

SECTION 3

OBJECTIVES

- Compare and contrast a chemical formula for a molecular compound with one for an ionic compound.
- Discuss the arrangements of ions in crystals.
- Define *lattice energy* and explain its significance.
- List and compare the distinctive properties of ionic and molecular compounds.
- Write the Lewis structure for a polyatomic ion given the identity of the atoms combined and other appropriate information.



FIGURE 12 Like most ionic compounds, sodium chloride is a crystalline solid.

Ionic Bonding and Ionic Compounds

Most of the rocks and minerals that make up Earth's crust consist of positive and negative ions held together by ionic bonding. A familiar example of an ionically bonded compound is sodium chloride, or common table salt, which is found in nature as rock salt. A sodium ion, Na^+ , has a charge of 1+. A chloride ion, Cl^- , has a charge of 1-. There is an electrical force of attraction between oppositely charged ions. In sodium chloride, these ions combine in a one-to-one ratio— Na^+Cl^- —so that each positive charge is balanced by a negative charge. The chemical formula for sodium chloride is usually written simply as NaCl .

An **ionic compound** is composed of positive and negative ions that are combined so that the numbers of positive and negative charges are equal. Most ionic compounds exist as crystalline solids (see **Figure 12**). A crystal of any ionic compound is a three-dimensional network of positive and negative ions mutually attracted to one another. As a result, in contrast to a molecular compound, an ionic compound is not composed of independent, neutral units that can be isolated and examined. The chemical formula of an ionic compound merely represents the simplest ratio of the compound's combined ions that gives electrical neutrality.

The chemical formula of an ionic compound shows the ratio of the ions present in a sample of any size. A **formula unit** is the simplest collection of atoms from which an ionic compound's formula can be established. For example, one formula unit of sodium chloride, NaCl , is one sodium cation plus one chloride anion. (In the naming of a monatomic anion, the ending of the element's name is replaced with *-ide*. See Chapter 7 for more details.)

The ratio of ions in a formula unit depends on the charges of the ions combined. For example, to achieve electrical neutrality in the ionic compound calcium fluoride, two fluoride anions, F^- , each with a charge of 1-, must balance the 2+ charge of each calcium cation, Ca^{2+} . Therefore, the formula of calcium fluoride is CaF_2 .

Formation of Ionic Compounds

Electron-dot notation can be used to demonstrate the changes that take place in ionic bonding. Ionic compounds do not ordinarily form by the combination of isolated ions, but consider for a moment a sodium