

## 5.3 Organic Compounds

Organic compounds always contain carbon and almost always contain hydrogen as well. Other elements, including metals and non-metals, may also be present. Inorganic compounds are all other compounds. To recognize a compound as organic, look for an indication of the presence of carbon in its name, chemical formula, or diagram. Organic chemistry is the study of compounds that contain carbon.

### Words to Know

alcohol  
hydrocarbon  
inorganic  
organic  
organic chemistry  
solvent

### Did You Know?

Organic chemistry is the basis of the study of biochemistry, which is a large branch of modern biology. Pharmacists, nurses, and physicians all study organic chemistry.

Chemists in the early 19th century knew that organisms produce a huge number of compounds containing carbon. The chemists called these organic compounds because the compounds were made by organisms. Today, we use the term **organic** compound to refer to almost all carbon-containing compounds, whether they are produced naturally by organisms or are synthesized in a laboratory. **Inorganic** compounds include compounds that generally do not contain carbon and also a few exceptions to the organic classification, such as carbon dioxide, carbon monoxide, and ionic carbonates.

**Organic chemistry** is the study of compounds that contain carbon. Well over half of all known compounds are classified as organic. Carbon is an element in group 14 of the periodic table. Carbon has four electrons in its valence shell and forms four covalent bonds. In almost all organic compounds, carbon atoms are bonded to hydrogen atoms or other elements that are near carbon in the periodic table, especially nitrogen, oxygen, sulfur, phosphorus, and the halogens. Carbon can also bond with itself to form long chains of atoms, such as found in plastics. Because carbon forms four bonds, it forms complex, branched-chain structures, ring structures, and even cage-like structures (Figure 5.18). Carbon can even make double or triple connections between two carbon atoms.

No other element can match carbon's ability to make stable compounds with such a variety of shapes and arrangements. Chemists have identified millions of different organic compounds and are synthesizing more every day. Many of these new compounds are used in medicines and foods and to create new materials for buildings and clothing.

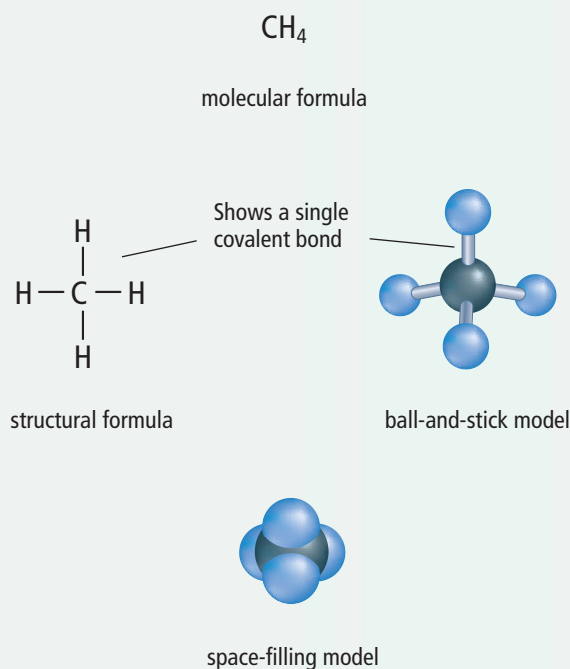


**Figure 5.18** Several forms of the organic compound chlorophyll are present in the leaves of green plants. One molecule of chlorophyll *b* contains 55 carbon atoms (shown as brown in this model) and 70 hydrogen atoms (blue). Chlorophyll also contains nitrogen (blue), oxygen (red), and magnesium (white).

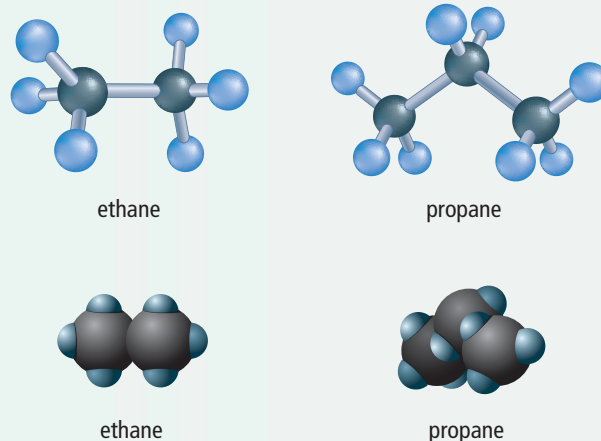
The simplest organic compounds contain only the elements carbon and hydrogen. How many different combinations do you think the two elements can form? In this activity, you will investigate simple organic compounds by analyzing models and drawing structural formulas.

### What to Do

- The following diagram shows four ways of representing the compound methane, the main component of natural gas. Examine the models of methane, and then copy the molecular formula and the structural formula for methane, just as they appear in the diagram below.



- The following diagram shows ball-and-stick models and space-filling models for the compounds ethane and propane.
  - Give the molecular formula of each compound.
  - Draw the structural formula of each compound.



- There are two different organic compounds that have the formula  $\text{C}_4\text{H}_{10}$ . Draw two different structural formulas for  $\text{C}_4\text{H}_{10}$ .
- How many different ways can the atoms in  $\text{C}_5\text{H}_{12}$  be put together? Write as many structural formulas for  $\text{C}_5\text{H}_{12}$  as you can.

### What Did You Find Out?

- How many different ways are there to build each of the following compounds?
  - $\text{CH}_4$
  - $\text{C}_2\text{H}_6$
  - $\text{C}_3\text{H}_8$
  - $\text{C}_4\text{H}_{10}$
  - $\text{C}_5\text{H}_{12}$
- Examine each formula in question 1. What is the pattern in the ratio of the number of carbon atoms to the number of hydrogen atoms?

## Recognizing Organic Compounds

You can often tell whether a compound is organic or inorganic by examining its chemical formula. The formula for an organic compound must contain carbon. Inorganic carbon compounds contain carbonates, carbides, and oxides. Examples of organic compounds and inorganic compounds are shown in Table 5.7.

**Table 5.7** Comparing Formulas of Organic Compounds and Inorganic Compounds

Organic: Must Contain Carbon		Inorganic Containing Carbon
$\text{CH}_4$	methane (a hydrocarbon)	$\text{CaCO}_3$ , $\text{Na}_2\text{CO}_3$ (carbonates)
$\text{CH}_3\text{CH}_2\text{OH}$	ethanol (an alcohol)	$\text{Al}_4\text{C}_3$ , $\text{SiC}$ (carbides)
$\text{C}_6\text{H}_5\text{COOH}$	benzoic acid (an organic acid)	$\text{CO}$ , $\text{CO}_2$ (oxides)
$\text{K}_2\text{HC}_6\text{H}_5\text{O}_7$	potassium citrate (an organic salt)	Inorganic Not Containing Carbon
$\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$	caffeine (a stimulant)	$\text{FeCl}_2$
$\text{CH}_3(\text{CH}_2)_n\text{CH}_3$	polyethylene (a plastic) where $n = 5000$ approximately and the $\text{CH}_2$ unit repeats about 5000 times	$(\text{NH}_4)_2\text{SO}_3$
		$\text{PBr}_3$

You may have noticed that hydrogen does not come first in the formulas in Table 5.7. For example, methane is  $\text{CH}_4$ , not  $\text{H}_4\text{C}$ . There is an important reason for this, which is that most organic compounds are not acids. Acids such as  $\text{HCl}$  have the hydrogen written on the left. Methane, however, is not an acid. Writing the formula with H coming after carbon, as in  $\text{CH}_4$ , helps to show the compound is not an acid.




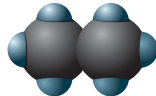
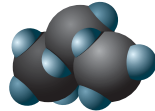
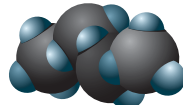
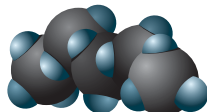
**Figure 5.19** Some Bunsen burners use propane as a fuel.

## Hydrocarbons

A **hydrocarbon** is an organic compound that contains only the elements carbon and hydrogen. Thousands of hydrocarbons are known. The simplest of all organic compounds is the hydrocarbon molecule called methane,  $\text{CH}_4$ , which consists of a carbon atom bonded to four hydrogen atoms. Other hydrocarbons are formed by linking two or more carbons together to make a chain. Table 5.8 shows the first five hydrocarbons as well as their common uses. These are presented as examples only. It is not necessary to memorize the names or formulas of specific hydrocarbons.

All of these hydrocarbons are flammable. Some hydrocarbons are regularly used as fuels. Methane and ethane are gases at room temperature. Propane and butane are gases but are easily turned into liquids under pressure. This is why they are useful as fuels for camp stoves, Bunsen burners, and hand-held lighters (Figure 5.19). The larger the molecule of a hydrocarbon, the more easily it becomes a liquid. Pentane is a liquid at room temperature.

**Table 5.8** The First Five Hydrocarbons

Name	Molecular Formula	Structural Formula	Shortened Structural Formula	Space-Filling Model	Common Uses
methane	CH <sub>4</sub>	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{H} \\   \\ \text{H} \end{array}$	CH <sub>4</sub>		<ul style="list-style-type: none"> <li>Natural gas heaters</li> </ul>
ethane	C <sub>2</sub> H <sub>6</sub>	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>3</sub>		<ul style="list-style-type: none"> <li>Manufacturing plastic</li> </ul>
propane	C <sub>3</sub> H <sub>8</sub>	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\   \quad   \quad   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\   \quad   \quad   \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>		<ul style="list-style-type: none"> <li>Camp fuel</li> </ul>
butane	C <sub>4</sub> H <sub>10</sub>	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\   \quad   \quad   \quad   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\   \quad   \quad   \quad   \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>		<ul style="list-style-type: none"> <li>Hand-held lighters</li> </ul>
pentane	C <sub>5</sub> H <sub>12</sub>	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\   \quad   \quad   \quad   \quad   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\   \quad   \quad   \quad   \quad   \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>		<ul style="list-style-type: none"> <li>Component of gasoline</li> </ul>

## Reading Check

1. What element must be present for a compound to be considered organic?
2. What other element is almost always present in an organic molecule?
3. List three carbon-containing compounds that are considered inorganic.
4. List three inorganic compounds that do not contain carbon.
5. What two elements are present in a hydrocarbon?

### Suggested Activity

Find Out Activity 5-3C on page 249

## Alcohols

An **alcohol** is one kind of organic compound that contains C, H, and O. There are many kinds of alcohols, such as methanol, ethanol, and isopropyl alcohol. Methanol, also called wood alcohol, is a poison that is very useful as a solvent. A **solvent** is a liquid that can dissolve other substances. Methanol will dissolve many substances that water cannot. For example, permanent black marker ink can often be removed using methanol, even though soapy water cannot do so.

Ethanol is used in some beverages as well as in some disinfectants. When consumed in large amounts, ethanol is a poison. Ethanol is used as a fuel or a fuel additive in gasoline mixtures and in medicines and plastics.

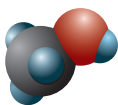
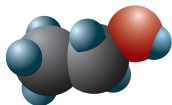
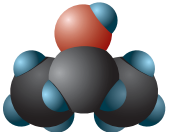
## Explore More

If you extended a hydrocarbon chain to about 5000 carbon atoms linked end to end, you would have the compound used in plastic sandwich wrap. Explore the organic chemistry of plastics at [www.bcscience10.ca](http://www.bcscience10.ca).

Isopropyl alcohol, commonly known as rubbing alcohol, is used in sterilizing pads and as a cleaner on contact pins in electronic devices. Rubbing alcohol is poisonous to drink but can be applied to the skin in small quantities as a disinfectant. Isopropyl alcohol can be used as a solvent and to keep automobile fuel lines free from ice in cold weather.

Methanol, ethanol, and isopropyl alcohol are highly flammable compounds. Table 5.9 shows several ways to represent alcohols. It is not necessary to memorize the names or formulas of specific alcohols.

**Table 5.9** Some Common Alcohols

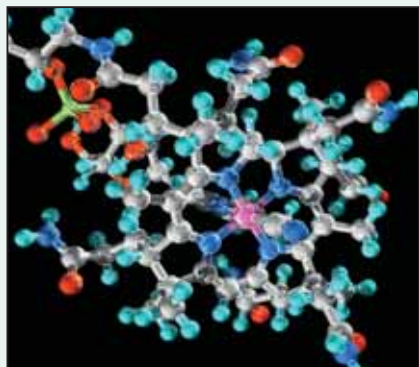
Name	Molecular Formula	Structural Formula	Shortened Structural Formula	Space-Filling Model	Common Use
methanol	CH <sub>4</sub> O	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	CH <sub>3</sub> OH		<ul style="list-style-type: none"> <li>• Solvent</li> </ul>
ethanol	C <sub>2</sub> H <sub>6</sub> O	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> OH		<ul style="list-style-type: none"> <li>• Fuel</li> </ul>
isopropyl alcohol	C <sub>3</sub> H <sub>8</sub> O	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\   \quad   \quad   \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	(CH <sub>3</sub> ) <sub>2</sub> CH <sub>2</sub> OH		<ul style="list-style-type: none"> <li>• Sterilizer</li> <li>• Cleaner</li> </ul>

## 5-3B Researching a Group of Organic Compounds

## Think About It

There are many groups of organic compounds, including antibiotics, herbicides, pesticides, explosives, and the plastic fibres used in fabrics. In this activity, you will research either a group of organic compounds or one specific compound.

Vitamin B<sub>12</sub> is a specific compound in a class of compounds called vitamins.



### What to Do

1. Select a group of organic compounds or a particular organic compound to research.
2. Consult with your teacher about your topic to make sure that it is appropriate.
3. Research your topic.
4. Prepare a presentation on the discovery, development, uses, benefits, and disadvantages of using the compound or compounds. Your teacher may give you an assessment guide for your presentation. Make sure to provide a complete bibliography including Internet references. The presentation should be appropriate to your audience, and your ideas should be presented logically. Try to make sure each part of the presentation captures the attention of your audience. Where possible, use examples and analogies that help make the topic memorable.



## 5-3C Using Models to Represent Organic Compounds

### Find Out ACTIVITY

In this activity, you will use models to represent organic molecules containing carbon, hydrogen, oxygen, and chlorine. Most model kits have standard colour coding for the elements. Usually, carbon atoms are black with four holes, hydrogen atoms are white with one hole, oxygen is red with two holes, and chlorine is green with one hole. Filling the holes in the models represents completing a valence shell of an atom.

All the bonds in this activity are covalent. Single bonds are represented with a short connector. Long flexible connectors are used for double bonds and triple bonds in which more than one connection exists between the same two atoms.

#### Materials

- organic model kit

#### What to Do

- Work in a group as directed by your teacher. Carefully build the molecules, and then examine their shapes.
- Build models to represent the following formulas. The models can be put together in only one way, regardless of the order in which you assemble the atoms. Your teacher may ask you to draw a structural diagram to represent them.
  - $\text{CH}_4$  (methane)
  - $\text{C}_2\text{H}_6$  (ethane)
  - $\text{C}_2\text{H}_4$  (ethene)
  - $\text{C}_2\text{H}_2$  (ethyne, commonly called acetylene)
  - $\text{C}_3\text{H}_8$  (propane)
  - $\text{CH}_4\text{O}$  (methanol)
  - $\text{C}_2\text{H}_5\text{Cl}$  (chloroethane)
- Build models to represent the following formulas. These have more than one way of being put together. This means that more than one arrangement of the atoms in that compound with the same number of atoms is possible. You may wish to leave off hydrogen atoms and the bonds that connect to them. You may be asked to draw structural diagrams to represent them.
  - $\text{C}_3\text{H}_6$  (two ways)
  - $\text{C}_4\text{H}_{10}$  (two ways)
  - $\text{C}_3\text{H}_7\text{Cl}$  (two ways)
  - $\text{C}_2\text{H}_6\text{O}$  (two ways)
  - $\text{C}_2\text{H}_4\text{Cl}_2$  (two ways)

#### Science Skills

Go to Science Skill 8 for information on using models in science.

#### What Did You Find Out?

- How many covalent bonds do atoms of each of the following elements make?
  - carbon
  - oxygen
  - hydrogen
  - chlorine
- State which of the following elements are capable of forming a double bond: hydrogen, carbon, oxygen, chlorine.
- Explain how the positions of the holes in the models representing carbon and oxygen produce a 3D shape.

## Research and Development Chemist

Moulding resin, gloss pomade, structurizing paste, root volumizer, styling lotion. These are just a few of the products that Zdravka Stoyeff, from Vancouver, British Columbia, helps to develop and test as a research and development chemist for a hair cosmetics company.



Zdravka Stoyeff

- Q.** What do you do as a research and development chemist?
- A.** I create products that meet the manufacturer's standards for performance, effectiveness, and safety. We are continually conducting research on existing products as well as creating new and innovative products.
- Q.** What is a typical day like for you?
- A.** Every day is different. Sometimes I have meetings with the marketing, production, and sales teams to see where the needs are in the consumer market. Then, I go back to the lab to develop and test products. I create and prepare samples of these products for our stylist teams and then refine them with the feedback from the stylist.

- Q.** What training do you need to become a product developer with a hair cosmetics company?
- A.** You need a university degree in chemistry, biology, or natural sciences. Then, you train to familiarize yourself with the materials generally used in the industry. Over time, you gain experience in formulating products and learn what works and what does not.
- Q.** How is chemistry connected to hair care products?
- A.** Chemistry is involved in almost everything we do. When you cleanse, condition, or thicken your hair, there are chemical and physical changes that occur. When you colour, perm, or straighten your hair, chemical reactions are occurring. I am always using chemistry when I take the raw materials, mix them according to the formulas we create, and then observe the chemical reactions and the products that are created.
- Q.** How are acids and bases used in your work?
- A.** We use organic acids like citric acid ( $C_6H_8O_7$ ) to adjust the pH of products. We use stearic acid ( $C_{18}H_{36}O_2$ ) as an emulsifier in making creams. We also use inorganic bases like sodium hydroxide (NaOH) and organic bases like triethanolamine ( $C_6H_{15}NO_3$ ) to neutralize some of the hair-set polymers.
- Q.** What safety issues do you need to be aware of in your work?
- A.** We usually wear protective clothing, safety glasses, and protective footwear. There are many laboratory safety regulations we follow, including ones from Health Canada. We also have to comply with the GMP (Good Manufacturing Practice) for the plant and have SOPs (Standard Operation Procedures) in place for the lab. We have to ensure the Material Safety Data Sheet (MSDS) is readily available for every chemical we use.

### Questions

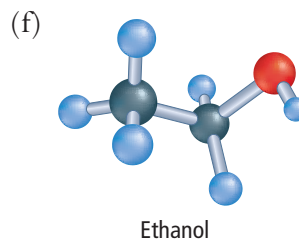
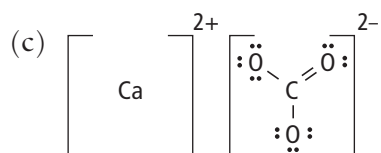
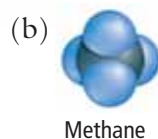
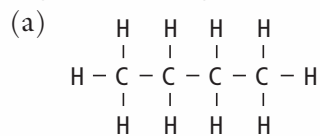
1. How are acids used in hair care products?
2. How are bases used in hair care products?
3. Why is knowledge of chemistry important for developing new hair care products?

## Checking Concepts

- What is organic chemistry the study of?
- (a) What element do all organic compounds contain?  
(b) What other element do most organic compounds contain?
- Explain why carbon forms so many compounds.
- Classify each of the following compounds as organic or inorganic by examining their formulas.
  - $\text{CH}_3\text{CH}_2\text{OH}$
  - $\text{K}_2\text{HC}_6\text{H}_5\text{O}_7$
  - $\text{Al}_4\text{C}_3$
  - $\text{C}_8\text{H}_{10}\text{CH}_2\text{OH}$
  - $\text{CaCO}_3$
  - $\text{FeCl}_2$
  - $\text{CH}_4$
  - $\text{PBr}_3$
  - $\text{CO}_2$
  - $\text{C}_6\text{H}_5\text{COOH}$
- What is the definition of a hydrocarbon?
- (a) What is the chemical name of the simplest hydrocarbon?  
(b) What is its common name?  
(c) What is it used for?
- What three elements are present in alcohols?
- What is the definition of a solvent?
- What is one use for each of the following?
  - methanol
  - ethanol
  - isopropyl alcohol
- What is the difference in molecular formula between each of the following pairs?
  - methane and methanol
  - ethane and ethanol
  - propane and isopropyl alcohol

## Understanding Key Ideas

- Classify each of the compounds illustrated as organic or inorganic.



## Pause and Reflect

Organic compounds are modelled using molecular formulas, structural formulas, ball-and-stick models, and space-filling models. Which model do you find easier to use? Why? List some advantages and disadvantages of each type of model.



## Prepare Your Own Summary

In this chapter, you learned about the properties of acids, bases, and salts, and also how to distinguish between organic and inorganic compounds. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 11 for help with using graphic organizers.) Use the following headings to organize your notes:

- Using pH and Acid-Base Indicators to Measure Acidity Levels
- Names, Formulas, and Properties of Common Acids and Bases
- Common Reactions Involving Acids
- Distinguishing between Organic Compounds and Inorganic Compounds
- Hydrocarbons and Alcohols

## Checking Concepts

- State the pH value or pH range of the following.
  - a neutral solution
  - a basic solution
  - an acidic solution
- Copy and complete the following chart in your notebook.

Term	Definition	Used to Describe Acids, Bases, or Both?
Alkaline		
Corrosive		
Caustic		
Low pH		

- What is a pH typical of each of the following?
  - pure water
  - normal rainwater
  - acid precipitation
  - human blood
  - human saliva
- What is the increase in acidity associated with a decrease of one unit on the pH scale?
- Describe how you would use litmus paper to determine whether a solution is acidic, basic, or neutral.
- How can you identify an acid by looking at its chemical formula?
- How can you identify a base by looking at its chemical formula?
- State the formula of each of the following.
  - an acid used to make fertilizers
  - a base that has the common name of caustic soda
  - a household base used as a kitchen cleaner
  - the active ingredient in milk of magnesia
  - an acid in your stomach that helps digest food
  - the battery acid used in automobiles
  - hydrated lime, used in soil and water treatment
  - the acid present in vinegar
- Give the chemical name for each compound in question 7.
- State whether each of the following describes acids, bases, or both.
  - taste sour
  - taste bitter
  - feel slippery
  - conduct electricity
  - have a pH greater than 7
  - produce hydrogen ( $H^+$ ) ions in solution
  - react with metals, causing them to corrode
- What is meant by the term acid-base neutralization?
- When metal oxides are dissolved in water, are the resulting solutions acidic or basic?
  - When non-metal oxides are dissolved in water, are the resulting solutions acidic or basic?
- How does adding lime (calcium carbonate) help reduce the effects of acid precipitation in lake water?
- Define:
  - organic compound
  - inorganic compound
- What two elements are present in all hydrocarbon compounds?
  - What are three uses for hydrocarbons?

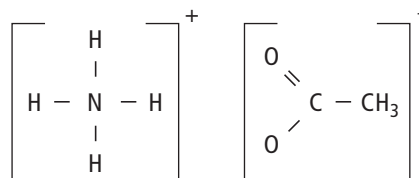
15. (a) What three elements are present in all alcohols?  
 (b) What are three uses for alcohols?

### Understanding Key Ideas

16. How many times more basic is a solution of pH 11 compared to a solution of pH 9?
17. What is the colour of the indicator after it is added to each of the following solutions? (Assume the colour of the solution being tested does not mask the colour of the indicator.) Refer to the indicator chart in Figure 5.6 on page 224.
- (a) lemon juice in the presence of indigo carmine indicator  
 (b) milk in methyl red indicator  
 (c) bleach in phenolphthalein  
 (d) tap water in phenolphthalein  
 (e) egg white in litmus
18. Change the following names to the names used when the acid is aqueous.
- (a) hydrogen fluoride  
 (b) hydrogen perchlorate  
 (c) hydrogen sulfate  
 (d) hydrogen chloride
19. Complete and balance the following neutralization reactions. Then, write the names of all the reactants and all the products in each chemical reaction.
- (a)  $\text{HNO}_3 + \text{Al}(\text{OH})_3 \rightarrow$   
 (b)  $\text{HF} + \text{KOH} \rightarrow$   
 (c)  $\text{H}_3\text{PO}_3 + \text{Ca}(\text{OH})_2 \rightarrow$   
 (d)  $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow$   
 (e)  $\text{H}_2\text{SO}_4 + \text{NaOH} \rightarrow$
20. Complete and balance the following chemical reactions between an acid and a metal.
- (a)  $\text{HBr} + \text{Mg} \rightarrow$   
 (b)  $\text{H}_2\text{SO}_3 + \text{Al} \rightarrow$   
 (c)  $\text{HI} + \text{Ca} \rightarrow$   
 (d)  $\text{HClO} + \text{Zn} \rightarrow$   
 (e)  $\text{H}_3\text{PO}_3 + \text{Na} \rightarrow$
21. State whether each of the following is an acid, a base, a salt, or none of these.
- (a)  $\text{HCl}(\text{aq})$                       (d)  $\text{MgCl}_2$   
 (b)  $\text{KOH}$                               (e)  $\text{K}_3\text{PO}_4$   
 (c)  $\text{Sr}(\text{OH})_2$                       (f)  $\text{H}_2\text{SO}_4(\text{aq})$
22. Classify each of the following compounds as organic or inorganic by examining their formulas.
- (a)  $\text{CH}_3\text{OH}$                               (e)  $\text{FeBr}_3$   
 (b)  $\text{Mg}(\text{HC}_2\text{O}_4)_2$                       (f)  $\text{CH}_4$   
 (c)  $\text{SiC}$                                   (g)  $\text{NH}_3$   
 (d)  $\text{Na}_2\text{CO}_3$                               (h)  $\text{CO}$
23. Draw structural diagrams for these organic compounds.
- (a)  $\text{CH}_4$                                   (b)  $\text{CH}_3\text{CH}_2\text{CH}_3$

### Applying Your Understanding

24. Some compounds, such as ammonium acetate, can fall into more than one category at a time.



Ammonium acetate is made of positive ammonium ions and negative acetate ions, consistent with the formula of a salt. The acetate ion contains carbon atoms, making it organic. The ammonium ion can react with water to release hydrogen ions, so it is an acid. The acetate ion can react with water to make hydroxide ions, so it is a base.

- (a) Do you think it is possible for this salt to make a solution both acidic and basic at the same time?  
 (b) How would you test your prediction?

### Pause and Reflect

In this chapter, you used your knowledge of chemical formulas to classify compounds. How might you use this knowledge in your daily life? Why might it be important for you to recognize the type of compound by reading its chemical formula?