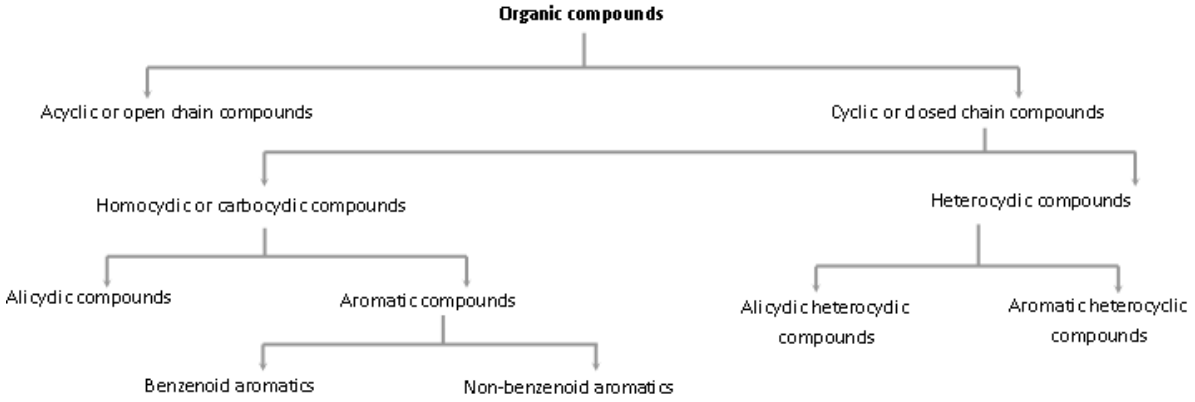
ORGANIC CHEMISTRY- SOME BASIC PRINCIPLES AND TECHNIQUES
CLASS –XI

Tetravalency of carbon

carbon is always tetracovalent, i.e. it forms 4 covalent bonds with other atoms C Due to tetravalency of carbon it has a tetrahedron shape.

Catenation- The self linking property of carbon is known as catenation.

Classification of organic compound.



Homologous series: Homologous series is defined as a family or group of structurally similar organic compounds all members of which contain the same functional group.

Functional groups:A functional group may be defined as an atom or a group of atoms present in a molecule which largely determines the chemical properties.

Nomenclature of Organic compound

1.) The longest carbon chain in the molecule is identified.

2.) The numbering is done in such a way that the branched carbon atoms get the lowest possible value.

3.) The names of the alkyl groups attached as a branch are then prefixed to the name of the parent alkane and its position is indicated by numbers. The substituents are alkane molecules with one less hydrogen atom. Hence, they are named by replacing **'ane'** in its name by **'yl'**.

4.) The lower number is given to the first in alphabetical order.

5.) If two or more similar substituents are present, then the prefix di (for 2), tri (for 3), tetra (for 4), etc., are used before the name of the substituents and the position of each substituent is specified and separated by commas

Organic compounds having Functional Groups: The longest chain of carbon atoms containing the functional groups is numbered in such a way that the functional group attached to the carbon atom gets the lowest possible number in the chain. When there are more functional groups then a priority order is followed as: COOH ,-SO3H,-COOR,-COCl, $-CONH_2$,-CN, -HC=O> C=O, -OH, $-NH_2$> C=C= < -C≡C-.

Isomerism:Two or more compounds having the same molecular formula but different physical and chemical properties are called isomers and this phenomenon is called isomerism.

Isomerism can be divided into two types

(i)Structural Isomers have different *structural formulae* because their atoms are linked together in different ways

Chain isomerism: When two or more compounds having same molecular formula but different carbon skeletons are referred to as chain isomers.

Position Isomerism : Compounds which have the same structure of carbon chain but differ in position of double or triple bonds or functional group are called position isomers.
Functional Isomerism :Compounds which have the same molecular formula but different functional group are called functional isomers and this phenomenon is called functional isomerism.
Metamerism:It is due to the presence of different alkyl groups on either side of functional group in the molecule.
(ii)Stereoisomers have the same structure and bond order but their atoms and groups of atoms are arranged differently in space.
Geometric Isomerism
Involves a double bond, usually C=C, that does not allow *free rotation* about the double bond (unlike a C-C single bond). They are not superimposable.
e.g. *cis*-but-2-ene and *trans*-but-2-ene
Optical isomerism
Involves an atom, usually carbon, bonded to four different atoms or groups of atoms. They exist in pairs, in which one isomer is the mirror image of the other.
e.g. butan-2-ol
Fission of covalent bond
Heterolytic cleavage: In this cleavage the bond breaks in such a way that the shared pair of electron remains with one of the fragments. Heterolytic fission yields carbocations or carbanions.
H3C – Br +CH3 + Br-
Homolytic Cleavage: In this cleavage the shared pair of electron goes with each of the bonded atom.
R – X R. + X.Homolytic fission yields free radical
Concept of Nucleophiles and Electrophiles
Nucleophiles : A reagent that brings an electron pair is called nucleophile ie nucleus seeking e g -OH
Electrophiles: A reagent that takes away electron pair is called electrophile I e electron seeking e g > C= O , R3C – X
Inductive Effect: The displacement of the electron along the chain of the carbon atoms due to presence of an atom or group at the end of the chain.
ɗ+++ ɗ- ++ ɗ+
CH3- C H2 CH2 Cl
Resonance Effect :The polarity produced in the molecule by the interaction of two pi bonds or between a pi bond and lone pair of electron present on an adjacent atom. There are two types of resonance effect:
1) Positive resonance effect : In this effect the transfer of electrons is away from an atom or substituent group attached to the conjugated system.
The atoms or groups which shows +R effect are halogens,-OH , -OR,-NH2
2) Negative resonance effect : In this effect the transfer of electrons is towards the atom or substituent group attached to the conjugated system. The atoms or groups which shows -R effect are –COOH , -CHO , -CN
Electromeric effect: The complete transfer of shared pair of pi electrons to one of the atoms joined by a multiple bond on tne demand of an attacking reagent.Electromeric effect can be classified into +E and -E effects based on the direction of transfer of the electron pair.When the electron pair moves towards the attacking reagent, it is termed as the +E effect. The -E effect can be found in reactions when the electron pair moves away from the attacking reagent

Hyperconjugation:is the interaction of the electrons in a sigma bond with an adjacent empty or partially filled non-bonding p-orbital, antibonding σ or π orbital, or filled π orbital, to give an extended molecular orbital that increases the stability of the system-Only electrons in bonds that are β to the positively charged carbon can stabilize a carbocation by hyperconjugation

METHODS OF PURIFICATION OF ORGANIC COMPOUNDS :

Sublimation : This method is used to separate the sublimable compounds from non sublimable compounds.

Crystallisation: is a process of solidification of a pure substance from its dissolved state.

Distillation: This method is used to separate volatile liquids from non volatile liquids and liquids having sufficient difference in their boiling points.

Fractional distillation: If the boiling points of two liquids is not much , they are separated by this method.

Distillation under reduced pressure : This method is used to purify liquids having high boiling points and decomposes at or below their boiling points.

Steam distillation : This method is used to separate substances which are steam volatile and are immiscible with water.

Differential Extraction: When an organic compound is present in an aqueous medium it is separated by shaking it with organic solvent in which it is more soluble than in water. The aqueous solution is mixed with organic solvent in a separating funnel and shaken for sometimes and then allowed to stand for some time .when organic solvent and water form two separate layers the lower layer is run out by opening the tap of funnel and organic layer is separated, the process is repeated several times and pure organic compound is separated.

Chromatography :the technique of separating the constituents of a mixture by the differential movement of individual components through the stationary phase under the influence of mobile phase.

(i) Adsorption Chromatography : It is based on the fact that different compounds are adsorbed on an adsorbent to different degrees. Silica jel or alumina is used as adsorbents.

Types of adsorption chromatography:

Column chromatography:As the eluent (Solvent or mixture of solvents)passes down the column , it dissolves the different components.

b)Thin layer chromatography:Separtion of the components of the mixture is achieved over a thin layer of adsorbent .

(ii)Partition Chromatography : It is based on the continuous differential portioning of components of a mixture between stationary and mobile phase.

QUALITATIVE ANALYSIS OF ORGANIC COMPOUNDS

Detection of Carbon and Hydrogen: heating the compound with CoO in a hard glass tube when C present in the compound is oxidized to CO_2 which can be tested with lime Water and H is converted to water which can be tested with anhy $CuSO_4$ which turns blue.

$C + CuO \longrightarrow Cu + CO_2$

$2\,H + CuO \longrightarrow Cu + H_2O$

$CO_2 + Ca(OH) \longrightarrow 2\,CaCO_3 + H_2O$

$5H_2O + CuSO_4 \longrightarrow CuSO_4.5H_2O$

DETECTION OF OTHER ELEMENTS

Sodium Fusion Extract: A small piece of dry Na metal is heated with a organic compound in a fusion tube for 2 -3 minutes and the red hot tube is plunged in to distilled water contained in a china dish. The contained of the china dish is boiled ,cooled and filtered.

Test for Nitrogen : The sodium fusion extract is boiled with $FeSO_4$ and then acidified with Conc H_2SO_4 , the formation of Prussian blue colour confirms the presence of nitrogen.

$6CN^- + Fe^{2+} \longrightarrow [Fe(CN)_6]^{4-}$

$3[Fe(CN)_6]^{4-} + 4Fe^{3+} xH2O \longrightarrow Fe_4[Fe(CN)_6]^{3}.xH_2O$

Test for Sulphur: the sodium fusion extract is acidified with CH_3COOH and lead acetate is added to it. A black precipitate of PbS indicates the presence of sulphur.

$S^{2-} + Pb^{2+} \rightarrow$ PbS(black)

Test for halogens:The sodium fusion extract is acidified with HNO_3 and then treated with $AgNO_3$. A white pPT, soluble in NH_4OH shows the presence of Cl, a yellowish ppt. sparingly soluble in NH_4OH shows the presence of Br, a yellowish ppt. insoluble in NH_4OH shows the presence of I.

X- + Ag+ AgX

QUANTITIVE ANALYSIS(Carbon and Hydrogen) Let the mass of organic compound be m g. Mass of water and carbon dioxide produced be m1 and m2 g respectively;

% of carbon = 12 x m2 x 100 /44 x m

% of hydrogen = 2 x m1 x 100 18 x m

Nitrogen

DUMAS METHOD:

Volume of Nitrogen at STP = P1V1 x 273 760 x T1

%N = 28 x vol of N_2 at STP x 100/ 22400 x mass of the substance taken

KJELDAHL'S METHOD: %N= 1.4 x Molarity of the acid x Basicity of the acid x Vol of the acid used/ Mass of the substance taken

Halogens Carius method: A known mass of an organic compound is heated with fuming nitric acid in the presence of silver nitrate contained in a hard glass test tube known as carius tube in a furnace. Carbon and hydrogen present in the compound are oxidized to carbon dioxide and water. The halogen present forms the corresponding silver halide. It is filtered, dried, and weighed.