Chapter 4 Summary

4.1 Representing Ionic Compounds

Key Concepts

- Ionic compounds are composed of oppositely charged ions, called cations and anions.
- Solid ionic compounds are made up of repeating patterns of ions that occur in specific ratios. The chemical formula for an ionic compound shows the ratio of ions.
- Subscripts are used in the chemical formula for an ionic compound to show the ratio of ions needed to make the total charge zero.
- The name of an ionic compound contains the name of the cation followed by the name of the anion. For binary ionic compounds, the part that represents the anion always ends with the suffix *-ide*.
- When naming compounds with multivalent metals, a Roman numeral is used to indicate the ion form of the metal.
- Ternary ionic compounds contain polyatomic ions, which are composed of more than one atom. Polyatomic ions have specific names that are based on the group of atoms present.

4.2 Representing Molecular Compounds

Key Concepts

- Molecular compounds form when atoms share electrons in covalent bonds.
- Prefixes are used in the name of a binary molecular compound to indicate the number of atoms of each element in a molecule of the compound.
- The chemical formula for a binary molecular compound shows the number of each atom in a molecule of the compound. The subscripts correspond to the prefixes in the name of the compound.
- Molecular compounds have important functions in energy generation and in the production of chemicals used by agricultural industries. Many molecular compounds, however, are environmental pollutants. Other molecular compounds can have negative consequences if they are not handled correctly.

4.3 Conservation of Mass and Chemical Equations

Key Concepts

- The law of conservation of mass states that the total mass of the reactants must equal the total mass of the products in a chemical reaction.
- A chemical reaction can be represented by a word equation, in which the names of the reactants and products are shown, or by a skeleton equation, in which the chemical formulas of the reactants and products are shown.
- A balanced chemical equation has coefficients in front of the chemical formulas. The number of atoms of each element is the same in the reactants and the products.
- An understanding of the law of conservation of mass can be applied to the clean-up of hazardous materials and the manufacture of products, to reduce potential harm or waste.

Chapter 4 Review

Make Your Own Summary

Summarize the key concepts in this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify the key concepts. Refer to Study Toolkit 4 on pages 565–566 to help you decide which graphic organizer to use.

Reviewing Key Terms

1. To balance a chemical equation, you place a(n) _____ before the chemical formula for one or more substances. (4.3)

2. A compound that is formed from a metal and a non-metal is likely a(n) _____. (4.1)

3. Two atoms can join together by sharing electrons in a(n) _____. (4.2)

4. The substances that are formed during a chemical reaction are called the _____. (4.3)

5. A(n) _____ forms as the result of the loss or gain of electrons. (4.1)

6. The starting materials in a chemical reaction are called the _____. (4.3)

7. A group of atoms that have an overall charge is a(n) _____. (4.1)

Knowledge and Understanding K/U

8. Each photograph represents a prefix that is used when naming binary molecular compounds. Identify the prefix and the number it represents.

a.

A support can be used for a camera.

b.

The shape of a stop sign is distinctive.

9. Identify the compound as ionic or molecular. Write the chemical formula for each compound.

a. sodium sulfide

b. carbon tetrachloride

c. sulfur trioxide

d. calcium carbonate

e. phosphorus pentachloride

f. ammonium phosphate

g. aluminum sulfate

h. copper(II) nitrite

i. gold(III) fluoride

10. Identify the compound as ionic or molecular. Write the name of each compound.

a. Cl_2O

b. Li_2O

c. K_3PO_4

d. $Fe(OH)_2$

e. $SnCl_4$

f. FeI_3

g. $Al_2(SO_4)_3$

h. CO_2

11. List the total number of each type of atom in the following.

a. $2H_2O + 2NaF$

b. $3Br_2 + 2FeI_3$

c. $Pb(NO_3)_2 + 2NaI$

d. $2K_3PO_4 + 3(NH_4)_2SO_4$

12. Copy and balance each chemical equation.

a. $Mg_3N_2(s) \rightarrow Mg(s) + N_2(g)$

b. $Mn(s) + O_2(g) \rightarrow Mn_2O_3(s)$

c. $CO_2(g) + H_2(g) \rightarrow CH_4(g) + H_2O(g)$

d. $PbO(s) \rightarrow Pb(s) + O_2(g)$

e. $C_2H_6(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

f. $Cu(s) + AgNO_3(aq) \rightarrow Ag(s) + Cu(NO_3)_2(aq)$

g. $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

h. $PbCl_4(aq) + K_3PO_4(aq) \rightarrow KCl(aq) + Pb_3(PO_4)_4(s)$

13. Write a word equation, a skeleton equation, and a balanced chemical equation for each of the following reactions. Indicate the states of the reactants and products in each balanced equation.

a. Nitrogen gas and hydrogen gas react to form gaseous ammonia.

b. When solid calcium carbonate is heated, it changes into a solid residue of calcium oxide and carbon dioxide gas.

c. When aluminum metal is exposed to oxygen, a solid layer of aluminum oxide forms.

d. Photosynthesis is the process in which plants use energy from the Sun to convert water and carbon dioxide gas into oxygen and glucose, $C_6H_{12}O_6(aq)$.

e. An aqueous solution of calcium chloride reacts with fluorine gas to form an aqueous solution of calcium fluoride and chlorine gas.

f. Aqueous solutions of barium sulfate and sodium hydroxide react to form sodium sulfate in solution and solid barium hydroxide.

g. Solid titanium metal is prepared by reacting gaseous titanium(IV) chloride with molten magnesium metal. Molten magnesium chloride is also produced.

Thinking and Investigation T/I

14. Explain why each chemical formula in a skeleton equation must be written correctly before you try to balance the equation.

15. A chemistry researcher determines the mass of a chemical in an opener container. After heating the chemical and container over a Bunsen burner, she determines that the mass of the container and chemical has increased. Based on the conservation of mass, provide an explanation for this observation.

16. Each of the following chemical equations is balanced, but it is incorrect in some other way. State what is incorrect, and then write the equation correctly.

a. $NH_3 \rightarrow N + H_3$

b. $2C + 2O_2 \rightarrow 2CO_2$

Communication C

17. Make a flowchart to show the steps involved in determining whether a binary compound is ionic or molecular, and the steps involved in writing the name of the compound.

18. BIG IDEAS Chemicals react with each other in predictable ways. Create a graphic organizer to summarize the key features of a word equation, a skeleton equation, and a balanced chemical equation. Be sure to include the advantages and disadvantages of each type of equation.

19. BIG IDEAS Chemical reactions may have a negative impact on the environment, but they can also be used to address environmental challenges. Discuss the meaning of the phrase "green chemistry" and how it is beneficial to the environment.

Application A

20. Magnesium burns in the presence of oxygen to form a solid compound.

a. What is the name and chemical formula for the compound that is formed during the reaction between magnesium and oxygen?

b. Write a balanced chemical equation for the reaction. Include the states of the substances involved.

c. When 24 g of magnesium is burned, 40 g of product forms. How many grams of oxygen reacted? Explain why your calculation is valid.

21. Name an occupation that requires people to interpret chemical formulas for compounds. Discuss why you think this knowledge is required.