General Chemistry
Theoretical

First stage Students
Department of Physics

Course Instructors
Prof. Dr. Nafeesa Jabbar Kadhim
Dr. Muna Sarhan Sando

2024/2025

Principles of Organic Chemistry

Introduction

Organic Chemistry is a branch of chemistry concerned with the study of carbon compounds. The term "organic" was originally used to describe compounds of plant or animal origin. Hence, organic chemistry is defined as the chemistry of carbon compounds.

The reasons for the vast number of organic compounds formed by carbon are:

1. Carbon atoms can form strong bonds with each other to create long and branched chains. They can also form bonds with other atoms such as hydrogen, oxygen, and nitrogen.

2. Carbon is tetravalent, meaning it can form bonds with four other atoms, allowing for branching and the formation of complex structures.

3. Carbon can form multiple bonds, including double or triple bonds, both with itself and with other elements.

Classification of Organic Compounds

Given the existence of over a million organic compounds (natural or synthesized in laboratories), they are categorized into groups based on functional groups within their molecules.

Classification starts with compounds containing only carbon and hydrogen, followed by those containing one or more functional groups such as oxygen, nitrogen, or other elements.

Classification of organic compounds

Hydrocarbons

Hydrocarbons are compounds made of carbon and hydrogen. They are classified as follows:

1. Saturated hydrocarbons (Alkanes or Paraffins): Contain only single bonds.
2. Unsaturated hydrocarbons:Alkenes (Olefins): Contain double bonds.
3. Alkynes (Acetylenes): Contain triple bonds.
4. Aromatic compounds: Examples include benzene and its derivatives like naphthalene and anthracene.

Chemical Bonds

A chemical bond forms when two atoms approach each other closely enough for their atomic orbitals to overlap, creating a molecular orbital that encompasses both nuclei.

1. Ionic Bond:

Forms between two atoms with differing abilities to gain or lose electrons, resulting in ions with opposite charges that attract each other

Example:

Sodium (Na) loses an electron, and chlorine (Cl) gains it, forming an ionic bond:

$Na^+ Cl^-$

Na_{11}= $1s^2\ 2s^2\ 2p^6\ 3s^1$

Cl_{17}= $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

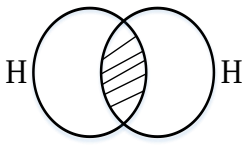
∴ يفقد Na الـ الالكترون ويكتسبها Cl مكوناً اصرة ايون

2.Covalent Bond:

Results from the sharing of two electrons between two atoms. Atoms tend to share electrons in a way that fills their valence shells.

Example: H_2 molecule

H—H

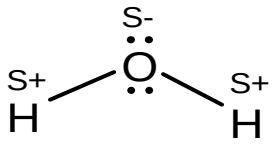


3. Polarized Covalent Bond:

Occurs when shared electrons in a bond are pulled toward the atom with higher electronegativity, resulting in partial positive and negative charges.

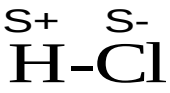
Example:

Water H_2O



$O_8=1s^2\ 2s^2\ 2p^4$

Hydrochloric acide HCl



Alkanes (Paraffins)

The general formula for alkanes is C_nH_{2n+2} (where n = number of carbon atoms). Their lack of reactivity toward acids, bases, and oxidizing agents is why they are called paraffins.

Definition: Saturated hydrocarbons where all carbon and hydrogen atoms are connected by single covalent bonds.

Nomenclature:

1.Straight-chain alkanes: Differ by the addition of CH_2 units.

Examples include:

CH_3-CH_2-CH_2-CH_3 CH_3-CH_2-CH_2-CH_2-CH_3

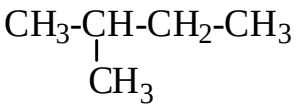
n-Butane **n-Pentane**

(n=normal) CH_3-CH_2-CH_3

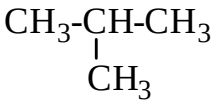
Propane

2.Branched alkanes (Isoalkanes): Formed by attaching a methyl group to the second carbon in the chain.

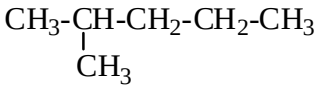
Examples include :isobutane, isopentane, and isohexane.



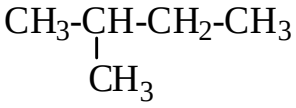
Isopentane



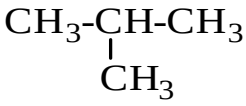
Isobutane



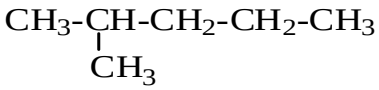
Isohexane



Isopentane



Isobutane



Isohexane

The naming of branched alkanes according to the International System (IUPAC) is as follows:

1. The name of the longest continuous chain of the alkane is used.
2. The branched alkane is called a derivative of the original alkane.
3. The branching positions are indicated by numbers.
4. The longest continuous chain of carbon atoms is numbered so that the branching has the smallest number.
5. When the branching is repeated twice or more, (di, tri, tetra, penta) is used.
6. If two or more different groups are attached to the original alkane as branches, their naming follows the alphabetical letters of the substituent groups.

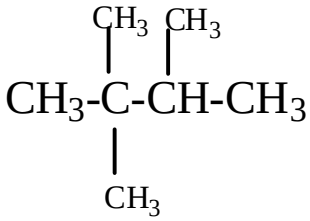
IUPAC Note

International Union of pure and Applied chemistry

Question: Draw the structural formula for the following compounds:

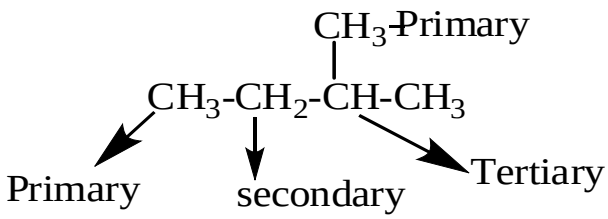
A)2,2,3−trimethylbutane B) 3,4−diethylhexane C)3,3−diethylpentane

Solution of branch (A)

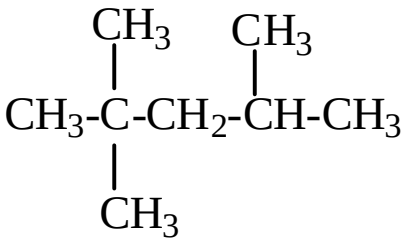


CH3- It is called **Methyl**. The **ane** is removed from the original alkane and the **(yl)** segment is added. **(It is called AlkylCnH2n+1)**

Alkyl groups can also be classified as monomeric, (primary), secondary, or tertiary, as shown in the following example :

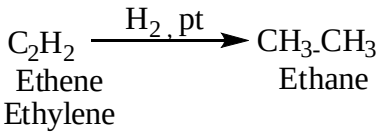


Question: Draw the structural formula for the compound **2,2,4-Trimethylpentane**



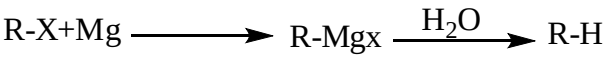
Preparation of alkanes

1.Hydrogenation of alkenes

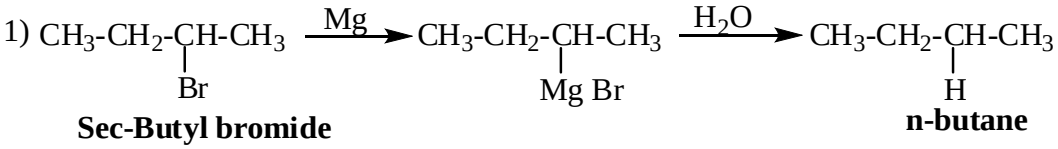


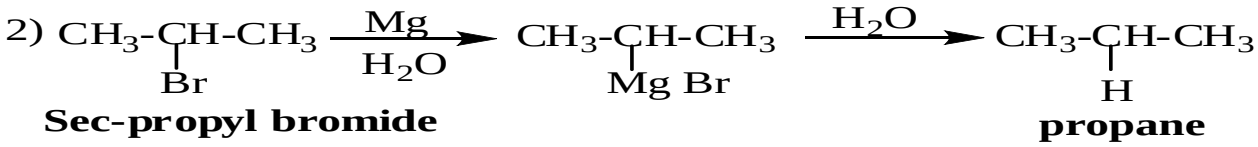
2.Reduction of alkyl halides

A.Hydrolysis of Grignard reagent.

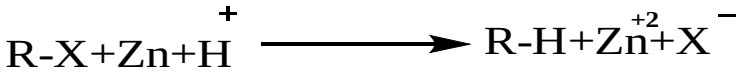


Examples:

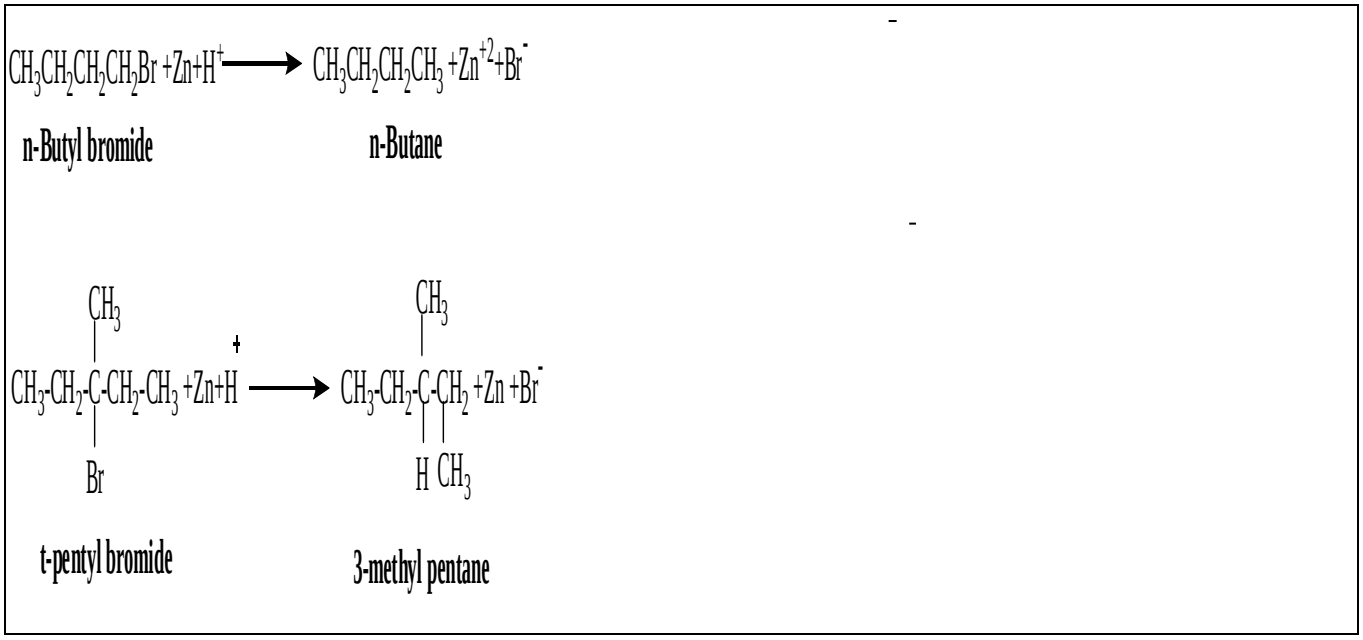




B. Reduction by metal and acid



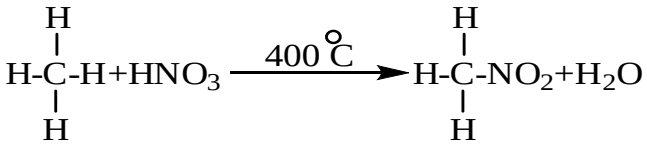
Examples:



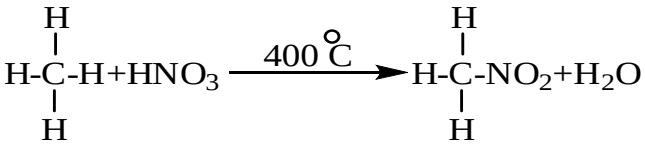
General reactions of alkanes

1) Substitution reactions

Alkanes react with nitric acid and are called nitration, where hydrogen is replaced by an NO_2 group



Nitro methane



Nitro methane

2) Oxidation Reactions

Alkanes burn in the presence of excess oxygen with a smokeless flame, releasing energy, carbon dioxide, and water vapor.

$C_nH_{2n+2} + O_2 \xrightarrow{flame} nCO_2 + (n+1)\,H_2O + \text{Energy}$

$CH_4 + 2O_2 \xrightarrow{flame} CO_2 + 2H_2O + \text{Energy}$

When oxygen is not sufficient, alkanes burn, releasing toxic carbon monoxide gas

$2CH_4 + 3O_2 \xrightarrow{850\,^\circ C} 2CO + 4H_2O$