Chapter 11 Introduction to Organic Chemistry: Hydrocarbons

Firefighters must be knowledgeable about fire codes, arson, and the handling and disposal of hazardous materials.

Since firefighters also provide emergency care for sick and injured people, they need to be aware of emergency medical and rescue procedures, as well as the proper methods for controlling the spread of infectious disease.

Chapter 11 Readiness

Core Chemistry Skills

- Drawing Electron-Dot Formulas (6.5)
- Predicting Shape (6.7)
- Balancing a Chemical Equation (7.3)

11.1 Organic Compounds

Organic chemistry is the study of carbon compounds.

Organic compounds such as vegetable oil contain carbon and hydrogen.

Learning Goal Identify properties characteristic of organic or inorganic compounds.

Organic Compounds

An **organic compound**
- is a compound made from carbon and hydrogen atoms
- may also contain other nonmetals such as oxygen, sulfur, nitrogen, phosphorus, or a halogen
- is often found in common products such as gasoline, medicines, shampoos, plastics, and perfumes

The formulas of organic compounds are written with carbon first, followed by hydrogen, and then any other elements.

Properties of Organic Compounds

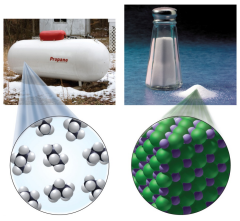
Organic compounds typically
- have covalent bonds
- have low melting and boiling points
- are flammable and undergo combustion
- are not soluble in water

Vegetable oil is a mixture of organic compounds and is not soluble in water.

Organic and Inorganic Compounds

Many inorganic compounds have high melting and boiling points.

Inorganic compounds that are ionic are usually soluble in water, and most do not burn in air.



Propane, C_3H_8, is an organic compound used as a fuel. NaCl, salt, is an inorganic compound composed of Na^+ and Cl^- ions.

Comparing Organic and Inorganic Compounds

TABLE 11.1 Some Properties of Organic and Inorganic Compounds

Property	Organic	Example: C_3H_8	Inorganic	Example: NaCl
Elements Present	C and H, sometimes O, S, N, P, or Cl (F, Br, I)	C and H	Most metals and nonmetals	Na and Cl
Particles	Molecules	C_3H_8	Mostly ions	Na^+ and Cl^-
Bonding	Mostly covalent	Covalent	Many are ionic, some covalent	Ionic
Polarity of Bonds	Nonpolar, unless a strongly electronegative atom is present	Nonpolar	Most are ionic or polar covalent, a few are nonpolar covalent	Ionic
Melting Point	Usually low	−188 °C	Usually high	801 °C
Boiling Point	Usually low	−42 °C	Usually high	1413 °C
Flammability	High	Burns in air	Low	Does not burn
Solubility in Water	Not soluble, unless a polar group is present	No	Most are soluble, unless nonpolar	Yes

Study Check

Identify each characteristic as most typical of compounds that are inorganic or organic.

A. It has a high melting point.
B. It is not soluble in water.
C. It has the formula $CH_3—CH_2—CH_3$.
D. It has the formula $MgCl_2$.
E. It burns easily in air.
F. It has covalent bonds.

Solution

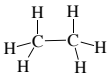
Identify each characteristic as most typical of compounds that are inorganic or organic.

A. It has a high melting point. — inorganic
B. It is not soluble in water. — organic
C. It has the formula $CH_3—CH_2—CH_3$. — organic
D. It has the formula $MgCl_2$. — inorganic
E. It burns easily in air. — organic
F. It has covalent bonds. — organic

Hydrocarbons

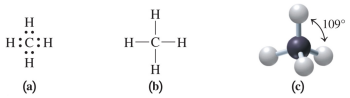
- **Hydrocarbons** are organic compounds that contain only carbon and hydrogen.
- In organic molecules, every carbon has four bonds.

- **Saturated hydrocarbons** contain only single bonds.



Carbon Compounds: Methane (CH_4)

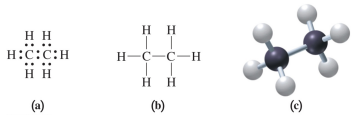
In methane, CH_4, carbon forms four covalent bonds to hydrogen. Methane is tetrahedral and has bond angles of 109°.



Two-dimensional and three-dimensional representations of methane, CH_4:
(a) electron-dot formula
(b) expanded structural formula
(c) ball-and-stick model

Carbon Compounds: Ethane (C_2H_6)

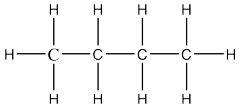
In ethane, C_2H_6, each tetrahedral carbon forms three covalent bonds to hydrogen and one to the other carbon.



Two-dimensional and three-dimensional representations of ethane, C_2H_6:
(a) electron-dot formula
(b) expanded structural formula
(c) ball-and-stick model

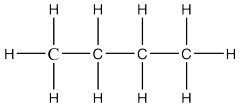
Study Check

In the butane molecule, C_4H_{10}, predict the shape around each carbon atom.



Solution

In the butane molecule, C_4H_{10}, predict the shape around each carbon atom.



Each carbon atom has four single covalent bonds and, therefore, a tetrahedral shape.