MEDICAL CHEMISTRY

Organic Chemistry

University Of Fallujah

College Of Medicine

Lecture : Medical Chemistry (Lecture 8)

Stage : 1st Stage

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Department: Chemistry and Biochemistry department

Date: 15/ 1/ 2026

Learning Objective:

- **To learn what is the Organic Chemistry.**
- **To learn why Organic Chemistry Is Essential for Medical Students**
- **To Know the hydrocarbons Classification**
- **To learn the naming of Alkanes**
- **To Know the Types of Isomerism in Alkanes.**
- **To learn the Physical Properties of Alkanes**
- **To learn how to prepare the alkanes**
- **To learn the reactions of the alkanes.**

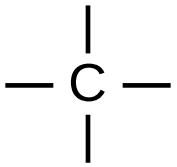
Why Organic Chemistry Is Essential for Medical Students

- Hydrocarbons are organic compounds have only of carbon and hydrogen.
- **Drugs**, **hormones**, **vitamins**, and **enzymes** are organic compounds
- They are the structural backbone of all biological molecules.
- Many biomolecules in the human body are derived directly or indirectly from hydrocarbon frameworks.

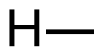
Why Organic Chemistry Is Essential for Medical Students

- Understanding hydrocarbons is essential for biochemistry, pharmacology, and toxicology.
- Lipids, and fat-soluble vitamins are hydrocarbon-rich molecules.
- Drug structures often contain hydrocarbon chains or rings that control activity and bioavailability.
- **“Every drug you will prescribe has an organic structure.”**

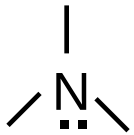
Carbon: normally forms four covalent bonds and has no unshared pairs of electrons.



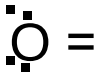
Hydrogen: forms one covalent bond and no unshared pairs of electrons.



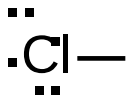
Nitrogen: normally forms three covalent bonds and has one unshared pair of electrons.



Oxygen: normally forms two covalent bonds and has two unshared pairs of electrons.

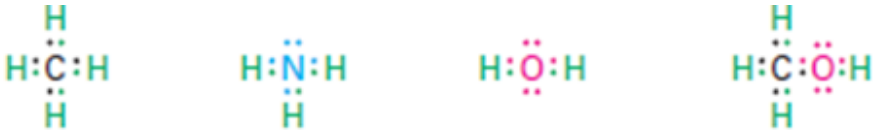


Halogen: normally forms one covalent bond and has three unshared pairs of electrons.

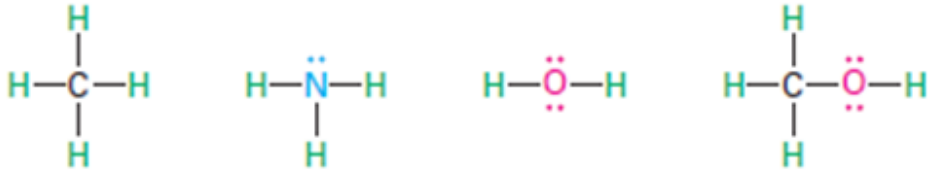


Lewis structures

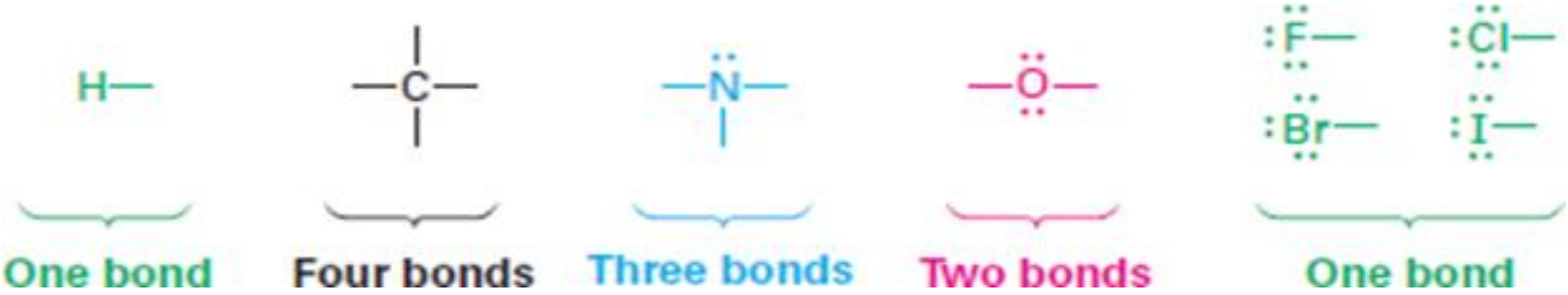
Electron-dot structures
(Lewis structures)

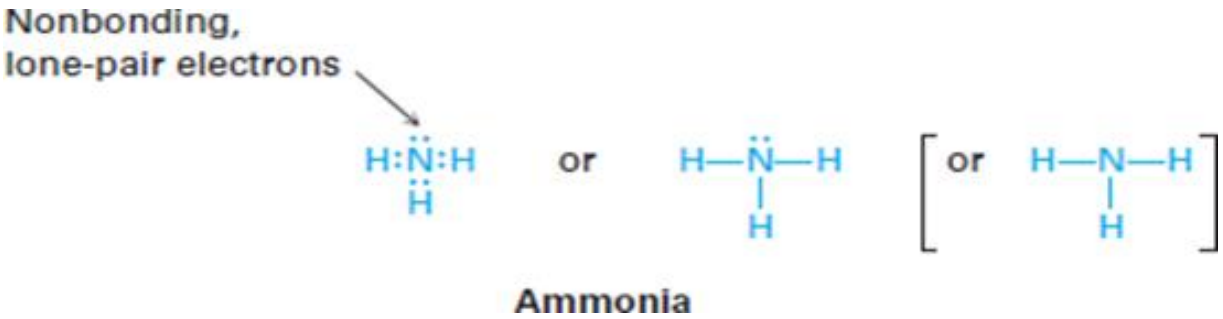


Line-bond structures
(Kekulé structures)



Methane (CH_4) | Ammonia (NH_3) | Water (H_2O) | Methanol (CH_3OH)

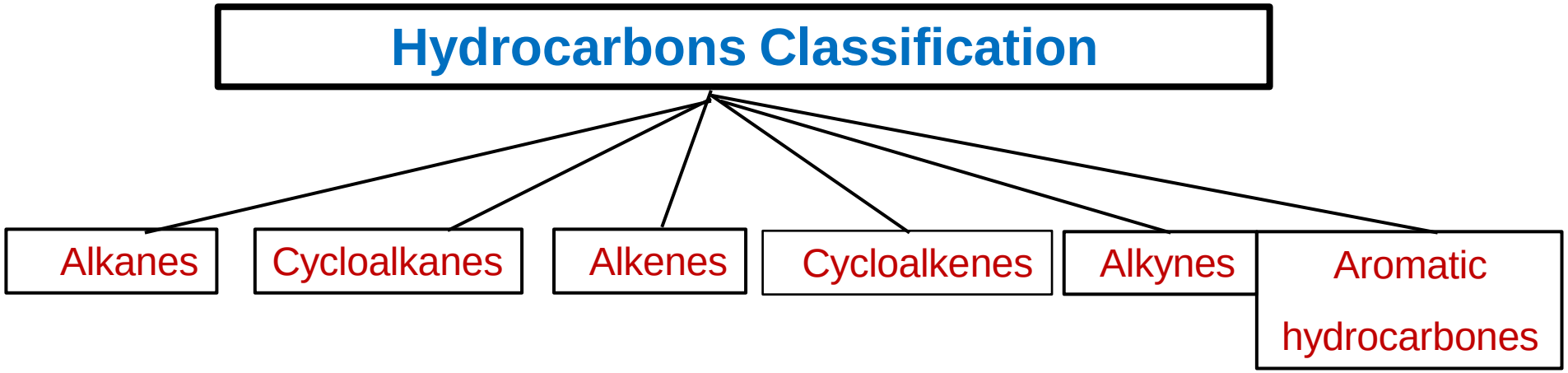




Ammonia

What is Organic chemistry?

- **Organic chemistry studies the structure, properties and reactions of organic compounds, which contain carbon in covalent bonding.**
- **First we will concentrate on compounds just containing carbon and hydrogen, these compounds are called hydrocarbons.**



Introduction to Organic compounds

Typical organic compounds:

* **Contain carbon and hydrogen**
* **Have covalent bonds**
* **Have low melting points**
* **Have low boiling points**
* **May be gases, liquids or solids**
* **Are soluble in nonpolar solvents**
* **Are flammable (all burn)**

C_3H_8
Propane

Alkanes: The Simplest Organic Compounds

Introduction

***Alkanes** are **aliphatic** hydrocarbons or **saturated** hydrocarbons. Having C—C and C—H σ bonds. They can be categorized as acyclic or cyclic.

* **Acyclic alkanes** have the molecular formula **CnH2n+2** (where n= an integer) and contain only linear and branched chains of carbon atoms.They are also called **open chain hydrocarbons**.

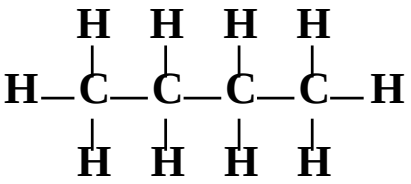
* **Cyclic alkanes (Cycloalkanes)** contain carbons joined in one or more rings. Because their general formula is **CnH2n**, they have two fewer H atoms than an acyclic alkane with the same number of carbons.

Rings of **five** and **six** carbon atoms are the most common in nature.

Types of carbon

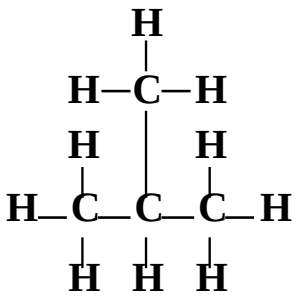
1. **Primary (1°) Carbon connected to one carbon atoms.**
2. **Secondary (2°) Carbon connected to two carbon atoms.**
3. **Tertiary (3°) Carbon connected to three carbon atoms.**

How many primary, secondary, and tertiary carbons in the two different structures of C_4H_{10}



Butane, C_4H_{10}

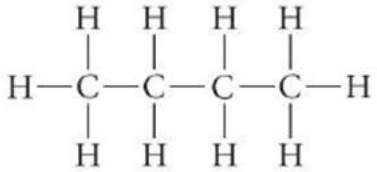
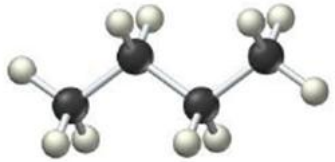
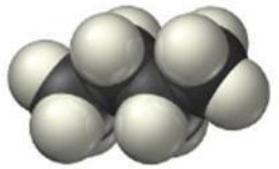
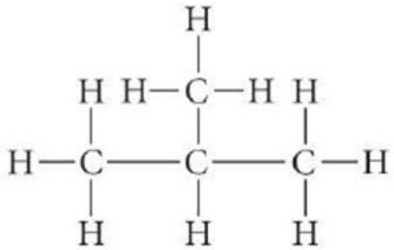
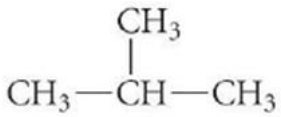
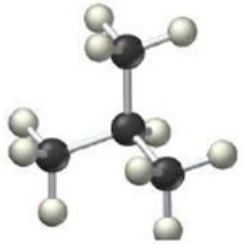
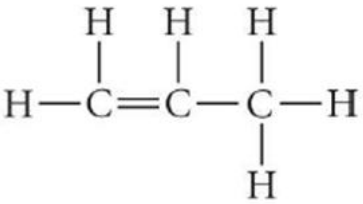
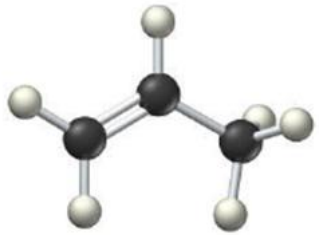
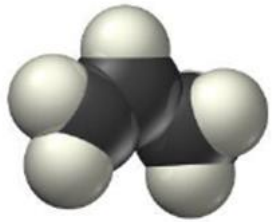
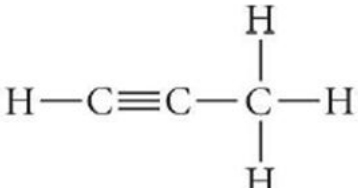
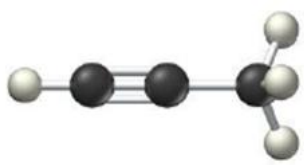
Primary carbon = **2**
Secondary carbon = **2**
Tertiary carbon = **0**



Isobutane C_4H_{10}

Primary carbon = **3** Secondary carbon = **0** Tertiary carbon = **1**

Formulas

	Structural formula	Condensed structural formula	Carbon skeleton formula	Ball-and-stick model	Space-filling model
Butane		$CH_3—CH_2—CH_2—CH_3$			
Isobutane					
Propene		$CH_2=CH—CH_3$			
Propyne		$CH\equiv C—CH_3$			

Isomerism

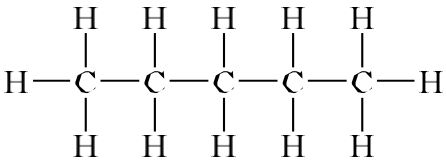
Constitutional Isomers (Structural Isomers (

are different compounds of the same formula. That means, have the same moleclar fomula but different structral formula.

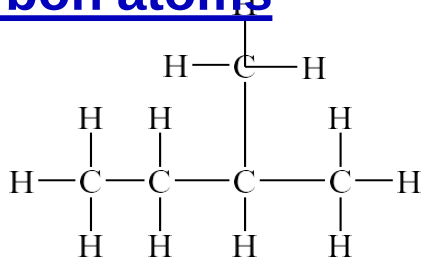
- **How many isomers are there of an alkane containing five carbons ($C_5H?_{12}$)**

Isomer Strategy – Draw Lewis possible different length chains of carbons atoms connected with a covalent bond.

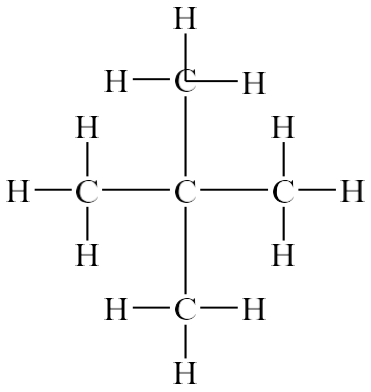
Chains of 5 carbon atoms



Chains of 4 carbon atoms

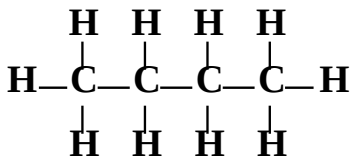


Chains of 3 carbon atoms



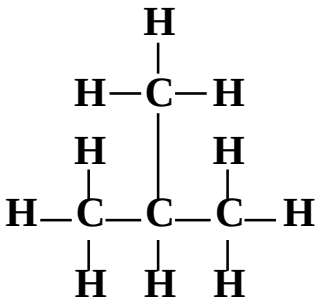
There are two different structures for C_4H_{10} called isomers, because they contain different types of carbon.

Structure 1



Butane, C_4H_{10}

Structure 2



Isobutane, C_4H_{10}

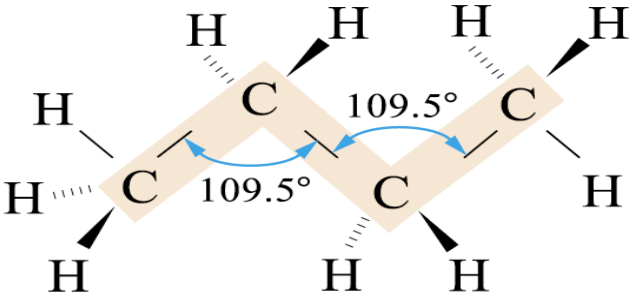
Physical Properties of Alkanes

*Alkanes are Nonpolar Compounds, that because the electronegativities of carbon and hydrogen are so similar that when these two elements form covalent bonds, the electrons are shared equally and the bond is nonpolar.

* Insoluble in water (hydrophobic).

* All carbon atoms are sp3-hybridized

* All bond angles are 109.5°



* The carbon chain is actually zigzag in shape

* Lower density than water : less than 1 g/mL (floats on water.(

* Low boiling and melting points.

Gases with 1-4 carbon atoms. (methane, ethane, propane, butane)

Liquids with 5-17 carbon atoms . (kerosene, diesel, and jet fuels)

Solids with 18 or more carbon atoms.

(wax, paraffin, Vaseline)

Boiling & melting points of Alkanes

Pentane
b.p. = 36°C

Dimethylpropane
b.p. = 9.5°C

Branched-chain alkanes have lower boiling points than straight-chain alkanes

Number of carbon atoms↑ ⇨ bp & mp↑

Number of branches↑ ⇨ bp & mp↓

Physical Properties of Alkanes

Number of carbon atom(s)	Straight-chain alkane	Boiling point (°C)	Melting point (°C)	Density at °20C)g cm⁻(³
1	Methane	161–	183–	—
2	Ethane	89–	172–	—
3	Propane	42–	188–	—
4	Butane	0	135–	—
5	Pentane	36	130–	0.626
6	Hexane	69	95–	0.657
7	Heptane	98	91–	0.684
8	Octane	126	57–	0.703
9	Nonane	151	54–	0.718
10	Decane	174	30–	0.730

- At R.T., $C_1 – C_4$: gases ; $C_5 – C_{17}$: liquids ; > C_{18}: waxy solid

Straight-Chain Alkanes

Name	Number of carbon atoms	Structure
Methane	1	CH_4
Ethane	2	CH_3CH_3
Propane	3	$CH_3CH_2CH_3$
Butane	4	$CH_3(CH_2)_2CH_3$
Pentane	5	$CH_3(CH_2)_3CH_3$
Hexane	6	$CH_3(CH_2)_4CH_3$
Heptane	7	$CH_3(CH_2)_5CH_3$
Octane	8	$CH_3(CH_2)_6CH_3$
Nonane	9	$CH_3(CH_2)_7CH_3$
Decane	10	$CH_3(CH_2)_8CH_3$

Naming Alkanes

A chemical name typically has four parts in the *IUPAC system of nomenclature*: **prefix**, **parent**, **locant**, and **suffix**.

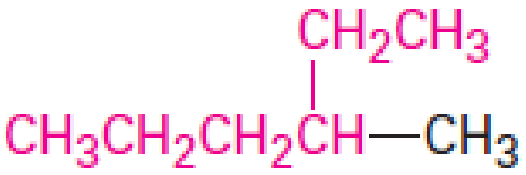
- The **prefix** identifies the various **substituent** groups in the molecule,
- the **parent** selects a main part of the molecule and tells how many carbon atoms are in that part,
- the **locants** give the positions of the functional groups and substituents,
- the **suffix** identifies the primary functional group.

Step 1

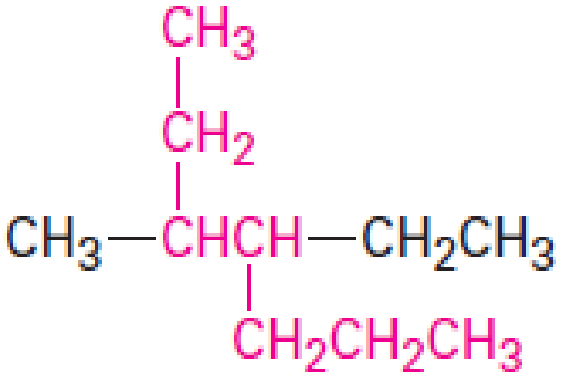
Find the parent hydrocarbon.

(a) Find the longest continuous chain of carbon atoms in the molecule, and use the name of that chain as the parent name.

- The longest chain may not always be apparent from the manner of writing; you may have to —turn corners.

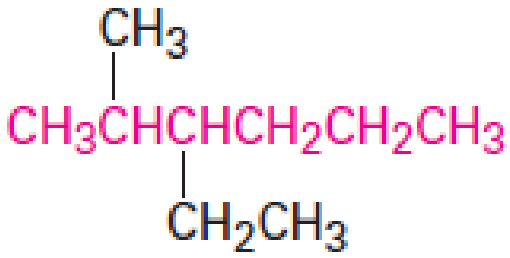


Named as a substituted hexane



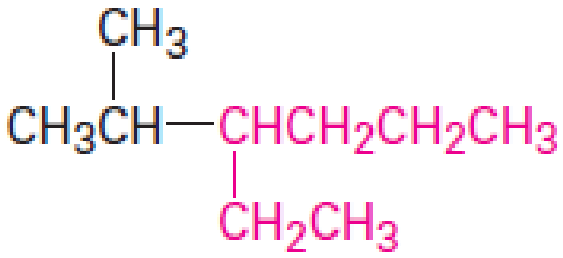
Named as a substituted heptane

(b) If two different chains of equal length are present, choose the one with the **larger number of branch** points as the parent.



Named as a hexane with *two* substituents

NOT

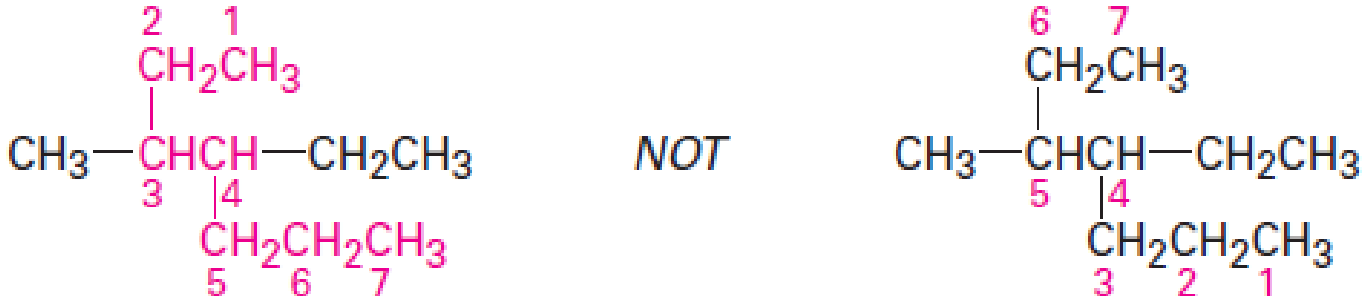


as a hexane with *one* substituent

Step 2

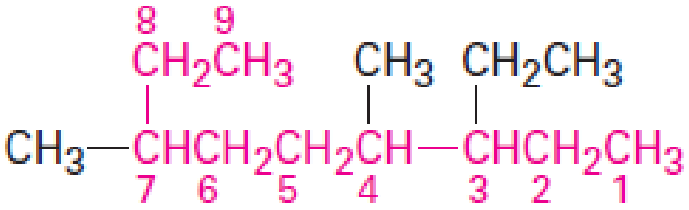
Number the atoms in the longest chain.

(a) Beginning at the end nearer the first branch point, number each carbon atom in the parent chain.



- **The first branch occurs at C3 in the proper system of numbering, not at C4.**

(b) If branching is an equal distance from both ends of the parent chain, begin numbering at the end nearer the second branch point.



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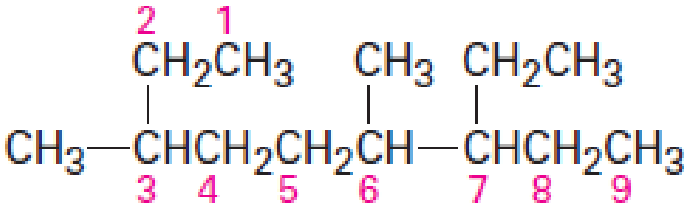
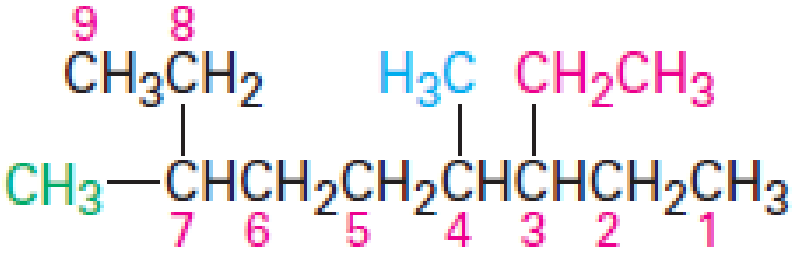


Step 3

Identify and number the substituents.

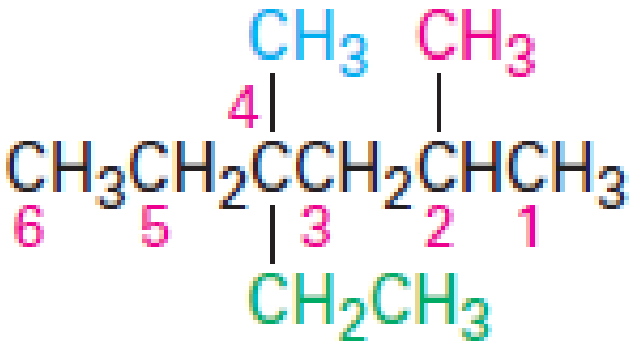
(a) Assign a number, or *locant,* to each substituent to locate its point of attachment to the parent chain.



Named as a nonane

Substituents:	On C3, CH_2CH_3	(3-ethyl)
	On C4, CH_3	(4-methyl)
	On C7, CH_3	(7-methyl)

(b) When two groups are on the same carbon, they share the same number, but both must be mentioned in the name.



Named as a hexane

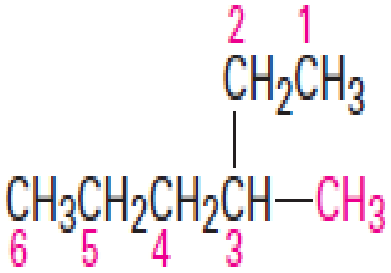
Substituents: On C2, CH_3 (2-methyl)
On C4, CH_3 (4-methyl)
On C4, CH_2CH_3 (4-ethyl)

❖ Step 4

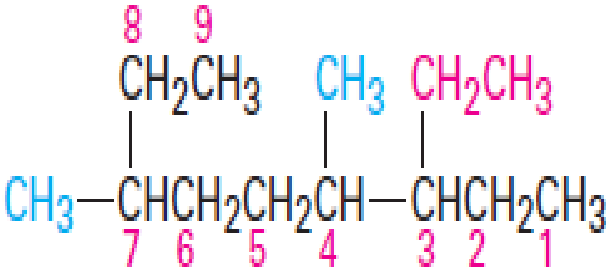
Write the name as a single word.

- If two or more different substituents are present, cite them in alphabetical order.
- If two or more identical substituents are present on the parent chain, use one of the multiplier prefixes *di*-, *tri*-, *tetra*-, and so forth, but don't use these prefixes for alphabetizing.

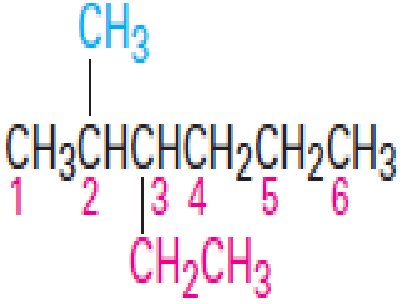
- Full names for some of the examples we have been using are as follows:



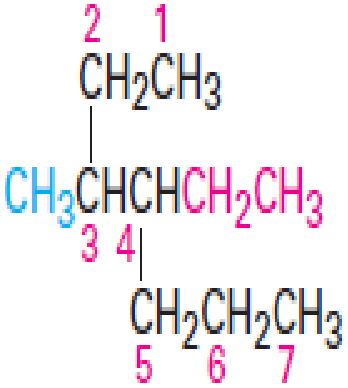
3-Methylhexane



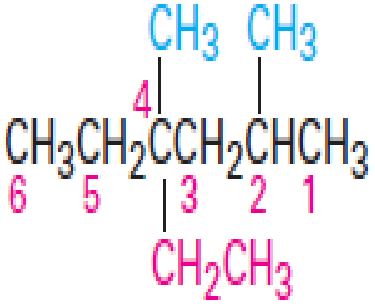
3-Ethyl-4,7-dimethylnonane



3-Ethyl-2-methylhexane



4-Ethyl-3-methylheptane



4-Ethyl-2,4-dimethylhexane

Reactions of Alkanes

-1Combustion

Alkanes react with sufficient oxygen to give carbon dioxide and water with the release of a large amount of energy.

General formula:

$$C_nH_{2n+2} + \left(\frac{3n+1}{2}\right)O_2 \longrightarrow nCO_2 + (n+1)H_2O$$

$$C_2H_6 + 7/_2\ O_2 \xrightarrow{\text{flame}} 2CO_2 + 3H_2O + \text{Heat (energy)}$$

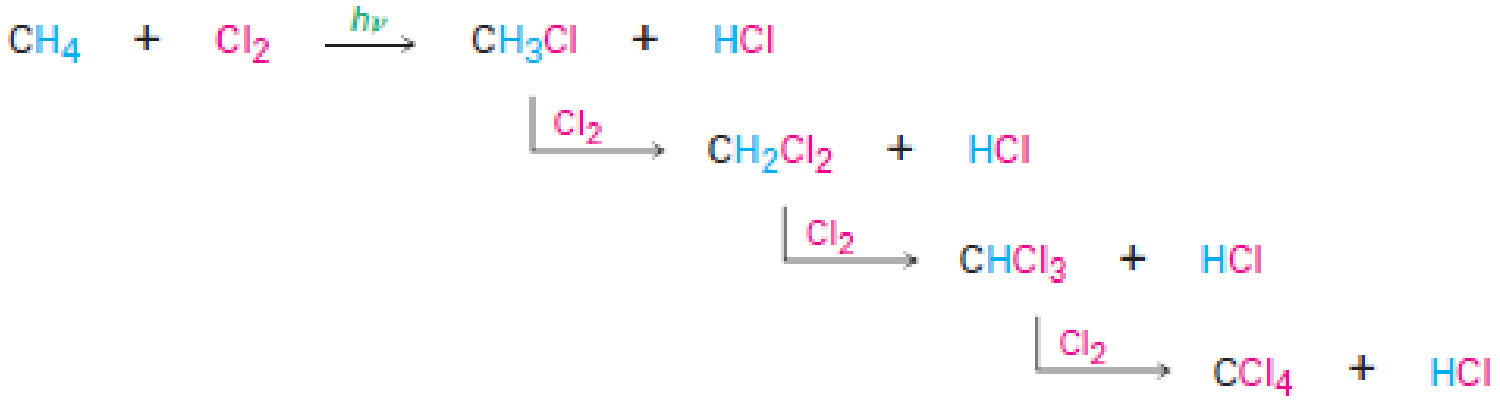
The energy released during combustion dominates a large part of world's transport, industry and domestic heating.

- **In the limited supply of oxygen, alkanes burn to give CO(*g*)**

2 - Halogenation

Halogenation Alkanes can react with halogens (F_2, Cl_2, Br_2, I_2) to form alkyl halides.

- **A mixture of products (CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4) is formed with the replacement of hydrogen by one or more chlorine atom**

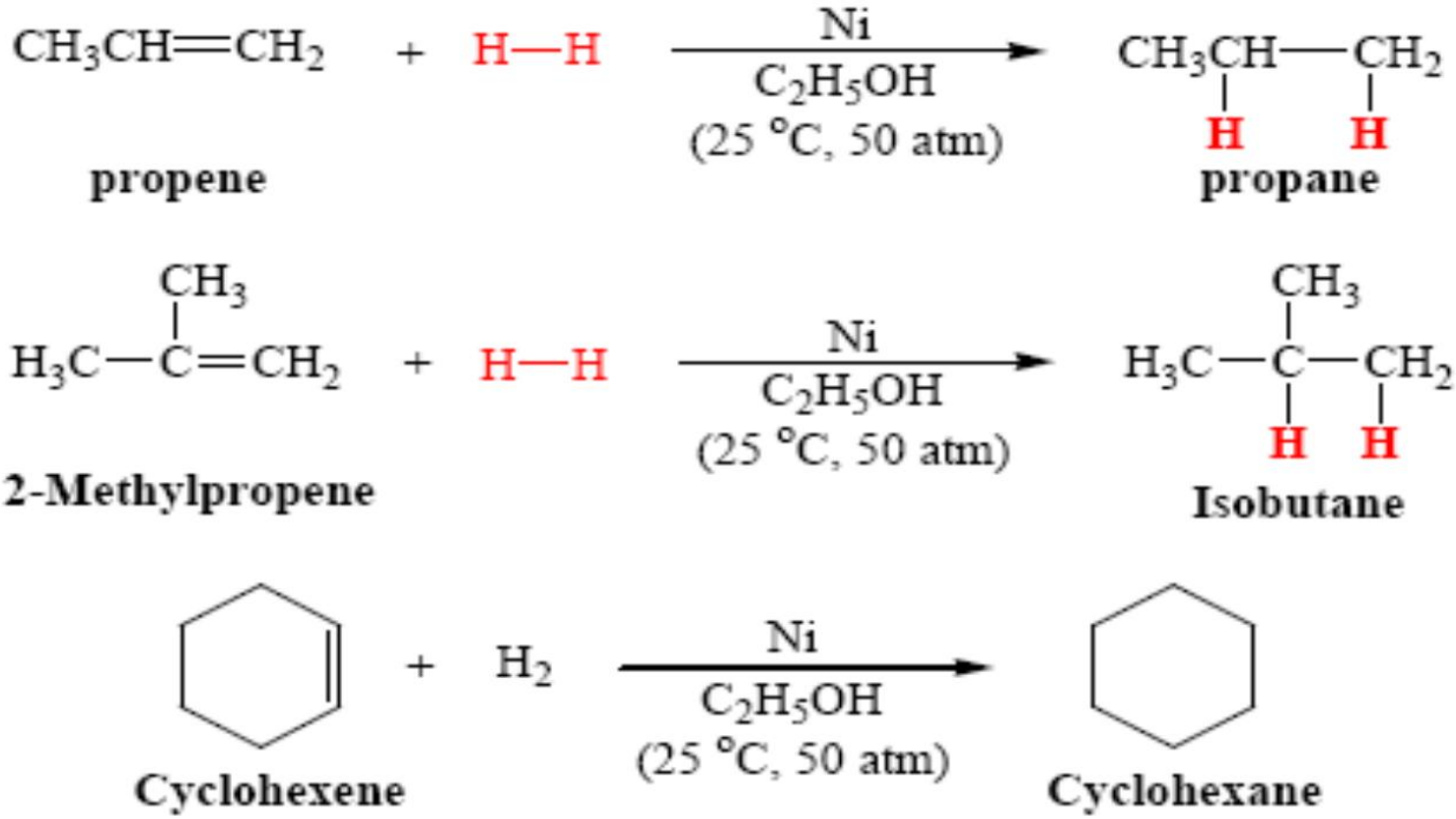


- **If methane is in excess, CH_3Cl is major product**
- **If chlorine is in excess, CCl_4 is major product**

General methods for the Preparation of Alkanes

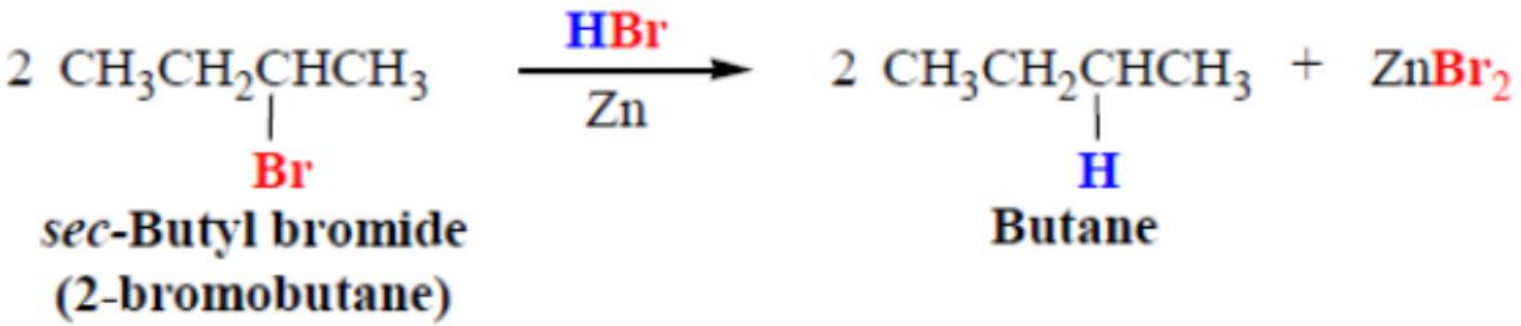
1- By hydrogenation of alkenes and alkynes

- *Specific Examples*

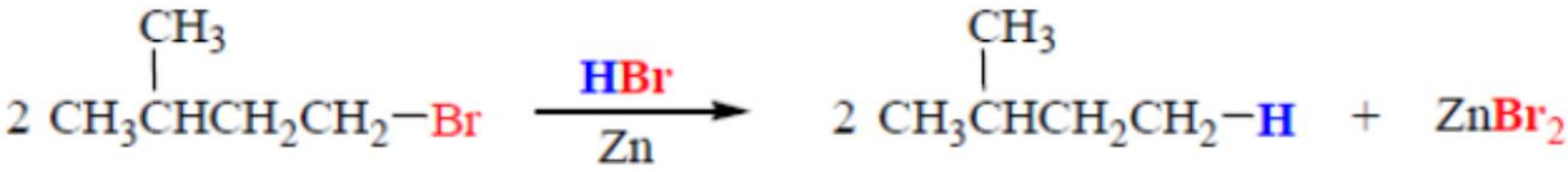


2- By the reduction of alkyl halides:

Specific Examples



sec-Butyl bromide (2-bromobutane) → **Butane**



Isopentyl bromide (1-bromo-3-methylbutane) → **Isopentane (2-methylbutane)**

Home work

Hydrocarbons are lipophilic compounds that are poorly excreted by the kidneys.

Explain why hydrocarbons are difficult to eliminate from the body? And describe how the body converts alkanes into more water-soluble compounds.