

The Periodic Table

Nonmetals and Metalloids

..... Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

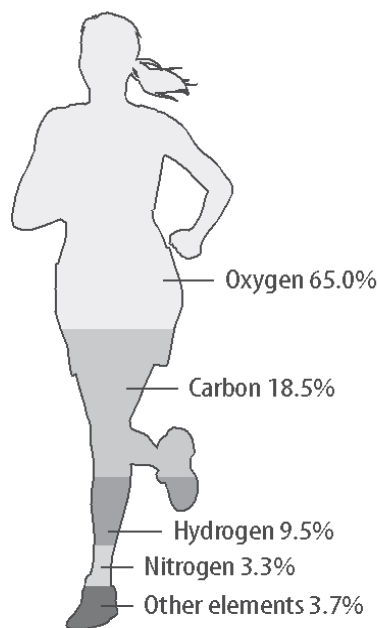
Before	Statement	After
	5. Most of the elements in living things are nonmetals.	
	6. Even though they look very different, oxygen and sulfur share some similar properties.	

..... Read to Learn

The Elements of Life

More than 96 percent of the mass of your body comes from just four elements. They are shown in the figure. All four of these elements—oxygen, carbon, hydrogen, and nitrogen—are nonmetals. **Nonmetals** are elements that have no metallic properties.

Of the remaining elements in your body, the two most common are also nonmetals—phosphorus and sulfur. These six elements (oxygen, carbon, hydrogen, nitrogen, phosphorus, and sulfur) form the compounds in proteins, fats, nucleic acids, and other large molecules in your body. These elements also form the compounds in all other living things.



Key Concepts

- Where are nonmetals and metalloids on the periodic table?
- What are the properties of nonmetals and metalloids?

Mark the Text

Underline Terms As you read this lesson, underline the names of important nonmetals. Highlight information about them. Use this information to review the lesson.

Visual Check

1. Identify Which three elements make up most of the mass of your body?

How are nonmetals different from metals?

Recall that metals have luster. They are ductile, malleable, and good conductors of electricity and thermal energy. All metals except mercury are solids at room temperature.

The properties of nonmetals are different from those of metals. Nonmetals do not conduct electricity or thermal energy well. Those that are solid at room temperature have no luster. Many of the nonmetals are gases at room temperature.

Key Concept Check

2. Identify What properties do nonmetals have?

FOLDABLES®

Make a chart with three columns and three rows to organize information about nonmetals and metalloids.

	Nonmetals	Metalloids
Properties		
Uses		

Reading Check

3. Predict Will bromine (Br) react with sodium (Na)? Explain your answer.

Visual Check

4. Identify Label each figure on the left with the correct group number from the periodic table.

Nonmetals in Groups 14–16

Look at the periodic table in this chapter or in the back of this book. Notice that groups 14–16 contain metals, nonmetals, and metalloids. The chemical properties of the elements in each group are similar. However, the physical properties of the elements can be different. Nonmetals in the groups include carbon, nitrogen, phosphorus, oxygen, sulfur, and selenium.

Group 17: The Halogens

Group 17 of the periodic table is above on the right. *An element in group 17 of the periodic table is called a halogen* (HA luh jun). Halogens can react with a metal and form a salt. For example, chlorine gas reacts with solid sodium and forms sodium chloride, or table salt. All halogens react readily with other elements and form compounds. In fact, they can occur naturally only in compounds. They do not exist as free elements.

Group 18: The Noble Gases

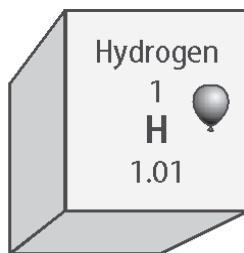
Group 18 of the periodic table is shown at right. *The elements in group 18 are known as the noble gases*. The elements helium, neon, argon, krypton, xenon, and radon are the noble gases. Unlike the halogens, the only way noble gases react with other elements is under special conditions in a laboratory. They do not form compounds naturally.

Fluorine 9 F 19.00
Chlorine 17 Cl 35.45
Bromine 35 Br 79.90
Iodine 53 I 126.90
Astatine 85 At (210)

Helium 2 He 4.00
Neon 10 Ne 20.18
Argon 18 Ar 39.95
Krypton 36 Kr 83.80
Xenon 54 Xe 131.29
Radon 86 Rn (222)

Hydrogen

The element key for hydrogen is shown at right. Hydrogen has the smallest atomic mass of any of the elements. Hydrogen is the most common element in the universe.



Hydrogen is most often classified as a nonmetal because it has many of the properties of nonmetals. For example, it is a gas at room temperature. However, hydrogen shares properties with the alkali metals in group 1. In liquid form, hydrogen conducts electricity just like a metal does. In some chemical reactions, hydrogen reacts like an alkali metal. However, under conditions on Earth, hydrogen usually behaves like a nonmetal. More than 90 percent of all the atoms in the universe are hydrogen atoms.

Metalloids

Between the metals and the nonmetals on the periodic table are elements known as metalloids. The elements boron, silicon, germanium, arsenic, antimony, tellurium, polonium, and astatine are metalloids. A **metalloid** (MEH tul oyd) is an element that has physical and chemical properties of both metals and nonmetals. Silicon is the most abundant metalloid in the universe. The metalloids are shown in the figure below.

Boron 5 B 10.81	Carbon 6 C 12.01	Nitrogen 7 N 14.01	Oxygen 8 O 16.00	Fluorine 9 F 19.00
Aluminum 13 Al 26.98	Silicon 14 Si 28.09	Phosphorus 15 P 30.97	Sulfur 16 S 32.07	Chlorine 17 Cl 35.45
Gallium 31 Ga 69.72	Germanium 32 Ge 72.64	Arsenic 33 As 74.92	Selenium 34 Se 78.96	Bromine 35 Br 79.90
Indium 49 In 114.82	Tin 50 Sn 118.71	Antimony 51 Sb 121.76	Tellurium 52 Te 127.60	Iodine 53 I 126.90
Thallium 81 Tl 204.38	Lead 82 Pb 207.20	Bismuth 83 Bi 208.98	Polonium 84 Po (209)	Astatine 85 At (210)

Visual Check

5. Identify What can you tell about the element hydrogen from looking at the element key on the right?

Key Concept Check

6. Identify Where are metalloids on the periodic table?

Visual Check

7. Identify Circle the portion of the figure at right that contains the metalloid elements.

Think it Over

8. Explain What property makes semiconductors useful in electronic equipment?

Semiconductors

Recall that metals are good conductors of thermal energy and electricity. Nonmetals are poor conductors of thermal energy and electricity. But they are good insulators. A property of metalloids is the ability to act as a semiconductor. A **semiconductor** (seh mee kun DUK tur) is an element that conducts electricity at high temperatures, but not at low temperatures. At high temperatures, metalloids act like metals and conduct electricity. But at lower temperatures, they act like nonmetals and do not conduct electricity. This property is useful in electronic devices such as computers and televisions.

Properties and Uses of Metalloids

Silicon is one of the most abundant elements on Earth. Sand, clay, and many rocks and minerals are made of silicon compounds. Pure silicon is used in semiconductor devices for computers and other electronic products. Germanium is also used as a semiconductor. Semiconductors are an important use of metalloids. Metalloids also have other uses. Boron is used in water softeners and laundry products. Boron also glows bright green in fireworks.

Metals, Nonmetals, and Metalloids

You have read that all metallic elements have common characteristics, such as malleability, conductivity, and ductility. However, each metal has unique properties that make it different from other metals. The same is true for nonmetals and metalloids. How can knowing the properties of an element help you understand how to use it?

Look at the periodic table. An element's position on the periodic table tells you a lot about the element. By knowing that sulfur is a nonmetal, for example, you know that it breaks easily and does not conduct electricity. You would not choose sulfur to make a wire. You would not try to use oxygen as a semiconductor or sodium as a building material. You know that transition elements are strong, malleable, and do not react easily with oxygen or water. These elements make good building materials because they are strong and malleable. They are less reactive than other elements. Being familiar with the properties of metals and other elements can help you understand how they are used in different situations. ✓

Reading Check

9. Explain Why would you not use an element on the right side of the periodic table as a building material?

After You Read

Mini Glossary

halogen (HA luh jun): an element in group 17 of the periodic table

metalloid (MEH tul oyd): an element that has physical and chemical properties of both metals and nonmetals

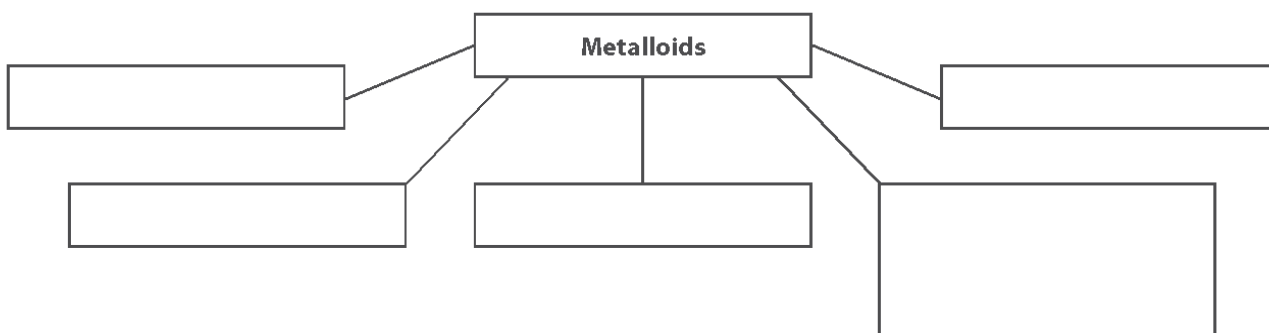
noble gas: an element in group 18 of the periodic table

nonmetal: an element that has no metallic properties

semiconductor (seh mee kun DUK tur): an element that conducts electricity at high temperatures, but not at low temperatures

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that compares nonmetals and metalloids.

2. In the graphic organizer below, write the names of five metalloids. In the largest box, write the name of the metalloid that is one of the most abundant elements on Earth.



3. Review the names of the nonmetals that you underlined and the information that you highlighted. How did this strategy help you learn about nonmetals?

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?



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END OF LESSON