Definitions and General Concepts in Organic Chemistry

Introduction

Organic chemistry is an important component of chemistry that is interested in the study of carbon compounds.

Carbon is a fundamental element in life on our planet. It is present in all organisms, food, fuels,…… etc.

There are a very considerable number of organic compounds compared to non-organic ones which are defined as compounds which contain everything else except carbon.

Example :

CH_4 (Methane) : is an organic compound.

$Fe(C_5H_5)_2$ (Ferocene) : is an organometallic compound.

NaCl (sodium chloride) : is a non-organic compound.

Noticed :

Organic compounds can be differentiated from non-organic compounds by the type of bonds: the bonds between atoms in organic compounds are generally covalent, whereas in non-organic compounds they are ionic, metallic,…… etc.

I/ Characterization of an organic compound

An organic compound is characterized by a chemical formula which can be crude, compact , semi-developed or developed .

1. Rough formula of an organic compound

The crude formula of any organic compound is always written as: $C_xH_yO_z$ such that x represents the number of carbon atoms, y the number of hydrogen atoms and z the number of oxygen atoms .

Example :

C_3H_8: propane, composed of 3 carbon atoms and 8 hydrogen atoms.

C_3H_7OH: propanol, composed of 3 carbon atoms and 8 hydrogen atoms and 1 oxygen atom.

Noticed :

The same crude formula can correspond to several organic compounds which are called isomers.

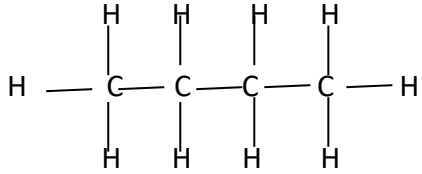
2. Structural formula of an organic compound

It allows us to give the relative positions of the atoms in the molecule.

Example :

Butane is an organic compound with the chemical formula: **C_4H_{10}**

Has a devellopped formula as it is shown bellow :

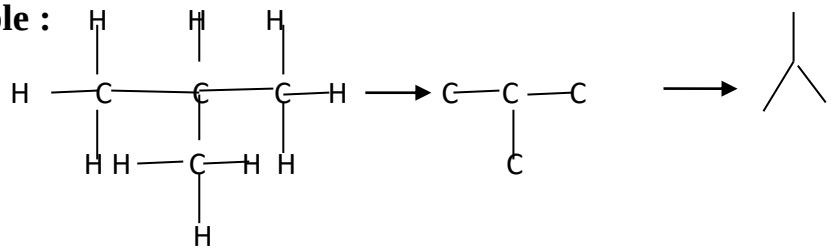


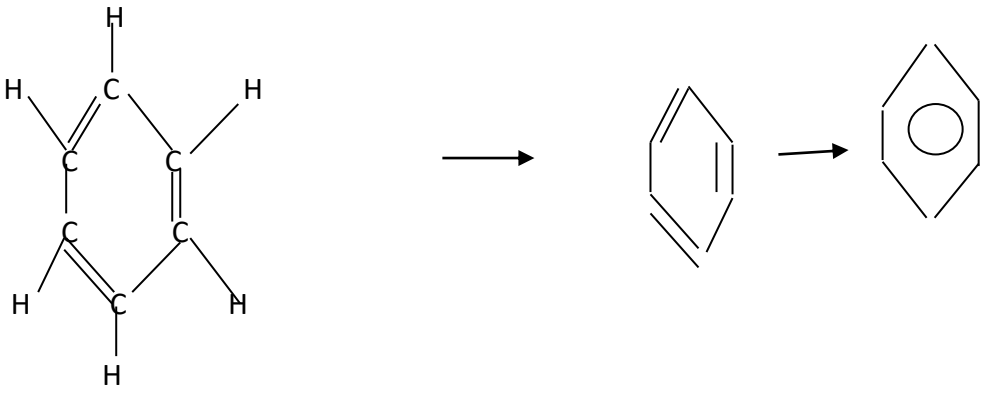
Noticed :

- The structural formula is only a projection of the molecule in the plan which is imprecise compared to that in space.

- The structural formula of the molecule can be simplified by the presentation of the skeleton.

Example :

a/ 

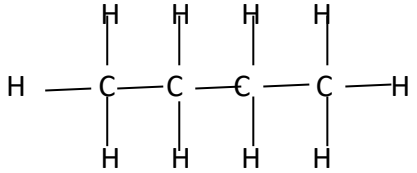
b/ 

3. Semi-developed formula of an organic compound

It is used when the developed formula becomes cumbersome

Example :

Structural formula butane:



Has the following semi-structural formula: CH_3 $-CH_2$ $-CH_2$ $-CH_3$

4. Compact formula of an organic compound

It simplifies the writing of expanded formulas. Bonds are not present and identical groups are not repeated.

Example :

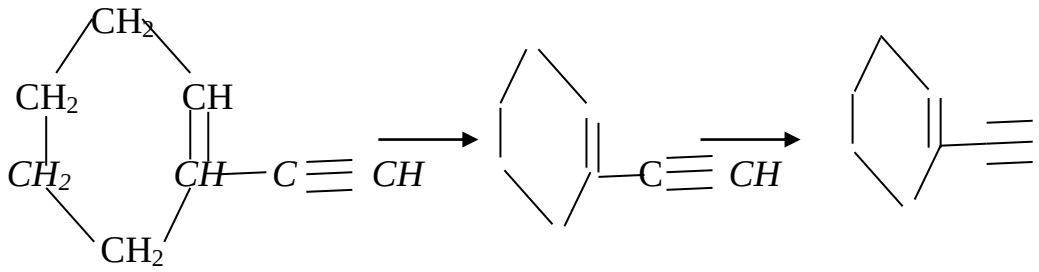
The following semi-developed formula: $CH_3-CH_2-CH_2-CH_3$,

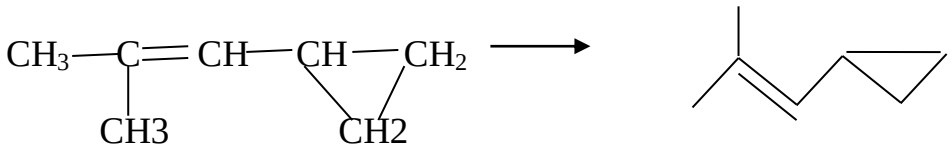
corresponds to the compact formula: $CH_3(CH_2)_2CH_3$.

5. Geometric presentation of an organic compound

To simplify the structural formulas of organic compounds, they can be presented in a way where the carbon and hydrogen atoms that they can carry are not presented.

Example :

a/ 

b/ 

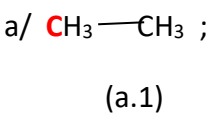
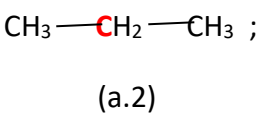
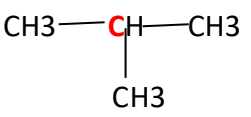
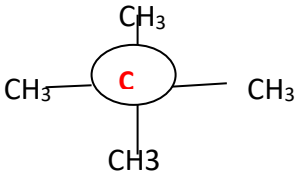
6. Classification of carbon atoms

A carbon atom is said to be: Nular, primary, secondary, tertiary or quaternary.

- The carbon atom is said to be quaternary if it is bonded to four carbon atoms.
- The carbon atom is said to be tertiary if it is bonded to three carbon atoms.
- The carbon atom is said to be secondary if it is linked to two carbon atoms.
- The carbon atom is said to be primary if it is linked to a carbon atom.

- The carbon atom is said to be zero if it is not bonded to any carbon atom.

Example :

a/  ;  ;  ; 

(a.1) (a.2) (a.3) (a.4)

(a.1): primary carbon ; (a.2): secondary carbon

(a.3): tertiary carbon ; (a.4): quaternary carbon

II/ Functions and functional groups

1. Definitions

Some organic compounds have common chemical properties due to the existence of a group of identical atoms called a functional group.

Example :

Organic compounds:$C_3H_6O_2$ and $C_5H_{10}O_2$.

having successively the following semi-developed formulas:

CH_3-CH_2-COOH and $CH_3-CH_2-CH_2-CH_2-COOH$ have common chemical properties due to the presence of the COOH functional group which is called carboxylic function.

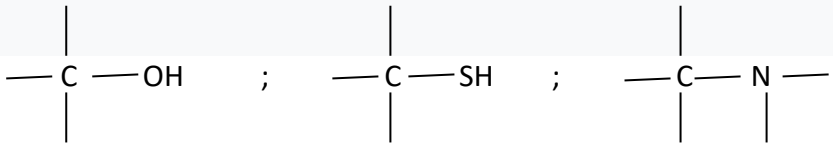
2. Main organic functions

Hydrocarbons are organic compounds that contain only carbon and hydrogen (generally denoted HC).

They are taken as a reference to define the main functions by replacing one or more hydrogen atoms with functional groups.

- The function is said to be monovalent when on the same carbon atom only one carbon is replaced.

Example :

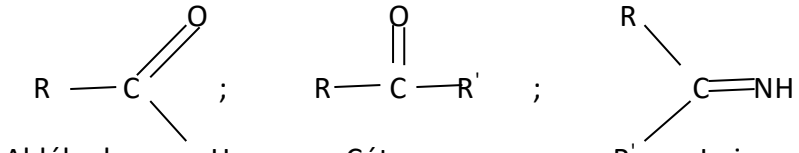


Alcool Thiol Amine

- The function is said to be bivalent when on the same carbon atom two hydrogen atoms are replaced.

Example :

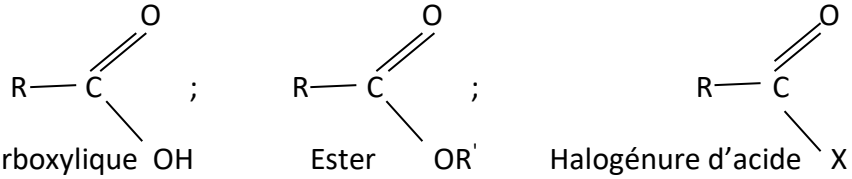
:



Aldéhyde H Cétone Imine

- The function is said to be trivalent when on the same carbon atom three hydrogen atoms are replaced.

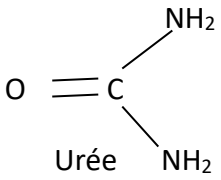
Example :



Acide carboxylique OH Ester OR' Halogénure d'acide X

- The function is said to be tetravalent when on the same carbon atom four carbon atoms are substituted.

Example :



Hydrocarbons are classified into three categories:

- Aliphatic or acyclic Hydrocarbons

- Cyclic Hydrocarbons

- Aromatic Hydrocarbons

a/ Aliphatic Hydrocarbons

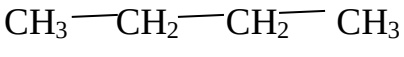
These are open-chain Hydrocarbons which are divided into three groups:

• **Saturated HC or alkanes** with the general formula C_nH_{2n+2}

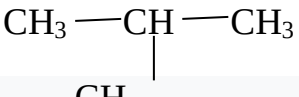
They are made up of carbon all hybridized in sp^3 and can be linear or branched (containing only single bonds).

Example :

The organic compound with the crude formula C_4H_{10} which is an alkane can be presented in two forms:



saturated linear HC



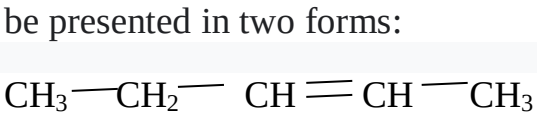
saturated branched HC

• **Ethylene HC or alkenes** with the general formula C_nH_{2n}

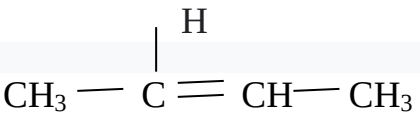
They include a double bond in their formulas and can be linear or branched.

Example :

The organic compound of chemical formula C_5H_{10} which is an alkene can be presented in two forms:



Linear alkene

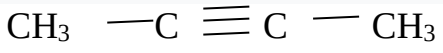


Branched alkene

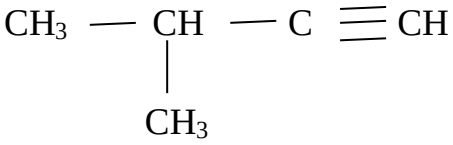
• **Acetylenic HC or Alkynes** with the general formula C_nH_{2n-2}

They include a triple bond in their formulas and can be linear or branched.

Example :



linear acetylenic HC



branched acetylenic HC

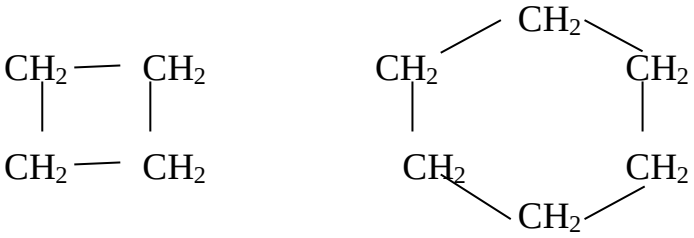
b/ Cyclic Hydrocarbons :

These are closed chain Hydrocarbons and are divided into three groups:

• **Cyclane**s with the general formula C_nH_{2n}:

Organic compounds which have the same crude formula as alkenes: they are isomers of alkenes.

Example :

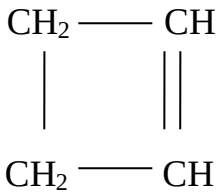


cyclobutane :C_4H_8 C_6H_{12}: cyclohexane

• **Cyclenes** with the general formula C_nH_{2n-2}:

Organic compounds which have the same crude formula as alkynes. The molecule contains a double bond.

Example :

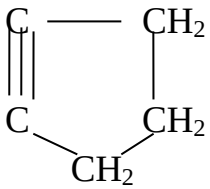


Cyclobutene : C_4H_6

• **Cyclyns** with the general formula C_nH_{2n-4}:

Cyclic organic compounds that contain a triple bond.

Example :

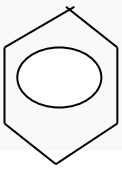


Cyclopentyne : C_5H_6

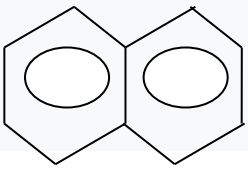
c/ Aromatic Hydrocarbons ::

These are compounds that contain one or more benzene ring(s).

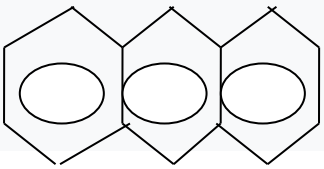
Benzene is the compound of formula C_6H_6 bearing three delocalized double bonds.



Benzene



Naphthalene



Anthracene