Section 3

Metals

Reading Preview

Key Concepts

- What are the physical properties of metals?
- How does the reactivity of metals change across the periodic table?
- How are elements that follow uranium in the periodic table produced?

Key Terms

- metal • malleable • ductile
- conductivity • reactivity
- corrosion
- alkali metal
- alkaline earth metal
- transition metal • alloy
- particle accelerator

Target Reading Skill

Using Prior Knowledge Before you read, write what you know about metals in a graphic organizer like the one below. As you read, write what you learn.

What You Know
1. Metals are shiny. 2.

What You Learned
1. 2.

Lab zone Discover Activity

Why Use Aluminum?

1. Examine several objects made from aluminum, including a can, a disposable pie plate, heavy-duty aluminum foil, foil-covered wrapping paper, and aluminum wire.
2. Compare the shape, thickness, and general appearance of the objects.
3. Observe what happens if you try to bend and unbend each object.
4. For what purpose is each object used?

Think It Over

Inferring Use your observations to list as many properties of aluminum as you can. Based on your list of properties, infer why aluminum was used to make each object. Explain your answer.

Metals are all around you. The cars and buses you ride in are made of steel, which is mostly iron. Airplanes are covered in aluminum. A penny is made of zinc coated with copper. Copper wires carry electricity into lamps, stereos, and computers. It's hard to imagine modern life without metals.

Properties of Metals

What is a metal? Take a moment to describe a familiar metal, such as iron, copper, gold, or silver. What words did you use—*hard, shiny, smooth*? Chemists classify an element as a **metal** based on its properties. Look again at the periodic table in Section 2. All of the elements in blue-tinted squares to the left of the zigzag line are metals.

Physical Properties **The physical properties of metals include shininess, malleability, ductility, and conductivity.** A **malleable** (MAL ee uh bul) material is one that can be hammered or rolled into flat sheets and other shapes. A **ductile** material is one that can be pulled out, or drawn, into a long wire. For example, copper can be made into thin sheets and wire because it is malleable and ductile.

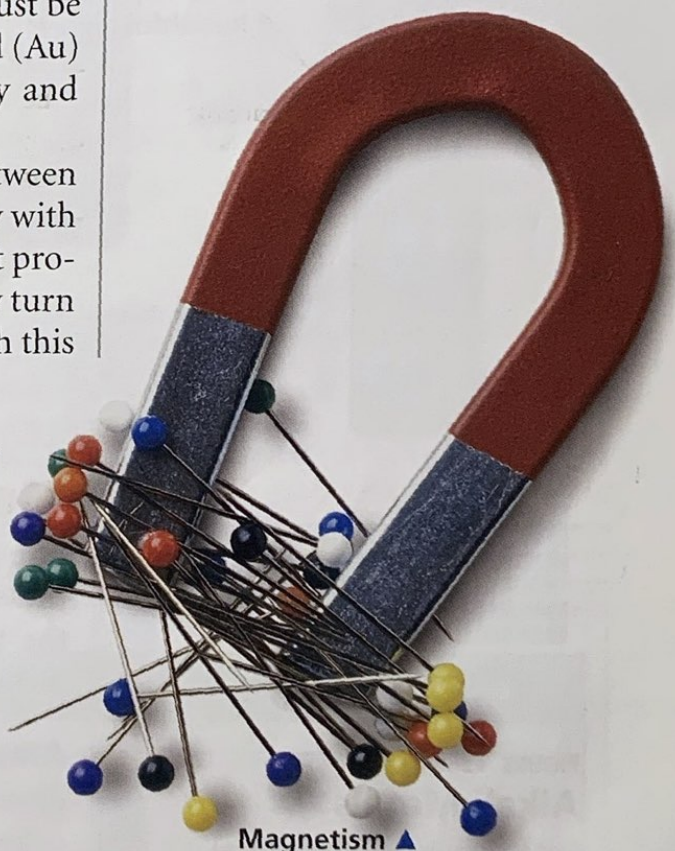
Conductivity is the ability of an object to transfer heat or electricity to another object. Most metals are good conductors. In addition, a few metals are magnetic. For example, iron (Fe), cobalt (Co), and nickel (Ni) are attracted to magnets and can be made into magnets like the one in Figure 12. Most metals are also solids at room temperature. However, one metal—mercury (Hg)—is a liquid at room temperature.

Chemical Properties The ease and speed with which an element combines, or reacts, with other elements and compounds is called its **reactivity.** Metals usually react by losing electrons to other atoms. Some metals are very reactive. For example, sodium (Na) reacts strongly when exposed to air or water. To prevent a reaction, sodium and metals like it must be stored under oil in sealed containers. By comparison, gold (Au) and platinum (Pt) are valued for their *lack* of reactivity and because they are rare.

The reactivities of other metals fall somewhere between those of sodium and gold. Iron, for example, reacts slowly with oxygen in the air, forming iron oxide, or rust. If iron is not protected by paint or plated with another metal, it will slowly turn to reddish-brown rust. The destruction of a metal through this process is called **corrosion.**

Reading Checkpoint **What are three physical properties of metals?**

FIGURE 12
Properties of Metals
Metals have certain physical and chemical properties.
Classifying *Categorize each of the properties of metals that are shown as either physical or chemical.*



Magnetism ▲
Many metals are attracted to magnets.

▼ Malleability
Gold can be pounded into coins.

Reactivity ▶
This iron chain is coated with rust after being exposed to air.

Section 4

Nonmetals and Metalloids

Reading Preview

Key Concepts

- What are the properties of nonmetals?
- How are the metalloids useful?

Key Terms

- nonmetal
- diatomic molecule
- halogen
- noble gas
- metalloid
- semiconductor

Target Reading Skill

Using Prior Knowledge Before you read, write what you know about the properties of nonmetals and metalloids in a graphic organizer like the one below. As you read, write what you learn.

What You Know
1. Nonmetals are not shiny. 2.

What You Learned
1. 2.

Lab zone

Discover Activity

What Are the Properties of Charcoal?

1. Break off a piece of charcoal and roll it between your fingers. Record your observations.
2. Rub the charcoal on a piece of paper. Describe what happens.
3. Strike the charcoal sharply with the blunt end of a fork. Describe what happens.
4. When you are finished with your investigation, return the charcoal to your teacher and wash your hands.

Think It Over

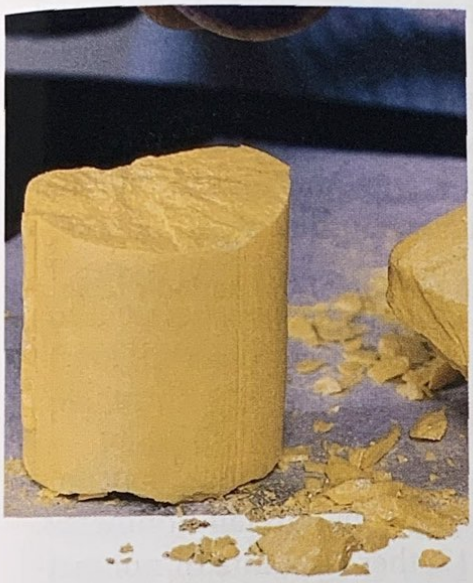
Classifying Charcoal is a form of the element carbon. Would you classify carbon as a metal or a nonmetal? Use your observations from this activity to explain your answer.

Life on Earth depends on nonmetals. All organisms are made from compounds of carbon. The air you and other living things breathe contains mostly nitrogen and oxygen. Water, a key compound in living cells, consists of hydrogen and oxygen. Yet, while many compounds made with nonmetals are essential to life, some nonmetals themselves are poisonous and highly reactive. Still others are completely unreactive. Compared to metals, nonmetals have a much wider variety of properties. However, nonmetals do have several properties in common.

These bears, the grass behind them, and all life on Earth is based on carbon, a nonmetal. ▶

FIGURE 20
Physical Properties of Nonmetals

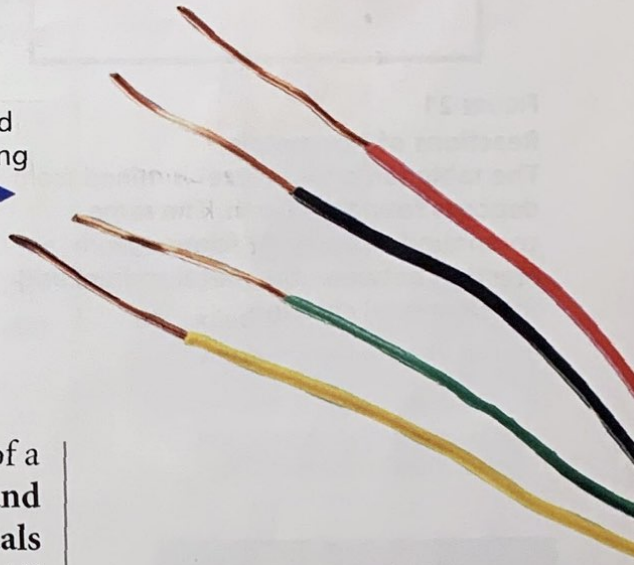
Nonmetals have properties that are the opposite of metals.
Comparing and Contrasting *Contrast the properties of these nonmetals with those of metals.*



▲ The helium filling this blimp is a gas at room temperature.

◀ Sulfur crumbles into a powder.

Nonmetals are good insulators. Carbon compounds are found in the plastic insulating these copper wires. ▶



Properties of Nonmetals

A **nonmetal** is an element that lacks most of the properties of a metal. **Most nonmetals are poor conductors of electricity and heat and are reactive with other elements. Solid nonmetals are dull and brittle.** Look at the periodic table in Section 2. All of the elements in green-tinted boxes are nonmetals. Many of the nonmetals are common elements on Earth.

Physical Properties Ten of the 16 nonmetals are gases at room temperature. The air you breathe is mostly a mixture of two nonmetals, nitrogen (N) and oxygen (O). Other nonmetal elements, such as carbon (C), iodine (I), and sulfur (S), are solids at room temperature. Bromine (Br) is the only nonmetal that is liquid at room temperature.

Look at examples of nonmetals in Figure 20. In general, the physical properties of nonmetals are the opposite of those of the metals. Solid nonmetals are dull, meaning not shiny, and brittle, meaning not malleable or ductile. If you hit most solid nonmetals with a hammer, they break or crumble into a powder. Nonmetals usually have lower densities than metals. And nonmetals are also poor conductors of heat and electricity.

Chemical Properties Most nonmetals are reactive, so they readily form compounds. In fact, fluorine (F) is the most reactive element known. Yet, Group 18 elements hardly ever form compounds.

Atoms of nonmetals usually gain or share electrons when they react with other atoms. When nonmetals and metals react, electrons move from the metal atoms to the nonmetal atoms, as shown by the formation of salt, shown in Figure 21. Another example is rust—a compound made of iron and oxygen (Fe_2O_3). It's the reddish, flaky coating you might see on an old piece of steel or an iron nail.

Many nonmetals can also form compounds with other nonmetals. The atoms share electrons and become bonded together into molecules.

Reading Checkpoint **In which portion of the periodic table do you find nonmetals?**