referred to as metalloids. A metalloid is an element that has some characteristics of metals and some characteristics of nonmetals. All metalloids are solids at room temperature. They tend to be less malleable than metals but not as brittle as nonmetals. Some metalloids, such as antimony, have a somewhat metallic luster.

Metalloids tend to be semiconductors of electricity. That is, their ability to conduct electricity is intermediate between that of metals and that of nonmetals. Metalloids are used in the semiconducting materials found in desktop computers, hand-held calculators, digital watches, televisions, and radios.

**Noble Gases**

The elements in Group 18 of the periodic table are the noble gases. These elements are generally unreactive. In fact, prior to 1962 no noble gas compounds had been identified. That year, the first noble gas compound, xenon tetrafluoride, was prepared. Their low reactivity sets noble gases apart from the other families of elements. Group 18 elements are gases at room temperature. Neon, argon, krypton, and xenon are all used in lighting. Helium is used in party balloons and weather balloons because it is less dense than air.

**SECTION REVIEW**

1. Use the periodic table on the inside back cover to write the names for the elements that have the following symbols: O, S, Cu, Ag.
2. Use the periodic table to write the symbols for the following elements: iron, nitrogen, calcium, mercury.
3. Which elements are most likely to undergo the same kinds of reactions, those in a group or those in a period?
4. Describe the main differences between metals, nonmetals, and metalloids.

**CHAPTER 1 SUMMARY**

1-1. Chemistry is the study of the composition, structure, and properties of matter and its changes.

- Chemistry is classified as physical science. Six areas of study in chemistry are organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, biochemistry, and theoretical chemistry.

- A chemical is any substance that has a definite composition or is used or produced in a chemical process.
- Basic research is carried out for the sake of increasing knowledge. Applied research is carried out to solve practical problems. Technological development involves the use of existing knowledge to make life easier or more convenient.

**Vocabulary**

chemical (6)

1-2. All matter has mass and takes up space. Mass is one measure of the amount of matter.

- An element is composed of one kind of atom. Compounds are made from two or more elements in fixed proportions.
- All substances have characteristic properties that enable chemists to tell the substances apart and to separate them.
- The physical properties of a substance can be observed or measured without changing the identity of the substance. Physical changes do not involve changes in identity.
- The three major states of matter are solid, liquid, and gas. The particles in these states differ in proximity to one another and ease of flow. Changes of state, such as melting and boiling, are physical changes.
- Chemical properties refer to a substance's ability to undergo changes that alter its composition and identity. Chemical changes, or chemical reactions, involve changes in identity.
- Energy changes accompany physical and chemical changes. Energy may be released or absorbed, but it is neither created nor destroyed.
- Matter can be classified into mixtures and pure substances. Pure substances differ from mixtures in that they have a definite composition that does not vary. Solutions are homogeneous mixtures.

**Vocabulary**

atom (10)  change of state (12)  element (18)  extensive property (11)  liquid (12)  plasma (12)
chemical change (13)  gas (12)  mass (10)  product (13)  matter (10)  pure substance (17)
chemical property (12)  heterogeneous (16)  reactant (13)  mixture (15)  reactant (13)  solution (16)
chemical reaction (13)  homogeneous (16)  physical change (12)  compound (11)  intensive property (11)  physical property (11)

1-3. Each element has a unique symbol. The periodic table shows the elements organized by their chemical properties. Columns on the table represent groups or families of elements with similar chemical properties. Properties vary across the rows, or periods.

- The elements can be classified as metals, nonmetals, metalloids, and noble gases. These classes occupy different areas of the periodic table. Metals tend to be shiny, malleable, ductile, and good conductors. Nonmetals tend to be brittle and poor conductors. Metalloids are intermediate in properties between metals and nonmetals, and they tend to be semiconductors of electricity. The noble gases are generally unreactive elements.

**Vocabulary**

family (21)  metal (22)  nonmetal (22)  group (21)  metalloid (24)  period (21)
REVIEWING CONCEPTS

1. What is chemistry? (1-1)
2. What branch of chemistry is most concerned with the study of carbon compounds? (1-1)
3. What is meant by the word chemical, as used by scientists? (1-1)
4. Briefly describe the differences between basic research, applied research, and technological development. Provide an example of each. (1-1)
5. a. What is mass? (1-2)
   b. What is volume? (1-2)
6. How does the composition of a pure compound differ from that of a mixture? (1-2)
7. a. Define property. (1-2)
   b. How are properties useful in classifying materials? (1-2)
8. What is the difference between extensive properties and intensive properties? (1-2)
9. a. Define physical property. (1-2)
   b. List two examples of physical properties. (1-2)
10. a. Define chemical property. (1-2)
    b. List two examples of chemical properties. (1-2)
11. Distinguish between a physical change and a chemical change. (1-2)
12. a. How does a solid differ from a liquid? (1-2)
    b. How does a liquid differ from a gas? (1-2)
    c. How is a liquid similar to a gas? (1-2)
    d. What is a plasma? (1-2)
13. What is meant by a change in state? (1-2)
14. What is the significance of the vertical columns of the periodic table? What is the significance of the horizontal rows? (1-3)
15. Compare the physical properties of metals, nonmetals, metalloids, and noble gases and describe where in the periodic table each of these kinds of elements is located. (1-3)
16. In which of the six branches of chemistry would a scientist be working if he or she were doing the following? (1-1)
   a. investigating energy relationships for various reactions
17. Identify the reactants and products in the following reaction: potassium + water → potassium hydroxide + hydrogen (1-2)
18. Suppose element X is a poor conductor of electricity and breaks when hit with a hammer. Element Z is a good conductor of electricity and heat. In what area of the periodic table does each element most likely belong? (1-3)
19. Identify each of the following as either a physical change or a chemical change. Explain your answers. (1-2)
   a. A piece of wood is sawed in half. (1-2)
   b. Milk turns sour. (1-2)
   c. Melted butter solidifies in the refrigerator. (1-2)
20. Use the periodic table to write the names of the elements that have the following symbols, and identify each as a metal, nonmetal, metalloid, or noble gas. (1-3)
   a. K (1-3)
   c. Si (1-3)
   e. Hg (1-3)
   b. Ag (1-3)
   d. Na (1-3)
   f. He (1-3)
21. An unknown element is shiny and is found to be a good conductor of electricity. What other properties would you predict for it? (1-3)
22. Identify each of the following as an example of either basic research, applied research, or technological development: (1-1)
   a. A new type of refrigerant is developed that is less damaging to the environment. (1-1)
   b. A new element is synthesized in a particle accelerator. (1-1)
   c. A computer chip is redesigned to increase the speed of the computer. (1-1)
23. Use the periodic table to identify the group numbers and period numbers of the following elements: (1-3)
   a. carbon, C (1-3)
   b. argon, Ar (1-3)
   c. chromium, Cr (1-3)
   d. barium, Ba (1-3)
24. a. Suppose different parts of a sample material have different compositions. What can you conclude about the material? (1-2)
   b. Suppose different parts of a sample have the same composition. What can you conclude about the material? Explain your answer. (1-2)

TECHNOLOGY & LEARNING

25. Graphing Calculator. Graphing Tabular Data

The graphing calculator can run a program that graphs ordered pairs of data, such as temperature versus time. In this problem you will learn how to create a table of data. Then you will learn how to use the program to plot the data. Go to Appendix C. If you are using a TI 83 Plus, you can download the program and data sets and run the application as directed. If you are using another calculator, your teacher will provide you with keystrokes and data sets to use. Remember that after creating the lists, you will need to name the program and check the display, as explained in Appendix C. You will then be ready to run the program. After you have graphed the data sets, answer these questions.
   a. Approximately what would the temperature be at the 16-minute interval? (1-3)
   b. Between which two intervals did the temperature increase the most: between 6 and 7 minutes, between 5 and 6 minutes, or between 8 and 9 minutes? (1-3)
   c. If the graph extended to 20 minutes, what would you expect the temperature to be?

HANDBOOK SEARCH

26. Review the information on trace elements in the Elements Handbook in the back of this text. (1-2)
   a. What are the functions of trace elements in the body? (1-2)
   b. What transition metal plays an important role in oxygen transport throughout the body? (1-2)
   c. What two Group 1 elements are part of the electrolyte balance in the body? (1-2)

RESEARCH & WRITING

27. Research any current technological product of your choosing. Find out about its manufacture and uses. Also find out about the basic research and applied research that made its development possible.

ALTERNATIVE ASSESSMENT

28. Make a list of all the changes that you see around you involving matter during a one-hour period. Note whether each change seems to be a physical change or a chemical change. Give reasons for your answers.
29. Make a concept map using at least 15 terms from the vocabulary lists. An introduction to concept mapping is found in Appendix B of this book.