

Chemistry : Basic Principles of Organic Chemistry

GENERAL INTRODUCTION

- ❑ In old days chemistry was divided in two branches organic and inorganic.
- ❑ The term organic was used to indicate the life i.e. compounds obtained from living bodies like plants and animals.
- ❑ Many organic compounds like alcohols, sugars, fats, soaps, vinegar, indigo, starch were known from ancient days.
- ❑ In 18th century many organic compounds were obtained from natural sources i.e. tartaric acid (from grapes), citric acid (from lemon), and malic acid (from apples).
- ❑ The Swedish chemist Berzelius (1815) proposed a vital force (vitalism / life force is responsible for the formation of organic compounds.)
- ❑ According to Berzelius organic chemistry was the study of compounds obtained from plants and animals.
- ❑ Inorganic chemistry was the study of rocks, minerals, gases and the compounds obtained from these in laboratory.
- ❑ Lavoiser (Father of chemistry) was showed that compounds obtained from vegetables and animals always contains carbon, hydrogen and some times nitrogen, phosphorous etc.
- ❑ In 1928 German chemist Friedrich Wohler prepare urea in laboratory by heating inorganic compound ammonium cyanate.
- ❑ urea is the first synthetic organic compound.
- ❑ Ammonium cyanate and urea have same molecular formula but arrangements of various atoms are different.
- ❑ In 1845 Acetic acid was synthesized in laboratory from elements by Kolbe.
- ❑ Acetic acid is the first synthetic organic compound prepared from their elements.

- ❑ In 1856 Berthelot prepared methane in laboratory.
- ❑ Synthesis of all these compounds depends upon the laws of formation applicable to inorganic compounds and does not depend upon vital force theory.
- ❑ There was no fundamental difference between the properties of organic and inorganic compounds.
- ❑ Organic compounds are vital for sustaining life on earth.
- ❑ Complex organic compounds like proteins, DNA (deoxyribonucleic acid) are responsible for genetic functions in living systems.
- **Modern definitions of organic chemistry :**
 - ❑ The branch of chemistry which studies the properties of compounds containing covalently bonded carbon either with H.O., N.S.R, halogens and metals is called organic chemistry.
 - ❑ In short and most conventionally it is defined as "Chemistry of carbon compounds"
 - ❑ The chemistry of hydrocarbons and their derivatives is called organic chemistry"
 - ❑ Organic chemistry can be defined as the chemistry of carbon compounds other than oxides of carbon, metal carbonates, metal cyanides and other related compounds."
- **General characteristics of organic compounds :**
 - ❑ Organic compounds contains carbon either with hydrogen, oxygen, nitrogen, halogen, phosphorus sulphur metal atoms etc.
 - ❑ Atoms in organic compounds are linked with each other by covalent bonds and they are called covalent compounds.
 - ❑ Number of organic compounds is very large due to catenation.
 - ❑ Most of the organic compounds show isomerism. Most of them are polymers.
 - ❑ Generally they are insoluble in water but most of them are soluble in organic solvents, like ethers, alcohols, benzene, chloroform etc. They have low m.p. and b.p. values.

- Most of them are combustible and volatile. They are bad conductor's of heat and electricity.
- Most of them have functional group. Most of them have characteristic odour.
- Their reactions are slow and nonionic. They form Homologous series.

• **Carbon as central atom.**

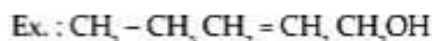
- Natural or synthetic organic compound contains carbon.
- Carbon atom in organic compounds is tetravalent. Carbon - carbon bond is strong and stable. Carbon can bind with other carbon and atoms of other elements like H, O, N, S, P, halogen to form compounds having different properties.
- Chemical bond formed by sharing of electrons is called covalent bond.
- Organic compounds having same molecular formula but different structural formulae are called Isomers and the property is called Isomerism.
- Property of carbon atom to combine with other carbon atoms through single, double and triple bonds to form simple chains, branched chains or rings is called catenation.
- Formula which indicate number of various atoms in molecule is called molecular formula, ex. H_2O , CH_4 , C_2H_6 .
- The formula which indicate actual attachment of various atoms in molecule is called structural formula.
- An atom or group of various atoms which indicate the properties of organic compound is called functional group ex. $-OH$, $-NH_2$, $-CHO$.
- Ground state electronic configuration of carbon is $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^0$.
- One electron from 2s orbital is excited to $2p_z$ orbital and forms excited state electronic configuration i.e.



- The tetravalency of carbon is explained on the basis of hybridization of s and p orbitals.
- During the formation of different organic compounds carbon undergoes sp , sp^2 and sp^3 hybridizations. sp^3 hybridized carbon in organic compounds is called saturated carbon.
- sp and sp^2 type hybridized carbon are called unsaturated carbon.
- Decreasing order of size of orbitals is $p > sp^3 > sp^2 > sp$.
- As the s character in hybridized orbital increases, electronegativity of carbon also increases.
- Decreasing order of electronegativity of carbon atoms having different hybridization is $sp > sp^2 > sp^3$.

STRUCTURAL REPRESENTATION OF ORGANIC COMPOUNDS

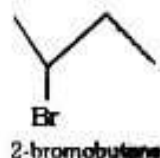
- Structures of organic compounds are represented by various ways.
- Lewis structure or dot structure**: The bonds in Lewis structure are indicated with the help of dot (•).
- Structural formula**: Each bond in two atoms contains two electrons. In this formula bonds are indicated with the help of dash (-).
- Single bond contains two electrons which are indicated by a single dash whereas double and triple dash are used to indicate double and triple bonds.
- Lone pairs of electrons on hetero atoms like O, N, P, S may or may not be shown example.
 $H-C \equiv C-H$
- Condensed structural formula**: This structure is written by omitting some or all the dashes used to represent covalent bond. The structure written by indicating the number of identical groups attached to an atom by subscript.



STATE OF CARBON ATOM IN ORGANIC COMPOUNDS

Org. Compound	Hybridization of C atoms	orbitals involved	No. of σ -Bond	No. of π -bonds	Bond angle	C-C bond length	C-H bond length	Geometry/orbital orientation
CH_4 (Methane)	sp^3	one s and three p	4	0	$109^\circ 28'$		112 pm	Tetrahedral
C_2H_6 (ethane)	sp^3	one s and three p	7	0	$109^\circ 28'$	154 pm	112 pm	Tetrahedral
C_2H_4 (ethylene)	sp^2	one s and two p	5	1	120°	134 pm	110 pm	Planar
C_2H_2 (ethyne)	sp	one s and one p	3	2	180°	120 pm	106 pm	Linear

- **Bond line structure** : In this representation carbon and hydrogen atoms are not shown:
- Carbon - carbon bonds are shown in zig-zag fashion
- Terminals of zig-zag line indicates - CH₃ group and junction denote carbon bonded with required Br number of H-atoms.

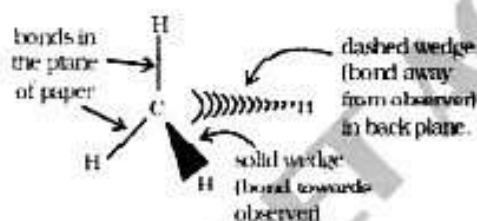


- Atoms like oxygen, nitrogen, halogens, metals are indicated by using their symbols.

Ex: CH₃ - CH₂ - CHBr - CH₃

Three dimensional representation of organic compound :

- In three dimensional structure of organic compounds bonds are arranged in three planes.
- The bonds or groups in organic compound arranged in the plane of paper are indicated by regular dash (-)
- Bond or groups arranged in back plane are indicated by dashed wedge whereas in the front plane of paper are indicated by solid wedge. Wedges are shown in such a way that the broad end of the wedge is towards the observer. Methane molecule can be represented as.



- **Classification of organic compounds** : They are classified on the basis of structures of functional groups.
- **Classification of organic compounds based on their structure** : They are classified in two types.

A) Acyclic or open chain or aliphatic compounds :

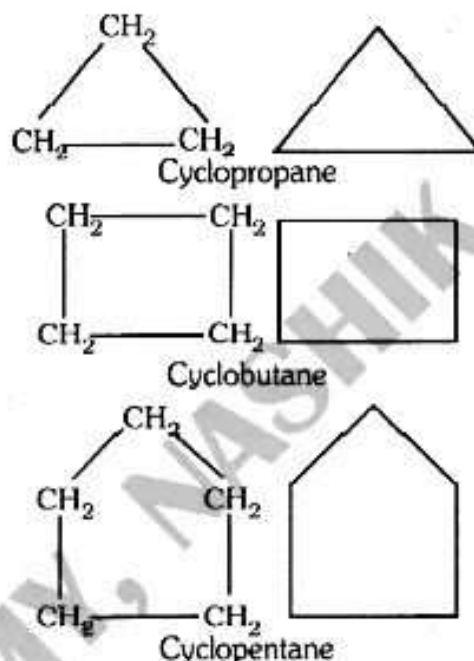
- In these compounds carbon atoms are linked to form an open chain. Ex. CH₃-CH₂-CH₂-CH₃ n-butane

B) Cyclic or closed chain or ring compounds :

- They contain one or more rings of carbon atoms. The ring of an organic compound may contain a non-carbon atom like O, N, S, R etc.
- They are classified in two types,
- a) **Homocyclic or carbocyclic compounds** : They contain one or more rings of carbon atoms.

- They are classified in two types.

- Alicyclic compounds** : They contain one or more rings of carbon atoms in their molecule.
- Their properties are similar to the properties of aliphatic compounds. Ex :



- Aromatic compounds** : They contain a ring of six carbon atoms having alternate double bonds. They contain at least one aromatic ring having properties like benzene.

- Aromatic (homocyclic) compounds are classified in two types.

- Benzenoid Aromatic compounds** : Aromatic compounds containing one or more benzene rings in their molecule are called benzenoid compounds. Ex. benzene, toluene, naphthalene, phenol, aniline,

- Non benzenoid aromatic compounds** : They contain an aromatic ring other than benzene.

Ex. tropone, tropolone



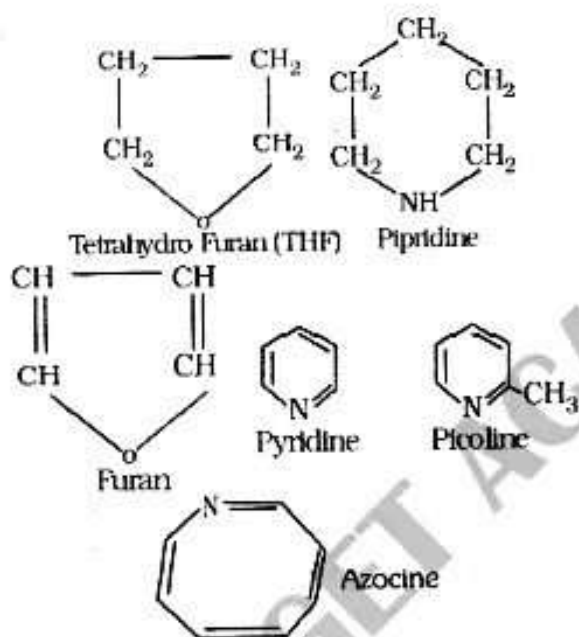
b) **Heterocyclic compounds** : Cyclic compounds containing one or more non carbon atom i.e. hetero atoms are called heterocyclic compounds. They are classified in two types.

i) **Heteroalicyclic compounds** : They contains hetero atoms are like O, N, S, R etc. -Their properties are like aliphatic compounds. Ex. Tetrahydro furan (THF), P'ipridine

ii) **Hetero aromatic compounds** : Heterocyclic compounds having properties like aromatics compounds are called hetero aromatic compounds. Ex. furan, pyridine. They are further classified in two types.

Benzenoid hetero aromatic compounds : They contain six membered ring. Ex. pyridine, picoline

Non benzenoid hetero aromatic compounds : They does not contain six membered aromatic ring but behave like aromatic compound. Ex.: azocine



□ Their general molecular formula is C_nH_{2n+2} . They are denoted by general formula R-H

• Common and IUPAC Names of nonbranched Alkanes

Alkane	Molecular formula	Alkane	Molecular formula
1. Methane	CH_4	13. Tridecane	$C_{13}H_{28}$
2. Ethane	C_2H_6	14. Tetradecane	$C_{14}H_{30}$
3. Propane	C_3H_8	15. Pentadecane	$C_{15}H_{32}$
4. Butane	C_4H_{10}	16. Hexadecane	$C_{16}H_{34}$
5. Fentane	C_5H_{12}	17. Heptadecane	$C_{17}H_{36}$
6. Hexane	C_6H_{14}	18. Octadecane	$C_{18}H_{38}$
7. Heptane	C_7H_{16}	19. Nonadecane	$C_{19}H_{40}$
8. Octane	C_8H_{18}	20. Eicosane	$C_{20}H_{42}$
9. Nonane	C_9H_{20}	21. Triacontane	$C_{30}H_{62}$
10. Decane	$C_{10}H_{22}$	22. Tetracontane	$C_{40}H_{82}$
11. Uridecane	$C_{12}H_{24}$	23. Peatacontane	$C_{50}H_{102}$
12. Dodecane	$C_{12}H_{26}$	24. Hexacontane	$C_{60}H_{122}$

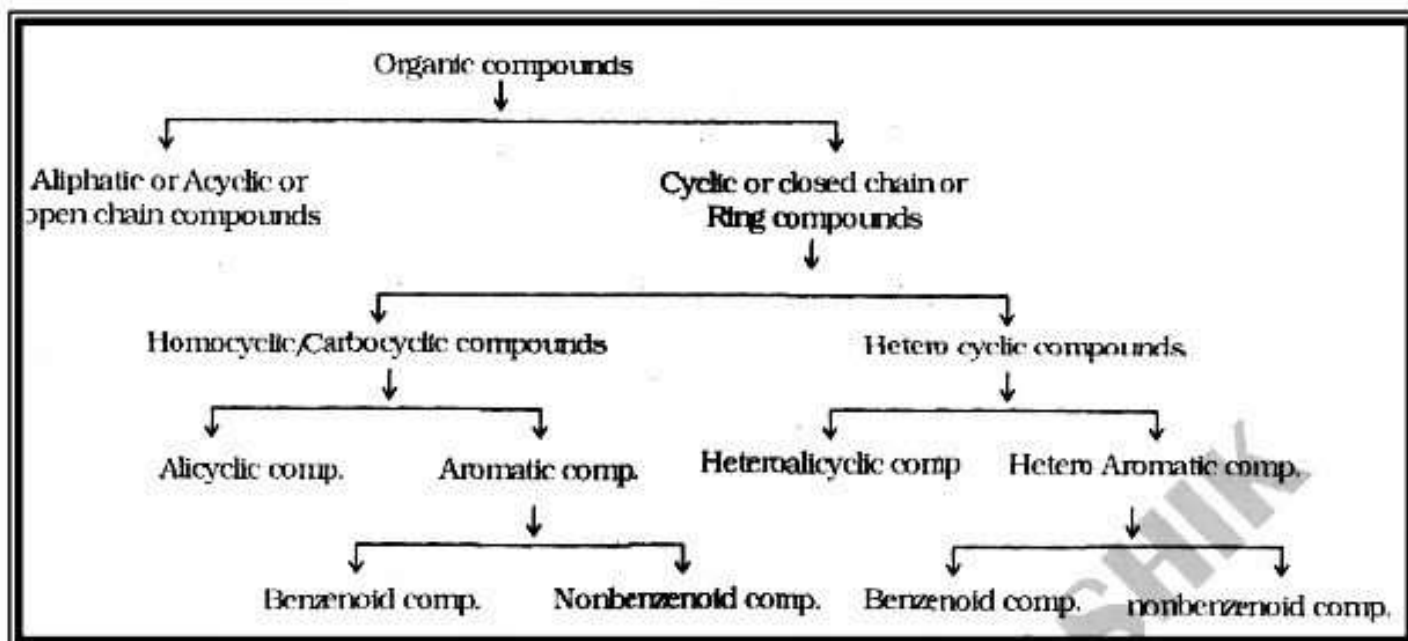
• Classification of organic compounds based upon functional group :

□ An atom a group of atoms in the organic compounds which determines their chemical properties is called functional group, on the basis of functional groups organic compounds are classified as follows.

A) **Alkanes** : These are the aliphatic saturated hydrocarbons in which all four valencies of each and every carbon atom are satisfied by four single covalent bonds.

□ In these compounds all carbon atom are linked with each other by carbon-carbon single bond.

CLASSIFICATION OF ORGANIC COMPOUNDS BASED ON THEIR STRUCTURE



Types of carbon atoms in organic compound :

- ❑ Organic compounds contain four types of carbon atoms.
- i) **Primary carbon (1°)** Carbon atom directly linked to other single carbon atom or not linked with any other carbon atom is primary carbon.
- ii) **Secondary carbon (2°)** Carbon atom directly linked to other two carbon atoms is secondary.
- iii) **Tertiary carbon (3°)** is linked to other three carbon atoms.
- iv) **Quaternary carbon (4°)** is directly linked to other four carbon atoms.

Alkyl radicals : They are obtained by removing one H atom from alkane and have one free valency and denoted by -R have general formula C_nH_{2n+1} .

- ❑ They are nominated by replacing ending ane of alkane by yl i.e. alkyl.ex:

$-CH_3$
Methyl

$CH_3-CH_2-CH_2-$
n-propyl

$CH_3-CH_2-CH_2-CH_2-$
n-butyl

$\begin{array}{c} CH_3 \\ | \\ CH_3-CH-CH_2 \end{array}$

iso-butyl

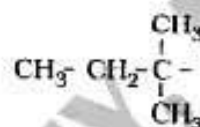
CH_3-CH_2-
Ethyl

$CH_3-\underset{|}{CH}-CH_3$
sec/iso propyl

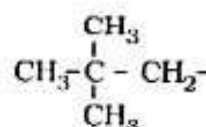
$CH_3-CH_2-\underset{|}{CH}-CH_3$
sec-butyl

$\begin{array}{c} CH_3 \\ | \\ CH_3-C- \\ | \\ CH_3 \end{array}$

tert-butyl



Ter-pentyl



neo-pentyl

Nomenclature of organic compounds :

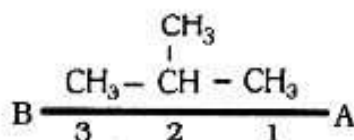
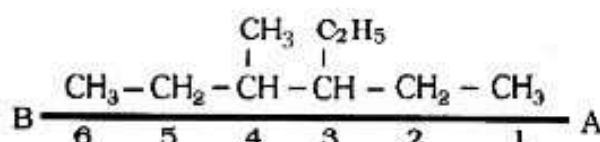
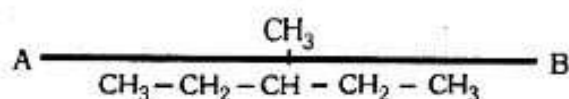
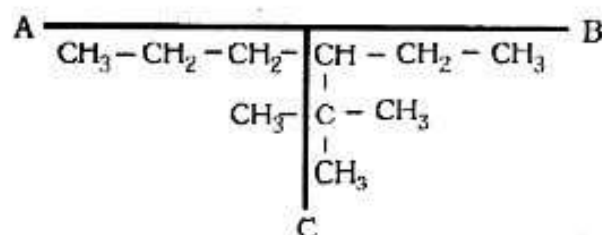
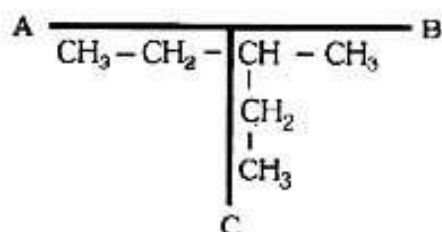
- ❑ In old days organic compounds were named from their properties and origin.
- ❑ Most effectively organic compounds are nominated by IUPAC system.
- ❑ IUPAC names of organic compounds contains three parts a) prefix b) root word c) suffix Prefix indicates the nature of substituent group which are present.
- ❑ Root name indicates number of carbon atoms in parent chain.

Suffix indicates the nature of functional group.

IUPAC nomenclature of branched chain alkanes:

- ❑ IUPAC rules are used to nominate branched chain alkanes.
- i) Select longest carbon chain from given branched chain alkane.

Carbon chain (A-C) is correct longest carbon chain.



- a) If the alkane contain more than one longest carbon chain containing same number of carbon atoms, the carbon chain containing more substituents is considered as correct carbon chain.

- ☐ Carbon chain A-B and A-C contains 6 carbon atoms.
☐ Carbon chain A-B contains one substituent where as A-C contains three substituents hence it is the correct longest chain.

- ☐ The compound is nominated as methyl derivative of pentane.

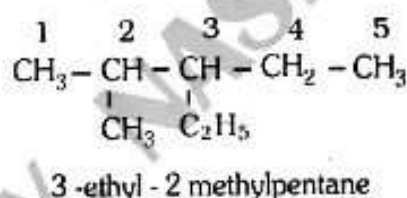
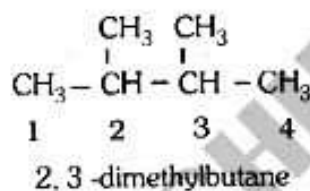
- iii) Number the longest carbon chain from the end nearer to side chain (branching)

- a) If two different side chains are arranged at equal distance from the either end then number the carbon chain from the end nearer to side chain comes first alphabetically, carbon chain should be numbered from A-B because end A is nearer to ethyl group.

- b) If the compound is more branched number the carbon chain from the end gives smallest some of locants.
 iv) Indicate the position of side chain by proper number of carbon atoms to which they are linked. In this compound side chain is methyl (-CH₃) of its position is 2.

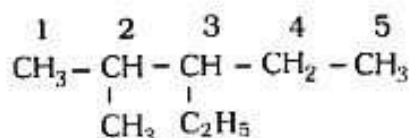
- v) If the same side chain is repeated for number erf times then they are indicated

by using prefixes like di, tri, & tetra respectively for two, three and four times.



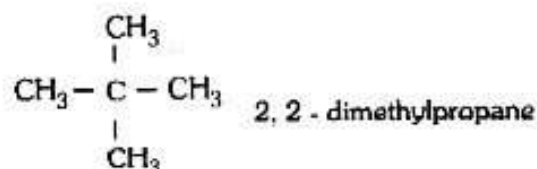
Prefixes like di, dri and tetra should be used immediately before the alkyl group.

- vi) Different side chain in branched chain alkane should be reported alphabetically.

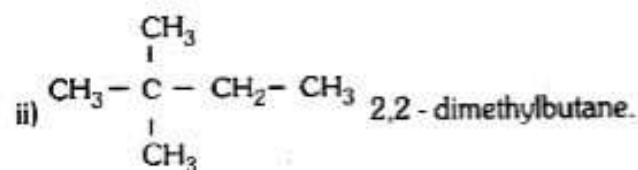
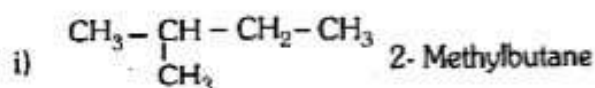


Numerical prefixes di, tri, tetra and so on as well as prefixes ter and sec. are ignored in alphabetic order but prefixes iso, neo and cyclo are considered in alphabetic order of the substituent groups.

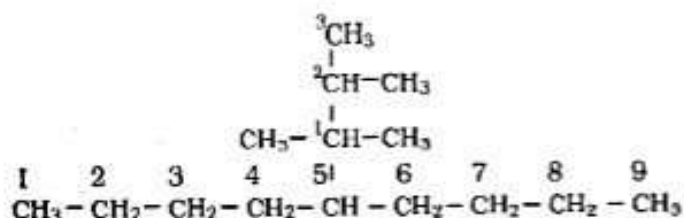
- vii) In IUPAC names numbers are separated by comma (,) where as numbers and names by hyphen (-)



- viii) The complete name of branched chain alkane is written as one word by prefixing the name of alkyl group with respective locant to the name of parent alkane. Ex :



- ix) In case of complex substituents (containing more than four carbon atoms) On carbon chain. It is nominated as substituted alkyl group whose carbon chain is numbered from the carbon attached to the main chain. The name of complex substituent should be written in bracket to avoid the confusion with the numbers of the parent chain.



b(1, 1, 2-trimethylpropyl) nonane.

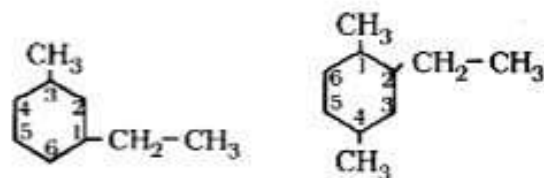
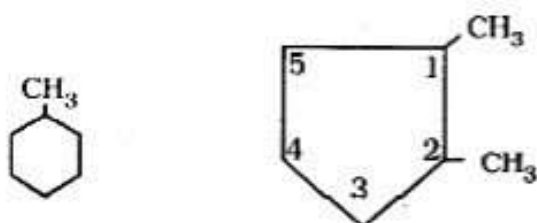
- x) Branched side chains sec propyl, sec butyl, isobutyl, ter butyl are reported as same or like complex side chain.

IUPAC Name of Cyclic Compounds :

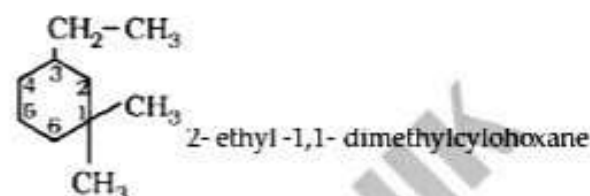
- Saturated monocyclic hydrocarbon are nominated as cyclo alkanes. Ex :



- Mono substituted cyclic compounds does not require numbering of carbon ring.
- Substituted cyclo alkanes are nominated as alkyl cyclo alkanes.
- If the compound contains more alkyl side chains then it should be numbered in alphabetical order but it must satisfy lowest sum of locants rule.

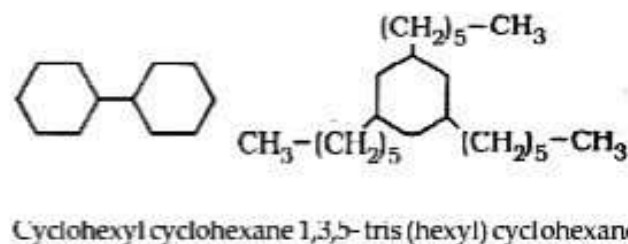
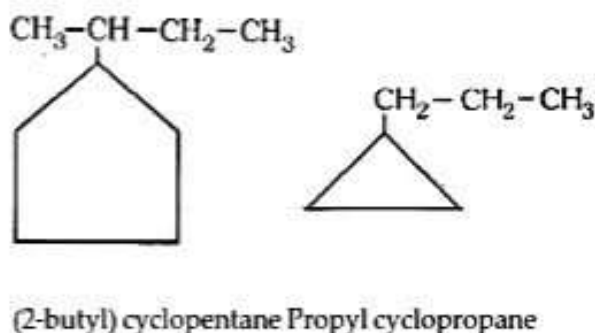
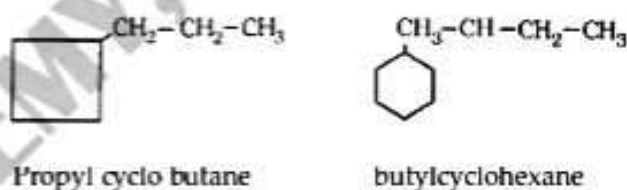


(Alphabetical order) (Smallest sum of locants)

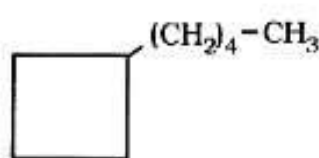


(More branched carbon get number)

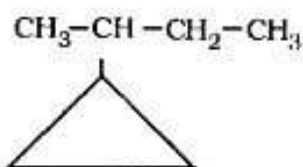
- Cyclo alkane when contains a side chain having less or same carbon then they are nominated as alkyl derivative of cyclo alkane.



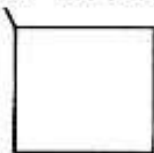
- If the alkyl side chain in cyclo alkane contains more number of carbon atoms then they are nominated as cyclo derivatives of open chain alkane. Ex.



1 - cyclobutylpentane



2 - cyclopropylbutane



3 - cyclobutylpentane

IUPAC Nomenclature of organic compounds having functional group

- Aliphatic open chain organic compound are nominated as the derivatives of parent hydrocarbon.
 - Organic compounds having functional groups are obtained by replacing one or more hydrogen atoms by different side chains of functional groups.
 - IUPAC names of organic compounds contains two to three parts.
 - Root word : - Number of carbon atoms in continuous chain of organic compounds is indicated by root words as follows. (In general root word for any carbon chain is alk)
 - Secondary suffix is attached to primary suffix by replacing ending e of primary suffix,
- ii) Suffix
- a) Primary suffix: It indicate saturation and unsaturation in carbon chain. It is added to root word.
 - b) Secondary suffix: It is added after the primary suffix

Root word	No. of C. atoms	Root word.	No. of atoms
Meth -	C ₁	Tridec -	C ₁₃
Eth -	C ₂	Tetradec -	C ₁₄
Prop -	C ₃	Pentadec -	C ₁₅
But -	C ₄	Hexadec -	C ₁₆
Pent -	C ₅	Heptadec -	C ₁₇
Hex -	C ₆	Octadec -	C ₁₈
Hept -	C ₇	Nonadec -	C ₁₉
Oct -	C ₈	Eicos -	C ₂₀
Non -	C ₉	Triacot -	C ₃₀
Dec -	C ₁₀	Tetracont -	C ₄₀
Undec -	C ₁₁	Pentacont -	C ₅₀
Dodec -	C ₁₂	Hexacont -	C ₆₀

- iii) Prefix : - It is used to indicate different side chains in parent carbon chain before root word, atoms or groups like chloro (-Cl), Bromo (Br), nitro (-NO₂) alkoxy (-OR) are prefixes.

- Prefix, root word and suffix are arranged in the order, prefix + root word + primary suffix + secondary suffix

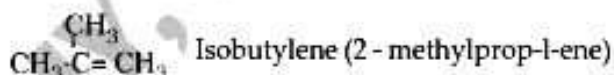
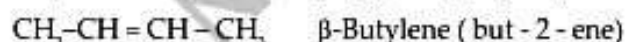
B) Alkenes :

- Aliphatic unsaturated hydrocarbons containing one or more carbon-carbon double bond are called alkenes. Due to presence of one pi bond they are called unsaturated compounds. They contain two hydrogen atoms less than parent alkane.

- Their general molecular formula is C_nH_{2n}

- Their functional group is C = C

- According to common system they are nominated as alkylene where as according to IUPAC system as alkenes. Ex (names in bracket are IUPAC)



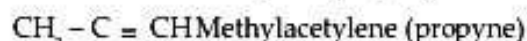
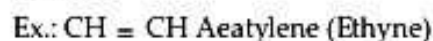
- C) **Alkynes** : Alkynes are the aliphatic unsaturated hydrocarbons containing one or more carbon-carbon triple bond in molecule.

- Due to presence of two pi bonds they are unsaturated compound.

- They contain four hydrogen atoms less than respective alkane & two hydrogen atoms less than parent alkane.

- Their general molecular formula is C_nH_{2n-2}

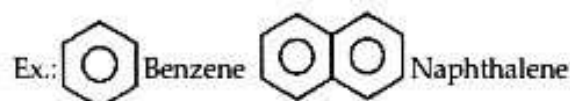
- According to common system they are nominated as acetylenes where as according to IUPAC system as alkynes.



- D) **Arenes** : These are aromatic hydrocarbons.

- They contain at least one six membered carbon ring having alternate double bonds.

- They have characteristic odour called aroma, i.e. pleasant odour. Benzene and its higher polynuclear derivatives are arenes.



E) Halides : (Halogen derivatives of Alkanes) :

- Derivatives of alkanes obtained by replacing one or more hydrogen atoms by same number of halogen atoms are called halogen derivatives of alkanes.

- Their functional group is halide group i.e. (X= F, Cl, Br, I,). According to common system they are nominated as alkylhalides where as according to IUPAC as haloalkanes. Ex.

$\text{CH}_3 - \text{Cl}$ Methyl chloride (Chloromethane)

$\text{CH}_3 - \text{CH}_2\text{Cl}$ ethyl chloride (Chloroethane)

$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{Cl}$

n-propylchloride (1-chloropropane)

$\text{CH}_3 - \text{CH} - \text{CH}_3$

|
Cl

iso/sec propyl chloride (2- chloropropane)

$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{Cl}$

n-butyl chloride (1 -chlorobutane)

$\text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH}_3$

|
Cl

sec-butyl chloride (2-chlorobutane)

$\text{CH}_3 - \text{CH} - \text{CH}_2 - \text{Cl}$

|
 CH_3

iso butyl chloride
(2-methyl-1-chloropropane)

CH_3
|

$\text{CH}_3 - \text{C} - \text{Cl}$

|
 CH_3

Ter-butyl chloride (2-methyl-2-chloropropane)

CH_3
|

$\text{CH}_3 - \text{CH}_2 - \text{C} - \text{Cl}$

|
Cl

Ter - pentyl chloride (2-methyl-2-chlorobutane)

CH_3
|

$\text{CH}_3 - \text{C} - \text{CH}_2 - \text{Cl}$

|
 CH_3

neo pentyl chloride.

(2,2-dimethyl-1-chloropropane)

CH_2Cl_2 Methylene dichloride (Dichloromethane)

CHCl_3 Chloroform (Trichloromethane)

CCl_4 Carbon tetra chloride (Tetrachloromethane)

$\text{CH}_3 - \text{CHCl}_2$

Ethylidene dichloride (1,1- dichloroethane)

$\text{CH}_2\text{Cl} - \text{CH}_2\text{Cl}$

Ethylene dichloride (1,2- dichloroethane)

$\text{CH}_3 - \text{CH}_2 - \text{CHCl}_2$

n-propylidene dichloride (1,1- dichloropropane)

$\text{CH}_3 - \text{CCl}_2 - \text{CH}_3$

Sec propylidene dichloride (2,2- dichloropropane)

$\text{CH}_3 - \text{CHCl} - \text{CH}_2\text{Cl}$

Propylene dichloride. (1,2- dichloropropane)

F) Alkyl Cyanides or Nitriles :

- These are derivatives of alkanes obtained by replacing H atom by - CN (Cyanide group)
- They may be considered as the derivatives of alkanes obtained by replacing three H atoms from same carbon atom by $\equiv \text{N}$.
- They contains - C \equiv N i.e. cyanide group and $\equiv \text{N}$ i.e. nitrile group in their molecule.
- They are nominated as alkyl cyanides, alkane nitriles or by replacing ending ic acid by nitrile from their hydrolysis products. They are denoted by general formula $\text{R}-\text{C} \equiv \text{N}$ Ex.:

$\text{H} \equiv \text{C} \equiv \text{N}$ Hydrogen cyanide/methane nitrile/ formonitrile

$\text{CH}_3 - \text{C} \equiv \text{N}$ Methyl cyanide/Ethane nitrile/ Acetonitrile.

$\text{CH}_3\text{CH}_2\text{C} \equiv \text{N}$ ethyl cyanide/propane nitrile/ propionitrile

G) Nitro alkanes :

- Derivatives of alkanes obtained by replacing H atom by - NO_2 (nitro groups) are called nitro alkanes.
- They are denoted by general formula $\text{R}-\text{NO}_2$ Their functional group is - NO_2 (nitro group)
- They are nominated as nitro derivatives of alkanes.

Ex.: $\text{CH}_3 - \text{NO}_2$ Nitromethane

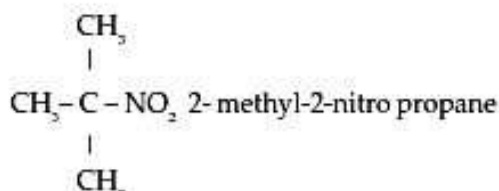
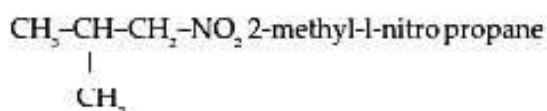
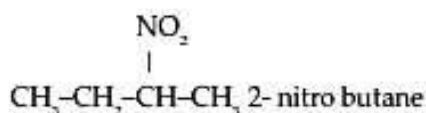
$\text{CH}_3 - \text{CH}_2 - \text{NO}_2$ Nitroethane

$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{NO}_2$ 1 - nitropropane

$\text{CH}_3 - \text{CH} - \text{CH}_3$ 2 - nitropropane

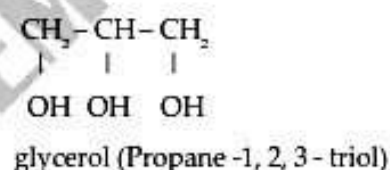
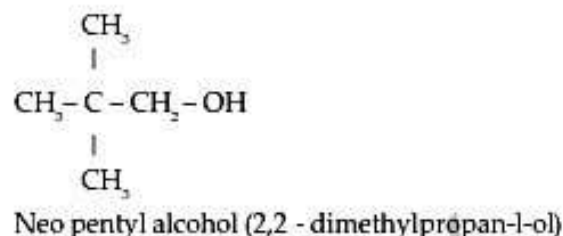
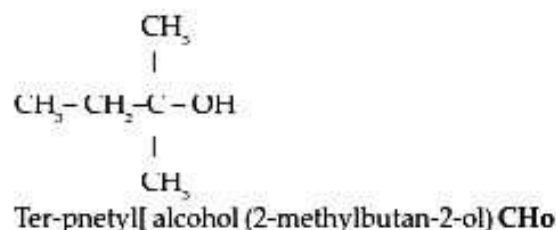
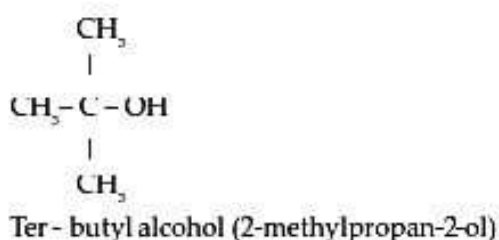
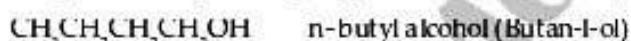
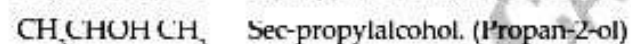
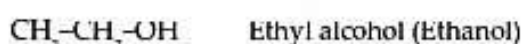
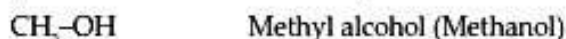
|
 NO_2

$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{NO}_2$ 1-nitro butane



H) **Alcohols** : These are the derivatives of alkanes obtained by replacing one or more H atoms by same number of -OH groups.

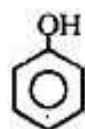
- More than one -OH groups should be arranged on different carbon atoms.
- Alcohols containing single -OH group are denoted by general formula R-OH
- Their functional group is -OH (Alcoholic)
- Their general molecular formula $\text{C}_n\text{H}_{2n+2}\text{O}$
- According to common system they are nominated as alkyl alcohol and according IUPAC as alkanol. Ex.: (names in bracket are IUPAC)



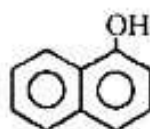
i) **Phenols** :

- These are the aromatic hydroxy compounds in which one or more -OH groups are directly linked to aromatic ring. They are acidic in nature.
- They are bifunctional compounds because they contain two functional groups

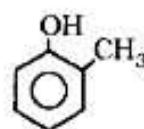
i) - OH (phenolic) ii) - aromatic ring Ex.:



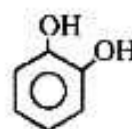
Phenol



α - Naphthol



O-cresol



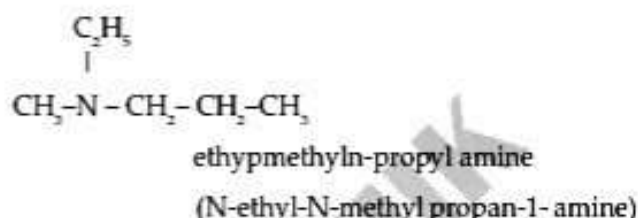
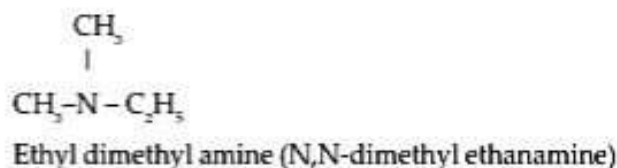
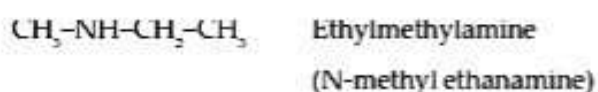
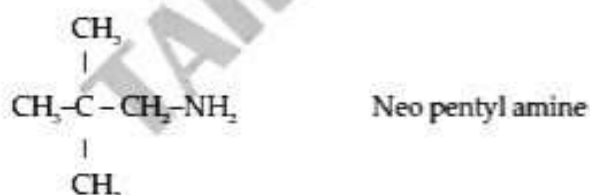
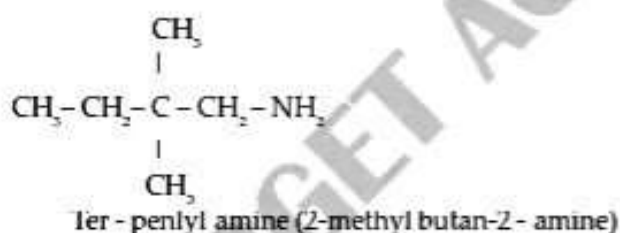
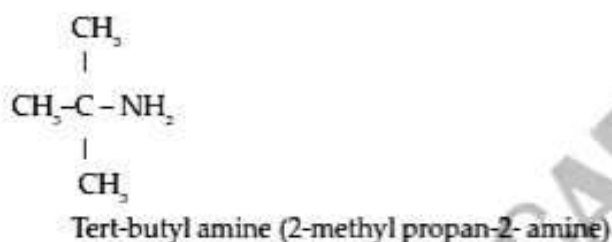
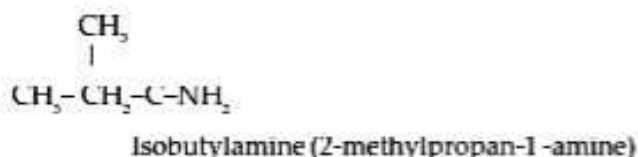
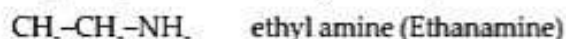
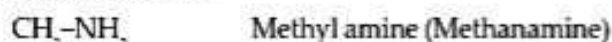
Catechol

J) **Amines** :

- These are monoalkyl, dialkyl and trialkyl derivatives of ammonia.
- They are denoted by general formula R-NH_2 , R-NH-R_1 and R_3N

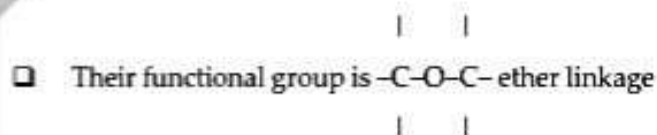
- Their functional groups are $-HN_2$, $-NH$ - and $=N$
- According to common system amines are nominated as alkyl amine, dialkyl amines or alkyl alkyl amines and trialkyl amines or alkyl dialkyl or alkyl alkyl alkyl amine.

- According to IUPAC system they are nominated M alkanamine or N-alkyl alkanamine or N,N-dialkyl alkanamine. Ex.:



K) Ethers :

- They are defined as dialkyl derivatives of water.
- Alkoxy derivatives of alkanes.
- Alkyl derivatives of monohydric alcohols.
- Anhydrides of monohydric alcohols.
- Derivatives of alkanes obtained by replacing $-CH_3$ group by $-O-$.
- They are denoted by general formula $R-O-R$,
- R and - R, are two same or different alkyl groups.



- Their general molecular formula is $C_nH_{2n+2}O$.
- According to common system they are nominated as dialkylether or alkyl alkyl ether where is according to IUPAC as alkoxyalkane of higher alkane.



L) Aldehydes :

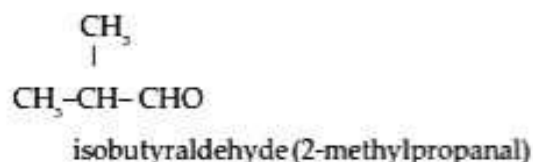
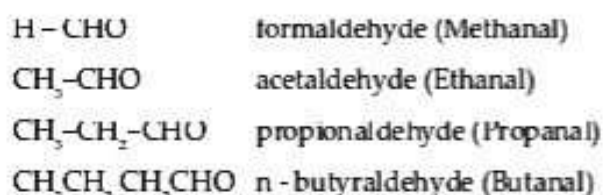
- Carbonyl compounds in which one valency of carbonyl carbon is always satisfied by H atom and another by any alkyl group or H atom are called aldehydes.

- Organic compounds containing $=C=O$ group are called carbonyl compounds.

- They are denoted by general formula $R-CHO$.

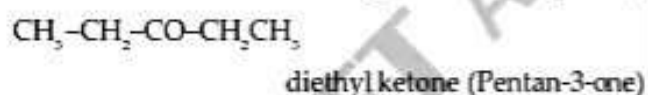
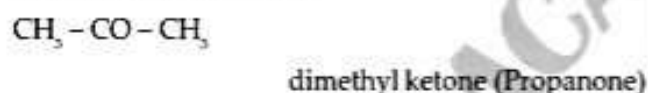
- Their general molecular formula is $C_nH_{2n}O$.

- According to common system they are nominated from their oxidation products carboxylic acids by replacing ending ic acid by aldehyde where as according to IUPAC as alkanal. Ex. :



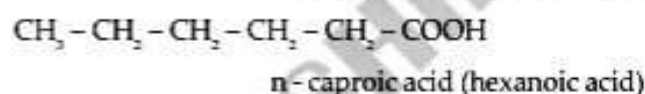
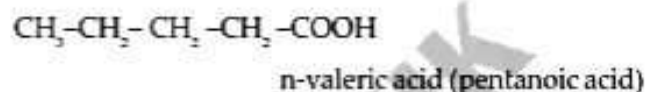
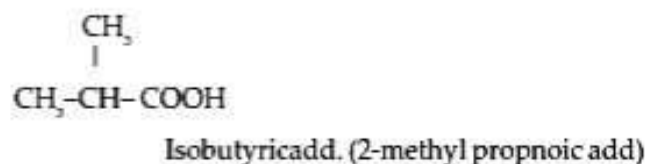
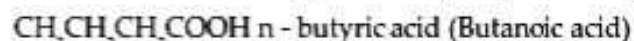
M) Ketones :

- Carbonyl compounds in which both valencies of carbonyl carbon are satisfied by two alkyl groups.
- They are denoted by general formula $\text{R}-\text{CO}-\text{R}_1$
- R & R_1 are two same or different alkyl groups.
- Their function group is $=\text{C}=\text{O}$ (Carbonyl group / ketonic group / oxo group).
- Their general molecular formula is $\text{C}_n\text{H}_{2n}\text{O}$
- Aldehydes and ketones have same general molecular formula but having different functional groups hence they are functional isomers of each other.
- According common system they are nominated as dialkyketone or alkyl alkyl ketone and according to IUPAC as alkanone. Ex. :



N) Carboxylic acids :

- Organic compounds containing $-\text{COOH}$ group in their molecule are called carboxylic acids.
- They are denoted by general formula $\text{R}-\text{COOH}$
- $-\text{R}$ is any alkyl group or H atom.
- Their functional group is $-\text{COOH}$ (carboxyl group)
- Their general molecular formula is $\text{C}_n\text{H}_{2n}\text{O}_2$
- According to common system they are nominated from their initial sources in Greek or Latin language.
- According to IUPAC system they are nominated as alkanoic acid Ex:



- O) **Esters :** These are the derivatives of carboxylic acids obtained by replacing H atom from OH group by any alkyl group.

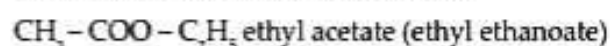
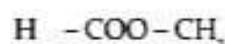
- They are denoted by formula $\text{R}-\text{COOR}_1$ where $-\text{R}$ and $-\text{R}_1$ are two same or different alkyl groups.

- Their functional group is $-\text{COOR}$ (Ester group)

- Their general molecular formula is $\text{C}_n\text{H}_{2n}\text{O}_2$

- According to common system they are nominated as alkyl carboxylate and their IUPAC names are as alkyl alkanoate.

Ex. :



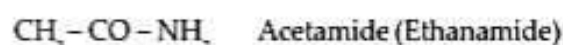
P) Amides :

- Derivatives of carboxylic acid obtained by replacing $-\text{OH}$ group by $-\text{NH}_2$ group are called amides.

- They are denoted by general formula $\text{R}-\text{CO}-\text{NH}_2$
 Their functional group is $-\text{CO}-\text{NH}_2$ amide groups.

- They are nominated by replacing ending 'ic acid' by amide from the name parent carboxylic acid.

- According to IUPAC they are nominated as alkanamide. Ex.:



Q) Acid anhydrides :

- Intermolecular dehydration products of carboxylic acids are called acid anhydrides.
- They are obtained by removing water molecule from two molecules of carboxylic acid.
- They are denoted by general formula $R-CO-O-CO-R$ and their functional group is $-CO-O-CO-$ (anhydride group)
- They are nominated by replacing ending acid by anhydride from the name of carboxylic acid.
- According to IUPAC they are nominated as alkanoid anhydride. Ex. :

$H-CO-O-CO-H$ formic anhydride
(Methanoic anhydride)

$CH_3CO-O-CO-CH_3$ Acetic anhydride
(Ethanoic anhydride)

$C_2H_5CO-O-CO-C_2H_5$ Propionic anhydride
(propanoic anhydride)

R) Acyl chlorides :

- These are the derivatives of carboxylic acids obtained by replacing $-OH$ group by $-Cl$.
- They are denoted by general formula $R-CO-Cl$
- Their functional group is $-CO-Cl$ (acyl chloride group).
- They are nominated by replacing ending acid by yl chloride from the name of carboxylic acid.
- According to IUPAC they are nominated as alkanoyl chlorides. Ex. :

$H-CO-Cl$ formyl chloride. (Methanoyl chloride)

$CH_3-CO-Cl$ acetyl chloride (ethanoyl chloride)

C_2H_5CO-Cl propionyl chloride. (Propanoyl chloride)

S) Sulphonic acids:

- Derivatives of hydrocarbons obtained by replacing H atom by SO_3H (Sulphonic acid group) are called sulphonic acids.
- They are denoted by general formula $R-SO_3H$
- Their functional group $-SO_3H$ (Sulphonic acid group)
- CH_3-SO_3H Methane Sulphonic acid
- $CH_3-CH_2-SO_3H$ ethane Sulphonic acid.

**Homologous series :**

- A series of organic compounds having same functional group and the successive members are constantly differ by $-CH_2$ (Methylene group) is called homologous series.
- Individual member of homologous series is called ; homologue.
- Homologous are represented by general formula.
Ex.: Alcohol series.
 CH_3-OH Methyl alcohol.
 CH_3-CH_2-OH Ethyl alcohol.
 $CH_3-CH_2-CH_2-OH$ propyl alcohol.
- Alcohol series is denoted by general formula $C_nH_{2n+1}OH$.
- Alkanes, Alkenes, Alkynes, alkyl halides, Aldehydes, carboxylic acids are the examples of homologous series.

Characteristics Homologous series :

Homologues belonging to same homologous series are denoted by same general formula.

- Homologues belongs to same series have same functional group.
- Successive members are differ by $-CH_2-$ group.
- They have difference of M_n in their molecular weights.
- Homologues are prepared by using same chemical process.
- Homologues have identical chemical properties due to presence of same functional group.
- Homologues show constant gradation in their physical properties like M_n , B.R density, solubility due to their different molecular size.
- Suffix indicates the nature of functional group.

IUPAC Nomenclature of polyfunctional organic compounds

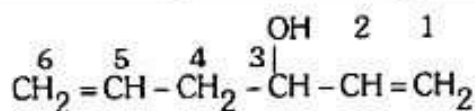
- Poly functional compounds contains more than one functional groups.
- One of the functional group is selected as principal functional group and compound is nominated on the basis of that functional group. The remaining functional groups are considered as side chains. Select longest carbon chain containing principal functional group including maximum functional groups.
- Number the carbon chain from principal functional group.
- In case of two substituents of same priority number the carbon chain in alphabetical order.

- Substituents, side chains and secondary functional groups are arranged in alphabetical order.
- Principal group is decided on the basis of order in following table from top to bottom. If same group is repeated for two or more times, they are indicated by using di, tri, tetra before the class suffix.
- In above cases full name of parent alkane is reported before the class name but in compounds having two or more double and triple bonds ending -ne of parent alkane is removed.

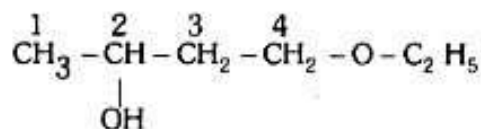
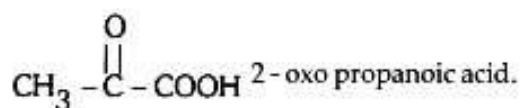
Priority order of principal groups :

(Decreasing order from top to bottom)

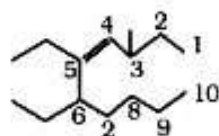
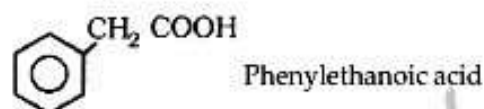
Functional group	Prefix name	Suffix Name
-COOH	Carboxyl	Oic acid
SO ₃ H	Sulpho	Sulphonic acid
-COOR	Alkoxy carbonyl/	
	Carbalkoxy	alkyloate
-COX	Holoformyl/	
	halocarbonyl	-Oylhalide
-CONH ₂	Carbamoyl	amide
-CN	Cyano	nitrile
-NC	Isocyano	Carbylamine
-CHO	formyl / aldo	al
>C=O	Keto/Oxo	one
-OH	hydroxy	ol
-SH	Mercapto	thiol
-NH ₂	Amino	amine
>C=C<	-	ene
$\text{-C}\equiv\text{C-}$	-	yne
-OR	alkoxy	-
-C-C- O	Epoxy	-
-N=N-	azo	-
-NO ₂	Nitro	-
-NO	Nitroso	-
-X	Halo	-
	(chloro, bromo, iodo)	



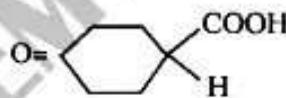
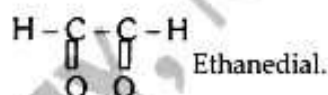
Hexa -1,5- dien - 3-ol



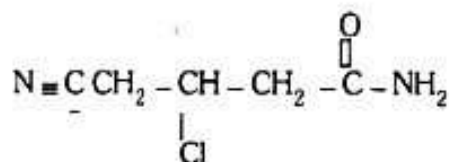
4-ethoxy butan - 2-ol.



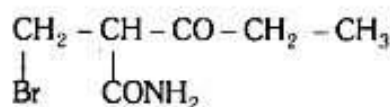
5,6 - diethyl - 3- methyl dec - 4 - ene



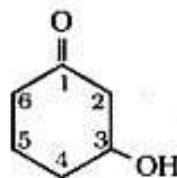
4 - Oxo cyclohexane -1- carboxylic acid.



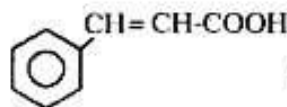
3-Chloro - 4 - cyano butanamide

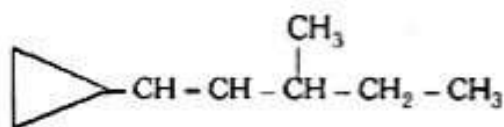


2 (Bromomethyl) - 3 - oxopentanamide

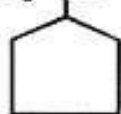
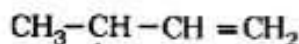


3 - hydroxy cyclohexanone

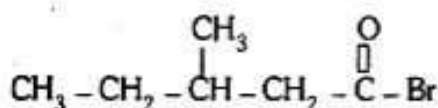




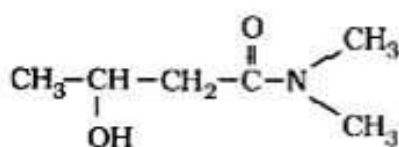
1-cyclopropyl-3-methylpent-1-ene.



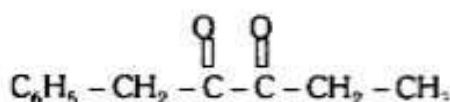
3-cyclopentylbut-1-ene



3-Methyl pentanoylbromide



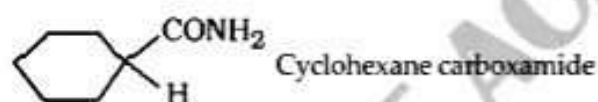
3-hydroxy-N,N-dimethylbutanamide



1-phenylpentane-2,3-dione



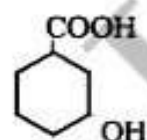
3(benzoyloxy)propanoic acid



Cyclohexane carboxamide



4-formyl-2-oxocyclohexane-1-carboxylic acid.



3-hydroxycyclohexane carboxylic acid.

FUNDAMENTAL CONCEPT IN ORGANIC REACTION MECHANISM

- Study of path followed by reactants during their conversion in products is called mechanism of reaction.

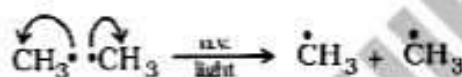
- Movement of electrons in organic reaction is shown as.

i) Shifting of electron pair from π bond to adjacent bond position is indicated as $\text{--}\overset{\curvearrowright}{\text{Z}}\text{--} \longleftrightarrow \text{--}\text{Z}=\text{}$

ii) Shifting of electron pair from π bond to adjacent atom is indicated as $\text{--}\overset{\curvearrowright}{\text{Z}}\text{--} \longleftrightarrow \text{--}\overset{\ominus}{\text{Z}}\text{--}$

iii) Shifting of electron pair from atom to adjacent bond position $=\overset{\ominus}{\text{Z}}\text{--} \longleftrightarrow \text{--}\text{Z}=\text{}$

iv) Movement of single electron is shown by half headed curved arrow (fish hook \curvearrowright)



Electronic displacements in a covalent bond :

- Shared pair of electrons in single and multiple bonds can move from one place to another.
- Shared pair of electrons in single bond can displace towards one of the bonding atoms having more electronegative atom is called inductive effect.
- Pi (π) electrons pair in multiple bonded compounds can transfer on one of the bonding atoms in presence of suitable reagent is called Electromeric effect.
- Inductive effect: (Mobility of electrons in single bond)** : Permanent polarization of single covalent bond between two atoms having different electronegativity values is called inductive effect.
- It is permanent effect because displaced a electrons pair can not be retained at the centre.
- Electron density on one of the bonding atoms increases and form partial negative ($-\delta$) charge and less electronegative atom form partial positive ($+\delta$) charge. Electrons can not loose the octet of any bonding atoms.
- It is denoted by I and represented by straight arrow (\longrightarrow) directed towards more electronegative atom.



In $\text{CH}_3\text{--Cl}$ shared pair of electrons is attracted towards more electronegative atom Cl where as in $\text{CH}_3\text{--Mg--I}$ Shared pair of electrons is displaced

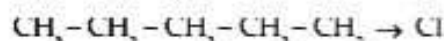
- towards carbon due to electron repelling tendency of Mg atoms.

Characteristics of inductive effect.

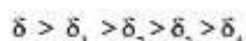
- It is permanent effect.
- It is found in single bonded compounds.
- In this effect o electron pair is displaced towards more electronegative atom.

- iv) Electrons cannot loose the octet of any bonding atoms.
- v) This effect does not require any external reagent.
- vi) It is indicated by arrow head which indicates displacement of electron pair towards more electronegative atom.

- Transmission of inductive effect can take place in carbon chain with decrease in intensity and it is neglected after four carbon atoms due to its negligible magnitude.

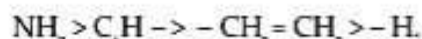


The magnitudes of positive charges decreases in the order



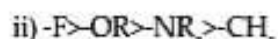
- The atoms or groups have strong shared pair electron attracting tendency than hydrogen are called electron attracting groups and they produce -I effect.

- Decreasing order of electron attracting tendency of groups is



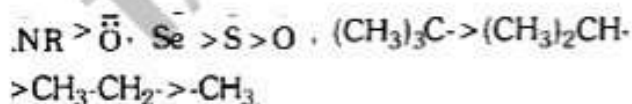
- More electronegative atoms have greater -I effect.
- Positively charged atoms or group have greater effect than neutral atoms or groups.

- Some important decreasing order are.



- The atoms or groups have strong electron releasing tendency than H are called electron releasing groups and result +I effect.

- The decreasing orders of electron releasing groups are



- Metals like Na, K, Mg, Zn and alkyl group like $-\text{CH}_3$, $-\text{CH}_2$, $-\text{CH}_2\text{-CH}_3$, $-\text{CH}(\text{CH}_3)_2$, $-\text{C}(\text{CH}_3)_3$, $-\text{C}(\text{CH}_3)_2$ are electron donating groups.

- Negatively charged ions like CH_3O^- , $\text{C}_2\text{H}_5\text{O}^-$, $-\text{COO}^-$, $-\text{R-S}^-$ show strong -I effect.

- Less electronegative elements have strong +I effects e.g. $\text{Be} > \text{B} > \text{C}$.

- Negatively charged ions have strong +I effect than neutral atoms or groups.

Electromeric effect

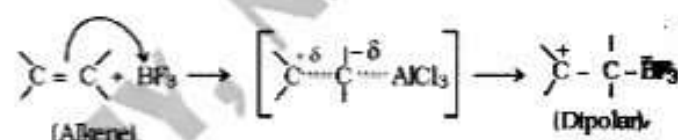
- Complete temporary transfer of π (pi) electrons pair on one of the atoms linked with each other by multiple bond in presence of suitable reagent is called electromeric effect.

- It is temporary effect because transferred π electrons pair come back to its original position when reagent is removed.

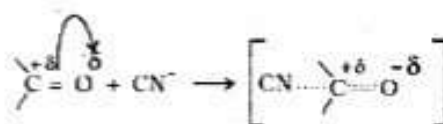
- It is denoted by E and represented by curved arrow or fish arrow which indicate transfer of π electron pair. It is observed in organic compounds having multiple bonds.

- In this effect complete positive and negative charges are formed on two bonding atoms.

- In the following example π electrons pair is transferred towards the attacking site of reaction initiating reagent is called +E effect. Ex.:

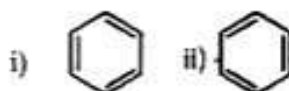


- In the above example π electrons pair is transferred away from the attacking site of reaction initiating reagent and is called -E effect.



Resonance The property of organic compound to have different electronic structures in which all are equally capable to explain most of the properties but not a single structure can explain all the properties is called Resonance or mesomerism and the different structures are called resonating structures.

- Kekules structure of benzene



can not explain all properties of benzene satisfactorily.

- These structures contain three carbon carbon single bonds and its bond length should be 154pm.

- These structures have carbon carbon double bond and their bond length should be 134pm but both bond lengths are not found in benzene,

- Only one carbon-Carbon bond length i.e. 139pm is experimentally observed in benzene.

- ❑ Kekules structure of benzene contains three carbon carbon double bonds hence It should behave like alkenes and show addition reactions but it behave like saturated compound and some other properties are not explained by these structures.

- ❑ The actual structure of benzene is between these two structures called resonance hybrid.



Resonance structure of benzene



Resonance hybrid of benzene

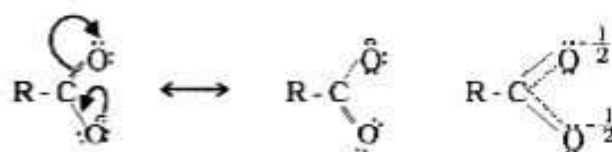
- ❑ Resonance hybrid is the hypothetical and never exists though it represents the actual structure of the molecule.
- ❑ Resonance hybrid may be defined as the actual structure of all the different possible structures that can be written for the molecule without changing the relative positions of its atom.

Characteristics features of Resonance hybrid

- Resonance hybrid is more stable than its any other resonating structures.
- ❑ The difference between the energies of resonance hybrid and the most stable resonating structures is called resonance energy of the molecule.
 - ❑ Energy of resonance hybrid of benzene is lower than the total energy of two kekules structure by 36 K cal/ mole. As the number of canonical (Resonance) structure increases the stability also increases.
- Bond lengths in resonance hybrid and contributing structures are different.

Factors affecting the stability of resonating structures

- Non polar structures are relatively more stable than polar structures,
 - Structures having isolated charges are less stable.
 - Among charged structures, If positive and negative charges are arranged respectively on most electropositive and most electronegative atoms are most stable.
 - Resonance structures having positive charge on electron deficient atoms have very high energy of hence unstable.
 - Resonating structures having more number of covalent bonds are most stable.
- ❑ Resonating structures of carboxylates ion.



Resonating structures

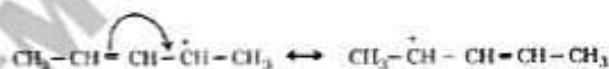
Resonance hybrid

Rules for drawing resonance structure

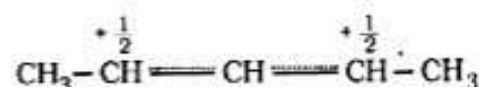
- Electrons in atoms in resonance structure can move where as their nuclei cant move
- Bond angles are same.
- Only π and lone pairs of electron can move:
- Number of unpaired electron should be same.
- Resonance having lowest energy and complete octet are most stable.
- They have little charge separation.
- Anions of more electronegative atoms like O, N and S are more stable.

- ❑ Movement of electron can take place as follows.

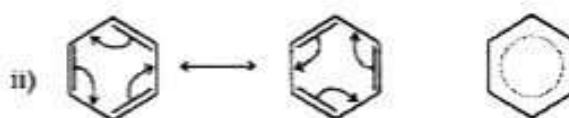
- Movement of π electrons towards a positive charge of π bond.



Resonance from



Resonance hybrid

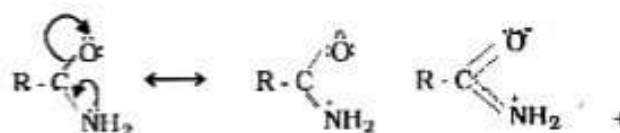


Resonance forms

Resonance hybrid.

(Movement of π electrons towards a π bond)

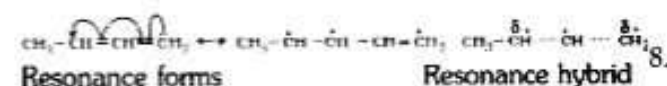
- Movement of lone pair of electrons towards π bonds



Resonance form

Resonance hybrid

- Movement of single nonbonding electron towards π bond:



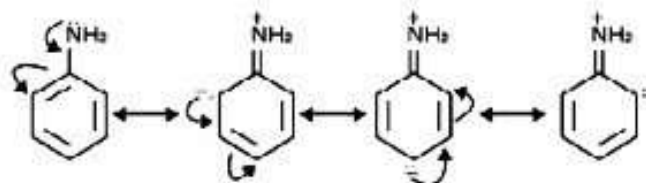
Resonance forms

Resonance hybrid

Resonance effect: Polarity produced in the molecule by the interaction between two π bonds or a π bond and a lone pair of electrons is called Resonance effect.

Positive Resonance effect : (+R) :

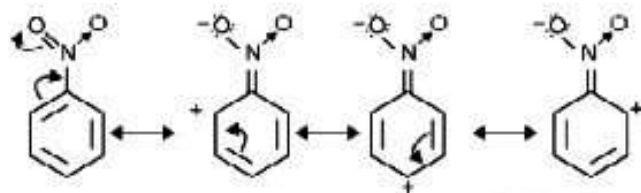
- When the electrons are transferred away from the substituent atom or group attached to the conjugated system is called positive resonance effect.
- The electron displacement can take place from high electron density. It is observed in aniline



- This effect is shown by halogens, $-\text{OH}$, $-\text{OR}$, $-\text{NH}_2$, $-\text{NHR}$, $-\text{NR}_2$, $-\text{NHCOR}$, OCOR etc.

Negative resonance effect (-R) :

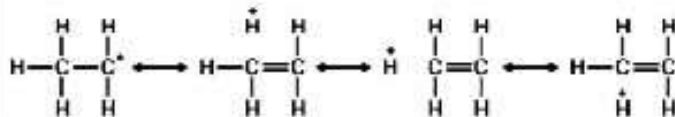
- The transfer of electrons towards substituent atoms or groups linked to conjugated system is termed as negative resonance effect.
- The electron displacement can take place towards less electron density. It is found in nitrobenzene.



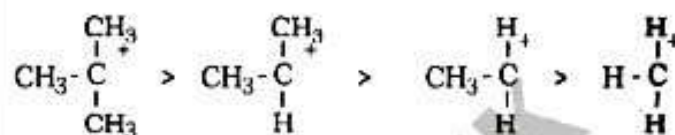
- This effect is shown by $-\text{COOH}$, $-\text{CHO}$, $-\text{CO}$, $-\text{CN}$, $-\text{NO}_2$ groups.

Hyperconjugation :

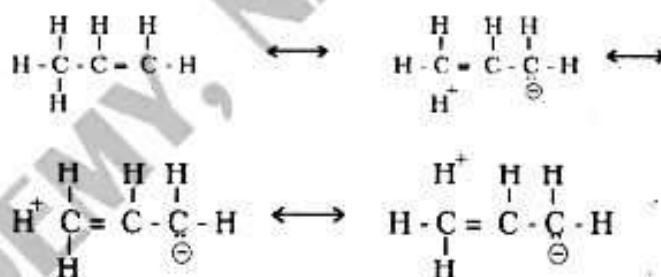
- It is a permanent stabilizing interaction of a electron pair with unshared p-orbital or unsaturated system.
- It is delocalization of a electrons of C-H bond of an alkyl group directly attached to an atom of unsaturated system or with unshared p-orbital.
- The σ electron pair of C-H bond of an alkyl group is involved in partial conjugation with unsaturated system or unshared p-orbital.
- Positively charged carbon of $\text{CH}_3-\text{CH}_2^+$ (ethyl cation) contains a empty p orbital.
- One of the C-H bonds of the methyl group may align in the plane of empty p-orbital and C-H bond of a electron pair can be delocalized in empty p-orbital.
- Due to dispersion of positive charge on carbonium ion by the delocalization of adjacent electron pair they are stabilized.



- As the number of alkyl groups attached to positively charged carbon atoms increases the stabilization of cation by hyperconjugation also increases.
- Decreasing order of stability of carbocations from ter, sec, and primary carbocations is due to same reason.



- It is found in aliphatic unsaturated hydrocarbons like alkenes and aromatic hydrocarbons like, arenes.
- It is considered as no bond resonance and It explained by propylene.

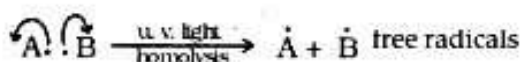


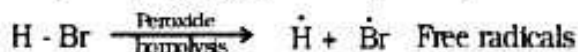
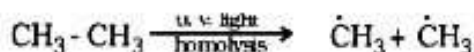
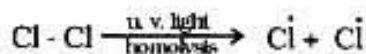
BOND FISSION

- The force of attraction which keeps atoms together in a molecule or ion is called chemical bond.
- Breaking, cleavage or rupture of a chemical bond is called bond fission.
- The process involves the breaking of old bond & formation of new bonds is called chemical reaction.
- On the basis of distribution of shared pair of electrons symmetrically and unsymmetrically the bond fission is divided in two types.

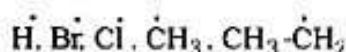
Homolytic bond fission :

- Symmetrical breaking of a covalent bond between two atoms in which both separating species retain their own electron from shared pair and form free radicals is called homolytic bond fission.
- Homolysis is favored by ultraviolet light, heat, sunlight, non polar solvent.
- Catalysts used for homolysis are called initiators Ex : organic peroxides, azo compounds and alkyl nitrates





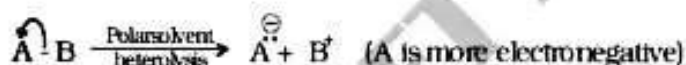
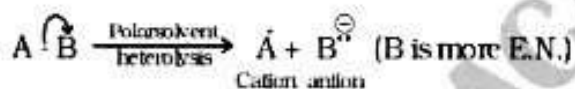
- Free radicals are neutral atoms or groups which contain an unpaired electron.
- Some examples of free radicals



- Generally homolysis is possible between the atoms of same elements or having nearly same electronegativities.
- Generally it occurs in gaseous phase.
- Organic reactions proceeding through homolysis are called free radical or homopolar or nonpolar reactions.
- The reactions are possible in non polar solvents.

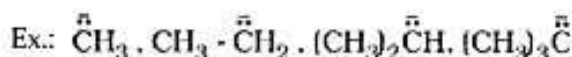
Heterolytic bond fission :

- Unsymmetrical breaking of a bond in which shared pair of electrons is gained by one of the separating species and form anion where as another species form cation due to loss of electron is called heterolytic bond fission or heterolysis.
- It is favored by polar solvent, acids, bases, oxidizing agents, reducing agents etc.



Carbanion :

- Triply bonded negatively charged carbon species having eight electrons in valence shell is called carbanion or carbanion.
- They are electron rich.



Organic reactions proceeding through heterolysis are called ionic or heteropolar or simply polar reactions because these are possible in polar solvent.

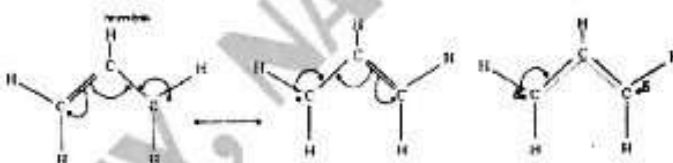
- Heterolysis is uncommon in gaseous state.

Free Radicals :

- Triply bonded charge less carbon species having an unpaired electron is called carbon free radical.
- Due to their transitory existence and high reactivity they are short lived.
- Hybridization of central carbon atom in carbon free radical is sp^2 and geometry is planar.
- H-C-H bond angle in CH_3 is of 120° .
- Central carbon atom contains seven electrons and they are electron deficient.
- The odd electron is in p orbital which is perpendicular to C-H bonds.

Stability of free radicals :

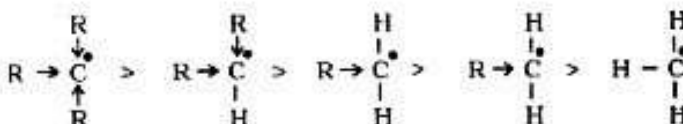
- Alkyl free radicals are stabilized by overlap of p orbital containing odd electron with p orbital of π bond.



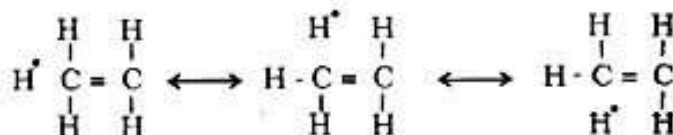
Resonance forms.

Resonance hybrid.

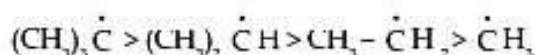
- Positive inductive effect of alkyl groups arranged on central carbon atom increase the stability of carbon free radicals.



- Stability of primary, secondary and tertiary carbon free radicals is also explained on the basis of hyper conjugation of σ C-H bonds an α -carbon.
- Hyper conjugation in ethyl free radical is



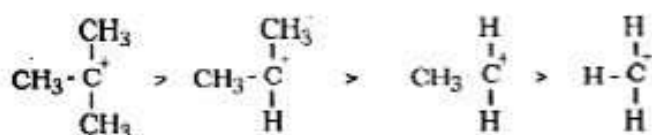
- Isopropyl free radical have six hyper conjugation structures while tertiary butyl have nine.
- As the number of contributing structure increases stability of carbon free radical also increases.



- Due to presence of odd electron carbon free radicals are paramagnetic i.e. they have small permanent magnetic moment.

Carbocations : Triply bonded positively charged carbon species having six electrons in valance shell are called carbonium ion or carbocation. Positively charged carbon is sp^2 hybridized and have planar structure with bond angle 120°

- Unhyridised p orbital is empty and perpendicular to the plane containing three C-H bonds.
- These are electron deficient species and behave, as a lewis acid.
- It is stabilized by alkyl groups linked to central carbon through inductive and hyper conjugation effects.
- Positive inductive effect of alkyl groups linked to central carbon atom increase the stability.
- Decreasing order of stability is



- Due to rotation of alkyl groups on positively charged carbon one of its σ bond is aligned with empty p orbital and stabilize the positive charge through hyper conjugation.
- Carbocations having a π bond adjacent to positively charged carbon get stabilized through, resonance effect.



- Two π electron hold three carbon nuclei together.

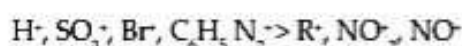
TYPES OF REAGENTS

- electron deficient or electron rich species convert substrate in product is called reagent.
- on the basis of electron deficient or rich nature of reagent they are classified in two types

Electrophilic reagents or Electrophiles :

- Positively charged ions or natural molecules having electron deficient centre and attack on electron rich substrate to gain electron pair to form covalent or coordinate bond is called electrophile.
- Electrophiles are electron loving reagents.

Ex.: All Cations



- These are positively charged species having six electrons in valance shell (except H^+).
- Neutral electrophiles : natural molecules having electron deficient centre without positive charge. $> \%$ They contains atom with incomplete octet
Ex. BF_3 , AlCl_3 , ZnCl_2 , FeCl_3 , BeCl_2 , etc.
- Some neutral molecules having vacant d-orbital also behave as electrophile
Ex. PCl_5 , PCl_3 , SO_2 , SO_3 , etc.
- They are lewis acids. They are electron deficient species.
- They attack on electron rich centre.
- They gain electron pair from donor.

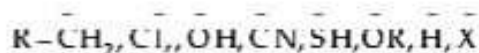
NH_4^+ , Ca^{++} , K^+ , H_3O^+ are +vely charged ion but they are not electrophile due to absence of empty orbitals.

ii) Nucleophilic reagents or nucleophiles

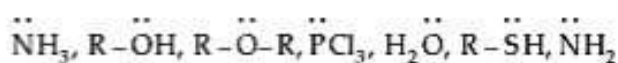
- Negatively charged ion or natural molecules having electron rich center and attack on electron deficient substrate to donate electron pair are called nucleophiles or nucleophilic reagents.
- These are attracted towards nucleus hence called nucleus loving reagents.
- Ex.: They are of two types

a) Negative Nucleophiles :

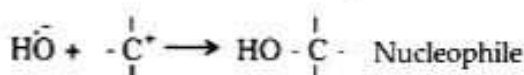
These are negatively charged ions carry an excess electron like.



- They attack on positively charged substrate to form neutral molecule.
- Neutral nucleophiles :
- They are electrically neutral molecules having lone pair of electrons and they acts as lewis bases.
- Ex.



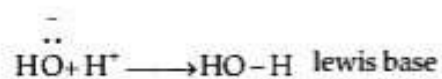
- They are electron rich species.
- They attack an electron deficient centre They donate electron pair to acceptor.
- Distinction between Nucleophile and Base :



- ❑ The electron rich species donate electron pair other than H^+ are called nucleophiles.

Nucleophile

- ❑ The electron rich species which donate electron pair to H^+ are called bases.



TARGET ACADEMY, NASHIK