FIGURE 9

Periodic Table of the Elements

The periodic table includes over 100 elements. Many of the properties of an element can be predicted by its position in the table.

Go Online **active art**

For: Periodic Table activity
Visit: PHSchool.com
Web Code: cgp-1032

Key

C	Solid
Br	Liquid
H	Gas
Tc	Not found in nature

Symbol
One- or two-letter symbols identify most elements. Some periodic tables also list the names of the elements.

Period

Group

Period	1	2	3	4	5	6	7	8	9
1	1 H Hydrogen 1.0079								
2	3 Li Lithium 6.941	4 Be Beryllium 9.0122							
3	11 Na Sodium 22.990	12 Mg Magnesium 24.305							
4	19 K Potassium 39.098	20 Ca Calcium 40.08	21 Sc Scandium 44.956	22 Ti Titanium 47.90	23 V Vanadium 50.941	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.933
5	37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.22	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91
6	55 Cs Cesium 132.91	56 Ba Barium 137.33	71 Lu Lutetium 174.97	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.2	77 Ir Iridium 192.22
7	87 Fr Francium (223)	88 Ra Radium (226)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (264)	108 Hs Hassium (265)	109 Mt Meitnerium (268)

To make the table easier to read, the lanthanides and the actinides are printed below the rest of the elements. Follow the blue shading to see how they fit in the table.

Lanthanides

57	58	59	60	61	62
La Lanthanum 138.91	Ce Cerium 140.12	Pr Praseodymium 140.91	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.4

Actinides

89	90	91	92	93	94
Ac Actinium (227)	Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)

Key

- Metal
- Metalloid
- Nonmetal
- Properties not established

Atomic Mass
Atomic mass is the average mass of an element's atoms. Atomic masses in parentheses are those of the most stable isotope.

Atomic Number
The atomic number is the number of protons in an atom's nucleus.

Many periodic tables include a zigzag line that separates the metals from the nonmetals.

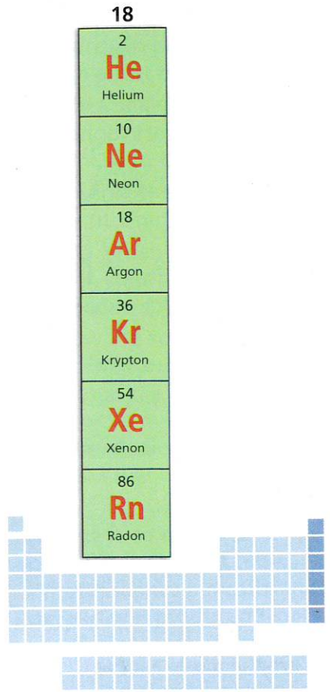
10	11	12	13	14	15	16	17	18
								2 He Helium 4.0026
			5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.179
			13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
28 Ni Nickel 58.71	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
46 Pd Palladium 106.4	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.30
78 Pt Platinum 195.09	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
110 Ds Darmstadtium (269)	111 *Uuu Unununium (272)	112 *Uub Ununbium (277)		114 *Uuq Ununquadium				

*Name not officially assigned

63	64	65	66	67	68	69	70
Eu Europium 151.96	Gd Gadolinium 157.25	Tb Terbium 158.93	Dy Dysprosium 162.50	Ho Holmium 164.93	Er Erbium 167.26	Tm Thulium 168.93	Yb Ytterbium 173.04

95	96	97	98	99	100	101	102
Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)

FIGURE 26
The Noble Gases
Electricity makes the Group 18 elements glow brightly inside glass tubes. **Applying Concepts** *Why are neon and the other noble gases so unreactive?*



The Noble Gases The elements in Group 18 are known as the **noble gases.** They do not ordinarily form compounds because atoms of noble gases do not usually gain, lose, or share electrons. As a result, the noble gases are usually unreactive. Even so, scientists have been able to form some compounds of the heavy noble gases (Kr, Xe) in the laboratory.

All the noble gases exist in Earth's atmosphere, but only in small amounts. Because they are so unreactive, the noble gases were not discovered until the late 1800s. Helium was discovered by a scientist who was studying not the atmosphere but the sun.

Have you made use of a noble gas? You have if you have ever purchased a floating balloon filled with helium. Noble gases are also used in glowing electric lights. These lights are commonly called neon lights, even though they are often filled with argon, xenon, or other noble gases.

Hydrogen Alone in the upper left corner of the periodic table is hydrogen—the element with the simplest and smallest atoms. Each hydrogen atom has one proton and one electron. Some hydrogen atoms also have neutrons. Because the chemical properties of hydrogen differ very much from those of the other elements, it really cannot be grouped into a family. Although hydrogen makes up more than 90 percent of the atoms in the universe, it makes up only 1 percent of the mass of Earth's crust, oceans, and atmosphere. Hydrogen is rarely found on Earth as a pure element. Most hydrogen is combined with oxygen in water (H_2O).

Reading Checkpoint **Why were the noble gases undiscovered until the late 1800s?**

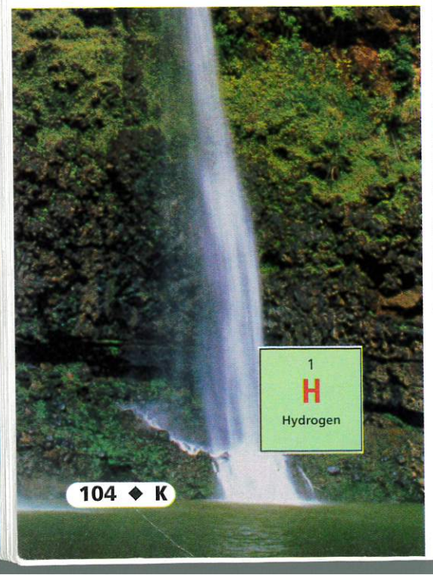


FIGURE 27
Importance of Hydrogen
Water is a compound of hydrogen and oxygen. Without liquid water, life on Earth would be impossible.

The Metalloids

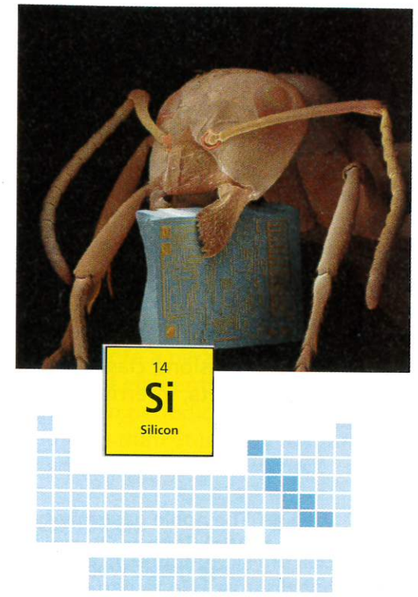
Along the border between the metals and the nonmetals are seven elements called metalloids. These elements are shown in the yellow squares in the periodic table in Section 2. The **metalloids** have some characteristics of both metals and nonmetals. All are solids at room temperature. They are brittle, hard, and somewhat reactive.

The most common metalloid is silicon (Si). Silicon combines with oxygen to form silicon dioxide (SiO_2). Ordinary sand, which is mostly SiO_2, is the main component of glass. A compound of boron (B) and oxygen is added during the process of glassmaking to make heat-resistant glass. Compounds of boron are also used in some cleaning materials.

The most useful property of the metalloids is their varying ability to conduct electricity. Whether or not a metalloid conducts electricity can depend on temperature, exposure to light, or the presence of small amounts of impurities. For this reason, metalloids such as silicon, germanium (Ge), and arsenic (As) are used to make semiconductors. **Semiconductors** are substances that can conduct electricity under some conditions but not under other conditions. Semiconductors are used to make computer chips, transistors, and lasers.

Reading Checkpoint **What is the most common metalloid, and where is it found?**

FIGURE 28
Silicon
A silicon computer chip is dwarfed by an ant, but the chip's properties as a semiconductor make it a powerful part of modern computers.



Section 4 Assessment

Target Reading Skill **Using Prior Knowledge** Review your graphic organizer about nonmetals and metalloids, and revise it based on what you learned in the section.

Reviewing Key Concepts

1. a. **Reviewing** What physical and chemical properties are found among the nonmetals?
   b. **Making Generalizations** What happens to the atoms of most nonmetals when they react with other elements?
   c. **Comparing and Contrasting** How do the physical and chemical properties of the halogens compare with those of the noble gases?
2. a. **Identifying** Where in the periodic table are the metalloids found?
   b. **Describing** What are three uses of metalloids?
   c. **Applying Concepts** What property makes certain metalloids useful as "switches" to turn a small electric current on and off?

Lab zone At-Home Activity

Halogen Hunt Identify compounds in your home that contain halogens. Look at labels on foods, cooking ingredients, cleaning materials, medicines, and cosmetics. The presence of a halogen is often indicated by the words *fluoride, chloride, bromide,* and *iodide* or the prefixes *fluoro-, chloro-, bromo-,* and *iodo-*. Show your family these examples and describe properties of the halogens.