

## 6

## CHEMICAL NAMES AND FORMULAS

**SECTION 6.1 INTRODUCTION TO CHEMICAL BONDING (pages 133–137)**

*This section explains how to distinguish between ionic and molecular compounds. It also defines cation and anion and relates them to metals and nonmetals.*

**► Molecules and Molecular Compounds (pages 133–134)**

1. All living and nonliving things are made up of building blocks called \_\_\_\_\_.

2. Most elements found in nature, with the exception of the \_\_\_\_\_, exist as molecules.

3. What is a molecule?

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4. Compounds that are formed when two or more atoms combine to form molecules are called \_\_\_\_\_.

5. Circle the letter of the substances that do NOT exist as molecules in nature.

a. oxygen

b. water

c. neon

d. ozone

e. helium

6. List three properties of molecular compounds.

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

► Ions and Ionic Compounds (pages 135–137)

**CHAPTER 6, Chemical Names and Formulas** (continued)

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

7. What is an ion?

\_\_\_\_\_

8. How are ions formed?

\_\_\_\_\_

9. An atom that gains electrons is called a(n) \_\_\_\_\_; an atom that loses electrons is called a(n) \_\_\_\_\_.

10. Complete the table about anions and cations.

	Anions	Cations
Name		
Metal/Nonmetal		
Charge		

11. Give the name and symbol of the ion formed when

- a. a calcium atom loses two electrons \_\_\_\_\_
- b. an oxygen atom gains two electrons \_\_\_\_\_
- c. a copper ion loses one electron \_\_\_\_\_

12. Circle the letter of the choice that describes the makeup of an ionic compound.

a. anions only

b. cations only

c. both anions and cations

13. Explain how compounds made up of ions can be electrically neutral.

\_\_\_\_\_

14. List three properties of ionic compounds.

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

## SECTION 6.2 REPRESENTING CHEMICAL COMPOUNDS (pages 138–142)

This section explains how to distinguish between two types of chemical formulas—molecular formulas and formula units. It also uses experimental data to demonstrate that a compound obeys the law of definite proportions.

### ► Chemical Formulas (page 138)

1. A chemical formula shows the types and \_\_\_\_\_ of atoms in the smallest representative unit of a substance.

2. List the numbers and types of atoms represented by these chemical formulas.

a.  $\text{Fe}_2\text{O}_3$  \_\_\_\_\_

b.  $\text{KMnO}_4$  \_\_\_\_\_

c.  $\text{CH}_4$  \_\_\_\_\_

d.  $\text{NH}_4\text{NO}_3$  \_\_\_\_\_

### ► Molecular Formulas (pages 138–139)

3. What is a molecular formula?

\_\_\_\_\_

\_\_\_\_\_

Match each compound with its molecular formula.

\_\_\_\_\_ 4. carbon dioxide      a.  $\text{C}_2\text{H}_6$

\_\_\_\_\_ 5. ethane                      b.  $\text{CO}_2$

\_\_\_\_\_ 6. ammonia                    c.  $\text{NH}_3$

7. Is the following sentence true or false? A molecular formula shows the arrangement of the atoms in a molecule. \_\_\_\_\_

8. Look at Figure 6.5 on page 138. List seven elements that exist as diatomic molecules.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**► The Laws of Definite and Multiple Proportions (pages 141-142)**

17. What is the law of definite proportions?

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16. Describe the structure of ionic compounds.

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15. Explain why the ratio of magnesium ions to chloride ions in  $MgCl_2$  is 1 : 2.

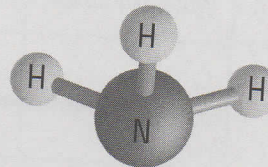
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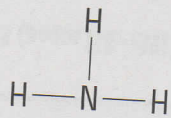
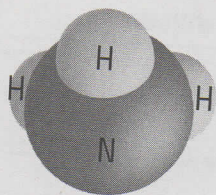
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14. What is a formula unit?

**► Formula Units (page 140)**



- a. ball-and-stick model
- b. molecular formula
- c. perspective drawing
- d. space-filling molecular model
- e. structural formula



In the diagram, match the type of model or formula with its representation.

**CHAPTER 6, Chemical Names and Formulas (continued)**

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

18. Circle the whole-number mass ratio of Li to Cl in LiCl. The atomic mass of Li is 6.9; the atomic mass of Cl is 35.5.

- a. 42 : 1
- b. 5 : 1
- c. 1 : 5

19. Circle the whole-number mass ratio of carbon to hydrogen in C<sub>2</sub>H<sub>4</sub>. The atomic mass of C is 12.0; the atomic mass of H is 1.0.

- a. 1 : 6
- b. 6 : 1
- c. 1 : 12
- d. 12 : 1

20. In the compound sulfur dioxide, a food preservative, the mass ratio of sulfur to oxygen is 1 : 1. An 80-g sample of a compound composed of sulfur and oxygen contains 48 g of oxygen. Is the sample sulfur dioxide? Explain.

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21. What is the law of multiple proportions?

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22. Complete the table using the law of multiple proportions.

	Mass of Cu	Mass of Cl	Mass Ratio Cl : Cu	Whole-number Ratio of Cl
Compound A	8.3 g	4.6 g		
Compound B	3.3 g	3.6 g		

### SECTION 6.3 IONIC CHARGES (pages 143–148)

*This section explains the use of the periodic table to determine the charge of an ion. It also defines polyatomic ion and gives the names and formulas for the most common polyatomic ions.*

#### ► Monatomic Ions (pages 143–146)

1. What are monatomic ions?

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**CHAPTER 6, Chemical Names and Formulas** (continued)

2. How is the ionic charge of a Group 1A, 2A, or 3A ion determined?

3. How is the ionic charge of a Group 5A, 6A, or 7A ion determined?

4. Circle the letter of the type of element that often has more than one common ionic charge.

a. alkali metal

b. alkaline earth metal

c. transition metal

d. nonmetal

5. The \_\_\_\_\_ of naming transition metal cations uses a Roman numeral in parentheses to indicate the numeric value of the ionic charge.

6. An older naming system uses the suffix *-ous* to name the cation with the

\_\_\_\_\_ charge, and the suffix *-ic* to name the cation with the

\_\_\_\_\_ charge.

7. What is a major advantage of the Stock system over the old naming system?

8. Use the periodic table to write the name and formula (including charge) for each ion in the table below.

Element	Name	Formula
Oxygen		
Calcium		
Fluorine		

**▶ Polyatomic Ions (pages 146–148)**

9. What is a polyatomic ion?

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

10. Is the following sentence true or false? The names of polyatomic anions always end in *-ide*. \_\_\_\_\_

11. What is the difference between the anions sulfite and sulfate?  
\_\_\_\_\_

12. Look at Table 6.4 on page 147. Circle the letter of a polyatomic ion that is a cation.

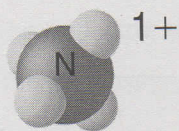
- a. ammonium
- b. acetate
- c. oxalate
- d. phosphate

13. How many atoms make up the oxalate ion and what is its charge?  
\_\_\_\_\_  
\_\_\_\_\_

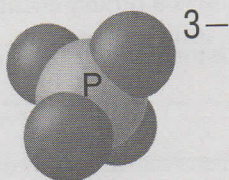
14. What three hydrogen-containing polyatomic anions are essential components of living systems?

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_

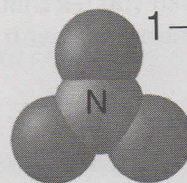
15. Look at Figure 6.14 on page 146. Identify each of the ions shown below.



a. \_\_\_\_\_



b. \_\_\_\_\_



c. \_\_\_\_\_

## SECTION 6.4 IONIC COMPOUNDS (pages 149–156)

*This section explains the rules for naming and writing formulas for binary and ternary ionic compounds.*

### ► Writing Formulas for Binary Ionic Compounds (pages 149–151)

- Traditionally, common names were based on some \_\_\_\_\_ of a compound or its \_\_\_\_\_.
- What is the general name for compounds composed of two elements?  
\_\_\_\_\_

**CHAPTER 6, Chemical Names and Formulas** (continued)

3. When writing the formula for any ionic compound, the charges of the ions must \_\_\_\_\_.

4. What are two methods for writing a balanced formula?

a.

b.

5. What are the formulas for the compounds formed by the following pairs of ions?

a.  $\text{Fe}^{2+}$ ,  $\text{Cl}^-$

b.  $\text{Cr}^{3+}$ ,  $\text{O}^{2-}$

c.  $\text{Na}^+$ ,  $\text{S}^{2-}$

6. What are the formulas for these compounds?

a. lithium bromide

b. cupric nitride

c. magnesium chloride

**► Naming Binary Ionic Compounds (pages 151-153)**

7. The name of a binary compound is written with the name of the \_\_\_\_\_ first followed by the name of the \_\_\_\_\_.

8. How can you tell that cobalt(II) iodide is a binary compound formed by a transition metal with more than one ionic charge?

9. Write the names for these binary ionic compounds.

a.  $\text{PbS}$

b.  $\text{MgCl}_2$

c.  $\text{Al}_2\text{Se}_3$

**► Ternary Ionic Compounds (pages 154-156)**

10. What is a ternary compound?

11. Is the following sentence true or false? Ternary compounds rarely contain polyatomic ions.

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_



12. Why are parentheses used to write the formula  $\text{Al}(\text{OH})_3$ ?

\_\_\_\_\_

13. Complete the table for these common ternary ionic compounds.

Cation	Anion	Name	Formula
$\text{NH}_4^+$	$\text{S}^{2-}$		
$\text{Fe}^{3+}$		iron(III) carbonate	
	$\text{NO}_3^-$		$\text{AgNO}_3$
		potassium cyanide	$\text{KCN}$

## SECTION 6.5 MOLECULAR COMPOUNDS AND ACIDS (pages 158–160)

*This section explains the rules for naming and writing formulas for binary molecular compounds. It also briefly describes how to name and write formulas for common acids.*

### ► Binary Molecular Compounds (pages 158–159)

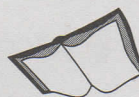
- Circle the letter of the types of elements that form binary molecular compounds.
  - two nonmetallic elements
  - a metal and a nonmetal
  - two metals
- Is the following sentence true or false? Two nonmetallic elements can combine in only one way. \_\_\_\_\_
- What method is used to distinguish between different molecular compounds that contain the same elements? \_\_\_\_\_

Match the prefix with the number it indicates.

- |                 |      |
|-----------------|------|
| _____ 4. octa-  | a. 4 |
| _____ 5. tetra- | b. 7 |
| _____ 6. hepta- | c. 8 |
| _____ 7. nona-  | d. 9 |

8. What are the names of the following compounds?

- $\text{BF}_3$  \_\_\_\_\_
- $\text{N}_2\text{O}_4$  \_\_\_\_\_
- $\text{P}_4\text{S}_7$  \_\_\_\_\_



## Reading Skill Practice

Writing a summary can help you remember the information you have read. When you write a summary, include only the most important points. Write a summary of the information in Section 6.5 on pages 158–160. Your summary should be shorter than the text on which it is based. Do your work on a separate sheet of paper.

Acid Name	Formula	Anion Name
sulfuric acid		
phosphoric acid		
nitric acid		
hydrochloric acid		
carbonic acid		
acetic acid		

12. Use Table 6.4 on page 147 to help you complete the table about acids.

as necessary to create an electrically neutral compound.

connected to as many \_\_\_\_\_ ions

11. When naming acids, you can consider them to be combinations of

10. Acids produce \_\_\_\_\_ ions when dissolved in water.

### ► Naming Common Acids (page 160)

9. What are the formulas for the following compounds?

**CHAPTER 6, Chemical Names and Formulas** (continued)

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

## SECTION 6.6 SUMMARY OF NAMING AND FORMULA WRITING (pages 161–163)

This section explains the use of flowcharts to write the name or formula of a compound.

### ▶ Practicing Skills: Follow the Arrows (pages 161–162)

1. How can a flowchart help you to name chemical compounds?  
\_\_\_\_\_

2. Use the flowchart in Figure 6.21 on page 161 to write the names of the following compounds:

- a. CsCl \_\_\_\_\_
- b. SnSe<sub>2</sub> \_\_\_\_\_
- c. NH<sub>4</sub>OH \_\_\_\_\_
- d. HF \_\_\_\_\_
- e. Si<sub>3</sub>N<sub>4</sub> \_\_\_\_\_

3. Complete the following five rules for writing a chemical formula from a chemical name.

- a. In an ionic compound, the net ionic charge is \_\_\_\_\_.
- b. An *-ide* ending generally indicates a \_\_\_\_\_ compound.
- c. An *-ite* or *-ate* ending means there is a \_\_\_\_\_ ion that includes oxygen in the formula.
- d. \_\_\_\_\_ in a name generally indicate that the compound is molecular and show the number of each kind of atom in the molecule.
- e. A \_\_\_\_\_ after the name of a cation shows the ionic charge of the cation.

4. Look at Figure 6.22 on page 162. Name five metallic elements that are commonly found in the rock formations shown in the photo.

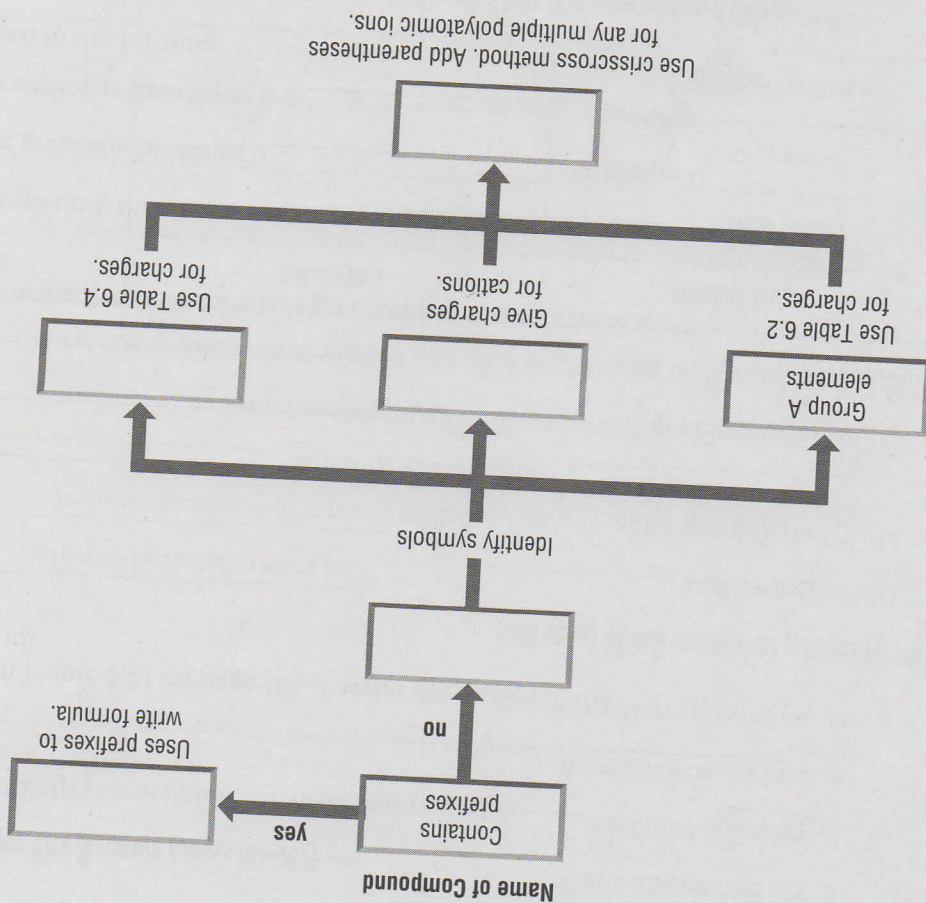
- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_
- b. \_\_\_\_\_
- e. \_\_\_\_\_

5. What is the indication that these metals are present in rocks?  
\_\_\_\_\_

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7. Use the flowchart in Figure 6.23 to write the formulas of the following compounds:

- a. potassium silicate \_\_\_\_\_
- b. phosphorus pentachloride \_\_\_\_\_
- c. manganese(II) chromate \_\_\_\_\_
- d. lithium hydride \_\_\_\_\_
- e. diiodine pentoxide \_\_\_\_\_



6. Fill in the missing labels from Figure 6.23 on page 162.

**CHAPTER 6, Chemical Names and Formulas (continued)**

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

# MathWise

## GUIDED PRACTICE PROBLEM 10 (page 142)

10. Lead forms two compounds with oxygen. One compound contains 2.98 g of lead combined with 0.461 g of oxygen. The other compound contains 9.89 g of lead with 0.763 g of oxygen. What is the lowest whole-number mass ratio of lead in the two compounds that combines with a given mass of oxygen?

Complete the following steps to solve the problem.

**Step 1.** Write the ratio of lead to oxygen for each compound.

First compound	Second compound
$\frac{\boxed{\phantom{00}} \text{ g lead}}{0.461 \text{ g oxygen}}$	$\frac{9.89 \text{ g lead}}{\boxed{\phantom{00}} \text{ g oxygen}}$

**Step 2.** Divide the numerator by the denominator in each ratio.

$\frac{6.46 \boxed{\phantom{00}}}{\boxed{\phantom{00}}}$	$\frac{\boxed{\phantom{00}} \text{ g lead}}{\text{g oxygen}}$
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**Step 3.** Write a ratio comparing the first compound to the second.

$\frac{\boxed{\phantom{00}} \text{ g lead/g oxygen}}{13.0 \text{ g lead/g oxygen}}$
---

**Step 4.** Simplify. Note that this ratio has no units.

$$\frac{0.497}{1} = \text{roughly } \frac{1}{\boxed{\phantom{00}}}$$

The mass ratio of lead per gram of oxygen in the two compounds is \_\_\_\_\_.

## GUIDED PRACTICE PROBLEMS 24B AND 24C (page 151)

24. Write formulas for compounds formed from these pairs of ions.

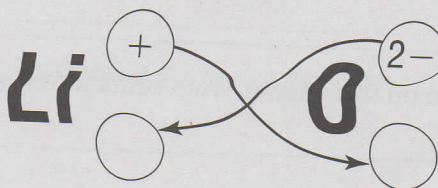
b.  $\text{Li}^+$ ,  $\text{O}^{2-}$

### Analyze

**Step 1.** Do the ions combine in a one-to-one ratio? How do you know?

### Solve

**Step 2.** Use the crisscross method to balance the formula.



• Based on this answer, what suffix will be at the end of the compound name?

• How do you know that the answer to the second question in the flowchart is *no*?

• How do you know that the answer to the first question in the flowchart is *no*?

a. FeS

Use the flowchart in Figure 6.21, page 161, to help you. Answer each question to find which path to take to the next question.

a. ZnS

c. BaO

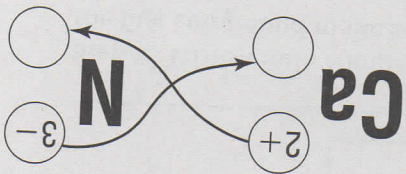
26. Write the names for these ionic binary compounds.

### GUIDED PRACTICE PROBLEMS 26 (page 153)

Step 3. How do you know this formula is reasonable?

**Evaluate**

Step 2. Use the crisscross method to balance the formula.



**Solve**

Step 1. Will the calcium ( $\text{Ca}^{2+}$ ) and nitride ( $\text{N}^{3-}$ ) ions combine in a 1 : 1 ratio? How do you know?

**Analyze**

c.  $\text{Ca}_2^+, \text{N}_3^-$

Step 3. How do you know your formula is reasonable?

**Evaluate**

### CHAPTER 6, Chemical Names and Formulas (continued)

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

- Is Fe a metal? \_\_\_\_\_ Is it a Group A element? \_\_\_\_\_
- What is the name of the element Fe? \_\_\_\_\_ Of the element S? \_\_\_\_\_
- What Roman numeral belongs with the cation? How do you know?  
\_\_\_\_\_

• Name the compound FeS. \_\_\_\_\_

c. BaO

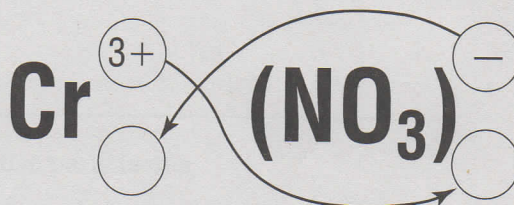
- What element is O? \_\_\_\_\_ What element is Ba? \_\_\_\_\_
- How does the name of this compound end? \_\_\_\_\_
- Is Ba a metal? \_\_\_\_\_ Is it a Group A metal? \_\_\_\_\_
- Name the compound BaO. \_\_\_\_\_

### GUIDED PRACTICE PROBLEM 29 (page 155)

29. Write the formula for chromium(III) nitrate.

- Is the compound ionic or molecular? Explain.  
\_\_\_\_\_

- Use Table 6.4 on page 147 to write the formula for the nitrate ion. \_\_\_\_\_
- Use the crisscross method to balance the formula.
- Write the formula. \_\_\_\_\_



### GUIDED PRACTICE PROBLEM 31b (page 155)

31. Write the name for the compound NaClO<sub>3</sub>.

Use the flowchart in Figure 6.21 on page 161 to help you.

- Is the first element hydrogen? What does this tell you?  
\_\_\_\_\_

- Does the formula contain more than two elements? What does this tell you?  
\_\_\_\_\_

- Is sodium a Group A metal? What does this tell you about the name of the first ion in the compound?  
\_\_\_\_\_

- Use Table 6.4 on page 147 to find the name of the anion. Write the name of the compound. \_\_\_\_\_