9.4 Naming and Writing Formulas for Acids and Bases

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.

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.

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.

Figure 9.14 To create designs such as this on glass, the glass is first coated with wax and the design is drawn through the wax. When the glass is dipped into hydrofluoric acid (HF), the acid etches (eats away) the glass wherever the wax has been removed.

Table 9.5

Naming Common Acids

Anion ending	Example	Acid name	Example
-ide	chlor*ide*, Cl^-	*hydro*-(stem)-*ic acid*	*hydro*chlor*ic acid*
-ite	sulf*ite*, SO_3^{2-}	(stem)-*ous acid*	sulfur*ous acid*
-ate	nitr*ate*, NO_3^-	(stem)-*ic acid*	nitr*ic acid*

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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*.

1. **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, HCl(aq) (X = chloride) is named *hydro*chlor*ic acid*. $H_2S(aq)$ (X = sulfide) is named *hydro*sulfur*ic acid*.
2. **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 H_2SO_3 (*aq*) (X = sulfite) is named sulfur*ous acid*.
3. **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 $HNO_3(aq)$ (X = nitrate) is named nitr*ic 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 form*ate* 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.

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

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

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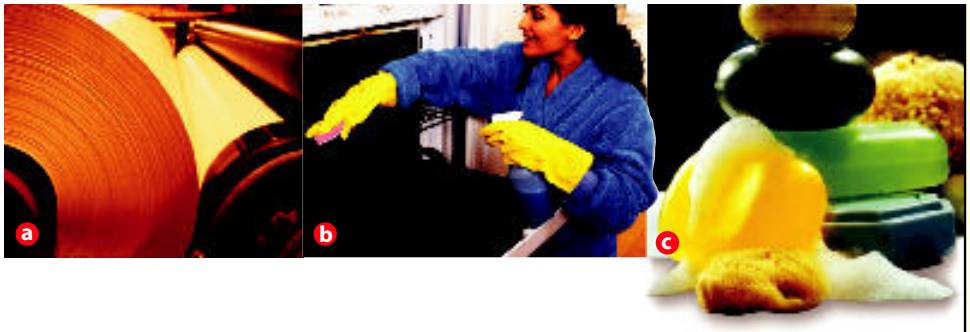

Names and Formulas for Bases

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 $Al(OH)_3$.

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.** $Pb(OH)_2$
- **c.** $Mg(OH)_2$ **d.** $Al(OH)_3$

31. Identify each compound as an acid or a base.
- **a.** $Ba(OH)_2$ **b.** $HClO_4$
- **c.** $Fe(OH)_3$ **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.

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