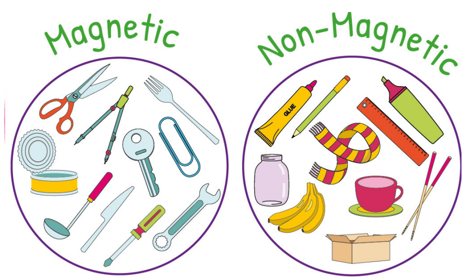
CG-4 (C 4.1, 4.2, and 4.3) investigates the properties of magnets, their interactions, and their practical uses in daily life through scientific exploration.

Mind Map

Exploring Magnets

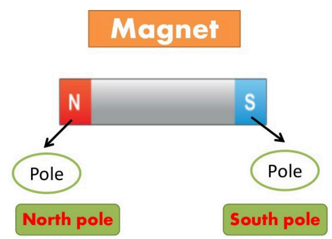
Magnetic and Non-Magnetic Materials

- ❖ **Magnetic Materials:** Attracted to magnets (e.g., iron, cobalt, nickel)
- ❖ **Non-Magnetic Materials:** Not attracted to magnets (e.g., wood, plastic, glass)



Magnetic Poles and Interactions

- ❖ **Poles:** North & South
- ❖ Like poles repel, Unlike poles attract
- ❖ **Magnetic field:** Invisible force around a magnet

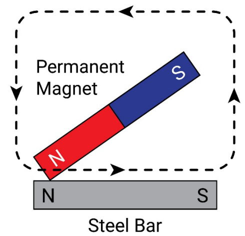


Navigation with Magnets

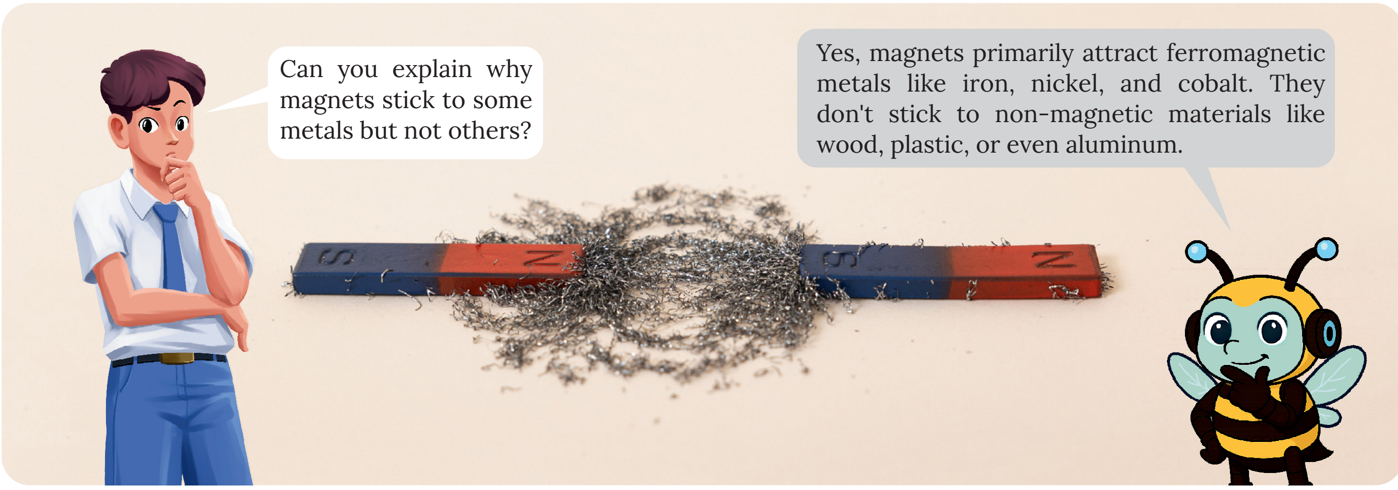
- ❖ **Compass:** Uses Earth's magnetic field for direction
- ❖ **North & South alignment:** Helps in navigation

Magnetic Wonders

- ❖ **Single touch method:**



- ✓ **Magnetism in technology:** Motors, generators, MRI machines
- ✓ **Levitation using magnets:** Maglev trains



In Focus

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

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.

From History's Pages

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

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

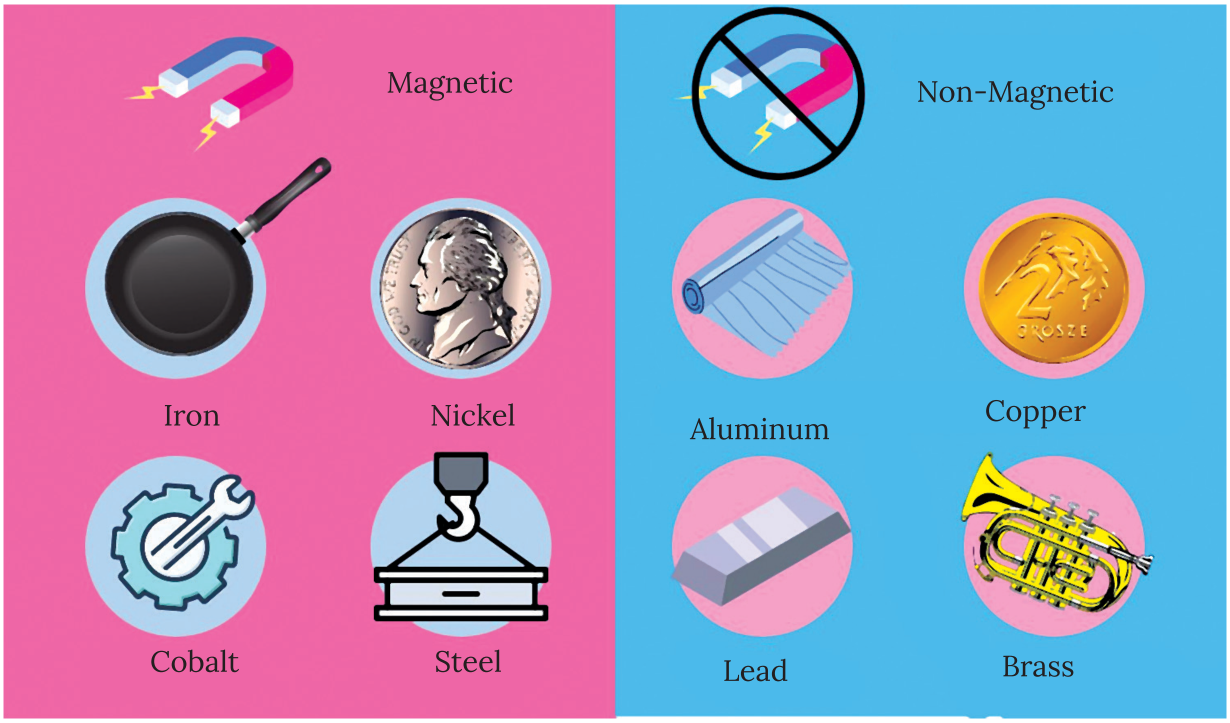


Fig. 4.1 Magnetic and Non-Magnetic Materials

Natural and Artificial Magnets Materials

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.

Fig. 4.2 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.

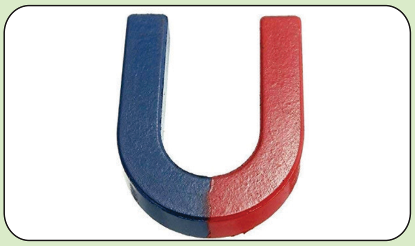
Shapes of Artificial Magnets

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

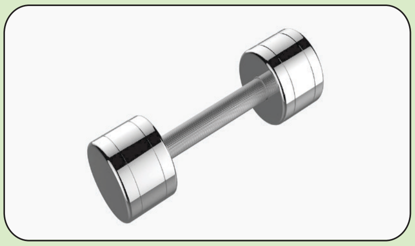
1. **Rectangular Bar Magnet:**
   - Shaped like a flat rectangular bar.
   - Commonly used in physics experiments and as fridge magnets.

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.

Fact Flash

Did you know that the Earth itself acts like a giant magnet, with its own north and south poles? Also, some animals, like homing pigeons and sea turtles, use the Earth's magnetic field to navigate during their long migrations!

Common Misconceptions

× **Misconception:** All metals are magnetic.
✓ **Correction:** Only certain metals like iron, nickel, and cobalt are magnetic. Aluminum and copper, for example, are not.
× **Misconception:** Magnets only attract.
✓ **Correction:** Magnets can also repel each other if like poles (north-north or south-south) are brought together.

Science Around You

Magnetism is a fundamental force that surrounds us, influencing everything from compasses guiding sailors to electric motors powering our homes. It arises from the movement of electric charges and allows certain materials to attract or repel each other. For instance, a simple bar magnet has invisible lines of force extending from its poles, attracting magnetic materials like iron. This force is strong enough to hold notes on a refrigerator or power powerful industrial machinery. Today, magnetic technologies, like MRI scans which use strong magnetic fields to create detailed images of the human body, continue to transform healthcare and our understanding of the world.

Activity

Attraction Test: Magnetic or Non-Magnetic?

Objective: To test different materials and classify them as magnetic or non-magnetic.

- **Materials:** A small bar magnet, various objects to test (coin, wooden stick, plastic button, iron nail, aluminum foil, key, rubber band).
- **Procedure:**
    1. Tester Setup: Hold the bar magnet by one end.
    2. Test the Tester: Bring the magnet close to a known magnetic material like a paper clip. The paper clip should be attracted to the magnet.
    4. Record your observations in a table.
- **Observation:** Note which materials were attracted to the magnet and which were not.

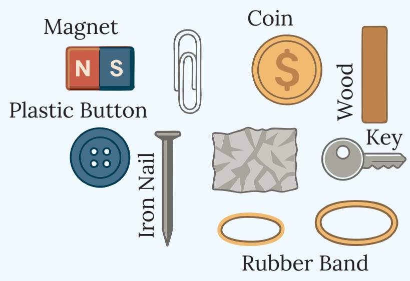


Fig. 4.3 Materials Required

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering

Multiple Choice Questions:

1. Which of these materials is typically attracted to a magnet?

   (a) Wood ☐ (b) Plastic ☐ (c) Iron ☐ (d) Glass ☐

Understanding

2. 2. What happens when two North poles of magnets are brought close together?

   (a) They attract ☐ (b) They repel ☐

   (c) They stick permanently ☐ (d) Nothing happens ☐

3. 3. Which of the following uses magnetism in its operation?

   (a) A wooden chair ☐ (b) A plastic bottle ☐

   (c) A compass ☐ (d) A ceramic plate ☐

Short Answer Question:

Analyzing

4. Give two everyday uses of magnets and state two safety steps when working with strong magnets.
5. Explain magnetic and non-magnetic materials with two examples each. Why is Earth called a giant magnet?

Long Answer Question:

Evaluating

6. Explain why magnetism is so widely used in modern technology. Describe three different applications where magnetism plays a crucial role and discuss the importance of both magnetic and non-magnetic properties in an electrical device like an electric bell.

Magnetic Poles and Interactions

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.

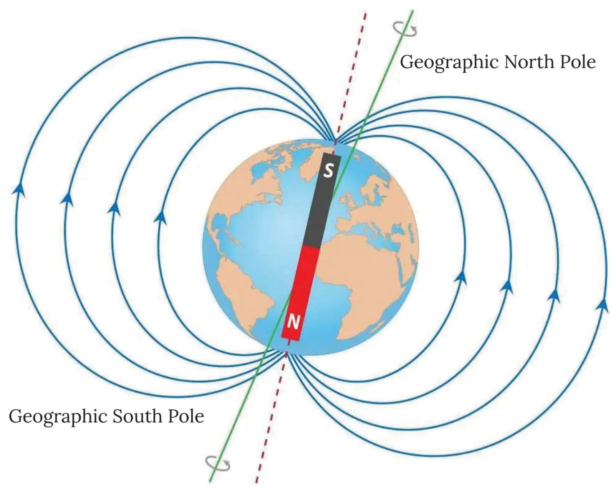


Fig. 4.4 Earth Magnetic Field

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.

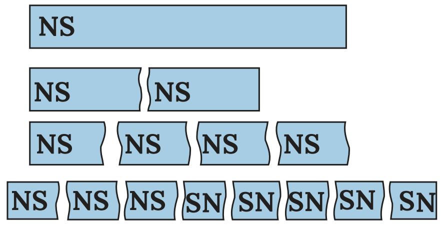


Fig. 4.5 Magnetic Poles

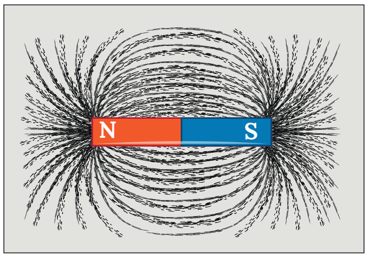


Fig. 4.6 Strength and Distribution

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:

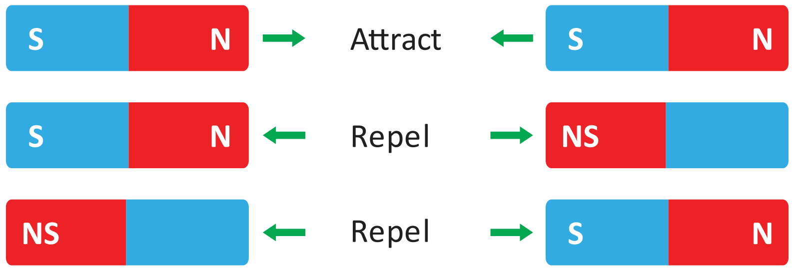


Fig. 4.7 Interaction Between Magnets

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

Fact Flash

Did you know that magnets can lose their strength if they are heated to a very high temperature? This is because the extreme heat disrupts the alignment of their internal magnetic domains! Also, some ancient civilizations, like the Chinese, discovered natural magnets (lodestones) thousands of years ago and used them as early compasses!

Common Misconceptions

× **Misconception:** All metals are magnetic.

✓ **Correction:** Only ferromagnetic metals like iron, nickel, and cobalt are strongly attracted to magnets. Aluminum and copper, for example, are not.

× **Misconception:** Magnets only attract.

✓ **Correction:** Magnets can both attract and repel. Opposite poles attract, while like poles repel each other.

Science Around You

Magnetism is a fundamental force that surrounds us, influencing everything from compasses to complex technologies. It arises from moving electric charges, creating invisible fields that exert force on other magnetic materials. For instance, the Earth's magnetic field extends thousands of kilometers into space, protecting us from harmful solar radiation by deflecting charged particles. This protective shield is vital for life on our planet. Today, magnetic phenomena are harnessed in countless ways, from generating electricity in power plants to storing data on hard drives and enabling MRI scans in medicine, continuing to transform how we interact with the world.

Activity

Attraction and Repulsion: The Magnet Test

Objective: To observe the attractive and repulsive forces between magnets and different materials.

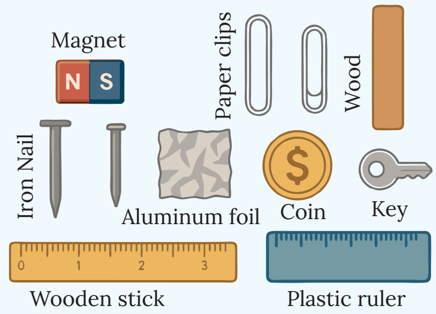


Fig. 4.8 Materials Required

- **Materials:**
  - Two bar magnets (labeled North and South poles if possible), various small objects to test (e.g., paper clips, iron nails, aluminum foil, wooden stick, plastic ruler, coin, key).
- **Procedure:**
  - **Tester Setup:** Place one bar magnet flat on a table.
  - **Test the Tester:** Bring the North pole of the second magnet near the North pole of the first magnet – you should feel a push (repulsion). Then bring the North pole of the second magnet near the South pole of the first – you should feel a pull (attraction).
  - **Testing Materials:** Bring one end of a magnet close to each object to test.
  - Record your observations in a table.
- **Observation:** Note which materials were attracted to the magnet and whether the magnets attracted or repelled each other based on their poles.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering

Multiple Choice Questions:

1. Which of these animals is known to use Earth's magnetic field for navigation?
   (a) Dolphin ☐ (b) Homing pigeon ☐ (c) Dog ☐ (d) Cat ☐
2. The force that arises from moving electric charges is called:
   (a) Gravity ☐ (b) Friction ☐ (c) Magnetism ☐ (d) Buoyancy ☐

Understanding

3. Which of the following is NOT a common application of magnetism?
   (a) Compasses ☐ (b) Generating electricity ☐
   (c) Photosynthesis ☐ (d) MRI machines ☐

Short Answer Question:

Analyzing

4. State two properties of magnets and show two ways magnetism is applied in daily technology.
5. Explain what magnetic poles are and how they act. Why is the Earth's magnetic field important for life?

Long Answer Question:

Evaluating

6. Explain why magnetism is a powerful and widely used force in modern society. Describe three different applications of magnetism in technology and discuss the importance of both magnetic attraction and repulsion in designing magnetic devices.

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.

Fig. 4.9 Compass

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.

Fact Flash

Did you know that the Earth's magnetic field is constantly, albeit slowly, shifting? Over thousands of years, the magnetic North and South poles can even swap places entirely! Also, the aurora borealis (Northern Lights) and aurora australis (Southern Lights) are spectacular natural light displays caused by charged particles from the sun interacting with the Earth's magnetic field!

Common Misconceptions

× **Misconception:** A compass points to the geographic North Pole.

✓ **Correction:** A compass points to the magnetic North Pole, which is constantly moving and is distinct from the geographic North Pole.

× **Misconception:** Magnets work perfectly everywhere on Earth.

✓ **Correction:** Magnetic compasses can be affected by local magnetic anomalies (like large iron deposits) and are less reliable near the Earth's magnetic poles.

Science Around You

Navigation has been a cornerstone of human exploration and survival for millennia, and magnetism has played a pivotal role in this endeavor. At its heart, navigation relies on knowing one's position and desired direction. The Earth acts as a giant natural magnet, producing a pervasive magnetic field that permeates our planet and extends far into space. This field aligns with the Earth's geographic poles, providing a consistent directional reference. Early navigators discovered that a magnetized needle, free to pivot, would always align itself with this magnetic field, pointing towards the magnetic North. This simple yet profound discovery led to the invention of the compass, an indispensable tool that revolutionized sea travel and overland exploration. Today, while advanced **GPS systems** dominate modern navigation, the fundamental principle of magnetic direction-finding remains critical as a backup and in environments where satellite signals are unavailable. Understanding magnetism is key to appreciating how humans have historically, and continue to, master the art of finding their way.

Activity

Making a Simple Compass: The Floating Needle Test

Objective: To construct a basic compass and observe its alignment with the Earth's magnetic field.

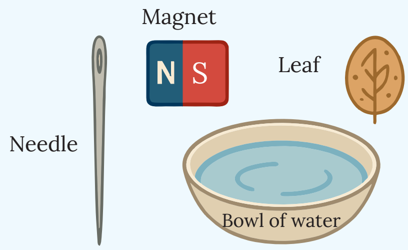


Fig. 4.10 Materials Required

- **Materials:**
  - A sewing needle, a small magnet (e.g., refrigerator magnet), a shallow bowl of water, a small piece of cork or a leaf.
- **Procedure:**
  - **Magnetize the Needle:** Rub the needle repeatedly in one direction with one pole of the magnet (e.g., 20-30 times). Ensure you only rub in one direction, lifting the magnet after each stroke.
  - **Prepare the Float:** Gently push the magnetized needle through the small piece of cork or place it on top of the leaf.
  - **Float the Compass:** Carefully place the cork/leaf with the needle onto the surface of the water in the bowl.
  - **Observe:** Allow the needle to settle. It should slowly align itself in a specific direction.
  - **Test Direction:** Compare the direction the needle points to a known compass or **cardinal directions** (North, South, East, West).
  - Record your observations.
- **Observation:** Note the direction the magnetized needle points and whether it consistently aligns itself after being disturbed.

Keywords

GPS: (Global Positioning System) is a satellite-based navigation system that helps determine exact location anywhere on Earth. It is commonly used in phones, vehicles, and maps for tracking and route guidance.
Cardinal Directions: They are the four main points of a compass: North, South, East, and West. They help in navigation and locating places on maps and in the real world.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering / Understanding / Analyzing / Evaluating

Multiple Choice Questions:

1. What natural phenomenon is caused by the interaction of solar particles with Earth's magnetic field?

   (a) Rainbows ☐ (b) Thunderstorms ☐ (c) Auroras ☐ (d) Eclipses ☐

2. A compass needle aligns itself with which of the following?

   (a) Geographic Equator ☐ (b) Earth's magnetic field ☐

   (c) Sun's rays ☐ (d) Prevailing winds ☐

3. Which of the following is NOT a primary use of a magnetic compass?

   (a) Determining direction ☐ (b) Locating buried treasure ☐

   (c) Aiding navigation ☐ (d) Orienting maps ☐

Short Answer Question:

4. Explain two ways Earth's magnetic field protects us and give two examples of animals using it for travel.
5. Explain the magnetic North Pole and why it differs from the geographic one. How did the compass change travel?

Long Answer Question:

6. Explain why magnetism has been and continues to be crucial for human navigation. Discuss the importance of understanding magnetic variations for accurate directional guidance.

Magnetic Wonders

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.

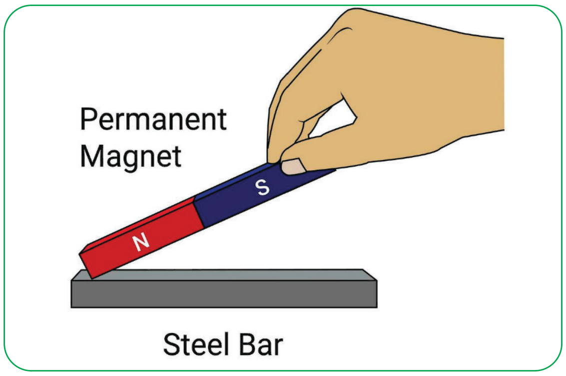


Fig. 4.11 Single-Touch Method

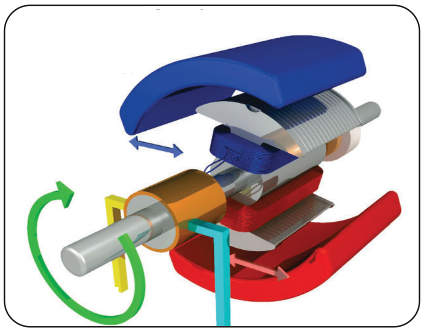
Uses of Magnets

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.


Speaker


Electric Motor


Junkyard

- **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.
- **Junkyards:** Magnets are used to efficiently lift and sort iron and steel materials.

Fact Flash

Did you know that some species of bacteria contain tiny magnetic crystals that allow them to "swim" along the Earth's magnetic field lines? This helps them navigate to areas with optimal oxygen levels! Also, magnets are crucial in creating the stunning images you see in an MRI (Magnetic Resonance Imaging) scan, helping doctors "see" inside the human body!

Common Misconceptions

× **Misconception:** Magnets lose their strength over time.

✓ **Correction:** Permanent magnets retain their magnetism indefinitely under normal conditions, though extreme heat or strong opposing magnetic fields can demagnetize them.

× **Misconception:** Magnetism is only found in solid objects.

✓ **Correction:** Magnetic fields exist in space around magnets and electric currents; they are not limited to the solid material itself.

Science Around You

Magnetism is a fundamental force, a hidden wonder that shapes much of our modern world and the natural phenomena around us. It originates from moving electric charges, creating invisible magnetic fields that exert forces on other magnets and magnetic materials. Consider the Earth's own magnetic field: it acts as a colossal shield, deflecting harmful charged particles from the sun, safeguarding our atmosphere and life itself from intense solar radiation. This protective bubble is what allows auroras, like the Northern and Southern Lights, to dance in the sky, as solar particles interact with these magnetic lines. From the delicate compass needle aligning itself with this planetary force to the powerful electromagnets in industrial machinery, magnetism is not just a theoretical concept; it's a practical, indispensable force that continues to drive innovation and unveil the "magnetic wonders" of our universe.

Activity

Exploring Magnetic Fields: The Iron Filings Test

Objective: To visualize the invisible magnetic field lines around a magnet.

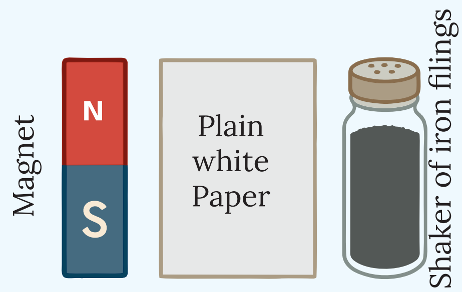


Fig. 4.12 Materials Required

- **Materials:**
  - A bar magnet, a sheet of plain white paper, a shaker of iron filings (or very fine iron powder).
- **Procedure:**
  - **Setup:** Place the bar magnet flat on a table.
  - **Cover with Paper:** Carefully place the sheet of white paper over the magnet.
  - **Sprinkle Filings:** Gently and evenly sprinkle the iron filings over the paper, especially above and around the magnet.
  - **Observe:** Lightly tap the paper a few times. Observe how the iron filings arrange themselves, forming a distinct pattern.
  - **Draw the pattern:** Sketch the pattern you observe on the paper.
- **Observation:** Note the shape and density of the lines formed by the iron filings, especially at the ends (poles) of the magnet compared to the middle.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering

Multiple Choice Questions:

1. What causes the Earth's auroras (Northern/Southern Lights)?
   (a) Lunar phases ☐ (b) Volcanic eruptions ☐
   (c) Solar particles interacting with the magnetic field ☐
   (d) Ocean currents ☐

Understanding

2. What is the fundamental source of magnetism?
   (a) Gravity ☐ (b) Stationary electric charges ☐
   (c) Moving electric charges ☐ (d) Heat energy ☐
3. Which of the following is NOT a common application of magnetism?
   (a) Compass navigation ☐ (b) Storing data on hard drives ☐
   (c) Photosynthesis in plants ☐ (d) MRI medical imaging ☐

Short Answer Question:

Applying

4. Explain two ways Earth's magnetic field protects the planet and give two technologies that depend on magnetism.
5. Explain what a magnetic field is and show how iron filings reveal it. Why do such fields exist around magnets?

Long Answer Question:

Analyzing

6. Explain why magnetism is considered a "wonder" that underpins much of modern technology and natural phenomena. Describe three different applications of magnetism, illustrating how its unique properties are harnessed.

SUMMARY

1. Magnetic and Non-Magnetic Materials

Magnets have the special ability to attract certain materials. These materials are called magnetic materials and mainly include iron, nickel, and cobalt. Steel, which is made from iron, is also magnetic. Objects like pins, nails, scissors, and iron rods get attracted to magnets because they contain magnetic materials.

On the other hand, non-magnetic materials do not get attracted to magnets. These include plastic, wood, rubber, paper, cloth, aluminum, and glass. Understanding the difference between magnetic and non-magnetic materials helps us in separating materials, designing magnetic tools, and using magnets in various everyday applications.

2. Magnetic Poles and Their Interactions

Every magnet has two ends or poles – a North Pole and a South Pole. These poles are the regions where the magnetic force is the strongest. The interaction between magnetic poles follows a simple rule:

This property is important in understanding the force of magnetism. For example, if two bar magnets are brought close, they either pull towards each other or push away, depending on how their poles face. This interaction is used in magnetic levitation, magnetic locks, and even in magnetic toys.

Magnets can also induce magnetism in some objects temporarily. For instance, if an iron nail is kept in contact with a magnet for some time, it becomes a temporary magnet and can attract other nails.

3. Navigation with Magnets

Magnets have been used for centuries in navigation. The magnetic compass, a simple device, uses a freely moving magnetic needle that aligns itself with Earth's magnetic field and always points toward the magnetic north. This is possible because Earth behaves like a giant magnet, with its own magnetic poles.

Before modern GPS systems, sailors, travelers, and explorers relied on compasses to find directions while sailing across oceans or crossing unknown lands. Even today, pilots, trekkers, and hikers carry compasses as a backup navigation tool. Compasses work only on Earth or nearby, as they depend on Earth's magnetic field.

4. Magnetic Wonders – Uses of Magnets in Daily Life

Magnets are all around us and are used in many amazing and practical ways:

In Transportation: High-speed maglev trains use magnetic repulsion to float above tracks, reducing friction and allowing smooth, fast movement.

In Technology: Computers, mobile phones, and speakers all use magnets in their internal components. Magnets in hard drives help in data storage and retrieval.

Magnets can be natural (like lodestone) or man-made in different shapes such as bar magnets, horseshoe magnets, and ring magnets.

Example Based Questions

Multiple Choice Questions

1. Which of the following is a non-magnetic material?

   (a) Iron nail (b) Nickel coin

   (c) Plastic scale (d) Cobalt piece

   Answer: (c) Plastic scale

   Explanation: Iron, nickel, and cobalt are magnetic materials attracted by magnets. Plastic does not get attracted to a magnet, making it a non-magnetic material.

2. When the north pole of a magnet is brought near the north pole of another magnet, they:

   (a) Attract each other (b) Repel each other

   (c) First attract then repel (d) Show no effect

   Answer: (b) Repel each other

   Explanation: Like poles of magnets (N–N or S–S) always repel, while unlike poles (N–S) attract. This interaction is a fundamental law of magnetism.

Short Answer Questions

3. Give two examples each of magnetic and non-magnetic materials.

   Answer: Magnetic materials: Iron, Nickel
   Non-magnetic materials: Wood, Plastic
   This distinction helps in designing tools, machines, and daily-use objects where magnetism may or may not be desirable.

4. Why do the poles of a magnet always exist in pairs?

   Answer: Magnetic poles cannot be isolated. If we cut a magnet into two pieces, each piece still has a north pole and a south pole. This happens because magnetic domains inside always align in pairs. Hence, a single north pole or south pole cannot exist alone.

5. How did sailors in ancient times use magnets for navigation?

   Answer: In ancient times, sailors used a lodestone (a naturally magnetized stone). When suspended freely, it pointed towards the north–south direction. Later, magnetic compasses were developed from this property, helping sailors navigate across seas without getting lost.

Long Answer Questions

6. Ramesh places different objects like an iron nail, a coin, a wooden stick, and a plastic bottle near a bar magnet. Only some objects are attracted, while others are not. Explain why this happens. Also, classify the given objects into magnetic and non-magnetic groups.

   Answer: Magnets attract only specific materials such as iron, nickel, and cobalt. These are called magnetic materials. Materials that do not get attracted by magnets, such as wood, plastic, and glass, are called non-magnetic materials.

   Magnetic: Iron nail, Coin (if made of nickel or iron content)
   Non-magnetic: Wooden stick, Plastic bottle

   This happens because magnetic materials have domains that align with the magnetic field, while non-magnetic materials do not. This experiment shows the selective nature of magnets and why they are used in industries for separating materials.

7. Explain in detail how Earth itself behaves like a giant magnet. How does this property of Earth help in navigation?

   Answer: Earth acts like a giant bar magnet with its magnetic axis tilted slightly from the geographical axis. The magnetic south pole lies near Earth's geographical north pole, and the magnetic north pole lies near Earth's geographical south pole. This is why a compass needle always points north–south.

   Importance in Navigation:

   Travelers and sailors use compasses to determine directions.

   Even before maps and GPS, this property allowed sailors to cross oceans safely.

   Birds and some animals also sense Earth's magnetic field to migrate long distances.

   Thus, Earth's magnetism is a natural wonder that has guided humans and animals for centuries. Without it, early navigation and exploration would have been nearly impossible.

Gap Analyzer™
Complete Chapter Test

EXERCISE

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 magnetism (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.

1. Materials that do not interact with magnets are called _________.
2. The north pole of a magnet always points towards the _________.
3. A freely suspended magnet aligns itself in the _________ direction.
4. Like poles of a magnet _________, while opposite poles _________.
5. 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. Assertion and Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is NOT the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

(e) Both A and R are false.

1. **Assertion (A):** A magnet can attract an iron nail.
   Reason (R): Iron is a magnetic material.
2. **Assertion (A):** A compass needle always points north.
   Reason (R): The Earth itself acts like a giant magnet.
3. **Assertion (A):** Like poles of magnets attract each other.
   Reason (R): Magnetic forces cause repulsion between similar poles.

G. 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.

H. 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.

I. 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. How can an ordinary piece of iron be turned into a magnet? Explain the process.

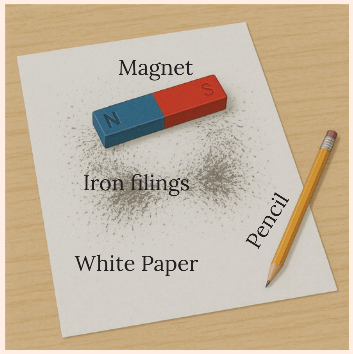
SKILL-BASED PRACTICE

Activity Time

STEM

Modelling a Magnetic Field

Materials Needed: A bar magnet, A sheet of white paper, Iron filings, A pencil or pen, A flat, non-magnetic surface.



Materials Required

Activity Steps:

1. Place the bar magnet flat on the table.
2. Carefully place the sheet of white paper over the magnet.
3. Gently sprinkle iron filings evenly over the paper covering the magnet.
4. Lightly tap the paper a few times.
5. Draw the pattern you observe on a separate piece of paper, indicating the magnet's poles.

Questions to Answer:

- What kind of pattern did the iron filings form around the magnet?
- Were the filings more concentrated at certain parts of the magnet? Which parts?
- How does this activity help you understand what a magnetic field is?

Skills Covered: Observation, Understanding Magnetic Fields, Spatial Reasoning

Creativity

Art

"Magnetic Compass Rose" Diagram

Task: Design a vibrant compass rose diagram that includes a working compass needle (or drawing one) and illustrates how the Earth's magnetism influences navigation. Show the North and South geographic poles, and indicate the direction a compass needle points. Add artistic elements related to travel or exploration.


Magnetic Compass

Materials to Use:

- Large chart paper or drawing board
- Coloured markers, pencils, or paints
- A ruler and protractor (for precision)
- A real small compass to place on the diagram

Questions to Answer:

- How did you visually represent the Earth's magnetic poles in relation to its geographic poles?
- What visual elements did you use to show the direction a compass needle points?
- How does your diagram explain why magnets are useful for navigation?

Skills Covered: Visual Representation, Communication of Scientific Concepts, Diagrammatic Skills

Scientific Method Storytelling

Group Activity

Investigating Magnet Strength with Paper Clips

Activity Instructions: Work in a group to conduct a simple experiment.

1. **Materials:** Gather 2-3 different sizes/types of magnets (e.g., bar magnet, horseshoe magnet, small disc magnet) and a pile of small paper clips.
2. **Experiment:** For each magnet, hold it over the pile of paper clips and slowly lift it, counting how many paper clips it can pick up and hold without dropping them. Repeat this 3 times for each magnet.
3. **Data Collection:** Create a table to record the type of magnet and the number of paper clips it picked up in each trial. Calculate the average for each magnet.
4. **Analysis:** Discuss your findings within your group.

Questions to Answer:

- Which magnet picked up the most paper clips on average?
- Were there any differences in the number of paper clips picked up by the same magnet across different trials? If so, why might this happen?
- What does the number of paper clips picked up tell you about the strength of the magnet?
- How did this activity help you understand magnetic strength and interaction?

Skills Covered: Experimental Design, Data Analysis, Understanding Magnetic Strength, Teamwork

The Lost Hiking Group

Case Study

Hiking Group

A group of five friends—Riya, Aarav, Meena, Kabir, and Tanya—went hiking in a dense forest. They carried a map but realized they had forgotten their GPS device. Luckily, Meena had brought a simple magnetic compass. Using the compass needle, which always pointed north, they figured out their direction and tried to get back on track.

As the sun moved overhead and shadows shifted, it became harder to rely on natural signs. The trees looked similar, and the air grew more humid. Kabir started to panic, worried they might walk in circles. Meena reminded everyone to stay calm and trust the compass. They paused, rechecked the map, and took turns leading, always watching the needle.

Bird calls and rustling leaves surrounded them as they moved slowly, careful not to miss landmarks. Tanya noticed a large rock they had passed earlier—it gave them hope. They continued forward, growing more confident with each step. Finally, they reached a clearing with a familiar tree marked with a red cloth.

Guiding Questions:

1. Why was the compass more useful than the map alone in helping the friends find their way?
2. What role did teamwork play in the group's successful return to the trail?
3. How did the compass needle help the friends stay oriented in the dense forest?
4. What could have gone wrong if the friends had relied only on landmarks like trees and rocks?

Skills Covered: Observation, Natural Phenomena, Magnetic Field Awareness, Cause and Effect

Safety Guidence for Magnetic Toys

Source Based Question

According to the U.S. Consumer Product Safety Commission (CPSC), some small toys that use powerful magnets can be dangerous if swallowed. The CPSC warns that if two or more strong magnets are swallowed, they can attract each other inside the body, leading to serious injuries such as blockage or damage to internal organs. Therefore, manufacturers must follow safety guidelines when designing magnetic toys. At the same time, magnets are safe and fun when used carefully, helping children explore scientific ideas like attraction and repulsion of poles.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

This document has been electronically approved and signed.

THIS MATTER IS NOT SCHEDULED FOR A BALLOT VOTE
BRIEFING AND DECISIONAL MEETINGS FOR THIS MATTER ARE TO BE DETERMINED

DATE: October 6, 2021

TO: The Commission
Alberta E. Mills, Secretary

THROUGH: Pamela J. Stone, Acting General Counsel
Mary T. Boyle, Executive Director

FROM: Daniel R. Vice, Assistant General Counsel, Regulatory Affairs
Meridith L. Kelsch, Attorney, Regulatory Affairs

SUBJECT: Proposed Rule: Safety Standard for Magnets

Staff is forwarding to the Commission a briefing package recommending that the Commission issue a notice of proposed rulemaking (NPR), pursuant to section 7 and 9 of the Consumer Product Safety Act, to address the risk of injury associated with ingestion of small high-powered magnets. The Office of the General Counsel is providing for the Commission's consideration a draft NPR that would establish requirements for subject magnet products.

Image Credit: USCPC

Guiding Questions & Tasks

1. **Toy Design – Magnetic Interactions**
   a. To make the toy parts stick together firmly, what kind of magnetic poles should the designer ensure face each other?
   b. To make parts push away from each other, what kind of magnetic poles should be used? Explain the principle behind this.
2. **Industrial Separation – Magnetic Materials**
   a. What property of iron allows it to be separated from non-metal waste using a magnet?
   b. Name two other materials that would be attracted to the magnet in this separation process, and two that would not be attracted.
3. **Magnetic Fields and Strength**
   a. If the industrial engineer needs a very strong magnet for efficient separation, what feature of the magnet's force field would be more intense?
   b. How could the engineer test if one magnet is stronger than another without specialized equipment?

Skills Covered: Observation, Understanding Natural Phenomena, Cause and Effect, Classification