chapter 7

Magnetism and Its Uses

section 1 Magnetism

What You'll Learn

- how a magnet applies force
- how temporary and permanent magnets act
- magnetic materials and magnetic domains

Before You Read

Think about a magnet that you have used. Tell what it looked like and the kinds of materials it attracted.

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Read to Learn

Magnets

Magnets were discovered over 2,000 years ago. Greeks discovered a mineral that could attract pieces of iron. This mineral is now called magnetite. About 1,000 years ago, Chinese sailors used magnetite to make compasses. Compasses are tools that can help you determine which direction you are traveling. Since then many items have been invented that use magnets. **Magnetism** refers to the properties of magnets and how magnets interact when they are near each other.

What is a magnetic force?

Magnets apply a force on each other. These forces make magnets do one of two things. The magnets can attract, which means they pull together. Or the magnets can repel, which means they push each other away. How they react depends on which ends of the magnets are close together. Two magnets interact with each other even before they touch. As the magnets move closer together, the force between them increases. As the magnets move farther apart, the force decreases.

What is a magnetic field?

The way magnetic forces interact with each other is caused by magnetic fields. The **magnetic field** exerts a force on other magnets and objects that are made of magnetic material. The magnetic force is strongest close to the magnet.

Study Coach

Discussion After reading this section, use an index card to write down the two most important things you learned. Put one idea on one side and the second idea on the back. Form a group of four students to discuss your topics.

Reading Check

1. **Infer** What causes the ways magnetic forces interact with each other?

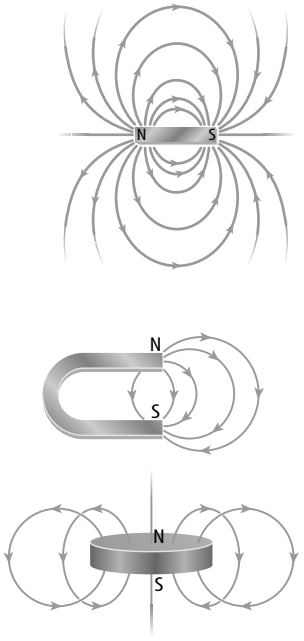
_____

Lines can represent a magnetic field. The figures below show what magnetic fields might look like. The arrows show that magnetic fields have direction.

What are magnetic poles?

Magnetic poles are the places on a magnet that exert, or put forth, the strongest magnetic force. All magnets have a north and a south pole. As shown, the north and south poles are at the opposite ends of a bar magnet. The lines that represent the magnetic field are closest together at the poles.

The next figures show the magnetic poles of two magnets with different shapes. A horseshoe-shaped magnet has its north and south poles at its two ends. The magnetic field lines start at the north pole and end at the south pole. Look at the disk magnet and the bar magnet. Like all magnets, the magnetic field lines of the disk magnet and the bar magnet go from north pole to south pole.



Magnetic Fields

How do magnetic poles interact?

Remember, two magnets can either attract or repel each other. This depends on which poles of the magnets are placed close together. Two north poles will repel each other. The same is true for two south poles. However, a north pole and a south pole always attract each other. Like magnetic poles repel each other and unlike poles attract each other.

How do magnets affect compasses?

A compass needle is a small bar magnet. The force exerted by another bar magnet will make the compass needle turn. The needle turns until it lines up with magnetic field lines. The south pole in a compass needle is attracted to the north pole of a magnet.

How does Earth act like a magnet?

Earth is like a giant bar magnet. It is surrounded by a magnetic field and has a north and a south magnetic pole. Earth also has a north and a south geographic pole. The geographic poles are at opposite ends of Earth—one in the north and one in the south. These are different from the magnetic poles. The south magnetic pole is near the geographic north pole.

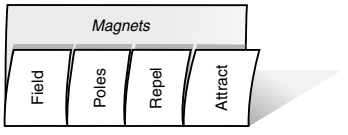
Picture This

2. Highlighting Using a highlighter, trace the lines of the magnetic fields for all three types of magnets shown on this page. At which magnetic pole did you always start ?

FOLDABLES™

A Organizing Information

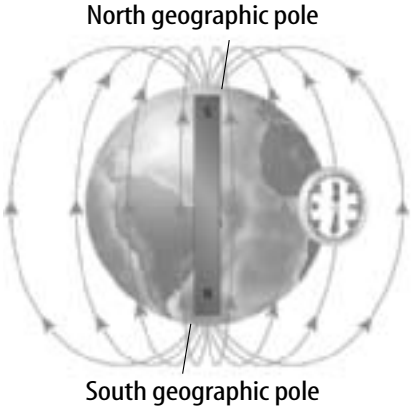
Make the following Foldable to help you organize information about magnetic fields, magnetic poles, and how magnets repel and attract.



Why does a compass point north?

A compass needle lines up with Earth's magnetic field lines. The needle always points toward Earth's geographic north pole. Remember that magnetic poles are attracted only to their opposite. So, even though the compass is pointing at the geographic north pole of Earth, the north pole of the compass is pointing at the south magnetic pole of Earth.

The figure shows the magnetic field lines around Earth. No one is sure what causes Earth's magnetic field. Earth's inner core is made of iron and nickel. One theory suggests that this may produce Earth's magnetic field.



Picture This

3. **Determine** Write an N on the figure to show where Earth's north magnetic pole is. Write an S on the figure to show where Earth's south magnetic pole is.

Magnetic Materials

A magnet will not attract all metal objects. For example, a magnet will not attract aluminum foil. Only a few metals, such as iron, cobalt, and nickel are attracted by magnets. These metals can be made into permanent magnets. Permanent magnets keep their magnetism even after they have been removed from a magnetic field. Think back to what you have learned about electrons. Recall that electrons have magnetic properties. In most elements, the magnetic properties of the electrons cancel out. But in iron, cobalt, and nickel, they don't cancel out. Each atom in these metals acts like a small magnet with its own magnetic field.

Reading Check

4. **Explain** Why do the atoms in nickel act like a magnet?

_____

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Even though the atoms in iron, cobalt, or nickel have magnetic fields, objects made from them do not always act like magnets. For example, a nail is made from iron. If you hold an iron nail close to a refrigerator door and then let it go, it will fall to the floor. However, you can make the nail act like a magnet temporarily and it will stick to the door.

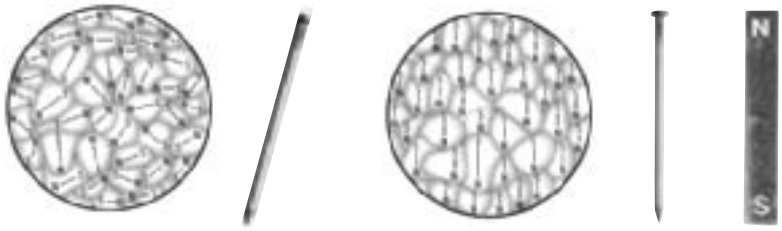
What are magnetic domains?

In magnetic materials, the magnetic field made by each atom exerts a force on other nearby atoms. This causes the atoms to rotate and form a magnetic domain. A **magnetic domain** is a large group of atoms with their magnetic poles lined up in the same direction. Because the atoms are lined up, a domain acts like a magnet. A domain has a north pole and a south pole.

How do domains line up?

An iron nail has a large number of magnetic domains that act like magnets. So why doesn't a nail act like a magnet? The poles of the domains point in different directions. Since the domains do not line up, the magnetic fields cancel each other out. Therefore, the nail does not act like a magnet. The figure below shows the magnetic domains of a nail.

One way to make the domains line up is to touch a bar magnet to the nail. The domains will rotate and point in the same direction because of the magnetic field of the magnet. Now the nail acts like a magnet. The second figure shows domains that have lined up.



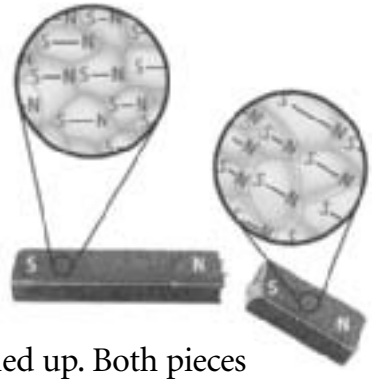
If the bar magnet is taken away, the atoms in the nail move around and bump each other. This causes the domains to move out of line. This is why a nail is not always a magnet.

How can you make a permanent magnet?

Permanent magnets can be made by placing a magnetic material, such as iron, in a strong magnetic field. The strong magnetic field causes the magnetic domains to line up and combine to make a strong magnetic field inside the material. This field keeps the atoms from bumping the domains out of line. The material becomes a permanent magnet.

Heating a permanent magnet causes it to lose its magnetism. Heat causes the atoms in the magnet to move faster. This moves the domains out of line. The permanent magnet will then lose its magnetic field.

Can a pole be isolated?



Suppose a magnet is broken into two pieces as shown in the figure. Is one piece a north pole and the other piece a south pole? Remember, each atom in a magnetic material acts like a tiny mag net. So, every magnet is made up of many smaller magnets that are lined up. Both pieces of a broken magnet have their own north and south poles.

Reading Check

5. **Explain** Why doesn't a nail act like a magnet?

_____

_____

Picture This

6. **Observe** Look at the second figure. How are the north and south poles lined up?

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Picture This

7. **Infer** If the two pieces of magnet were put back together, what would happen to the north and south poles at the broken edge?

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After You Read

Mini Glossary

magnetic domains: groups of atoms with magnetic poles that line up in the same direction

magnetic field: the lines of force around a magnet

magnetic poles: the north and south pole where the forces of the magnet are strongest

magnetism: the properties of magnets and how magnets interact with each other

1. Review the definitions of the vocabulary words. Write a sentence that explains how Earth is a magnetic field.

2. Complete the chart below. List the different things you learned about magnetism that have the word *magnetic* as part of their description.

Magnetism
1. magnetic force
2.
3.
4.
5.

3. Study Coach Review the ideas your group wrote on the index cards. Write one idea that you all agreed was important. How did this idea help you to understand magnetism?

End of Section