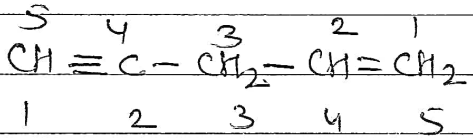
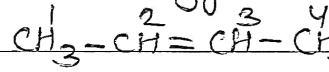
3. If however, there is a choice in numbering the double bond is always given preference over the triple bond.



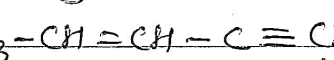
→ correct

→ wrong

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

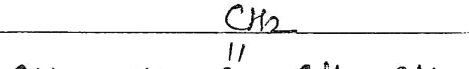


— But-2-ene.



— Pent-3-ene-1-yne.

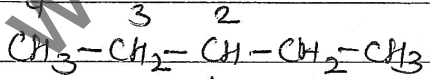
In some case all the double and triple bonds present in the molecule cannot be included in the longest chain.

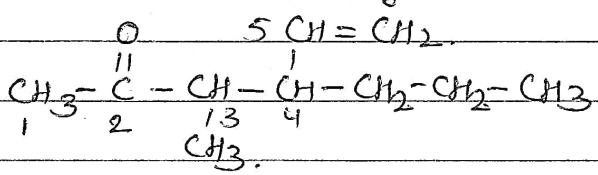


3-Methylenepenta-1-4 diene.

— Rules for IUPAC Nomenclature of compounds containing one functional group, multiple bonds, and substituents.

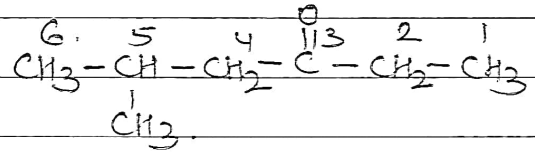
1 Parent chain — Select the longest possible chain of carbon atoms containing the functional group and the maximum number of multiple bonds as the parent chain without caring whether it also denotes the longest possible carbon chain or not.



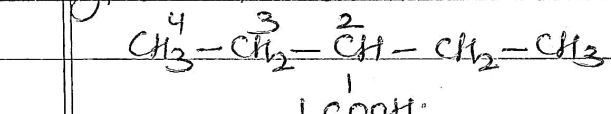


2. Lowest locant rule for the functional group — Number the parent chain in such a way that the functional group gets the lowest possible number followed by the double and triple bond even if

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.



2-Ethyl butan-1-oic acid.

— 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.

While 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.

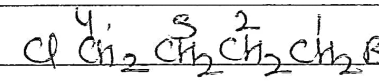
The prefixes for secondary functional group are :-

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.	Alkoxycarbonyl.
—NH_2	— Amino	—COCl.	Halocarbonyl.
—NHR.	— Alkylamino	—CN.	Cyano
—NR_2	— Dialkylamino.	—$CONH_2$	Carboxamido.

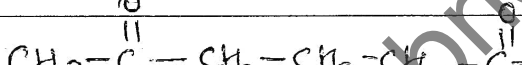
Selecting the Principle chain – While selecting the Principle chain present in a Polyfunctional Compound care should be taken that it must contain the Principle functional group and the maximum number of secondary functional groups and multiple bonds.

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.

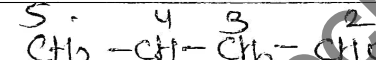
4. Alphabetical order :- The Prefixes for the secondary functional group and other substituents should be placed in alphabetical order before the wood root.
ex.



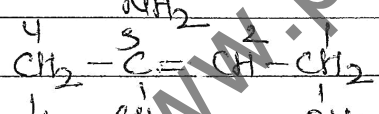
1-Bromo-4-chlorobutane.



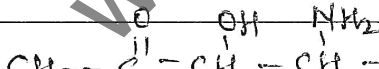
5-ketohexan-1-oic acid.



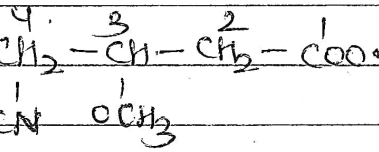
4-Aminopantan-2-ol.



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



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

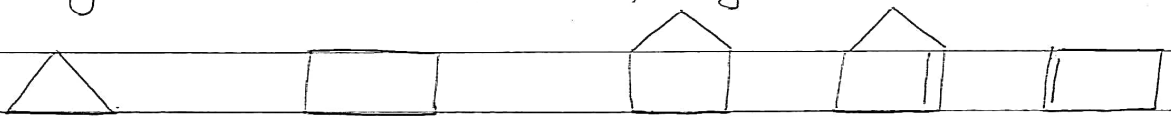


4-cyno-3-methoxybutan-1-oate.

– Rules for naming Alicyclic Compounds.

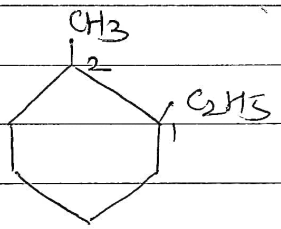
1 The name of alicyclic compounds are obtained by adding.

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



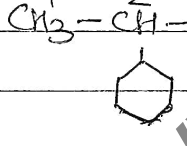
cyclopropane cyclobutane cyclopentane cyclopentene cyclobutene

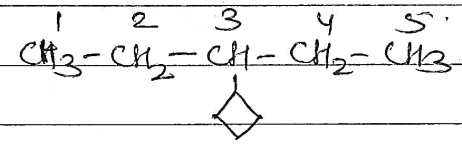
2. If two or more alkyl group or other substituents groups are present in the ring, their position are indicated by 1,2,--etc. while numbering the Carbon atoms of the ring, the substituents which comes first in alphabetical order is given the lowest number



1-ethyl-2-methyl cyclohexane.

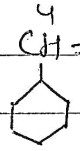
3(a) If the ring contain more or equal number of Carbon atoms than the alkyl group attached to it, it is named as a derivative of cycloalkane and the alkyl group is treated as a substituent group, otherwise it is named as a derivative of alkane and the cycloalkyl group is considered as a substituent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





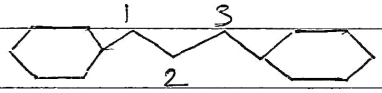
(2-Butyl) cyclohexane. 3-cyclobutyl Pentane.

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



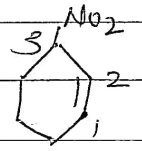
4 cyclohexyl but-3-ene-2-one

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.



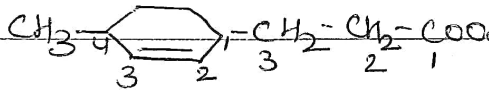
1,3 dicyclohexyl propane.

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.



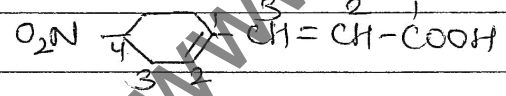
3-Nitrocyclohex-1-ene

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



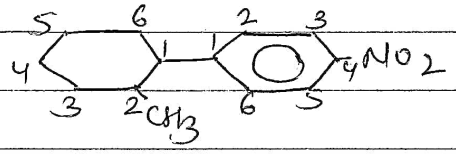
3-(4-methyl cyclohex-2-en-1-yl) Propanoic acid.

6. If the ring as well as the side chain contain 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.



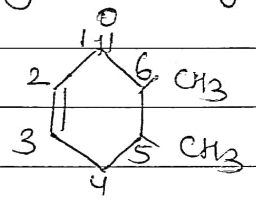
3-(4-Nitrocyclo-1-en-1-yl)-Prop-2-ene-1-oic acid.

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 one 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.
$-COX$. ($X = F, Cl, Br, I$)	Halo carbonyl.	Carbonyl halide.
$-COOR$.	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.

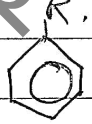
5. Identify the name and position of the other substituents if any from the IUPAC name of the compound and fix them at their right position along the carbon chain.

6. Finally wherever necessary, attach the required number of hydrogen atom 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 consist of two parts.

(i) 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 nucleous.

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.



(ii) 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.

(iii) Side chain substituents — Those in which the functional group is present in the side chain 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 molecules 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 molecules 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 molecules 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.

$CH_3-CH_2-CH_2-CH_3$.
Butane

$CH_3-\overset{2}{\underset{}{CH}}(\overset{CH_3}{})-\overset{3}{CH_3}$. — 2-methyl propane

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.

$CH_3-CH_2-CH=CH_2$
But-1-ene

$CH_3-CH=CH-CH_3$
But-2-ene.

c. Functional isomerism — Compounds having the same molecules formula but different functional groups are called functional isomers and the phenomenon is called functional isomerism.

(i) Alcohols and ethers ($C_nH_{2n+2}O$)

CH_3-CH_2-OH
ethanol.

CH_3-O-CH_3
methoxymethane

(ii) Carboxylic acids and esters. ($C_nH_{2n}O_2$)

$CH_3-\overset{O}{\overset{\|}{C}}-OH$ $H-\overset{O}{\overset{\|}{C}}-OCH_3$.

Ethanoic acid. methyl methanoate.

(III) Aldehydes, Ketones, unsaturated alcohols and unsaturated ethers ($C_nH_{2n}O$).

$CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ $CH_3CH_2-\overset{O}{\overset{\|}{C}}-H$.

Propanone Propanal.

$\overset{3}{C}H_2=\overset{2}{C}H-\overset{1}{C}H_2OH$. $\overset{2}{C}H_2=\overset{1}{C}H-O-CH_3$.

Prop-2-ene-1-ol. methoxy eth-1-ene

(IV) Aromatic alcohols, phenols, and ethers

(V) Dienes, allenes, and alkynes (C_nH_{2n-2})

(VI) Nitroalkanes, Alkyl nitrites and amino acids ($C_nH_{2n+1}NO_2$)

(VII) 1°, 2° and 3° Amines.

(VIII) Cyanides and isocyanides ($C_nH_{2n-1}N$)

(IX) Amides and oximes ($C_nH_{2n+1}NO$)

D. Metamerism — Compounds having the same moleculer formula but different number of Carbon atoms (or alkyl groups) on either side of the functional group (-O-, -S-, -NH-, and -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 is arise 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 obtain are called tautomers and 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 Vanderwalls 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 walls 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 seperation of different components of a mixture by repeated crystallisation is known as fractional crystallisation.

– Sublimation – It involve 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.

Organic molecule $\xrightarrow[\text{reagent}]{\text{Attacking}}$ [Intermediate] $\nearrow$ Products
$\searrow$ By Products.

– 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 charg and C_1 acquires a small Positive charge.

$C_4 \rightarrow C_3 \rightarrow C_2 \rightarrow C_1 \rightarrow X$
$\delta\delta\delta\delta^+ \quad \delta\delta\delta^+ \quad \delta\delta^+ \quad \delta^+ \quad \delta^-$

The small Positive charge on C_1 in turn attracts the σ-electrons of the C_1–C_2 bond towards it. As a result C_2 acquires a small Positive charge($\delta\delta^+$)

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.

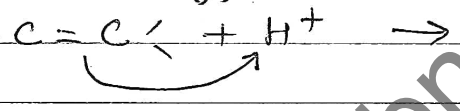
1 If the substituent attached to the end of the Carbon Chain is electron-withdrawing then the effect is called

-I-effect.

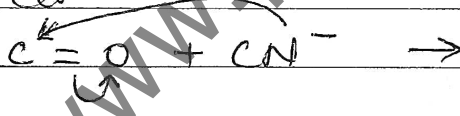
(ii) If the substituent attached to the Carbon chain is electron donating, the effect is called +I-effect.
Inductive effect is a Permanent effect.

— Electromeric effect— It involve the complete transfer of electrons of a multible bond to one of the bond atoms (usually more electronegativ) 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 transfered 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 transfered 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 to 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 structure 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. Furthermore, 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 seperation of positive and negative charges are of higher energy and hence contribute little towards the resonance hybrid.
4. Lesser the seperation 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

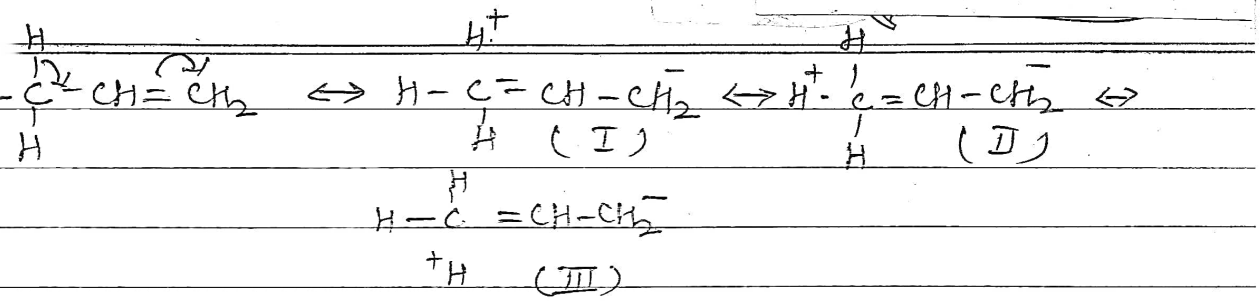
towards the resonance hybrid

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 take away one electron of the shared pair, it is called homolytic or symmetrical fission.

$$A:B \longrightarrow A^{\bullet} + B^{\bullet}$$

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 is occur 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.

$$A:B \longrightarrow A^{+} + :B^{-}$$ when B is more electronegative.

$$A:B \longrightarrow A^{-}: + B^{+}$$ when A is more electronegative.

It usually occur 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 valence shell are called carbanions.

stability — $1^\circ > 2^\circ > 3^\circ$
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 — $3^\circ > 2^\circ > 1^\circ$

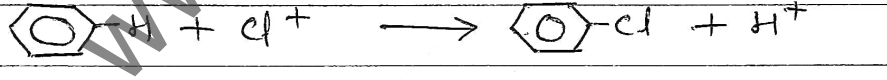
— Common types of Organic Reactions.

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

$$OH^- + R\overset{\delta^+}{\frown}x^{\delta^-} \longrightarrow R\text{-}OH + x^-$$

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.

$$CH_3\text{-}H + Cl_2 \longrightarrow CH_3\text{-}Cl + HCl.$$

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

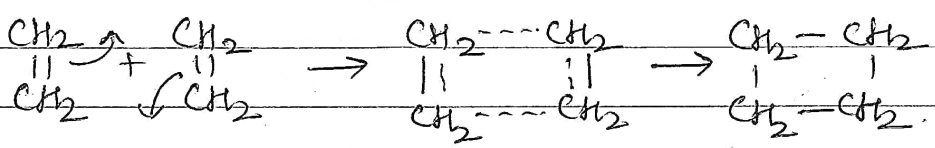
Elimination reaction — An elimination reaction is one that involves the loss of two atoms or group of atoms from the same or adjacent atoms of a substance leading to the formation of a multiple bond

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 $2s+2s$ or cycloaddition reaction.