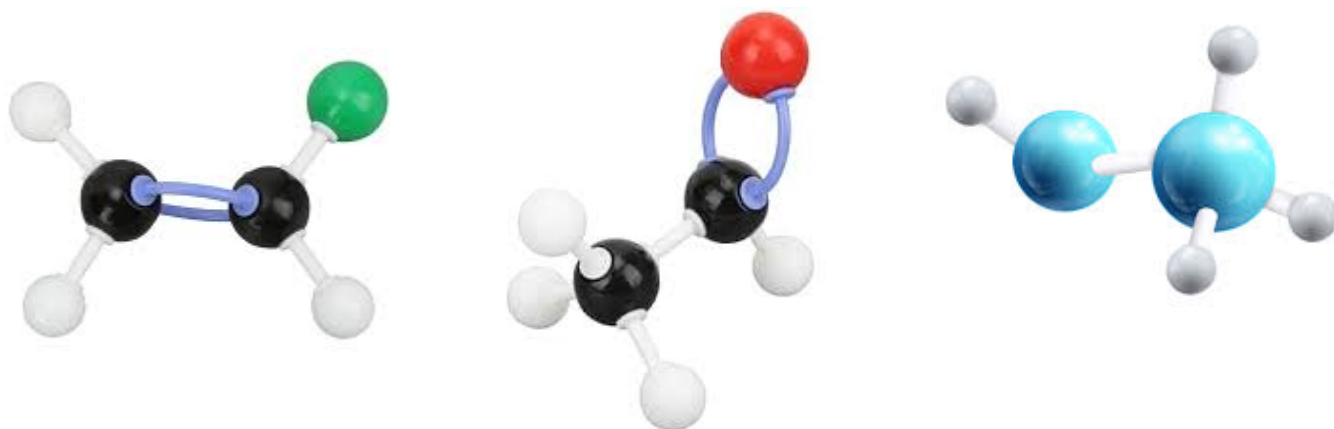


INTRODUCTION TO ORGANIC CHEMISTRY



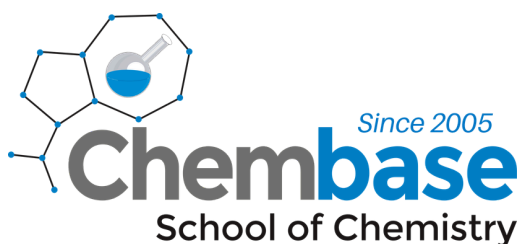
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INTRODUCTION TO ORGANIC CHEMISTRY

1. What is Organic Chemistry?

Organic Chemistry is the study of the carbon containing molecules other than carbonates & carbon dioxide

2. What are the elements found in Organic molecules?

Most of the organic compounds contain carbon & hydrogen (exception: CCl_4)
Many also contain oxygen, nitrogen & halogens.

3. What are hydrocarbons?

Organic molecules which contain ONLY carbon & hydrogen.

4. Name the different types of hydrocarbons based on their bonding

$\text{C}-\text{C}$ alkane (all $\text{C}-\text{C}$ bonds are single bonds)

$\text{C}=\text{C}$ alkene (at least one $\text{C}=\text{C}$ double bond is present)

5. Define the terms 'saturation' & 'unsaturation'

Saturation : the molecule contains $\text{C}-\text{C}$ single bonds only

Unsaturation : the molecule contains at least one $\text{C}=\text{C}$ double bond

6. Classify hydrocarbons as saturated & unsaturated

Alkanes are saturated & Alkenes are unsaturated

7. What are functional groups?

The hydrogen part of an organic molecule is fairly unreactive, so the chemistry of organic compounds is often dominated by other atoms or group of atoms joined to the chain, these atoms whose reactions dominate the chemistry of the molecule are called **functional groups**.

Some common functional groups

Compound type	Formulae	Structure
Carboxylic acids		
Alcohol group		
Ester Group		

8. State what general formulae are and write the general formulae of alkanes & alkenes

General formula is a simplified formula which represents the composition of any member of an entire class of compounds.

Alkanes : C_nH_{2n+2} (where "n" refers to the number of 'C' atoms)

eg: CH_4 , C_2H_6 , C_5H_{12} , C_6H_{14}

Alkenes : C_nH_{2n} (where "n" refers to the number of 'C' atoms)

eg: C_2H_4 , C_4H_8 , C_6H_{12}

9. Explain what a 'Homologous series' is?

A homologous series is a series of organic molecules which contains the same general formula & the same functional group and each adjacent molecules in the series will differ each other with a $-CH_2$ group.

10. Write down the molecular formulae of homologous series of alkanes and alkenes up to six carbon atoms.

ALKANES

ALKENES

Formulae of Organic Compounds

1. Explain giving examples the difference between structural & displayed formulae.

□ **Displayed formulae:**

A displayed formula is a formula exhibiting all the bonds. It shows both the relative placing of atoms & the detail of the no. of bonds between them. Each covalent bond is represented as a dash, single dash for single bond, two dashes for double & 3 dashes for triple bonds. In order to draw the structure correct it's very important to know the maximum number of bonds in which each element can hold

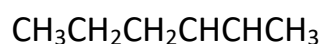
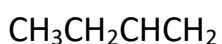
i.e.: Carbon 4 bonds, Oxygen 2, Hydrogen 1 ect.

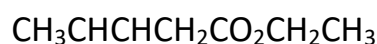
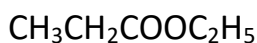
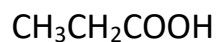
□ **Structural formulae: (Condensed formulae)**

A condensed structure formulae is a simplified structure which is drawn by omitting some or all other covalent bonds & placing the atoms bonded to a particular 'C' or any other atom next to it with a subscript to indicate the no. of such atoms.

E.g.:

2. Expand the following structural formulae into displayed formulae.





3. Explain giving examples the difference between empirical formulae and molecular formulae.

Empirical formulae is the formulae showing the simplest ration of elements in a compound and the molecular formulae is the whole number multiple of the empirical formulae

Eg: CH_3 is the empirical formula of C_2H_6 (Where the structural formulae is CH_3CH_3), therefore it cannot be as C_3H_9 where $\text{CH}_3\text{CH}_3\text{CH}_3$ cannot exist as the middle carbon got 5 bonds!

C_2H_5 is the empirical formulae of C_4H_{10} (Where the structural formulae is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$)

The elements are not repeated in a molecular formula unlike in structural formula, each element is followed by a subscript number to indicate the number of such elements.

$\text{CH}_3\text{CH}_2\text{OH}$ is written in molecular formulae as: $\text{C}_2\text{H}_6\text{O}$ / $\text{C}_2\text{H}_5\text{OH}$
(OH is shown in order to identify as an alcohol group)

$\text{CH}_3\text{CH}_2\text{COOH}$ is written in molecular formulae as: $\text{C}_3\text{H}_6\text{O}_2$ / $\text{C}_2\text{H}_5\text{CO}_2\text{H}$
(COOH/CO₂H is shown in order to identify as a carboxylic group)

4. Convert the following molecular formulae into the structural and displayed formulae.

Molecular Formula	Structural Formula	Displayed Formula
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C_3H_8

C_2H_4

C_4H_8

C_2H_6O (alcohol)

$C_2H_4O_2$ (carboxylic acid)

$C_2H_4O_2$ (ester)

5. Explain the following types of reactions, which occur in during reactions of Organic molecules, with examples for each reaction

Addition

Substitution

Combustion

▪ Addition Reaction:

Two reactants combine to form a new product.

▪ Substitution Reaction:

Two reactants exchange their atoms to form two new products.

▪ Combustion Reaction:

The reaction between oxygen and many of the hydrocarbons or burning of a hydrocarbon



i.e. : $-\text{CH}_3$ methyl, $-\text{C}_2\text{H}_5$ ethyl, $-\text{C}_3\text{H}_7$ propyl
 HCOOC_2H_5 ethyl methanoate
 $\text{CH}_3\text{CH}_2\text{COOCH}_3$ methyl propanoate

IUPAC Nomenclature of Organic Compounds

IUPAC Nomenclature of Organic Compounds

Isomerism

1. Define the term '**Isomerism**'

Isomers are molecules that have the same molecular formula but different structures / different arrangement of atoms.

2. Write short notes on the different types of **unbranched** structural isomers

- I. Chain Isomers:-

The Isomerism has different arrangement of 'C' chain

- II. Positional Isomers:-

The isomers have the same functional group at different positions.

- III. Functional group Isomers:-

The isomers have different functional groups.

3. Explain why molecules that have the same molecular formula differ in physical properties?

Because they exist as structural isomers. Each structural isomer will have its unique boiling point based on the surface area of the molecule. The straight chain isomer possesses higher boiling & melting point than branched isomers as the surface area of the straight chain isomer is greater than the branched isomer.

4. How do you explain the below observation.

An Organic compound having same molecular formula of C_4H_{10} shows two different boiling points of $-0.5^\circ C$ & $-11.7^\circ C$

C_4H_{10} exist as two structural isomers.

Butane has a large surface area when compared with the branched isomer. Hence butane will possess more intermolecular attraction than branched isomer. As a result, butane will exhibit a higher boiling ($-0.5^\circ C$) than the branched isomer ($-11.7^\circ C$)

Important points to ponder when drawing structural formulae of isomers

- The number of bonds around carbon is always four
- You must show all the bonds in a structural formula (though you will often find in books common groups written in a sort of shorthand as $-OH$, $-CH_3$ or $-COOH$)

5. Draw the structural formulae of different isomers of below compounds & name the unbranched – chain isomers according to IUPAC nomenclature.

- i) C_5H_{12} ii) C_4H_8 iii) C_5H_{10} iv) C_2H_5OH v) C_3H_7OH vi) C_3H_5OH
- vii) $C_2H_4(OH)_2$ viii) $C_3H_6(OH)_2$ ix) $C_2H_5CO_2H$ x) $CH_3CO_2CH_3$

ANSWERS



ANSWERS