

Some Basic Principles of Organic Chemistry

**Handwritten Notes
for CBSE
Class 11 Chemistry**



CHEMISTRY
ABC
— FREE PDF NOTES —

Organic Chemistry.

ancient definitions

- Compounds which were isolated directly or indirectly from living organism such as animals and plants were called organic compounds and the branch of chemistry which deal with the study of these compounds was called organic chemistry.
- Compounds which were isolated from living sources such as rocks and minerals were called inorganic compounds and the branch of chemistry which deal with the study of these compounds were called inorganic chemistry.

organic compounds are produced only under the influence of some mysterious force existing in the living organisms. This mysterious force was called the vital force. Since such a mysterious force can not be created artificially. it is impossible to synthesize organic compounds.

- Modern definition of organic compounds - organic chemistry is defined as the chemistry of carbon compounds containing usually hydrogen and one or more additional elements like oxygen, nitrogen, sulphur, halogens etc.
Inorganic chemistry is defined as the chemistry of all elements other than carbon and their compounds.

- Tetravalency of Carbon - Carbon is essential element in all organic molecules. Its electronic configuration is $2, 4$, so carbon has four electron in the valance shell and thus need four more electrons to complete the octate. therefore carbon is tetravalent. Carbon always combine with other atoms by mutual sharing of electrons and thus forms covalent bonds.

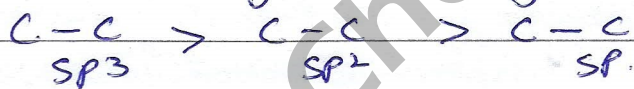
— Characteristics of π bond. —

For π -bond formation, it's essential that the p-orbitals on the adjacent Carbon atoms must be parallel for a proper sideways overlap.

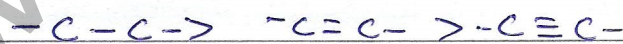
- I All the atoms directly attached to the Carbon atoms of the double bond lie in the same plane.
- II The p-orbitals of a π bond are mutually parallel and perpendicular to the plane of the molecule.
- III Rotation about Carbon-Carbon double bond is restricted.
- IV The electron charge cloud of the π bond lies above and below the plane of the bonding atoms.

— Effect of hybridization on bond length and bond strength.

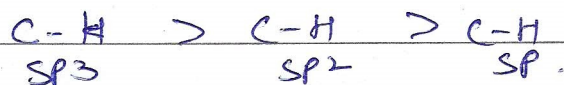
- I Bond length— Since a p-orbital is much bigger in size than an s-orbital of the same shell. therefore, as we go from $sp^3 \rightarrow sp^2 \rightarrow sp$ the percentage of p-character decrease in the same order. Since bigger orbital forms a longer bond therefore C-C single bond lengths decreases in order.



Since, the sideways overlap of two p-orbitals (to form π bond) brings the two Carbon atoms closer then



Similarly, a C-H bond may be formed by overlap of a sp^3, sp^2 and sp orbital of Carbon with an s-orbital of hydrogen, therefore as the size of the hybrid-orbital decreases, the length of C-H bond decreases.



2. Bond Strength— Shorter the bond, greater is its strength. thus σ bond formed by sp -hybridized Carbon is shortest than it has greatest strength.

3. **Electronegativity** - Greater the s-character, more the electronegativity. than sp-hybridization have more electronegative atom.

- **Hybridisation** - The Phenomenon of intermixing of orbitals of the same atom having the slightly different energies to form new orbitals which have identical shapes and equivalent energies is known as hybridization.

- **Classification of organic Compounds** -

The simplest organic Compounds containing only Carbon and hydrogen are called hydrocarbons.

1. **Acyclic or open chain Compounds** - These Compounds contain open chain of Carbon atoms in their molecule. The Carbon chain may be either straight chains or branched chains. open chain Compounds are also called aliphatic Compounds.

2. **cyclic or closed chain or ring Compounds** - These Compounds contain one or more closed chains or rings of atoms in their molecules.

Depending upon the Constitution of the ring these are further divided into two Categories.

a. **Homo cyclic or Carbocyclic Compounds** - These Compounds contain rings which are made up of only one kind of atoms. these are further divided.

(i) **Alicyclic Compounds** - Carbocyclic Compounds which resemble aliphatic Compounds in most of their properties are called Alicyclic Compounds.

(ii) **Aromatic Compounds** - These are special type of cyclic unsaturated Compounds. these are two types.

(P) **Benzenoid aromatic Compounds** - Organic compounds containing one or more fused or isolated benzene rings and their functionalized derivatives are called benzenoid aromatic compounds.

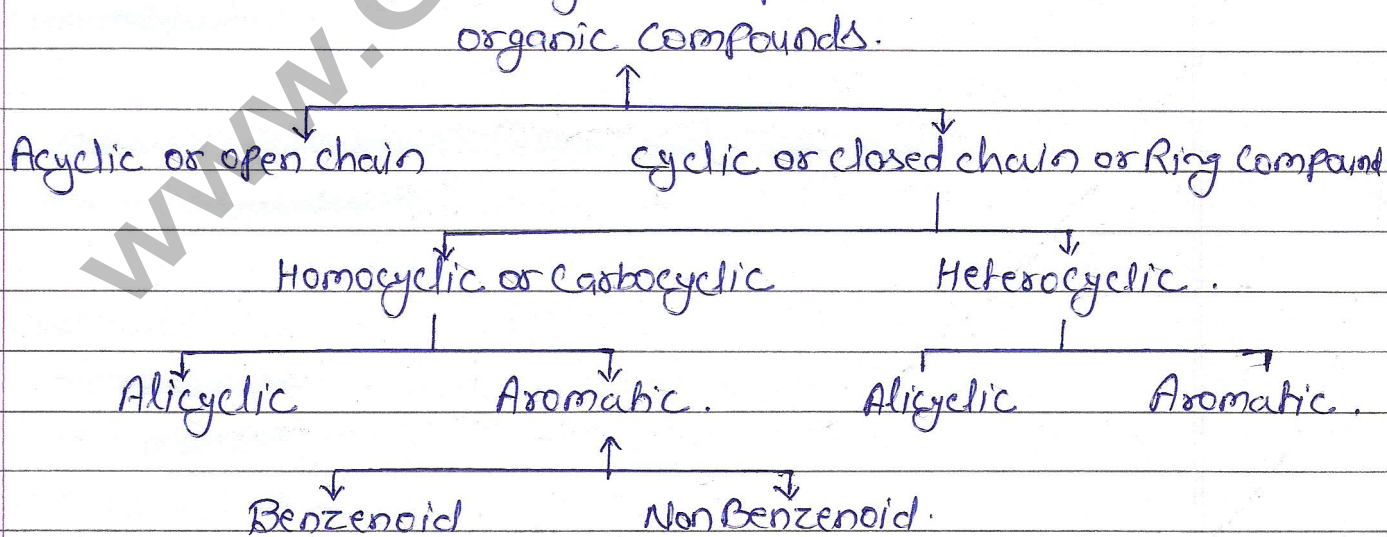
Compounds containing two or more benzene rings fused together are called **Polycyclic aromatic Compounds**.

(Q) **Non-benzenoid aromatic Compounds** - Aromatic compounds which do not contain a benzene ring but instead contain other highly unsaturated rings are called non-benzenoid aromatic compounds.

(b.) **Heterocyclic Compounds** - cyclic compounds containing one or more heteroatoms in their rings are called heterocyclic compounds.

(i) **Alicyclic heterocyclic Compounds** - Aliphatic cyclic compounds containing one or more heteroatoms in their rings are called alicyclic heterocyclic compounds.

(ii) **Aromatic heterocyclic Compounds** - Aromatic cyclic compounds containing one or more heteroatoms in their molecules are called aromatic heterocyclic compounds.



- Functional or characteristic groups — A functional group may be defined as an atom or a group of atoms present in a molecule which largely determines its chemical properties. Chemical properties of any organic compound are the properties of its functional group. Or the organic compounds containing the same functional group show similar chemical properties.
- Homologous Series — It is defined as a family or group of structurally similar organic compounds all the members of which contain the same functional group, show a gradation in physical and similarity in chemical properties and any two adjacent members of which differ by a $-CH_2$ group. The individual members of such a series are called homologues and the phenomenon is called homology.

Characteristics.

1. Each homologous series can be represented by a general formula.
- (i) All the members of a given homologous series possess the same functional group.
 - (ii) The successive members of a homologous series differ by a CH_2 group or by 14 mass unit.
 - (iii) The individual members of a homologous series can be prepared by the general methods of preparation developed for that series.
 - (iv) The physical properties of the members of a homologous series show a regular gradation with rise in molecular mass.
 - (v) The chemical properties of the members of a homologous series are similar though the first member may vary considerably from rest of the members.

— General Rules of IUPAC System for naming organic compounds.

IUPAC (International Union of Pure and applied Chemistry)
It may consist of three parts.

1. Word root — It is the basic unit of the name. It denote the number of Carbon atoms Present in the principle chain

C ₁ → Meth.	C ₅ → Pent	C ₉ → Non
C ₂ → Eth.	C ₆ → Hex.	C ₁₀ → Dec
C ₃ → Prop	C ₇ → Hept	C ₁₁ → Undec
C ₄ → But	C ₈ → Oct	C ₁₂ → Dodec.

2. Suffix — There are two types of Suffix.

(a) Primary Suffix — A Primary Suffix is always added to the word root to indicate whether the Carbon chain is saturated or unsaturated. There are three basic Primary Suffix are.

1. Saturated (Containing single bond) — ane — Alkane.
2. Unsaturated with one double bond — ene — Alkene.
3. Unsaturated with one triple bond — yne — Alkyne.

If the parent carbon chain contain two, three, four or more double or triple bond, numerical Prefixes such as di (two), tri (three), tetra (Four) etc. are added to the Primary suffix.

b. Secondary Suffix — A secondary suffix is then added to the Primary Suffix to indicate the nature of the functional group Present in the organic Compound.

Class of organic Compounds	functional group	Secondary Suffix.
Alcohols	-OH	-ol.
Aldehydes.	-CHO	-al.
Ketones	>C=O	-one.
Carboxylic acid	-COOH	-oic acid.
Acid amides.	-CONH ₂	-amide.

Acid Chlorides	-COCl	-oyl chloride.
Esters	-COOR.	Alkyl...oate.
Nitriles	-CN	Nitrile.
Thiol	-SH.	thiol.
Amines.	-NH ₂	amine

While adding the secondary suffix to the primary suffix, the terminal 'e' of the primary suffix (ane, ene, yne) is dropped if the secondary suffix begins with a vowel, but it is retained if the secondary suffix begins with a consonant.

- Important.

- (i) Locants are placed immediately before the part of the name to which they relate.
- (ii) The locant (1) is often omitted.

3. Prefix - There are two types of prefix.

a. Primary Prefix - A Primary Prefix is used simply to distinguish cyclic or acyclic compounds.

exam - In case of carbocyclic compounds, a primary prefix (cyclo,) is used immediately before the word root.

If the prefix cyclo is not used, it simply indicates that the compound is acyclic or open chain.

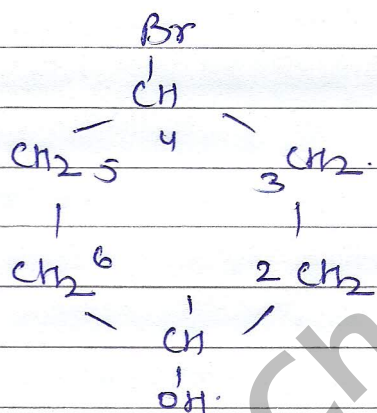
b. Secondary Prefix - In IUPAC system of nomenclature, certain groups are not considered as functional group but instead are treated as substituents. These are called Secondary Prefix and are added immediately before the word root or the primary prefix in case of carbocyclic compounds.

Substituent group	Second. prefix.		
-F	Fluoro	-NO ₂	Nitro
-Cl	chloro	-NO	Nitroso
-Br	Bromo	-N ⁺ ≡N	Diazo
-I	Iodo	-OR	Alkoxy.

OCH_3 (Ome) - Methoxy.	$-\text{CH}_2\text{CH}_2\text{CH}_3$ (n-Pr) - n-Propyl.
$-\text{OC}_2\text{H}_5$ (-OEt) - Ethoxy.	$-\text{CH}(\text{CH}_3)_2$ (i-Pr) - Isopropyl.
$-\text{CH}_3$ (-me) - methyl.	$-\text{C}(\text{CH}_3)_3$ - tert-Butyl.
$-\text{C}_2\text{H}_5$ (-Et) - Ethyl.	

The Complete IUPAC name of an organic compound.
 Secondary Prefix + Primary Prefix + word root + Primary Suffix + Secondary Suffix.

Compounds	Sec. Prefix.	wordroot	Pri. Suffix.	IUPAC Name.
$\text{CH}_3\text{CH}_2\text{Br}$	Bromo	eth	ane	Bromoethane.
CH_3NO_2	Nitro	meth	ane	Nitromethane.
$\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$	Ethoxy	eth	ane	Ethoxy ethane.



4-Bromo + cyclo + hex + an(e)
 + 1-ol.
 then 4-Bromo cyclohexan-1-ol.

- Compounds of Carbon and hydrogen are called hydrocarbons. These are further divided into two types.

- a. Saturated hydrocarbons - Alkanes - Hydrocarbons in which all the Carbon atoms are linked to one-another by only single bonds are called saturated hydrocarbons. These may be either cyclic or acyclic. In the IUPAC system saturated acyclic hydrocarbons are called alkanes. They were also called paraffins.

General formula - $\text{C}_n\text{H}_{2n+2}$ where $n = 1, 2, \dots$
 Primary suffix - ane.

Types of alkanes.

(i) **Straight chain alkanes** — These alkanes contain straight chains of carbon atoms in their molecules. or alkanes in which no-carbon atom is linked to more than two other atoms are called straight chain alkanes.

The common names of straight chain alkanes are the same as their IUPAC names except that the prefix n- is used in the common names.

(ii) **Branched chain alkanes** — In these alkanes all the carbon atoms are not arranged in a straight chain or alkanes in which at least one carbon atom is linked to three or four other carbon atoms are called branched chain alkanes.

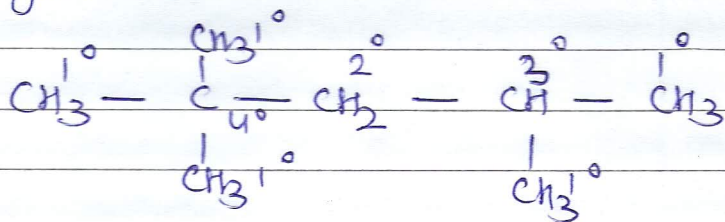
The prefix (iso) is used when the second carbon of the branched chain alkane carries one methyl group while (neo) is used for those branched chain alkanes which contain a quaternary carbon at the end of the chain.

Types of Carbon and Hydrogen atoms in Alkanes.

- I. A carbon atom attached to one — other carbon atom is called a primary carbon atom and is designated as 1° carbon.
- (ii) A carbon atom attached to two other carbon atoms is called a secondary carbon atom and is designated as 2° carbon.
- (iii) A carbon atom attached to three other carbon atoms is called a tertiary carbon atom and is designated as 3° carbon.
- (iv) A carbon atom attached to four other carbon atoms is called a quaternary carbon atom and is designated as 4° carbon.

The hydrogen atoms attached to 1° , 2° , 3° carbon atoms

are called primary (1°), secondary (2°) and tertiary (3°) hydrogen atoms.



- Alkyl group - The removal of one hydrogen atom from the molecule of an alkane gives an alkyl group. The general formula of alkyl group is $\text{C}_n\text{H}_{2n+1}$. These are often represented by the letter 'R'. Their names are derived by replacing the terminal 'ane' of the corresponding alkane by the suffix 'yl'.

Alkane - ane + yl \rightarrow Alkyl.

b. unsaturated hydrocarbons - open chain hydrocarbons which contain carbon-carbon double or triple bond in their molecule are called unsaturated hydrocarbons.

These are further classified into two types.

1. Alkenes :- Unsaturated aliphatic hydrocarbons containing a carbon-carbon double bond are called alkene. These are also called olefins. General formula for alkene is C_nH_{2n} .
Common name :- Alkene - ene + ylene = Alkylene.
2. Alkynes :- Unsaturated aliphatic hydrocarbons containing a carbon-carbon triple bond are called alkyne. In the common system they are called acetylenes. General formula for alkynes are $\text{C}_n\text{H}_{2n-2}$.

c. Haloalkanes - Halogen derivatives of alkanes are called haloalkanes. They are further classified as mono, di, tri, tetra etc. according as they contain one, two, three or four etc. halogen atoms in their molecules.

1. monohaloalkanes - The monohalogen derivatives of alkanes are called alkyl halides.

General formula: $C_nH_{2n+1}X$ where $n=1, 2, \dots$

$X = F, Cl, Br, I$

or $R-X$ where R is any alkyl group.

Functional group: X (halogen) Secondary Prefix-Halo.

Common name :- Alkyl + halide. \rightarrow Alkyl halide.

2. Dihalalkanes - Alkanes containing two halogen atoms per molecule are called dihaloalkanes.

General formula :- $C_nH_{2n}X_2$

Common name - For purpose of naming dihalogen derivatives of alkanes, these are divided into three categories.

- (i) Alkylidene dihalides :- Dihalogen derivatives of alkanes in which the two halogen atoms are attached to the same carbon atom are called alkylidene dihalides or alkylidene halides.
- (ii) Alkylene dihalides :- Dihalogen derivatives of alkanes in which the two halogen atoms are attached to adjacent carbon atoms of the chain are called alkylene dihalides or simply alkylene halides.
- (iii) Polymethylene dihalides - Dihalogen derivatives of alkanes in which the two halogen derivatives are present on the terminal carbon atoms are called polymethylene dihalides.

3. Tri and tetra haloalkanes :- The general formula of tri haloalkanes is $C_nH_{2n+1}X_3$ while for tetra haloalkanes $C_nH_{2n-2}X_4$
Common names - There are no systematic common names for tri and tetra haloalkanes

Trihalomethanes are best known by their trival names halforms and tetrahalogen derivatives of methane are called carbon tetrahalides, while symmetrical tetrahalogen derivatives of ethane are called acetylene tetrahalides.

d. Alcohols or Alkanols :- Alcohols are classified as monohydric, dihydric, trihydric, and polyhydric according as their molecules contain, one, two, three and many hydroxyl group. Since presence of two or more hydroxyl group on the same carbon atom makes the molecule unstable therefore in di, tri and polyhydric alcohols, each hydroxyl group is present on different carbon atoms.

(i) Monohydric alcohols :-

General formula - $C_nH_{2n+1}OH$ or $R-OH$.

Common name - Alkyl + Alcohol - Alkyl alcohol.

IUPAC name - Alkane - e + ol - Alkanol.

(ii) Dihydric alcohols -

General formula - $C_nH_{2n}(OH)_2$.

Because of their sweet taste, dihydric alcohols are called glycols.

(iii) Trihydric alcohols -

General formula - $C_nH_{2n-1}(OH)_3$

(e) Ethers or Alkoxyalkanes -

General formula - $RO-R'$ where R and R' are same or different alkyl groups. If $R=R'$ then ethers are called simple ethers and if $R \neq R'$ then ethers are called mixed ethers.

Functional group - $O-$

Secondary Prefix - Alkoxy.

Common name - In case of mixed ethers, add the word ether to the names of the alkyl groups arranged in alphabetical order. In case of simple ethers, the numerical prefix (di) is added to the name of the alkyl group.

IUPAC name - In IUPAC name, ethers are called alkoxy-alkanes. The smaller alkyl group forms a part of the alkoxy group while the bigger alkyl group forms a part of alkane.

Smaller part + oxy + Bigger part with (ane)

(f) Monocarboxylic acids or Alkanoic Acids -

General formula :- $C_nH_{2n+1}COOH$ or $R-COOH$.

functional group - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{OH} \end{array}$

Common name - These are derived from the name of the plant or animal which they were first isolated.

IUPAC Name - Replace terminal (e) from the name of the corresponding alkane by the suffix 'oic acid'.

Alkane - e + oic acid - Alkanoic acid.

(g) Aldehydes or Alkanals -

General formula - $C_nH_{2n+1}CHO$ or $R-CHO$.

functional group - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$

Common name - Replace 'ic acid' from the common name of the corresponding acid which they give upon oxidation by the word aldehyde. exam.

Acetic Acid - ic Acid + aldehyde = Acetaldehyde.

IUPAC Name - Replace the terminal 'e' from the name of the corresponding alkane by the suffix 'al'.

Alkane - e + al - Alkanal.

(h) Ketones or Alkanones :-

General formula :- $C_nH_{2n+1}CO C_nH_{2n+1}$ or $R-CO-R'$

where R and R' may be same or different alkyl group.

If $R=R'$ then ketones are called simple ketones and if $R \neq R'$ then ketones are called mixed ketones.

functional group : $>C=O$

Common name - In case of mixed ketones, name the alkyl group in alphabetical order and then add the word ketone.

In case of simple ketones, the numerical prefix (di) is used

before the name of the alkyl group.

IUPAC Name - Replace terminal 'e' from the name of the corresponding alkane by the suffix -one

Alkane - e + one \rightarrow Alkanone.

(I) Acid chlorides or acyl chlorides or Alkanoyl chlorides.

General formula - $R-CO-Cl$

functional group - $\begin{array}{c} \text{O} \\ \parallel \\ -C-Cl \end{array}$

Common name - Acetic acid - ic acid + yl chloride = Acetyl-chloride

IUPAC Name - Alkane - e + yl chloride - Alkanoyl chloride.

(J) Acid anhydrides -

General formula - $R-CO-O-CO-R'$ or $(RCO)_2O$ where R or R' may be same or different alkyl group.

functional group - $\begin{array}{c} \text{O} \quad \text{O} \\ \parallel \quad \parallel \\ -C-O-C- \end{array}$

Common name or IUPAC Name - Replace the word acid from the Common name or IUPAC name of the corresponding acid by the word -anhydride.

(K) Esters :-

General formula - $R-COO-R'$ where R = H or any alkyl group while group R' always an alkyl group.

functional group :- $\begin{array}{c} \text{O} \\ \parallel \\ -C-OR' \end{array}$

Common or IUPAC Name - Write the name of alkyl group before the Common or IUPAC name of the parent acid with its terminal ic acid replace by oate.

(L) Acid amides or Alkanamides.

General formula :- $R-CO-NH_2$

functional formula — — $-C(=O)-NH_2$.

Common name — Replace ic acid from the common name of the corresponding acid by the secondary suffix amide.

IUPAC Name — Replace the terminal 'e' from the name of corresponding alkane by the suffix amide.

(M) Primary Amines :-

General formula :- $R-NH_2$.

functional formula — — $-NH_2$

Common name :- (i) Add the word amine to the name of the alkyl group.

Alkyl + amine \rightarrow Alkylamine.

(ii) Attach the prefix amino to the name of the corresponding alkane.

Amino + Alkane \rightarrow Aminoalkane.

IUPAC Name — Replace the terminal 'e' from the name of the corresponding alkane by amine.

Alkane - e + amine \rightarrow Alkanamine.

(N) Secondary amines —

General formula — $R-NH-R'$

functional formula — — $-NH-$

Common name —

Name the alkyl groups in alphabetical order and then add amine.

In case the two alkyl group are the same the numerical prefix 'di' is used before the name of the alkyl group.

IUPAC Name —

Add the prefix N-alkyl to the name of the alkanamine

Corresponding to the larger alkyl group.

N-alkyl + alkanamine \rightarrow N-alkylalkanamine.

(O) Tertiary amines:-
General formula — $R-\overset{R'}{\underset{|}{N}}-R''$

Functional formula — $-\overset{|}{N}-$

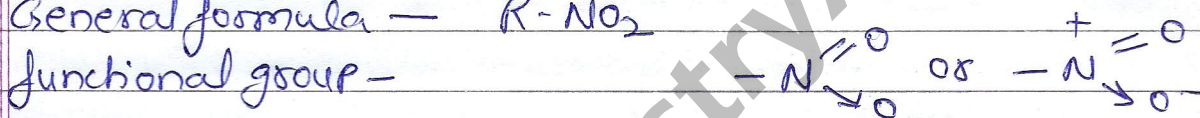
Common name :- Name the alkyl group in alphabetical order and add the suffix amine.

IUPAC Name — Add the Prefix N-alkyl and N-alkyl to the name of the alkanamine corresponding to the largest alkyl group.

(P) Nitroalkanes —

General formula — $R-NO_2$

Functional group —



Common name — There is no common name.

IUPAC Name — Add the Secondary Prefix nitro to the name of the alkane.

Nitro + alkane \rightarrow Nitroalkane.

(Q) Alkyl nitrites —

General formula — $R-O-N=O$

Functional group — $-O-N=O$.

Common name — Add the Secondary suffix nitrite to the name of the alkyl group.

Alkyl + nitrite \rightarrow Alkyl nitrite.

IUPAC Name — There is no IUPAC name.

(R) Alkyl cyanides or alkanenitriles —

General formula — $R-C \equiv N$

functional group — $-\text{C}\equiv\text{N}$

Common name —

- (1) Add the suffix cyanide to the name of the alkyl group.
Alkyl + cyanide \rightarrow Alkyl cyanide.
- (2) Replace ic acid from the Common name of the corresponding acid by the suffix onitrile.
Acetic Acid + o-nitrile — ic acid \rightarrow Acetonitrile.

IUPAC Name — Add the suffix nitrile to the name of the alkane containing the same number of Carbon atoms as the alkyl cyanide.

Alkane + nitrile \rightarrow Alkanenitrile

(3) Isocyanides or Isonitriles —

General formula — $\text{R}-\text{N}\equiv\text{C}$

functional group — $-\text{N}\equiv\text{C}$

Common name — Add the suffix isocyanide or carbamine to the name of the alkyl group.

IUPAC name — There are no IUPAC name.

— Rules for IUPAC nomenclature for Branched chain Alkanes.

1. Longest chain rule — Select the longest continuous chain of Carbon atoms, This is called the parent chain while other Carbon atoms which are not included in the parent chain are called substituents or side chain.
2. Rules for larger no of side chain — If two chain of equal lengths are possible, select the one with the larger number of substituents or side chain.
3. Lowest number rule :- Number the Carbon atoms of the parent chain as 1, 2, ... starting from that end which.

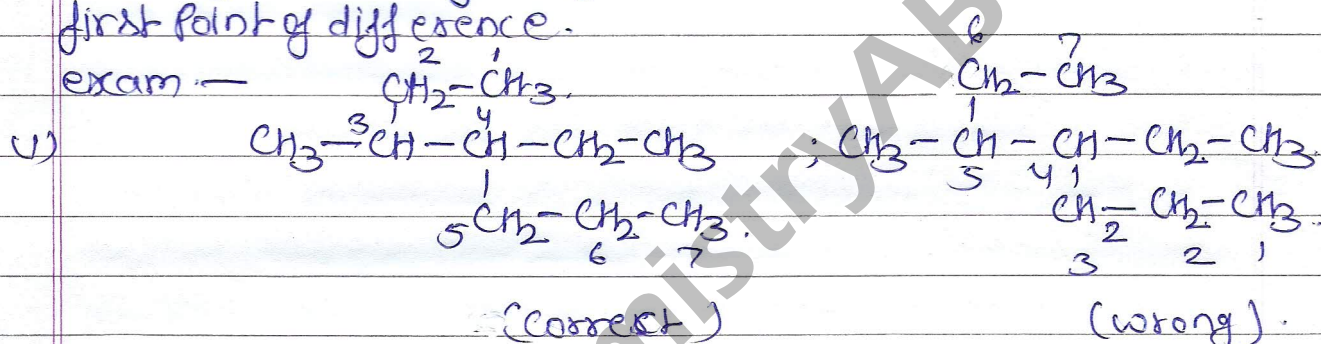
gives the lowest possible number to the Carbon atom carrying the substituent or side chain.

The number that indicates the position of the side chain on the parent chain is called the Positional number or the locant.

Lowest set of locants rule - when two or more substituents are present, the lowest set of locants rule is applied.

According to this rule - when two or more different set of locants containing the same number of terms is possible, then the set of locants is the lowest which when compared term by term with other sets, each in order of increasing magnitude has the lowest term at the first point of difference.

exam -

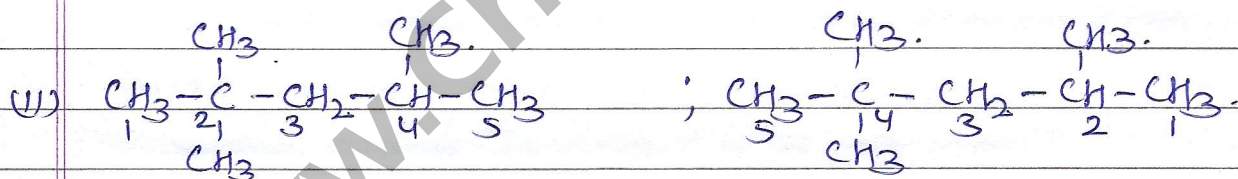


Set of locants (3,4)

(4,5)

Sum 7

9

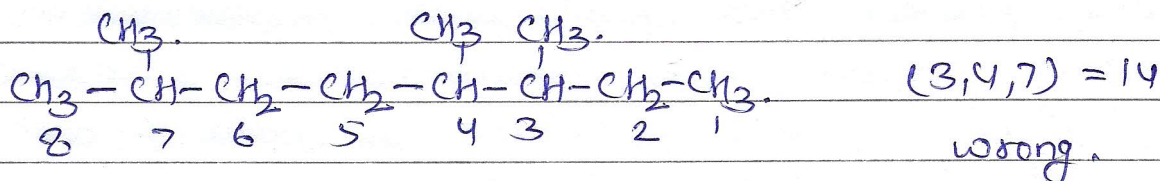
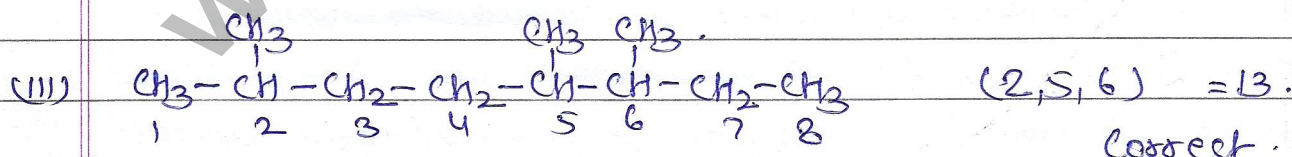


Correct

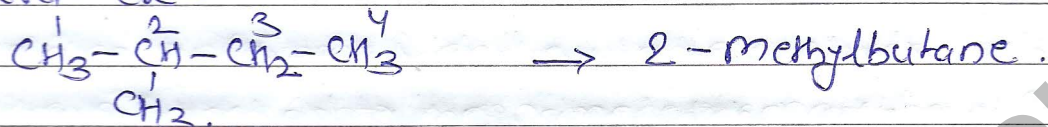
Wrong

(2,2,4) = 8

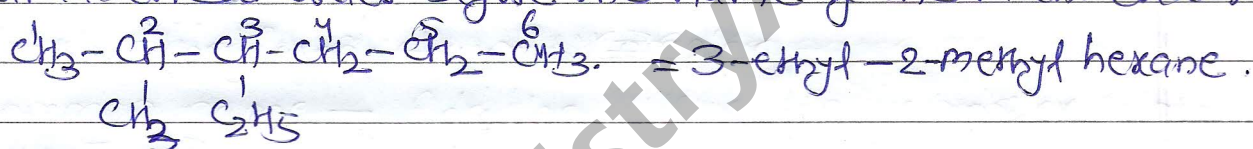
(2,4,4) = 10



4. Name the branched chain alkane :- Prefix the name of the substituent (the alkyl group) to the name of the parent alkane and indicate its position by writing before it the number of the Carbon atom carrying the substituent. The name of the substituents is separated from its locant by a hyphen (-). The final name of the alkane is always written as one word. ex-

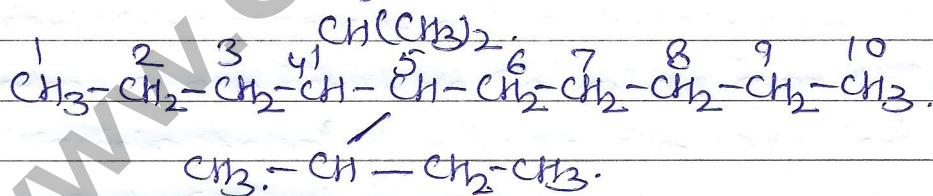


5. Alphabetical order of the side chain - when two or more alkyl groups are present on the parent chain, each alkyl group prefixed by its positional number is arranged in alphabetical order before the name of the parent chain.



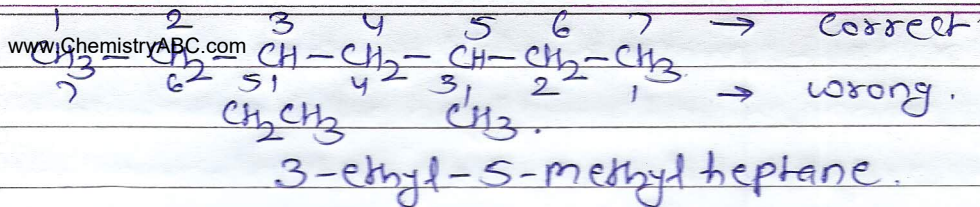
It may be noted that while deciding the alphabetical order of the various alkyl groups, prefixes iso and neo are considered to be part of the fundamental name of the alkyl group while the prefixes sec. and tert are not.

ex.

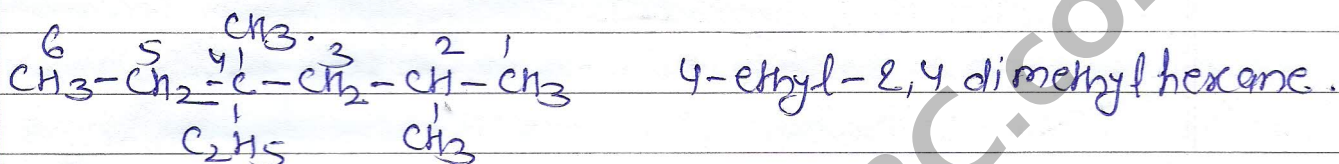


5-sec-butyl-4-isopropyldecane.

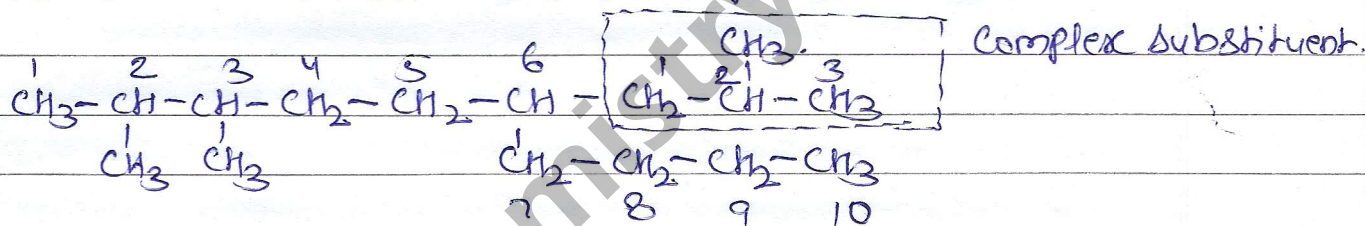
6. numbering of different alkyl groups at equivalent positions - if two different alkyl groups are present at same positions, the numbering of the parent chain is done in such a way that the alkyl group which comes first in the alphabetical order gets the lower number.



7. Name same alkyl group at different position - when the same alkyl group occurs more than once on the parent chain at different position, the positional number of each alkyl group is separated by commas and suitable prefixes such as di, tri etc. are attached to the name of the alkyl group.



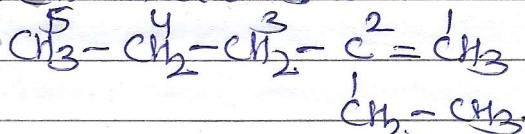
8. numbering the complex substituents - In case the substituents on the parent chain is complex.



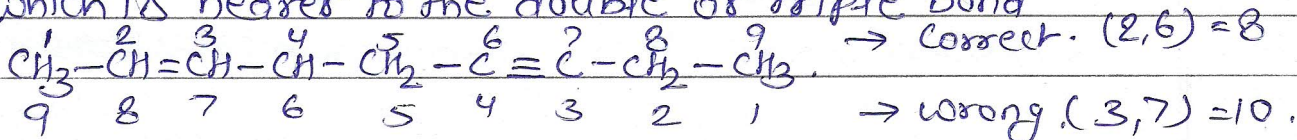
2,3 dimethyl-6-(2-methyl propyl) decane.

- Rules for IUPAC nomenclature of unsaturated hydrocarbons-

1. The parent chain must be contain the multiple bond regardless of the fact whether it also denotes the longest continuous chain of carbon atoms or not.

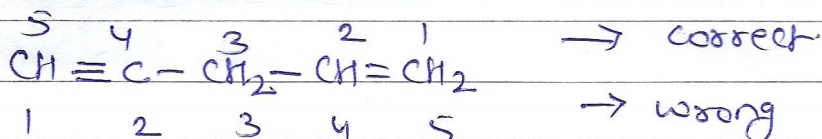


2. If both double and triple bond are present, the numbering of the parent chain should always be done from that end which is nearer to the double or triple bond.

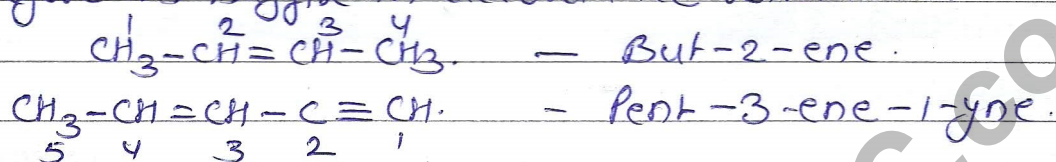


Organic Chemistry.

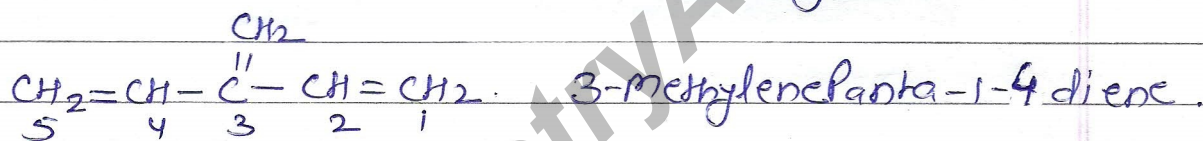
3. If however, there is a choice in numbering the double bond is always given preference over the triple bond.



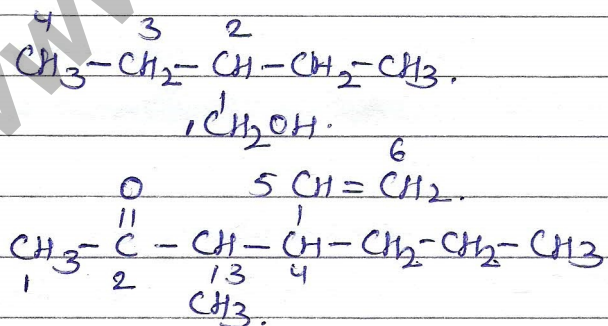
4. If the organic compound contains only one double or the triple bond its locant or the positional number is always placed before its suffix in accordance with 1993.



In some cases all the double and triple bonds present in the molecule cannot be included in the longest chain.

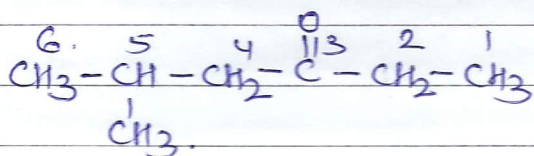


- Rules for IUPAC Nomenclature of Compounds containing one functional group, multiple bonds, and substituents.
1. Parent chain — select the longest possible chain of carbon atoms containing the functional group and the maximum number of multiple bonds as the parent chain without caring whether it also denotes the longest possible carbon chain or not.



2. Lowest Locant rule for the functional group — Number the parent chain in such a way that the functional group gets the lowest possible number followed by the double and triple bond even if

Violates the lowest set of locants rule



3. numbering the chain terminating functional group - when a chain terminating functional group is present, it is always given number 1.



- Rules for IUPAC nomenclature of Polyfunctional Compounds - Organic compounds which contain two organic functional group or more, are called Polyfunctional Compounds.

1. Principle functional group - when an organic compound contain two or more different functional group, one of the functional group is selected as the principle functional group while all other groups are treated as substituents.

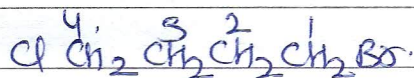
Writing the names of the Polyfunctional Compounds, the principle functional group is indicated by adding the secondary suffix to the word root while the secondary functional group are indicated by adding suitable prefixes to the word root.

The prefixes for secondary functional group are :-

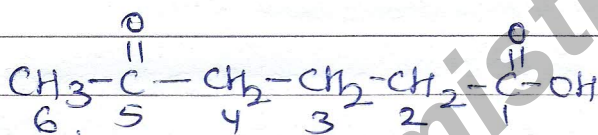
functional group.	Prefix	functional group	Prefix.
-x (F, Cl, Br, I)	Halo.	-CHO	Formyl.
-OH	Hydroxy.	>C=O	keto
-SH	Sulphanyl.	-COOH.	Carboxy.
-OR	Alkoxy.	-COOR.	Alkoxy carbonyl.
-NH ₂	Amino	-COCl.	Halo carbonyl.
-NHR.	Alkyl amino	-CN.	Cyano
-NR ₂	Dialkyl amino.	-CONH ₂	Carboxamido.

2. www.ChemistryABC.com Selecting the Principle chain - While selecting the Principle chain present in a Polyfunctional Compound care should be taken that it must contain the principle functional group and the maximum number of secondary functional groups and multiple bonds.
3. numbering the Principle chain - The principle chain present in a Polyfunctional Compound must be numbered in such a way that the principle functional group gets the lowest number.
Principle functional group > double bond > triple bond > substituents
4. Alphabetical order: - The Prefixes for the secondary functional group and other substituents should be placed in alphabetical order before the word root.

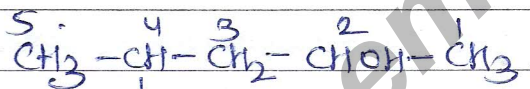
ex.



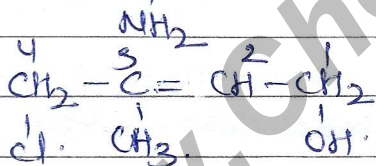
1-Bromo-4-chlorobutane.



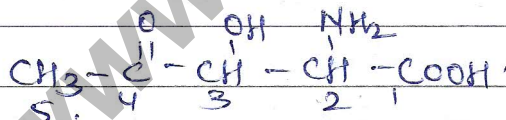
5-ketohexan-1-oic acid.



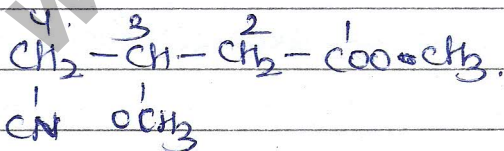
4-Aminopentan-2-ol.



4-chloro-3-methyl but-2-ene-1-ol.



2-Amino-3-hydroxy-4-ketopentan-1-oic acid.



4-cyano-3-methoxybutan-1-oate.

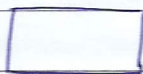
- Rules for naming Alicyclic Compounds.

1. The name of alicyclic Compounds are obtained by adding.

the prefix 'cyclo' to the name of the corresponding straight chain hydrocarbon. (Alkane, Alkene, Alkyne).



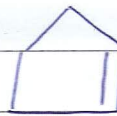
cyclopropane



cyclobutane



cyclopentane

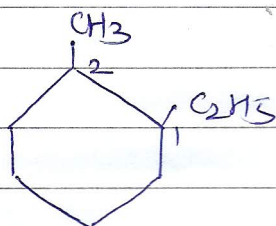


cyclopentene



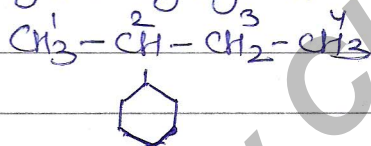
cyclobutene

2. If two or more alkyl group or other substituents groups are present in the ring, their position are indicated by 1, 2, ... etc. while numbering the carbon atoms of the ring, the substituent which comes first in alphabetical order is given the lowest number.

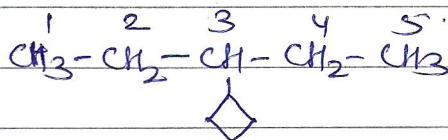


1-ethyl-2-methylcyclohexane

- 3(a) If the ring contains more or equal number of carbon atoms than the alkyl group attached to it, it is named as a derivative of cycloalkane and the alkyl group is treated as a substituent group, otherwise it is named as a derivative of alkane and the cycloalkyl group is considered as a substituent group.



(2-Butyl)cyclohexane



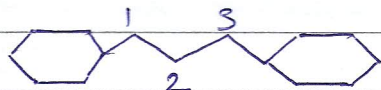
3-cyclobutylpentane

- (b) If the side chain contains a multiple bond or a functional group, the alicyclic ring is treated as the substituents irrespective of the size of the ring.



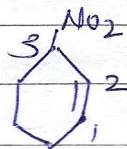
4-cyclohexylbut-3-ene-2-one

- c. If more than one alicyclic ring is attached to a single chain, the compound is named as a derivative of alkane, irrespective of the number of carbon atoms in the ring or the chain.



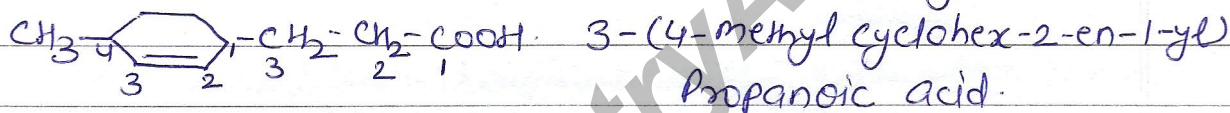
1,3 dicyclohexyl propane.

4. If a multiple bond and some other substituents are present in the ring, the numbering is done in such a way that the multiple bond gets lowest number.



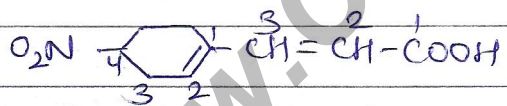
3-Nitrocyclohex-1-ene

5. If the ring contains a multiple bond and the side chain contains a functional group then the ring is treated as the substituent and the compound is named as a derivative of the side chain.



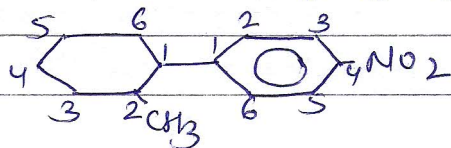
3-(4-methyl cyclohex-2-en-1-yl) Propanoic acid.

6. If the ring as well as the side chain contains functional groups, the compound is named as a derivative of the side chain or the alicyclic ring according as the side chain or the ring contains the principle functional group.



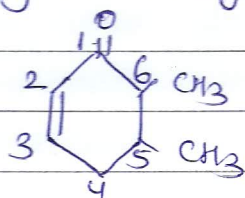
3-(4-Nitrocyclo-1-en-1-yl)-prop-2-ene-1-oic acid.

7. If a compound contains an alicyclic ring directly linked to the benzene ring, it is named as a derivative of benzene. The compound having lowest state of hydrogenation.



1-(2-methyl cyclohexyl)-4-nitro benzene.

8. If some functional group along with other substituent group are present in the ring. It is indicated by some appropriate prefix or suffix and its position is indicated by numbering the carbon atoms of the ring in such a way that the functional group gets lowest number.



5,6-dimethyl cyclohex-2-ene-1-one.

9. If an alicyclic ring is directly attached to a carbon containing functional group, the carbon atom of the functional group is not included in the parent name of the alicyclic system. Therefore for such system, the following prefixes and suffixes for the functional groups are commonly used.

Functional group.	Prefixes	Suffix
-CHO	Formyl	Carbaldehyde.
-COOH.	Carboxy	Carboxylic acid.
-COX.	halo carbonyl.	Carbonyl halide.
(X = F, Cl, Br, I)		
-COOR.	Alkoxy carbonyl.	Alkyl carboxylate.
-CONH ₂	Carbamoyl.	Carboxamide.
-CN.	Cyano	Carbonitrile.

— Writing structural formulae from the IUPAC Name of the Compound.

1. Select the longest carbon chain from the word root of the IUPAC name of the organic compound.
2. Number the carbon chain from either direction.
3. Identify the primary suffix, -ane, -ene or -yne from the name of the compound. If the compound contains a double or triple bond identify its position from the name of the organic compound and put the double or triple bond at its right position along the.

4. Identify the name and position of the functional group from the IUPAC name of the compound and fix it at its right position on the carbon chain.
5. Identify the name and position of the other substituents, if any from the IUPAC name of the compound and fix them at their right position along the carbon chain.
6. Finally wherever necessary, attach the required number of hydrogen atoms to satisfy the tetravalency of each carbon.

— Nomenclature of Simple Aromatic Compounds —

Aromatic compounds contain one or more isolated or fused benzene rings. An aromatic compound consists of two parts.

- (1) Nucleus — The most ideal aromatic compound is benzene. It is represented by a regular hexagon of six carbon atoms with three alternate single and double bonds. This is called the nucleus.



2. Side chain — The alkyl group or any other aliphatic group containing at least one carbon atom which is attached to the benzene ring is called the side chain.



- (i) Nuclear substituents — Those in which the functional group is directly attached to the benzene ring. In the IUPAC system they are named as derivatives of benzene.

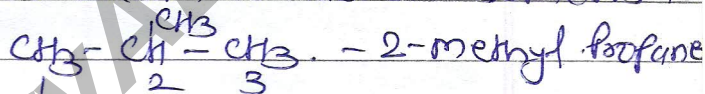
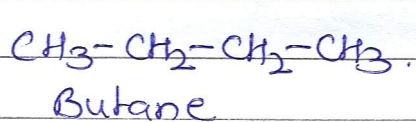
- (ii) Side chain substituents — Those in which the functional group is present in the side chain of the benzene ring. Both in the common and IUPAC system, these are usually named as phenyl derivative of benzene.

- **Isomerism** - Two or more compounds having the same molecular formula but different chemical and physical properties are called isomers and the phenomenon is known as isomerism. It is of two types.

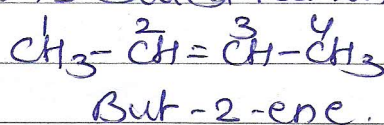
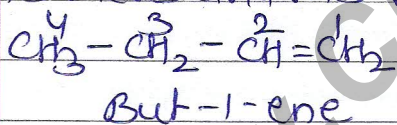
1. **Structural Isomerism** - Compounds having the same molecular formula but different structures, different arrangement of atoms within the molecule are called structural isomers and the phenomenon is called structural isomerism.

It is of six types.

a. **Chain or nuclear isomerism** - Compounds having the same molecular formula but different arrangement of carbon chain within the molecule are called chain or nuclear isomers and the phenomenon is called chain or nuclear isomerism.

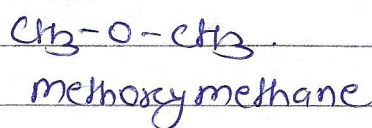
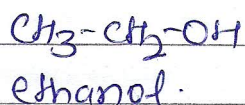


b. **Position isomerism** - Compounds which have the same structure of the carbon chain but differ only in the position of the multiple bond or the functional group are called position isomers and the phenomenon is called position isomerism.

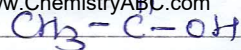


c. **Functional isomerism** - Compounds having the same molecular formula but different functional groups are called functional isomers and the phenomenon is called functional isomerism.

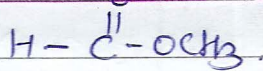
(i) Alcohols and ethers ($\text{C}_n\text{H}_{2n+2}\text{O}$)



(ii) Carboxylic acids and esters ($\text{C}_n\text{H}_{2n}\text{O}_2$)

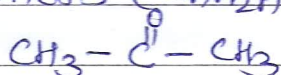


Ethanoic acid.

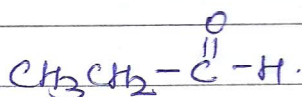


methyl methanoate.

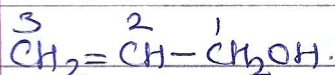
(III) Aldehydes, ketones, unsaturated alcohols and unsaturated ethers ($\text{C}_n\text{H}_{2n}\text{O}$).



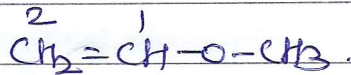
Propanone.



Propanal.



Prop-2-ene-1-ol.



Methoxy eth-1-ene

(IV) Aromatic alcohols, phenols, and ethers

(V) Dienes, allenes, and alkynes ($\text{C}_n\text{H}_{2n-2}$)

(VI) Nitroalkanes, Alkyl nitrites and amino acids ($\text{C}_n\text{H}_{2n+1}\text{NO}_2$)

(VII) 1° , 2° and 3° Amines.

(VIII) Cyanides and isocyanides ($\text{C}_n\text{H}_{2n+1}\text{N}$)

(IX) Amides and oximes ($\text{C}_n\text{H}_{2n+1}\text{NO}$)

D. Metamerism - Compounds having the same molecular formula but different number of carbon atoms (or alkyl groups) on either side of the functional group ($-\text{O}-$, $-\text{S}-$, $-\text{NH}-$, and $-\text{CO}-$) are called metamers and the phenomenon is called metamerism. Metamerism occurs among the members of the same homologous family.

E. Tautomerism - It is a special kind of isomerism in which the isomers exist in dynamic equilibrium with each other. It arises due to migration of a hydrogen atom from one polyvalent atom to the other within the same molecule with necessary rearrangement of linkage. The isomers thus obtained are called tautomers and the phenomenon is called tautomerism. It is also called desmetropism.

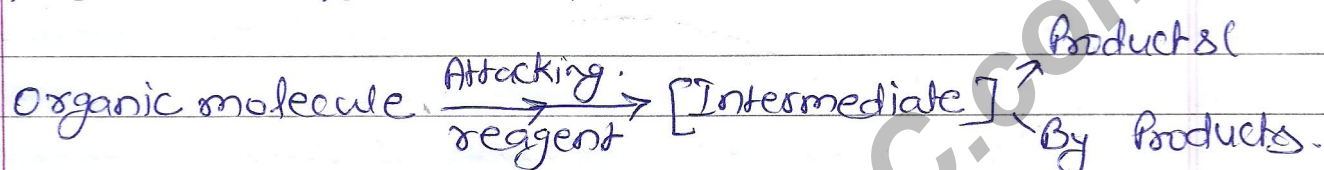
(F) Ring chain isomerism - Compounds having the same molecular formula but possessing open chain and cyclic structures are called ring chain isomers and the phenomenon is called ring chain isomerism.

2. Stereoisomerism - isomers which have the same structural formula but have different relative arrangements of atoms or groups in space are called stereoisomers and the phenomenon is called stereoisomerism.

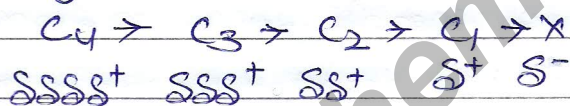
- Steric hindrance - If two non-bonded atoms or groups in an organic molecule are held together at a distance equal to or less than the sum of their van der Waals radii, then they repel each other due to a spatial crowding. This repulsion is referred to as steric hindrance or steric strain or van der Waals strain.
- Seeding - The process of inducing crystallisation by adding a crystal of the pure substance into its saturated solution is called seeding.
- Fractional crystallisation - The process of separation of different components of a mixture by repeated crystallisation is known as fractional crystallisation.
- Sublimation - It involves the direct conversion of a solid into the gaseous state on heating without passing through the intervening liquid state and vice versa, cooling.
- Distillation - It involves conversion of a liquid into vapours by heating followed by condensation of the vapours thus produce by cooling.

Chromatography - The technique of separating the components of a mixture in which separation is achieved by the differential movement of individual components through a stationary phase under the influence of a mobile phase.

- A sequential account of each step, describing details of electron movement, energetics during bond cleaves and bond formation and the rates of transformation of reactants into products is called the reaction mechanism.



- **Inductive effect** - whenever an electron-withdrawing atom such as halogen is attached to the end of a carbon chain, the σ electrons of the C-X bond are attracted by or displaced towards the more electronegative halogen atom. As a result the atom X acquires a small negative charge and C, acquires a small positive charge.



The small positive charge on C_1 in turn attracts the σ -electrons of the $\text{C}_1\text{-C}_2$ bond towards it. As a result C_2 acquires a small positive charge (SS^+)

This type of displacement of σ -electrons along a saturated carbon chain whenever an electron withdrawing group is present at the end of the chain is called the inductive effect or the I-effect. This effect weakens steadily with increasing distance from the substituents and actually dies down after three carbon atoms.

There are two type of I-effects.

1. If the substituent attached to the end of the carbon chain is electron-withdrawing then the effect is called

- I-effect.

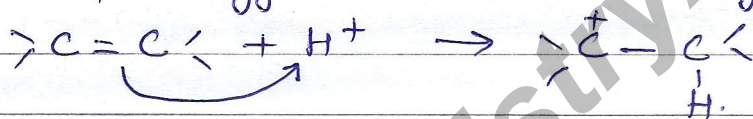
- (ii) If the substituent attached to the Carbon chain is electron donating, the effect is called +I-effect.
Inductive effect is a permanent effect.

- Electromeric effect - It involves the complete transfer of electrons of a multiple bond to one of the bond atoms (usually more electronegative) in presence of an attacking reagent. It is called E-effect.

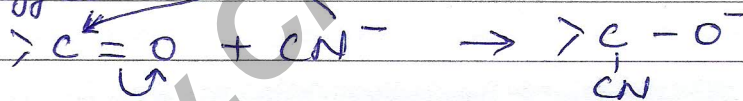
This effect is temporary and takes place only in the presence of a reagent.

E-effect is of two types.

- I. If the electrons of the π -bond are transferred to that atom of the double bond to which the reagent gets finally attached, the effect is called +E-effect.



- II. If the electrons of the double bond are transferred to an atom of the double bond other than the one to which the reagent gets finally attached, the effect is called -E-effect.



- Resonance or Mesomerism - The phenomenon of resonance is said to occur whenever for a molecule we can write two or more Lewis structures which differ in the position of electrons but not in the relative position of atoms. The various Lewis structures, none of which is capable of describing all the known properties of the compound are called resonance structures. The actual structure of the molecule is not represented by any of the resonance structures but is a resonance hybrid of all these structures.

- Resonance energy - It is defined as the difference in internal energy of the resonance hybrid and the most stable Canonical structure. Further, more the number of equivalent resonance structures, greater is the delocalization of electrons, higher is the resonance energy and hence more stable is the compound.

- Rules for writing resonance structures.

- I The various resonance structures should differ only in the position of electrons and not in the position of atom or nuclei.
- II All the resonance structures should have the same number of unpaired electrons.
- III In case of atoms of the second period in the periodic table, such resonance structures which violate octet rule should not be considered.
- IV As far as possible, all the resonance structures should have nearly the same energy.

- Relative Contributions of Resonance Structures.

- 1 Structures which have equal energy are contribute equally towards the resonance hybrid.
2. Structures with greater number of covalent bonds contribute more towards the resonance hybrid.
3. Structures which involve separation of positive and negative charges are of higher energy and hence contribute little towards the resonance hybrid.
4. Lesser the separation of positive and negative charges, more stable is the resonance structure.
5. When atom of different electronegativities are involved the structure with a negative charge on the more electronegative atom and positive charge on the less electronegative atom is of lower energy and hence contributes more.

towards the resonance hybrid

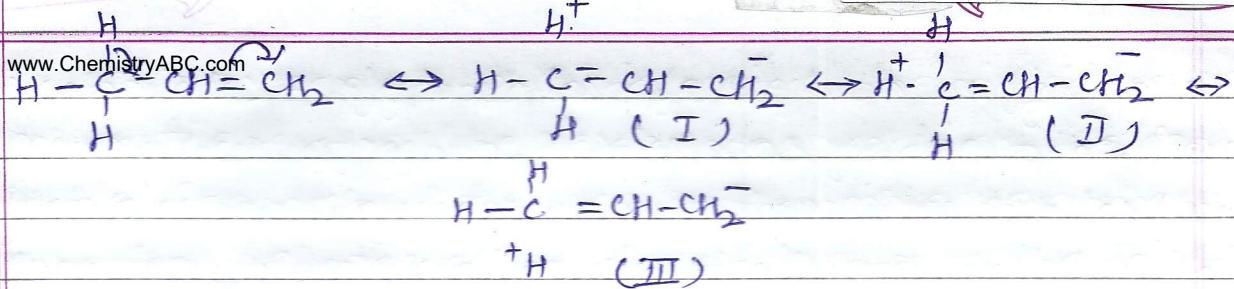
6. Structures having like charges on adjacent atoms are highly unstable and hence contribute little towards resonance hybrid.
7. Structures which help to delocalize the positive charge make important contribution towards the resonance hybrid
8. Resonance structures in which all the atoms have octet of electrons make larger contribution towards the resonance hybrid.

— Resonance effect or mesomeric effect — In case of conjugate systems, the electron can flow from one part of the system to the other due to resonance. This flow of electron from one part of the conjugated system to the other creating centers of low and high electron density due to the phenomenon of resonance is called resonance effect or mesomeric effect.

It is of two types -

1. Groups which donate electrons to the double bond or to a conjugated system are said to have (+R or +M) effect.
2. Groups which withdraw electrons from the double bond or from a conjugated system towards themselves due to resonance are said to have (-R or -M effect)

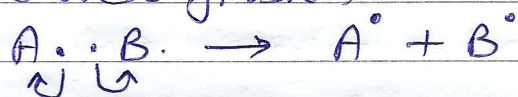
— Hyperconjugation effect — When an alkyl group is attached to an unsaturated system such as a double bond or a benzene ring, the order of inductive effect is actually reversed. This effect is called hyperconjugation effect or Baker-Nathan effect.



Structures I, II and III are called hyperconjugation structures. Since there is no bond between carbon and hydrogen atoms in these structures, hyperconjugation is also called no bond resonance.

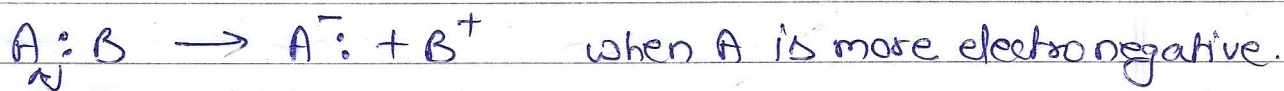
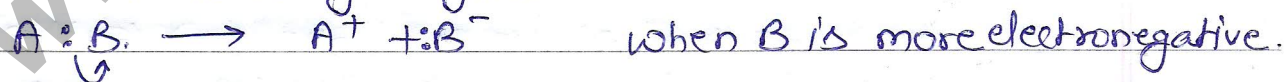
- Fission of a Covalent Bond -

1. Homolytic (Symmetrical) fission - If a covalent bond breaks in such a way that each atom takes away one electron of the shared pair, it is called homolytic or symmetrical fission.



The neutral chemical species which contain an odd or unpaired electron and which are produced by homolytic fission of covalent bond are called free radicals. It occurs in non-polar bonds.

2. Heterolytic (Unsymmetrical) fission - When a covalent bond joining two atoms A and B, breaks in such a way that both the electrons of the covalent bond are taken away by one of the bonded atoms, the mode of bond cleavage is called heterolytic fission.



It usually occurs in polar covalent bond.

- Electrophiles - electrophiles are electron loving chemical species. Their attraction for electrons is due to the presence of an electron-deficient atom in them. Electrophiles may be either positively charged or electrically neutral chemical species. These species behave as Lewis acids. Electrophiles always attack the substrate molecule at the site of highest electron-density.
- Nucleophiles - these are nucleus loving chemical species. Since the nucleus of any atom is positively charged, therefore nucleophiles must be electron rich chemical species containing at least one lone pair of electrons. They may be either negatively charged or neutral chemical species. These species behave as Lewis bases. Nucleophiles always attack the substrate molecule at the site of lowest electron density.
- Reactive intermediates - Most of the organic reactions occur through the involvement of certain chemical species. These are generally short lived and highly reactive and hence can not be isolated. These short lived highly reactive chemical species through which the majority of the organic reactions occur are called reactive intermediates.
- Carbocations - chemical species bearing a positive charge on carbon and carrying six-electron in its valance shell are called Carbocations or Carbonium ions.
 Stability - $3^\circ > 2^\circ > 1^\circ$ Carbon
 reactivity - $1^\circ > 2^\circ > 3^\circ$ Carbon.
- Carbanions - Chemical species bearing a negative charge on carbon possessing eight electrons in its valance shell are called Carbanions.

www.ChemistryABC.com $1^\circ > 2^\circ > 3^\circ$

reactivity - $3^\circ > 2^\circ > 1^\circ$

- Free radical - A free radical may be defined as an atom or a group of atoms having an odd or unpaired electron.

Stability - $3^\circ > 2^\circ > 1^\circ$

- Common types of Organic Reactions.

1. Substitution reactions - A substitution reaction is that which involves the direct replacement of an atom or a group of atoms in an organic molecule by other atom or group of atoms without any change in the remaining part of the molecule.

a. Nucleophilic substitution reaction - Substitution reaction which brought about by nucleophiles are called nucleophilic substitution reaction. In these reactions a stronger nucleophile usually displace a weaker nucleophile.



b. Electrophilic substitution reaction - Substitution reaction which are brought about by electrophiles are called electrophilic substitution reactions.



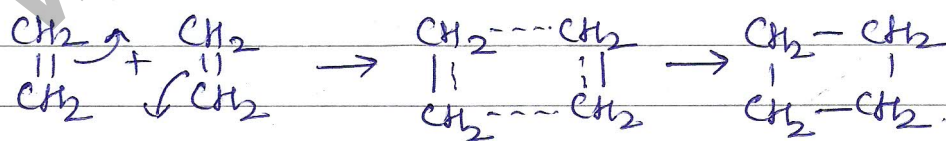
c. Free radical substitution reaction - Substitution reactions brought about by free radicals are called free radicals substitution reactions.



2. Addition reaction - Reaction which involves combination between two reacting molecules to give a single molecule of the product are called addition reaction.

3. ~~Elimination~~ ^{www.ChemistryABC.com} reaction - An elimination reaction is one that involves the loss of two atoms or group of atoms from the same or adjacent atoms of a substance leading to the formation of a multiple bond.
4. Condensation reactions - In these reactions two or more molecules of the same or different reactants combine to form a product with or without the elimination of simple molecule.
5. Rearrangement reactions - Reactions involving the migration of an atom or a group from one atom to another within the same molecule are called rearrangement reaction.
6. Isomerisation reactions - Reactions which involve interconversion of one isomer into another keeping the molecular formula as well as the carbon skeletons of the reactants and the products intact are called isomerisation reactions.
7. Pericyclic reactions - There are a large number of organic reactions which do not involve ionic or free radical intermediates. Instead these reaction occur in a single step via a cyclic transition state. In these reactions, bond making and bond breaking occurs simultaneously. These reactions do not require any catalyst and are initiated either by heat or light. All such reactions are called Pericyclic reactions.

ex.



This addition of one ethene molecule to another ethene molecule is commonly called $2\pi + 2\pi$ or cycloaddition reaction.