

Connecting to Your World

Some ants can give painful stings when threatened or disturbed. Certain ant species called formicines have poison glands that produce venom containing formic acid. Formicines protect themselves by spraying this venom on their predators. Formic acid can stun or even kill the ants' most common enemies. A formicine attack on a human, however, is much less severe. The contact of formic acid with the skin usually results only in blistering. In this section, you will learn the names and formulas of some important acids such as formic acid.

**Naming Acids**

Acids are a group of ionic compounds with unique properties. As you will see in Chapter 19, acids can be defined in several ways. For now, it is enough to know that an **acid** is a compound that contains one or more hydrogen atoms and produces hydrogen ions (H^+) when dissolved in water. Acids have various uses, one of which is shown in Figure 9.14. When naming an acid, you can consider the acid to consist of an anion combined with as many hydrogen ions as are needed to make the molecule electrically neutral. Therefore, the chemical formulas of acids are in the general form H_nX where X is a monatomic or polyatomic anion and n is a subscript indicating the number of hydrogen ions that are combined with the anion.

**Guide for Reading****Key Concepts**

- What are the three rules for naming acids?
- How are the formulas of acids determined?
- How are bases named?

Vocabulary

acid
base

Reading Strategy**Comparing and Contrasting**

When you compare and contrast things, you examine how they are alike and how they are different. After you have read this section, list similarities and differences between acids and bases and how they are named.

1 FOCUS**Objectives**

- 9.4.1** Apply three rules for naming acids.
- 9.4.2** Apply the rules in reverse to write formulas of acids.
- 9.4.3** Apply the rules for naming bases.

Guide for Reading**Build Vocabulary****L2**

Connect the Terms Tell students that one of the properties of acids is a sour or sharp taste, which they can use to recognize foods containing acids, such as lemons. Then ask students to infer what it might mean to say a person has "an acid tongue."

Reading Strategy**L2**

Summarize Encourage students to summarize the rules for naming acids in their own words.

2 INSTRUCT**Connecting to Your World**

Ask, **Why is an attack by a formicine ant not usually serious for a human?** (It would take more of the poison than a tiny ant could produce to be fatal for a person.) **Can you imagine conditions under which a formicine attack might be serious for a person?** (If many more than one ant attacked at once.)

Naming Acids**Use Visuals****L1**

Figure 9.14 Ask, **What inference can you make about the ability of glass to react with hydrofluoric acid compared to the ability of wax?** (Apparently, glass reacts with hydrofluoric acid, but wax does not.) **Would a glass bottle be an appropriate container for hydrofluoric acid?** (No, the glass would react with the acid.)

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**Section Resources****Print**

- **Guided Reading and Study Workbook**, Section 9.4
- **Core Teaching Resources**, Section 9.4
- **Transparencies**, T99

Technology

- **Interactive Textbook with ChemASAP**, Assessment 9.4
- **Go Online**, Section 9.4

Section 9.4 (continued)

Use Visuals

L1

Table 9.5 Remind students that all acids have hydrogen as one component. It is the anion combined with hydrogen that identifies the acid. Call attention to the first column in which the endings of anions are given. Ask students to name some anions with the endings *-ide*, *-ite*, and *-ate*. (They may mention *chloride*, *bromide*, *nitrite*, *sulfite*, *carbonate*, *formate*, among others) Call attention to the third column. Ask, **When the anion ends in *-ide*, what does the acid name begin with?** (*hydro-*) **What does the acid name end with?** (*-ic*) Have students name an acid containing the bromide anion. (*hydrobromic acid*) Continue the questioning and naming through the other two rows of the table and encourage students to use the table until they are comfortable with naming acids.



Writing Formulas for Acids

Discuss

L2

The table for naming acids is also the table for writing formulas for acids, but it must be used in reverse. Give students an acid name, for example, perchloric acid. Ask, **What does the *-ic* ending tell you?** (There is no *hydro-* in the name, so *-ic* means the anion ends in *-ate*.) Ask, **What is the name and formula for the anion?** (*perchlorate*, ClO_4^-) Ask, **How many hydrogen atoms will combine with the perchlorate ion?** (one, HClO_4)



Download a worksheet on **Acids** for students to complete and find additional teacher support from NSTA SciLinks.

Table 9.5

Naming Common Acids			
Anion ending	Example	Acid name	Example
<i>-ide</i>	chloride, Cl^-	<i>hydro-(stem)-ic acid</i>	<i>hydrochloric acid</i>
<i>-ite</i>	sulfite, SO_3^{2-}	<i>(stem)-ous acid</i>	<i>sulfurous acid</i>
<i>-ate</i>	nitrate, NO_3^-	<i>(stem)-ic acid</i>	<i>nitric acid</i>

Three rules can help you name an acid with the general formula H_nX . Read the rules and the examples carefully. Notice that the naming system depends on the name of the anion. Each of the rules deals with an anion with a different suffix: *-ide*, *-ite*, and *-ic*.

- ➡ **When the name of the anion (X) ends in *-ide*, the acid name begins with the prefix *hydro-*. The stem of the anion has the suffix *-ic* and is followed by the word *acid*.** Therefore, $\text{HCl}(\text{aq})$ (X = chloride) is named *hydrochloric acid*. $\text{H}_2\text{S}(\text{aq})$ (X = sulfide) is named *hydrosulfuric acid*.
- ➡ **When the anion name ends in *-ite*, the acid name is the stem of the anion with the suffix *-ous*, followed by the word *acid*.** Thus $\text{H}_2\text{SO}_3(\text{aq})$ (X = sulfite) is named *sulfurous acid*.
- ➡ **When the anion name ends in *-ate*, the acid name is the stem of the anion with the suffix *-ic* followed by the word *acid*.** Thus $\text{HNO}_3(\text{aq})$ (X = nitrate) is named *nitric acid*.

The three rules are summarized in Table 9.5. Use the table to help you write acid names until you become an expert.

Writing Formulas for Acids

If you know the name of an acid, you can write its formula. ➡ **Use the rules for writing the names of acids in reverse to write the formulas for acids.** For example, what is the formula of hydrobromic acid? Following Rule 1, hydrobromic acid (*hydro-* prefix and *-ic* suffix) must be a combination of hydrogen ion (H^+) and bromide ion (Br^-). The formula of hydrobromic acid is HBr . How do you write the formula for phosphorous acid? Using Rule 2, hydrogen ion and phosphite ion (PO_3^{3-}) must be the components of phosphorous acid. The formula of phosphorous acid is H_3PO_3 . (Note: Do not confuse *phosphorous* with *phosphorus*, the element name.) Finally, what is the formula for formic acid, the defensive weapon of the ants you read about in Connecting to Your World? According to Rule 3, formic acid (*-ic* ending) must be a combination of hydrogen ion (H^+) and formate ion (HCOO^-). The formula for formic acid is HCOOH .

Many industrial processes, including steel and fertilizer manufacturing, use acids. In the laboratory, you will regularly use a few common acids such as those listed in Table 9.6. You should become familiar with their names and formulas.

✓ **Checkpoint** When does an acid name begin with the prefix *hydro-*?

Table 9.6

Common Acids	
Name	Formula
Hydrochloric acid	HCl
Sulfuric acid	H_2SO_4
Nitric acid	HNO_3
Acetic acid	CH_3COOH
Phosphoric acid	H_3PO_4
Carbonic acid	H_2CO_3

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Facts and Figures

A Toxic Environmental Gas

The binary molecular compound carbon monoxide is a colorless, odorless, flammable gas that is highly toxic to humans. Upon inhalation, carbon monoxide binds to the hemoglobin molecules in red blood cells, where it replaces oxygen. It binds to hemoglobin about 200 times more effectively than oxygen does, keeping the red blood cells from carrying oxygen to body tissues. Thus, even at low levels, carbon monoxide is a fast-acting

poison that may cause serious illness or death. At peak traffic times, the level of carbon monoxide around roadways may reach as high as 100 parts per million (ppm) of air. In the U.S., automobiles must have catalytic converters that change toxic carbon monoxide to carbon dioxide. Carbon monoxide is also present in cigarette smoke. It takes several hours to replace the carbon monoxide in a smoker's blood after only one cigarette.



Names and Formulas for Bases

Relate

L1

Sodium hydroxide is a powerful base. It can turn wood into the mushy pulp from which paper is made. It breaks up and dissolves the greasy matter that clogs drains. Care must be taken to protect the body when using strong bases.

ASSESS

Evaluate Understanding

L2

Divide students into an even number of groups, and assign to each a number of the polyatomic ions listed in Table 9.3. (Omit the hydroxide ion and ammonium ion.) Have the groups write the formulas for the acids corresponding to each assigned anion by adding the correct number of hydrogen atoms. Then ask students to name the acids on a separate piece of paper. Have them exchange papers with another group and write the formulas for the acid names they receive.

Reteach

L1

Use the names of the six common acids in Table 9.6 as models. Ask students to name the anion and write the formulas using Table 9.5.

Elements Handbook

Answers should include information on how sulfuric acid is produced. They should also include the various products requiring sulfuric acid in their preparation.

Interactive Textbook

If your class subscribes to the Interactive Textbook, use it to review key concepts in Section 9.4.

with ChemASAP

Answers to...

Figure 9.15 She is protecting her hands from corrosive NaOH.



Checkpoint when the anion ends in *-ide*.

Names and Formulas for Bases

Another group of ionic compounds is the bases. A **base** is an ionic compound that produces hydroxide ions when dissolved in water. **Bases are named in the same way as other ionic compounds—the name of the cation is followed by the name of the anion.** For example, sodium hydroxide (NaOH) is a base used in making paper, cleaners, and soap, as shown in Figure 9.15. To write the formulas for bases, write the symbol for the metal cation followed by the formula for the hydroxide ion. Balance the ionic charges just as you do for any ionic compound. For example, aluminum hydroxide consists of the aluminum cation (Al^{3+}) and the hydroxide anion (OH^-). You need three hydroxide ions to balance the $3+$ charge of the aluminum cation. Thus the formula for aluminum hydroxide is $\text{Al}(\text{OH})_3$.

Figure 9.15 Sodium hydroxide is an important industrial and consumer product. (a) Recycled paper and wood are digested with NaOH to make pulp in the first step in making paper.

(b) Cleaners containing NaOH cut through heavy grease. (c) An important use of sodium hydroxide is in making soap.

Inferring Why is the woman in the second photo wearing gloves?

9.4 Section Assessment

26. **Key Concept** List the rules for naming acids.
27. **Key Concept** How are the formulas for acids determined?
28. **Key Concept** How are bases named?
29. Give the names of these acids.
 - a. HNO_2 b. HMnO_4
 - c. HCN d. H_2S
30. Write the names of these bases.
 - a. LiOH b. $\text{Pb}(\text{OH})_2$
 - c. $\text{Mg}(\text{OH})_2$ d. $\text{Al}(\text{OH})_3$
31. Identify each compound as an acid or a base.
 - a. $\text{Ba}(\text{OH})_2$ b. HClO_4
 - c. $\text{Fe}(\text{OH})_3$ d. KOH
32. Write the formulas for these compounds.
 - a. carbonic acid
 - b. sulfurous acid
 - c. iron(III) hydroxide
 - d. strontium hydroxide
33. What element generally appears in the formula of an acid? What ion generally appears in the formula of a base?

Elements Handbook

Sulfuric Acid Sulfuric acid is important to our economy. Refer to page R30 to learn more about H_2SO_4 . Write a short report summarizing what you learn.

Interactive Textbook

Assessment 9.4 Test yourself on the concepts in Section 9.4.

with ChemASAP

Section 9.4 Naming and Writing Formulas for Acids and Bases 273

Section 9.4 Assessment

26. See the rules for naming on the SE facing page (page 272).
27. The rules for writing the names of acids are used in reverse to write the formulas for acids.
28. The name of the cation is followed by the name of the anion.
29. a. nitrous acid b. permanganic acid
c. hydrocyanic acid d. hydrosulfuric acid
30. a. lithium hydroxide b. lead(II) hydroxide c. magnesium hydroxide
d. aluminum hydroxide
31. a. base b. acid c. base d. base
32. a. H_2CO_3 b. H_2SO_3 c. $\text{Fe}(\text{OH})_3$
d. $\text{Sr}(\text{OH})_2$
33. acid, hydrogen; base, hydroxide ion