

Hydrocarbons-1

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Lecture 10

Lecture Goals

- In this chapter you will learn how to:
 - Distinguish organic compounds from ionic inorganic compounds
 - Recognize the characteristic features of organic compounds
 - Characteristic features of Alkane, Alkene and alkyne
 - Isomer and stereoisomer
 - A relation to medical activity of organic compounds and living system

1. Introduction

- ***What is organic chemistry?***
- Organic chemistry is the study of compounds that contain the element carbon.
- Clothes, foods, medicines, gasoline, refrigerants, and soaps are composed almost solely of organic compounds.
- Organic compounds exist as discrete molecules with much weaker intermolecular forces, the forces that exist between molecules, than those seen in **ionic compounds**, which are held together by very strong interactions of oppositely charged ions.

Figure 10.1 Some Common Products of Organic Chemistry Used in Medicine

a. Oral contraceptives



b. Plastic syringes



c. Antibiotics



d. Synthetic heart valves



Property	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ (An Organic Compound)	NaCl (An Inorganic Compound)
Bonding	Covalent	Ionic
Physical state	Gas at room temperature	Solid at room temperature
Boiling point	Low ($-0.5\text{ }^\circ\text{C}$)	High ($1413\text{ }^\circ\text{C}$)
Melting point	Low ($-138\text{ }^\circ\text{C}$)	High ($801\text{ }^\circ\text{C}$)
Solubility in water	Insoluble	Soluble
Solubility in organic solvents	Soluble	Insoluble
Flammability	Flammable	Nonflammable

The Physical Properties of organic compounds

1. Organic compounds resemble other covalent compounds.
2. They have much lower melting points and boiling points than ionic compounds.
3. Many organic compounds are liquids and some are even gases.

The Characteristic Features of organic compounds

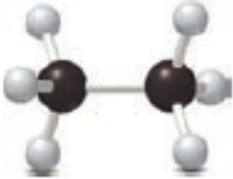
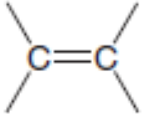
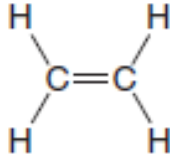
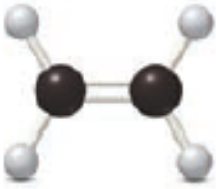



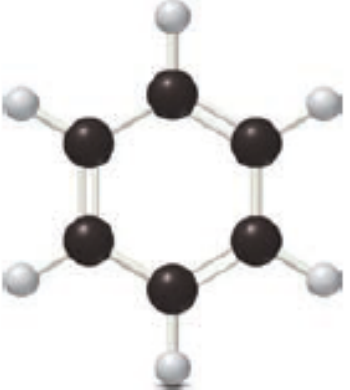
1. All organic compounds contain carbon atoms and most contain hydrogen atoms. Carbon always forms four covalent bonds, and hydrogen forms one covalent bond.
2. Carbon forms single, double, and triple bonds to other carbon atoms.
3. Some compounds have chains of atoms and some compounds have rings.
4. Organic compounds may also contain elements other than carbon and hydrogen. **Any atom that is not carbon or hydrogen is called a heteroatom.**

2. Hydrocarbon

- **Hydrocarbons** are compounds that contain only the elements of carbon and hydrogen.
- Hydrocarbon can be classification to :
 - A. Saturated Hydrocarbon (alkane); have only C-C single bonds and no functional group. Ethane, CH_3CH_3 , is a simple alkane.
 - B. Unsaturated Hydrocarbon; have a double or triple bond as their functional group. Ethylene, Acetylene.
 - C. Aromatic Hydrocarbon; contain a benzene ring, a six-membered ring with three double bonds.

✓ All hydrocarbons other than alkanes contain multiple bonds. Alkanes, which have no functional groups and therefore no reactive sites, are notoriously unreactive except under very drastic conditions.

Table 10.3 Hydrocarbons

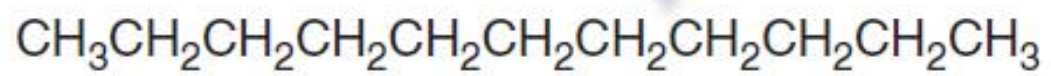
Type of Compound	General Structure	Example	3-D Structure	Functional Group
Alkane	$R-H$	CH_3CH_3		—
Alkene				Carbon-carbon double bond
Alkyne	$-C\equiv C-$	$H-C\equiv C-H$		Carbon-carbon triple bond
Aromatic compound				Benzene ring

2.1. Alkane

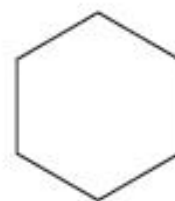
- Alkanes are hydrocarbons having only C-C and C-H single bonds. The carbons of an alkane can be joined together to form chains or rings of atoms.

- ✓ Alkanes that contain chains of carbon atoms but no rings are called **acyclic alkanes**. An acyclic alkane has **the molecular formula C_nH_{2n+2}** , where n is the number of carbons it contains. **Acyclic alkanes are also called saturated hydrocarbons because they have the maximum number of hydrogen atoms per carbon.**
- ✓ **Cycloalkanes** contain carbons joined in one or more rings. Since a cycloalkane has two fewer H's than an acyclic alkane with the same number of carbons, **its general formula is C_nH_{2n}** .

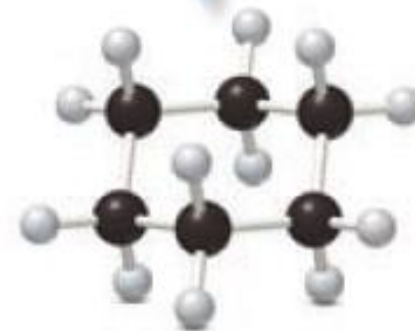
- Undecane and cyclohexane are examples of two naturally occurring alkanes. Undecane is an acyclic alkane with molecular formula $C_{11}H_{24}$.
- Cyclohexane, a cycloalkane with molecular formula C_6H_{12} , is one component of the mango, the most widely consumed fruit in the world.



undecane



=



cyclohexane

PROBLEM

How many hydrogen atoms are present in each compound?

- a. an acyclic alkane with three carbons
b. a cycloalkane with four carbons
c. a cycloalkane with nine carbons
d. an acyclic alkane with seven carbons

Which formulas represent acyclic alkanes and which represent cycloalkanes?

- a. C_5H_{12} b. C_4H_8 c. $C_{12}H_{24}$ d. $C_{10}H_{22}$

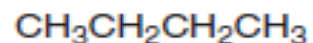
CONSUMER NOTE



Propane is the principal alkane in LPG (liquefied petroleum gas), a fuel used for vehicles and cooking. LPG has also been used as an aerosol propellant, replacing the ozone-depleting chlorofluorocarbons (Section 6.9).

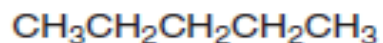
The Physical Properties of Alkane

1. Alkanes have low melting points and boiling points.
2. The melting points and boiling points of alkanes increase as the number of carbons increases.
3. Low molecular weight alkanes are gases at room temperature, and alkanes used in gasoline are all liquids.
4. Increased surface area increases the force of attraction between molecules, thus raising the boiling point and melting point.
5. Alkanes are insoluble in water; because nonpolar alkanes.
6. Less dense than water



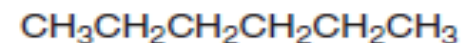
butane

bp = $-0.5\text{ }^\circ\text{C}$



pentane

bp = $36\text{ }^\circ\text{C}$



hexane

bp = $69\text{ }^\circ\text{C}$



Increasing surface area
Increasing boiling point

PROBLEM

Answer the following questions about pentane (C_5H_{12}), heptane (C_7H_{16}), and decane ($C_{10}H_{22}$).

- Which compound has the highest boiling point?
- Which compound has the lowest boiling point?
- Which compound has the highest melting point?
- Which compound has the lowest melting point?

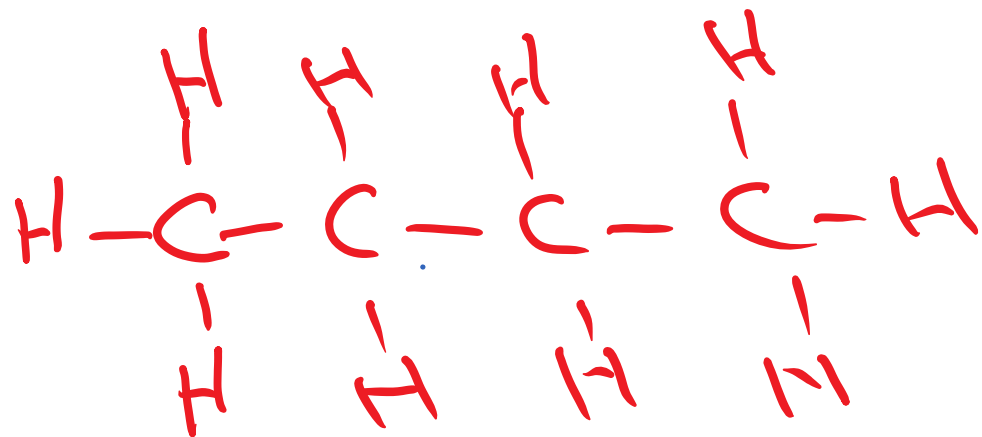
ENVIRONMENTAL NOTE



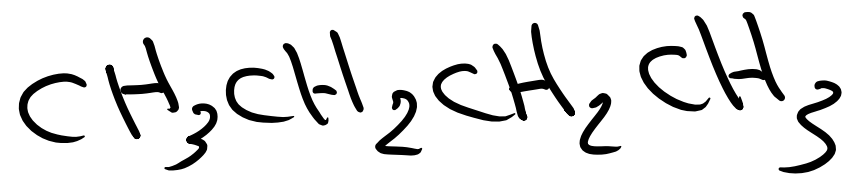
Crude oil that leaks into the sea forms an insoluble layer on the surface.

Formula of Alkanes

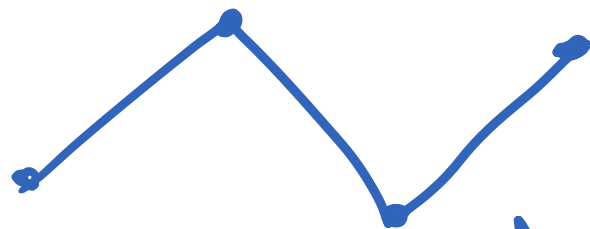
1. Complete structural formulas.
2. Condensed Structural Formulas.
3. Skeletal Formula



Complete



Condensed



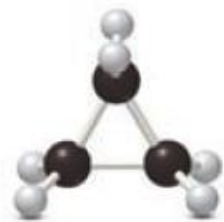
Skeletal

Table 10.6 Straight-Chain Alkanes

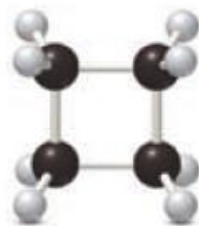
Number of C's	Molecular Formula	Structure	Name
1	CH ₄	CH ₄	<i>methane</i>
2	C ₂ H ₆	CH ₃ CH ₃	<i>ethane</i>
3	C ₃ H ₈	CH ₃ CH ₂ CH ₃	<i>propane</i>
4	C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃	<i>butane</i>
5	C ₅ H ₁₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	<i>pentane</i>
6	C ₆ H ₁₄	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<i>hexane</i>
7	C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<i>heptane</i>
8	C ₈ H ₁₈	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<i>octane</i>
9	C ₉ H ₂₀	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<i>nonane</i>
10	C ₁₀ H ₂₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<i>decane</i>

Cycloalkanes

- **Cycloalkanes** contain carbon atoms arranged in a ring. Think of a cycloalkane as being formed by removing two H's from the end carbons of a chain, and then bonding the two carbons together.
- Simple cycloalkanes are named by adding the prefix *cyclo-* to the name of the acyclic alkane having the same number of carbons. Cycloalkanes having three to six carbon atoms are shown in the accompanying figure.
- Each corner of the polygon has a carbon atom with two hydrogen atoms to give it four bonds.



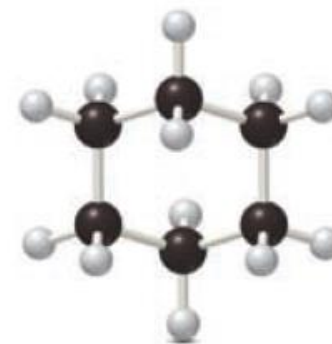
cyclopropane
 C_3H_6



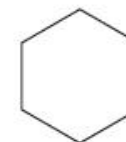
cyclobutane
 C_4H_8



cyclopentane
 C_5H_{10}



cyclohexane
 C_6H_{12}

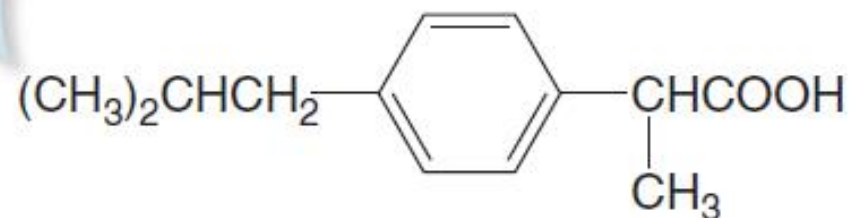


FOCUS ON HEALTH & MEDICINE

Naming New Drugs

➤ Naming organic compounds has become big business for drug companies. The IUPAC name of an organic compound can be long and complex. As a result, most drugs have three names:

- ✓ **Systematic:** The systematic name follows the accepted rules of nomenclature; this is the IUPAC name.
- ✓ **Generic:** The generic name is the official, internationally approved name for the drug.
- ✓ **Trade:** The trade name for a drug is assigned by the company that manufactures it. Trade names are often “**catchy**” and easy to remember. Companies hope that the public will continue to purchase a drug with an easily recalled trade name long after a cheaper generic version becomes available.



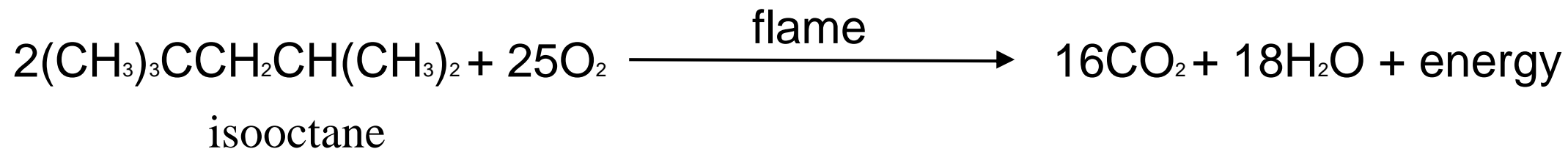
Systematic name: 2-[4-(2-methylpropyl)phenyl]propanoic acid

Generic name: ibuprofen

Trade name: Motrin or Advil

Combustion of Alkanes

- **Alkanes** are the only family of organic molecules that has no functional group.
- so alkanes undergo few reactions. In this chapter, we consider only one reaction of alkanes—**combustion**—
- Alkanes burn in the presence of oxygen to form **carbon dioxide** (CO₂) and **water**. This is a practical example of oxidation. Every C-H and C-C bond in the starting material is converted to a C-O bond in the product.



- ✓ Note that the products, **CO₂ + H₂O**, are the same regardless of the identity of the starting material.
- ✓ **Combustion of alkanes** in the form of natural gas, gasoline, or heating oil releases energy for heating homes, powering vehicles, and cooking food.

When there is not enough oxygen available to completely burn a hydrocarbon, **incomplete combustion** may occur and **carbon monoxide** (CO) is formed instead of carbon dioxide (CO₂).



Carbon monoxide is a poisonous gas that binds to hemoglobin in the blood, thus reducing the amount of oxygen that can be transported through the bloodstream to cells. CO can be formed whenever hydrocarbons burn. When an automobile engine burns gasoline, unwanted carbon monoxide can be produced.

End