

## Chapter 7 Periodic Table

### Classifying Substances

7. c. *Students know* substances can be classified by their properties, including their melting temperature, density, hardness, and thermal and electrical conductivity.

#### Classifying Substances Using Properties

The physical properties of substances reflect their chemical makeup and atomic structure. For example, substances that are hard and dense tend to have strong forces holding together the individual atoms or molecules. They also tend to have higher melting temperatures, because it takes more energy to break the atoms or molecules out of their fixed positions as a solid. In general, metals have higher melting temperatures, higher densities, and greater hardness than nonmetals. Solid nonmetals tend to be more brittle and less dense than metals.

Even slight differences in atomic structure between two elements can result in very different properties. For example, carbon (element 6) and nitrogen (element 7) are adjacent elements on the periodic table. Both are nonmetals. However, carbon is a solid up to very high temperatures (3,600°C), while nitrogen is a gas until it is cooled to below  $-196^{\circ}\text{C}$ .

Two other physical properties, thermal and electrical conductivity, are directly related to how tightly electrons are held to individual atoms. **Thermal conductivity** is the ability of an object to transfer heat. **Electrical conductivity** is the ability of an object to transfer an electric current. In both types of conductivity, electrons are responsible for the transfer. In metals, the atoms form regular patterns in which valence electrons are free to move from atom to atom. As a result, metals have high electrical and thermal conductivity. In contrast, nonmetals are generally poor conductors of heat and electric current.

When a scientist is confronted with an unknown substance, he or she can classify it based on its properties. For example, if a substance is a hard, dense solid at room temperature and conducts heat or electric current well, then the substance is probably a metal. A scientist can also conduct chemical tests to observe how the substance reacts with other known substances. The results of these tests can be used to further identify the substance.

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### Patterns of Properties

The periodic table is arranged horizontally in order of increasing atomic number (number of protons) and vertically in columns of elements with similar chemical properties. You can predict the properties of an element based on its location on the table. For example, metals are located on the left, with the most reactive metals on the far left, in Group 1.

Recall that valence electrons determine the ways in which an atom can bond with other atoms. Elements within the same group in the periodic table have the same number of valence electrons. As a result, they have similar chemical properties. Elements in Group 1 have only one valence electron. Group 17 elements have seven, and Group 18 elements (except for helium) have eight.

Most atoms are stable when they have eight valence electrons. When atoms combine, they tend to either share or transfer electrons so that each atom has a set of eight valence electrons. This helps explain why a Group 1 metal, such as sodium (Na), reacts readily with a Group 17 nonmetal, such as chlorine (Cl). The sodium atom becomes more stable by losing its one valence electron. The chlorine atom, with seven valence electrons, becomes more stable by gaining one electron. The two atoms form an ionic bond, resulting in the compound NaCl.

### Standard 7. c. Check

**9** The melting temperature and hardness of an element are related to

- A the number of isotopes the element has.
- B the forces that hold the atoms together.
- C the reactivity of the element.
- D the number of ionic bonds.

**10** Compared to metals, solid nonmetals tend to be

- A harder.
- B more dense.
- C less dense.
- D better conductors.

**11** Metals are good electrical conductors because

- A they are brittle substances.
- B metal atoms readily gain electrons.
- C the protons are free to move from atom to atom.
- D the valence electrons are free to move from atom to atom.

**12** Thermal conductivity refers to the ability of a substance to conduct

- A electric current.
- B heat.
- C light.
- D sound.

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**13** You are given a sample of an unknown metal. Which of the following properties would *best* help you to identify the metal?

- A shape
- B density
- C mass
- D volume

**14** Elements within the same group or family tend to have similar chemical properties because these elements have the same number of

- A protons.
- B neutrons.
- C valence electrons.
- D isotopes.