Magnetic Metals

Section FORCES & INTERACTIONS

Estimated Time Setup: 5 minutes; Procedure: 5-10 minutes

OVERVIEW

Students will learn about magnetism by testing whether a variety of objects are attracted to a magnet.

The force of magnetism isn't visible traveling through the air, but we can see it because it makes objects move. In this activity, students place a variety of metal items on a desk and try and attract each item with a magnet. Based on whether or not an object moves, students can tell whether or not the object has magnetic properties.

INQUIRY QUESTIONS

Getting Started:

- What objects are magnetic?

Learning More:

- What are the properties of magnets?

Diving Deeper:

- How does a magnet work?

CONTENT TOPICS

This activity covers the following content topics: physical properties of matter, properties of metals, magnetism, forces, magnetic fields, temporary magnets, permanent magnets, magnetic poles, non-contact forces

This activity can be extended to discuss: periodic table of elements, contact forces, chemical properties of matter

NGSS CONNECTIONS

This activity can be used to achieve the following Performance Expectations of the Next Generation Science Standards:

- **3-PS2-3:** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

MATERIALS

For one setup:

- 1 magnet wand
  - Alternative: 1 refrigerator magnet (other types of magnets will work too), 1 wood or stiff plastic ruler, clear plastic tape
- Assorted metal objects (e.g. keys, paper clips, spoon, ball of aluminum foil, pieces of pipe cleaner, coins) and non-metal objects (e.g. toothpicks, pencils, erasers, hairbands, plastic bottle cap, ball of tape, rubber bands)

ACTIVITY NOTES

This activity is good for:

- Individuals
- Pairs
- Small groups
- Concept introduction

Safety Tips & Reminders:

- Review the Safety First section in the Resource Guide for additional information

Fun Fact #1

A naturally magnetic mineral commonly called lodestone was used in the past to make magnetic compass needles. The word "lode" means "lead" because the compasses were used to lead sailors home. Today, compasses have tiny bar magnets that float in liquid. The magnet naturally aligns to the earth's poles and will always point north and south!

ENGAGE

Use the following ideas to engage your students in learning about forces:

- Start by brainstorming a list of what objects are metals and what are not metals. What are the properties of metals and nonmetals? Of the metals and nonmetals discussed, which ones are magnetic? How do students know? How would they describe magnetism? What does it feel like? Look like? Sound like?
- Have students make predictions based on the objects in front of them: which will be magnetic, and which will not? Why do they think that? Now test to see if their predictions are correct!

See more ideas for engagement in the Forces & Interactions Background section! You can also look at the Elaborate section of this activity for other ideas to engage your students.

Notes

EXPLORE

Procedure:

1. If you do not have a magnet wand, start by making one: use the tape to attach a magnet to a ruler so the magnet is facing away from the ruler.
2. Place all the objects in a row on a table. Ask students to predict which will be magnetic and which will not. Record all observations.
3. Test the predictions by holding a magnet over each item one-by-one.

DATA COLLECTION & ANALYSIS

Analyze and discuss the results of this activity using the following questions:

- Record the names of each item.
- What material is each item made from? How do you know? What are some physical properties of these materials?
- Note your predictions: which objects will be attracted to the magnet and which will not? Why?
- Look closely: what happens when the magnet approaches an object that it is NOT attracted to? What happens when the magnet approaches an object that it IS attracted to?
- Revisit your predictions: which objects were magnetic, and which were not? Were you correct in your predictions?
- What surprised you?
- What similarities do you note between objects that are all magnetic?
- What similarities do you note between objects that are all not magnetic?
- What differences do you note between objects that are magnetic and objects that are not magnetic?

EXPLAIN

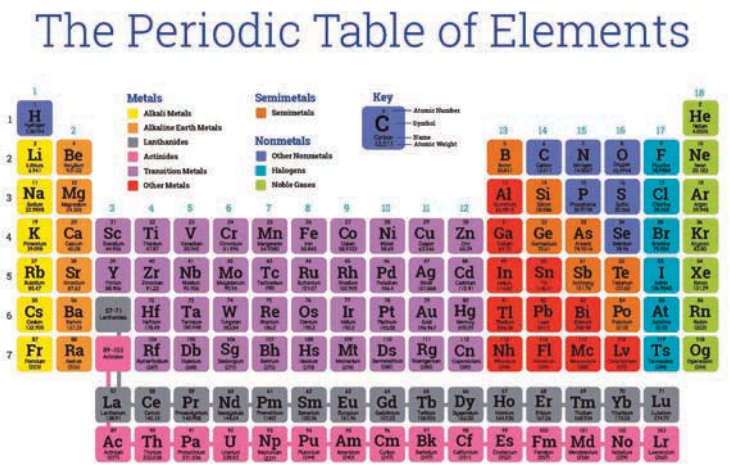
What's happening in this Activity?

First review the Forces & Interactions Background section to gain a deeper understanding of the scientific principles behind this activity.

Chemistry is the study of matter, its properties, and the changes it undergoes. **Matter** is anything that has mass and takes up space. Matter exists in many different shapes, sizes, and forms. All matter is made up of some combination of 118 building blocks called elements, each of which is unique. **Elements** are the simplest chemical substances and cannot be broken down further through physical or chemical means. The periodic table shows all the elements that we know exist.

Fun Fact #2

Metal paper clips are generally made from steel wire. Steel is an alloy of iron and carbon. The iron in the paper clips causes them to be attracted to the magnet.



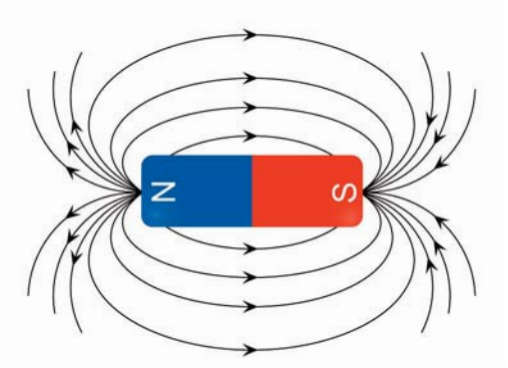
Each of these elements has unique properties. **Physical properties** are properties of a substance that can be observed or measured without changing the substance's chemical makeup, or its identity. Color, size, and conductivity are all physical properties.

One physical property that can used to identify what material a substance is made of is magnetism. **Magnetism** is a force between objects that acts at a distance through a magnetic field. A **force** is any kind of push or pull on an object. The force of magnetism can be either **attractive** and pull objects closer together, or **repulsive** and push objects farther apart .

Magnetism is a **non-contact** force because it happens between objects that are not physically touching each other. Think about sending a message from your phone to a friend's phone through an internet connection. If you are somewhere with Wi-Fi, you are connecting to the internet through radio waves moving through the air around you. You can send a message to someone even if they are far away by using these radio waves.

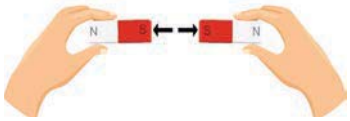
The symbol we use to represent Wi-Fi (left) is based on how we illustrate radio waves coming from a radio tower (right).

In the same way that radio waves move through the air but are not visible, the force of magnetism acts over a distance by creating a magnetic field, even though we can't see it. A magnet is any object that creates a strong magnetic field .

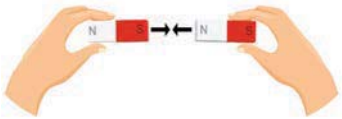


EXPLAIN continued

The two ends of a magnet, where the force is the strongest, are called its poles. Every magnet has a **north pole (N)** and a **south pole (S)**. Opposite poles are attracted to each other, and poles that are the same repel each other.



Two north poles are repelled from each other and a magnetic force pushed them apart. The same is true for two south poles.



The north pole of one magnet is attracted to the south pole of another magnet so a magnetic force pulls them together. Opposites attract !

If a material is magnetic, it will be attracted to one of the two poles of a magnet. Some metal elements have magnetic properties—these are called **ferromagnetic metals**. Iron, nickel, and cobalt are the three strongest magnetic elements.

In this activity, students test which metal objects are attracted to a refrigerator magnet. Anything that is attracted to the magnet must have some magnetic properties, and therefore must contain some ferromagnetic metal. We may not be able to see the magnetic field, but we can tell that it is there because it makes objects move.

Many of the objects you are testing might be attracted to the refrigerator magnet, but not exert any force on each other. This is because some magnetic forces are stronger than others. A **permanent magnet** creates its own magnetic field, and always has magnetic properties. The refrigerator magnet is a permanent magnet. A **temporary magnet** only acts like a magnet when something else creates a magnetic field. The objects attracted to the refrigerator magnet in this experiment are temporary magnets .

In the presence of the magnet, some objects become temporary magnets and stick to it.

When the magnet is gone, these objects don't create a magnetic field. They don't move towards each other or away from each other because they stop exerting a magnetic force.

Differentiation for Younger or More Advanced Students

You can differentiate this activity for students of different grade levels by focusing on the concepts outlined below.

GETTING STARTED

For younger students, emphasize the following concepts:

- All matter is made up of building blocks called elements.
- Each element can be identified by its unique physical and chemical properties.
- Magnetism is a physical property.
- Forces can be either attractive (pulling) or repulsive (pushing).

DIVING DEEPER

For more advanced students, emphasize the following concepts:

- Magnetism is a force that acts over a distance through a magnetic field.
- Magnets have two poles. Opposite poles attract each other and like poles repel each other.
- Magnetic forces can have different strengths.
- Permanent vs. temporary magnets

ELABORATE

Elaborate on your students' new ideas and encourage them to apply them to different situations. The section below provides some alternative methods, modifications, and extensions for this activity.

- Take the experiment one step further. Use one of the objects that was attracted to the magnet and place it on the magnet for about a minute. Next, remove the object from the magnet, and see if it can attract your other magnetic objects. Metals that are magnetic can be made into temporary magnets themselves!
- Task students with finding magnets in their homes! They can take a magnet home or use it around school for a day and write their observations in a journal. What objects were magnetic? What objects were not? What surprised them? What is a question they still have?
- Tie this activity in with explorations in the Separation Techniques section of the Activity Guides. Provide a mixture that includes some magnetic items, and some nonmagnetic items, along with a variety of tools which could be used to separate them – including a bar magnet. What are the different ways a separation can be done? For ideas on what materials can be used, check out the Activity Guides "The Great Divide" and "Separating Salt and Pepper," where salt or pepper can be substituted or used in addition to magnetic sand!
- Connect this activity to a study of the periodic table of elements: which elements are magnetic? Students can do research online or in a science textbook, then present an overview of each element to their peers.

CHEMISTRY IN ACTION

Share the following real-world connections with your students to demonstrate how chemistry is all around us.

Real-World Applications

The earth is surrounded by an enormous magnetic field! This magnetic field is caused by the movement of molten iron in the outer core of the earth combined with heat escaping from the inner core. The magnetic north and south poles are slightly different from the geographic north and south poles. And in fact, the geographic north pole is actually the geomagnetic south pole !

Throughout your day, you use dozens of products that are made possible through magnets and magnetism. Everything from alarm systems, to MRI machines, to microphones, and car horns!

Careers in Chemistry

- Magnets and magnetic technology have been widely used in the mining industry. Powerful magnets are used to separate valuable materials from within the mine. They are also used to remove contaminants from the mined materials, such as coal.
- In rare cases, liquids can also have magnetic properties! This fascinating phenomenon is seen in ferrofluids, which are made of iron suspended in oil with a surfactant to prevent clumping. Ferrofluids are used in electronics for a variety of applications, like in hard drives to prevent debris from entering the device, and in speakers to improve quality.

Notes

EVALUATE

- Provide students with a new set of materials they did not test previously. Ask them to make informed predictions of whether each object will respond to a magnet based on their results from the original activity. They can then test their predictions and explain why they were correct or how they are revising their predictions and why.
- Ask students to reflect on their takeaways from this activity. What were they expecting? What surprised them? What are three things they learned? What three questions do they still have for further investigation? What was their favorite part of the activity? What was the most challenging? What new vocabulary did they learn today, and can they define the terms in their own words?

Fun Fact #3

Over the course of thousands of years, the geomagnetic poles of the earth flip! This means that in the past – and maybe sometime soon – our compasses directed us north to Antarctica, instead of south!

Fun Fact #4

Magnets are one of the many tools used to separate materials in the recycling process.