

Organic Chemistry: Some Basic Principles and Techniques

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Date	

*

Organic compounds:

Hydrocarbons and their derivatives and study of these compounds is called organic chemistry.

1. Symbol = C
2. $Z = 6$ [K-2, 2-4]
3. Valency = 4 [Tetravalent] $\begin{array}{c} | \\ -C- \\ | \end{array}$
4. Non-metal

*

Why so many carbon compounds?

1. Tetravalent
2. Catenation [self-linkage power].

*

Hydrocarbons:

Organic compound containing 'C' and 'H' only.
eg: CH_4 , C_2H_6 , C_3H_8 etc.

Saturated Hydrocarbon

⇒ Hydrocarbon having single [Alkane] covalent bond b/w carbons

⇒ eg: CH_3-CH_3 , $CH_3-CH_2-CH_3$

⇒ Alkane general formula:
 C_nH_{2n+2}

Unsaturated Hydrocarbon

⇒ Hydrocarbon having double [Alkenes] or triple [Alkynes] covalent bonds b/w carbons.

⇒ eg: $CH \equiv CH$, $CH_2=CH-CH_3$

⇒ Alkene general Formula
 C_nH_{2n}

⇒ Alkyne general Formula
 C_nH_{2n-2}

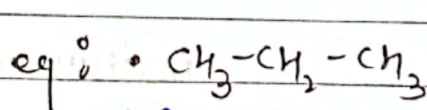


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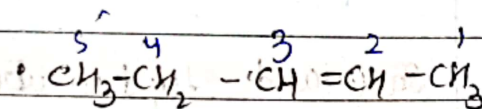
Naming of Hydrocarbons.

No. of Carbons	Prefix
1	Meth
2	Eth
3	prop
4	but
5	pent
6	Hex
7	Hept
8	Oct
9	Non
10	Dec.

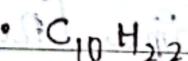
H.C	Suffix
Alkane	ane
Alkene	ene
Alkyne	yne



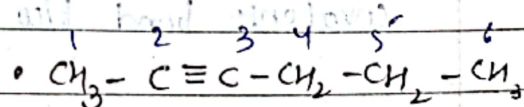
$\Rightarrow$ Propane



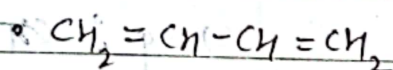
$\Rightarrow$ Pent-2-ene



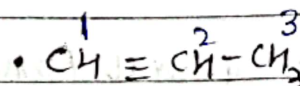
$\Rightarrow$ Decane



$\Rightarrow$ Hex-2-yne

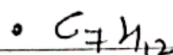


$\Rightarrow$ Buta-1,3-diene

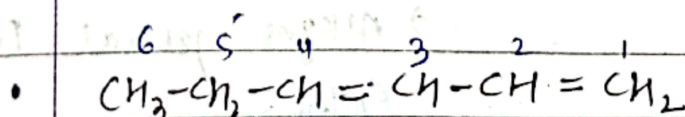


$\Rightarrow$ Prop-1-yne

↓
जब भी दो Double Bond हो तो नाम के पीछे 'a' लगाना है



$\Rightarrow$ Heptyne

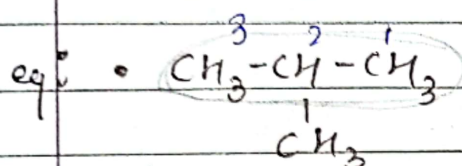


$\Rightarrow$ Hexa-1,3-diene

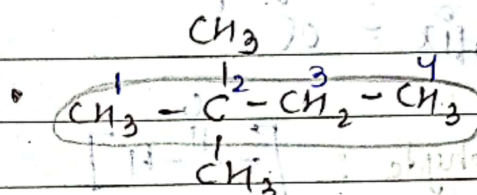


* Branched Hydrocarbon

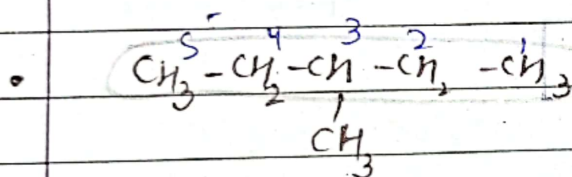
1. Select the longest chain.
2. Consider side carbons as alkyl group [methyl, Ethyl, Propyl]
3. Number your chain in a way to give alkyl groups the smallest possible number.
4. Write name of alkyl groups before parental chain.



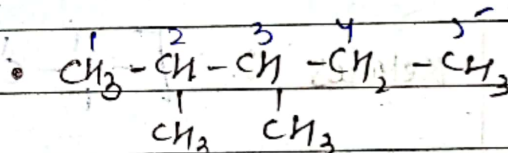
⇒ 2-methylpropane



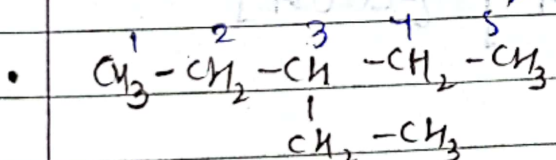
⇒ 2,2-Dimethylbutane



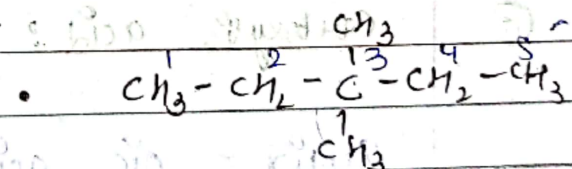
⇒ 3-methylpentane



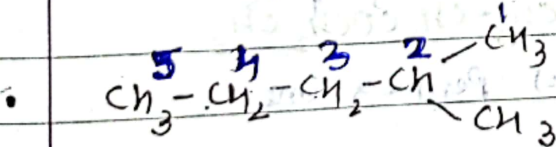
⇒ 2,3-Dimethylpentane



⇒ 3-Ethylpentane

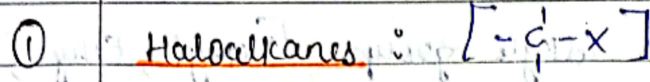


⇒ 3,3-Dimethylpentane



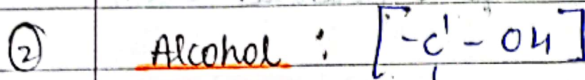
⇒ 2-methylpentane

* Functional groups.

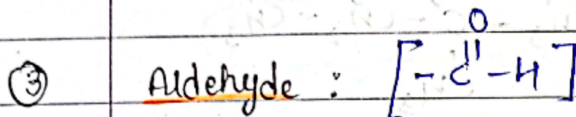


X = F, Cl, Br, I

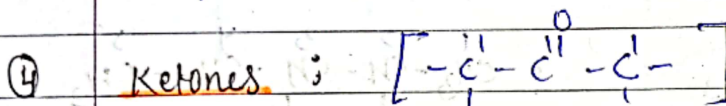
Prefix = Halo



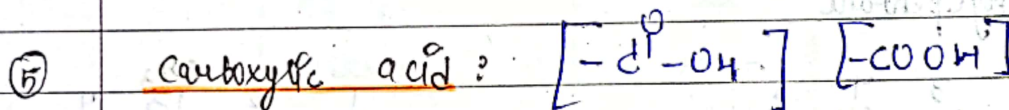
Suffix = ol



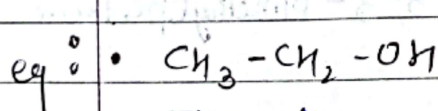
Suffix = al



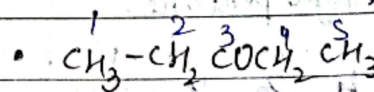
Suffix = one



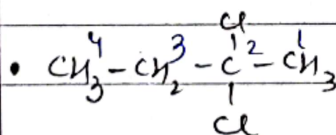
Suffix = oic acid



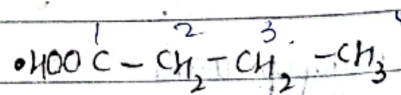
⇒ Ethanol



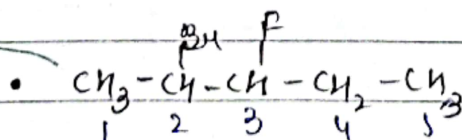
⇒ Pent-3-one



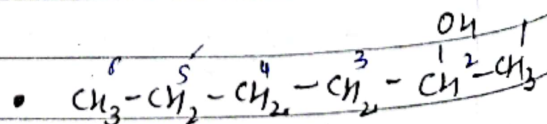
⇒ 2,2-Dichlorobutane



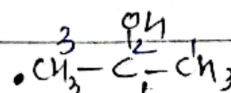
⇒ Butanoic acid



⇒ 2-Bromo-3-Fluoropentane



⇒ Hex-2-ol



⇒ Propane-2,2-diol

Alphabetical order follow

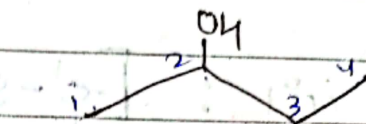
* Bond line Diagrams [Structures]

1. Each corner, vertex and intersection represents carbon.
2. Line represents covalent bond
3. Atoms other than 'C' and 'H' are visible.

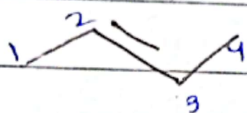
eg.



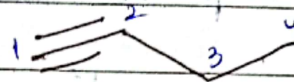
=> Butane



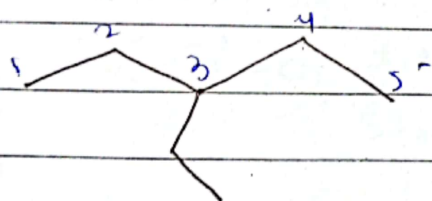
=> Butan-2-ol



=> But-2-ene



=> But-1-yne / Butyne



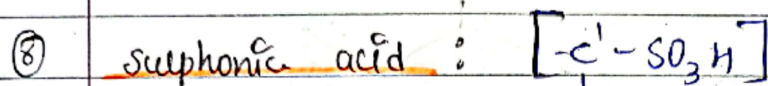
=> 3-Ethylpentane

eg: CH_3-CH_2
 $\hookrightarrow$ alkyl group.

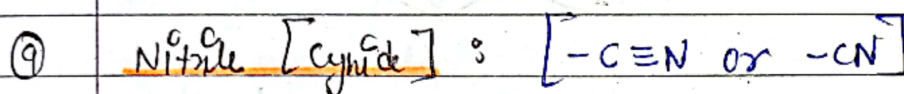
* Other organic compounds



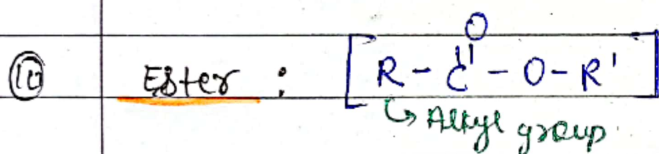
Prefix = Nitro



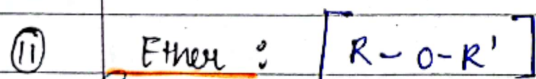
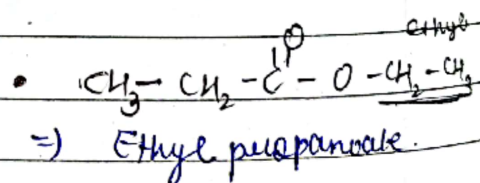
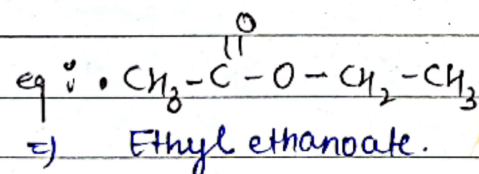
suffix = sulphonic acid



suffix = nitrile

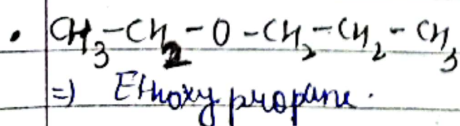
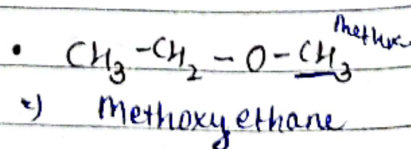
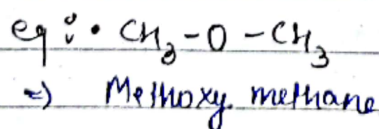


Naming: Alkyl alkanoate



Naming: Alkoxy alkane

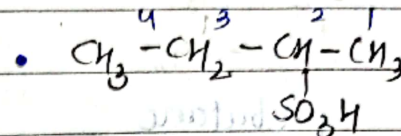
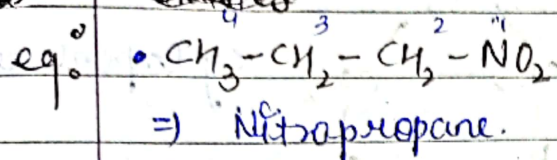
Identify the longest chain and name it.



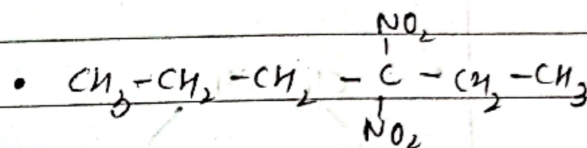
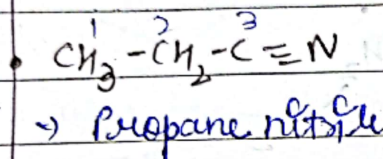
(12) Acid halides [Acyl halides] : $\left[-\overset{\overset{O}{\parallel}}{C}-X \text{ or } -COX \right]$
 $[X = F, Cl, Br, I]$

Suffix = oyl halide.

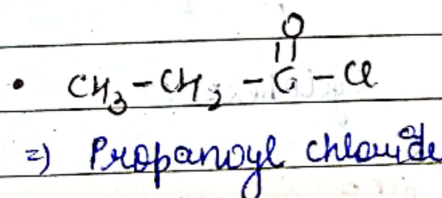
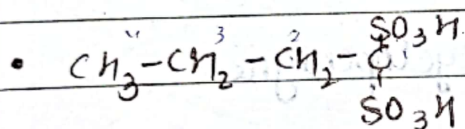
eg. ~~Compounds~~



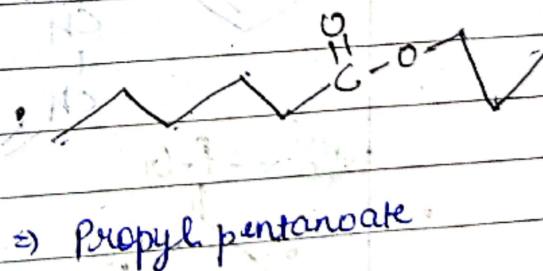
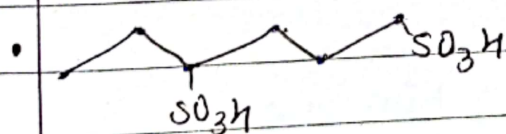
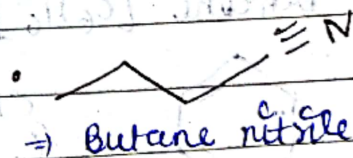
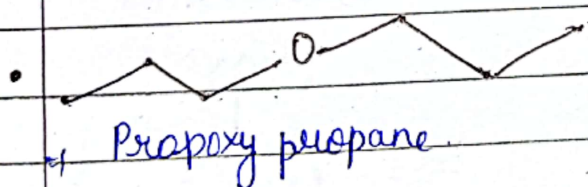
$\Rightarrow$ Butane-2-sulphonic acid



$\Rightarrow$ 3,3-Dinitrohexane



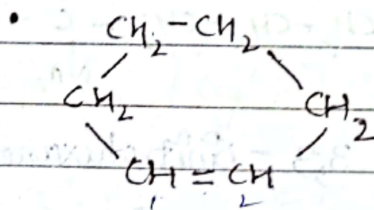
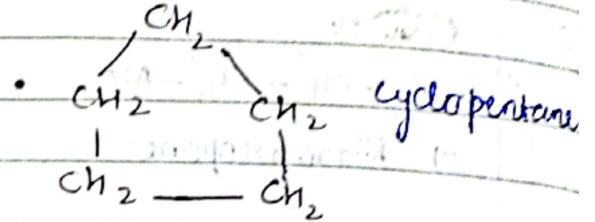
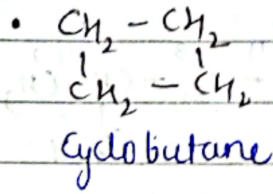
~~Compound~~
 $\Rightarrow$ Butane-1,1-disulphonic acid



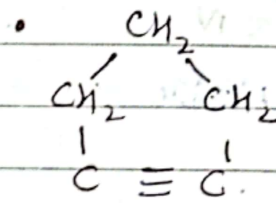
* Cyclic Compounds

=> Prefix : cyclo.

eg.



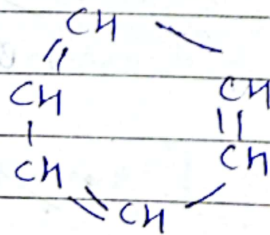
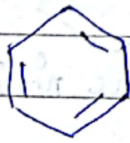
Cyclohexene



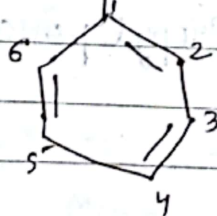
cyclopentyne

* Positions of benzene and its derivative

• Benzene $[\text{C}_6\text{H}_6]$



Function group ← F.G

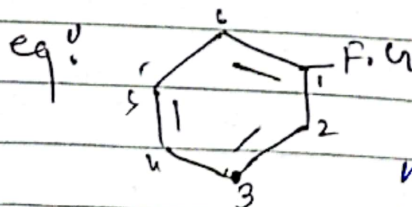


2, 6 → Ortho

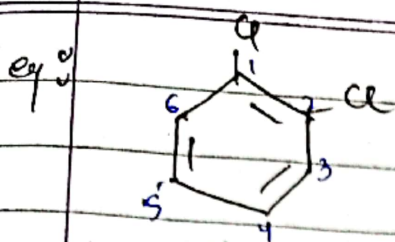
3, 5 → meta

4 → Para

Function group at side with ortho.



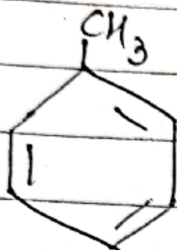
What is 3?
2) meta.



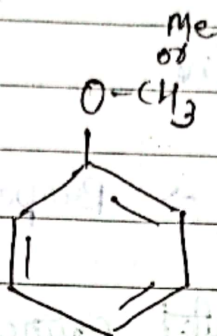
=> 1, 2 - Dichlorobenzene.

=> O - Dichlorobenzene.

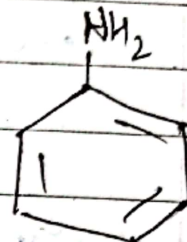
*



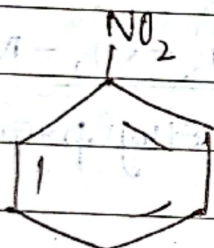
Methylbenzene
[Toluene]



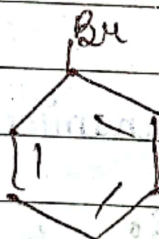
Methoxybenzene
[Anisole]



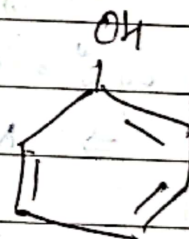
Aminobenzene
[Aniline]



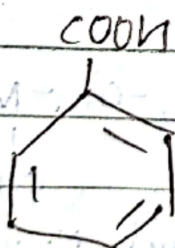
Nitrobenzene



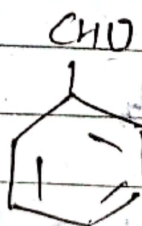
Bromobenzene



Phenol



Benzoic acid

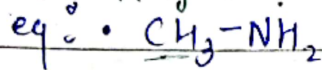


Benzaldehyde

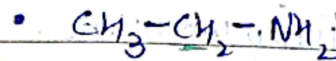
(13) Amines: $[C-NH_x]$ $x = 0, 1, 2$

i) Primary amines [1° Amines]

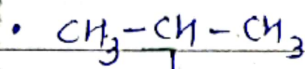
$\rightarrow$ Nitrogen के साथ एक carbon जुड़ा होता है।



$\Rightarrow$ Methanamine



$\Rightarrow$ Ethanamine

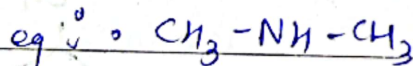


$\Rightarrow$ Propan-2-amine

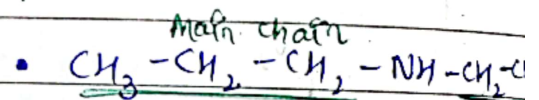
Naming: $\rightarrow$ IUPAC के पीछे Amine

ii) Secondary amines [2° Amines]

$\rightarrow$ Nitrogen के साथ 2 carbon जुड़े हैं



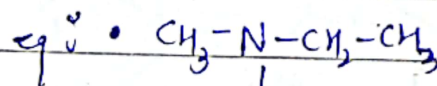
$\Rightarrow$ N-methylmethanamine



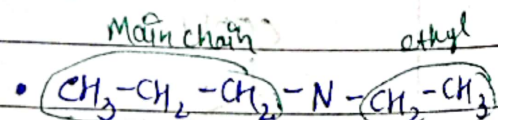
$\Rightarrow$ N-Ethylpropanamine

iii) Tertiary amines [3° amines]

$\rightarrow$ Nitrogen के साथ 3 carbon जुड़े हैं



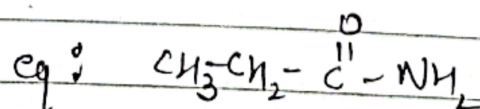
$\Rightarrow$ N,N-Dimethylethanamine



$\Rightarrow$ N-Ethyl, N-methylpropanamine

(14) Amides: $[>C(=O)-NH_2]$ $[>CONH_2]$

suffix = amide

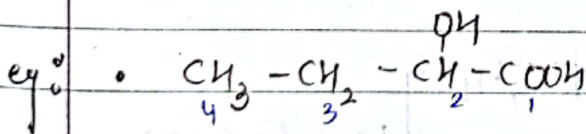
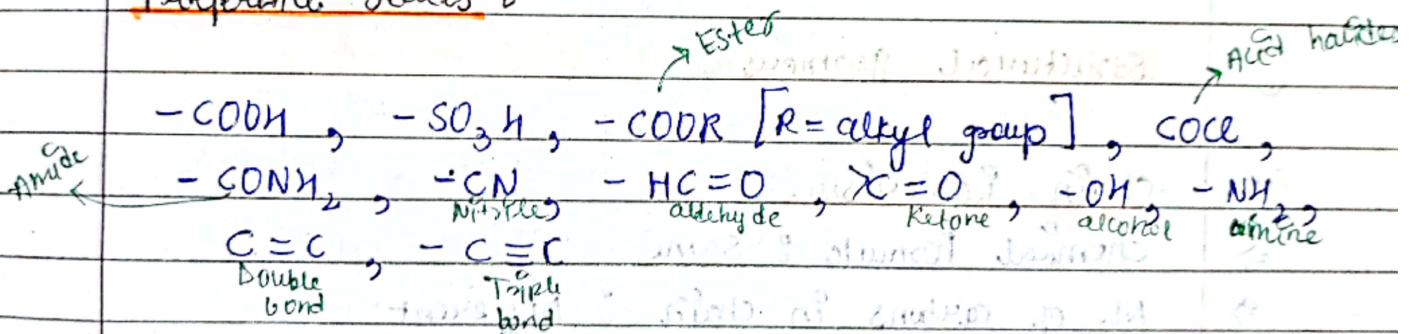


Propanamide

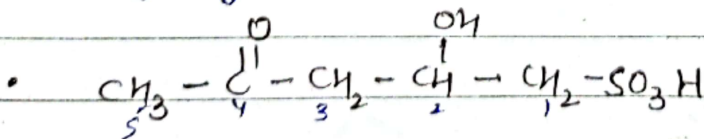
functional group	Prefix name
Alcohols	hydroxy
Aldehydes	formyl, oxo
ketones	oxo
Carboxylic Acid	carboxy
Acyl halides	halocarbonyl
Amines	amino
Sulphonic acid	sulpho
Nitriles	cyano

* Naming of organic compound having more than 1 functional group

Preference series :

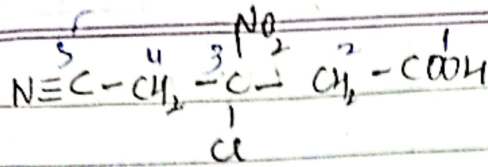


2-Hydroxy butanoic acid



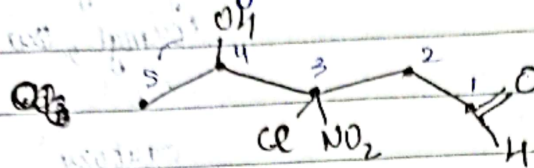
2-Hydroxy-4-oxopentane sulphonic acid

oxo
hydroxy
H
alphabetical
order



chloro
cyano
nitro

⇒ 3-chloro-5-cyano-3-nitropentanoic acid.



hydroxy
chloro
nitro

⇒ 3-chloro-4-hydroxy-3-nitropentanal

* Isomerism and isomers :

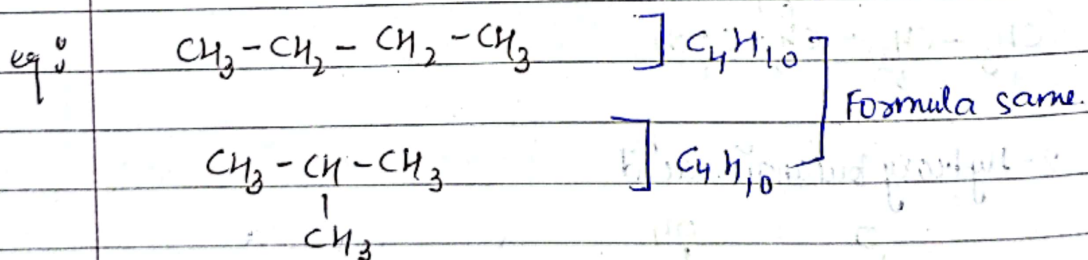
⇒ Compounds having same formula but different structure or geometry are called isomers & process is called isomerism.

① Structural isomers :

(a) chain isomerism.

⇒ chemical formula : same

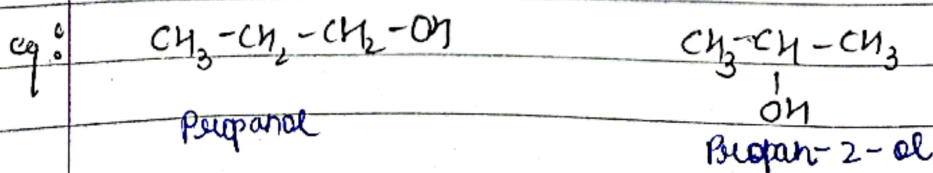
⇒ NO. of carbons in chain : Different.



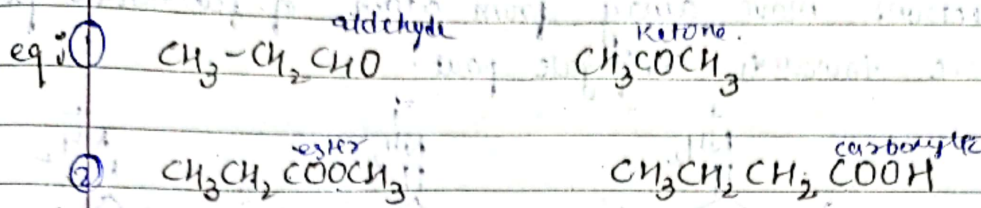
(b) Positional isomerism

⇒ chemical formula : same

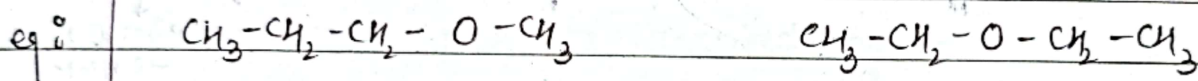
⇒ Position of functional group : Different.



- c) Functional isomerism :
- ⇒ chemical formula : same
 - ⇒ Functional group : Different

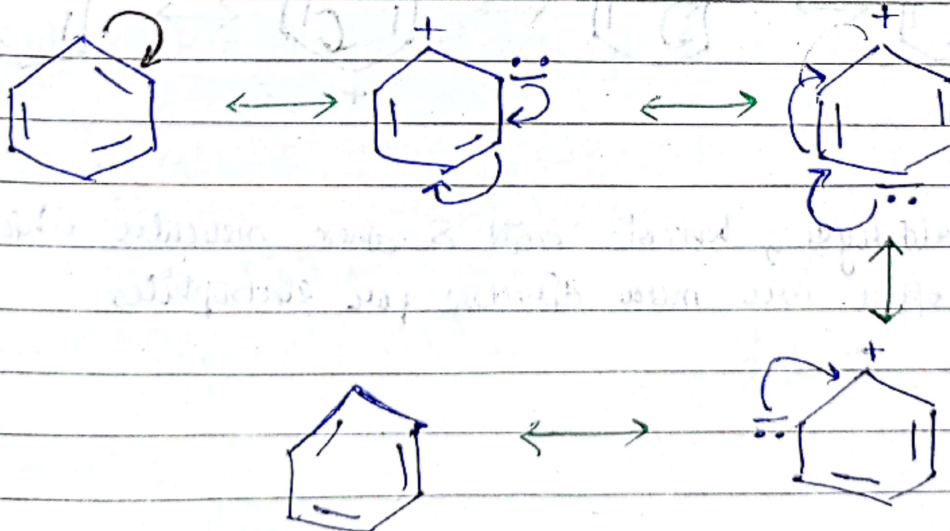


- d) metamerism :
- ⇒ chemical formula : same
 - ⇒ Number of carbons on either side of chain : Different



* Resonance in organic : [R-effect]

⇒ Delocalization of π -bonds or π electrons for the sake of stability of molecule or ion.

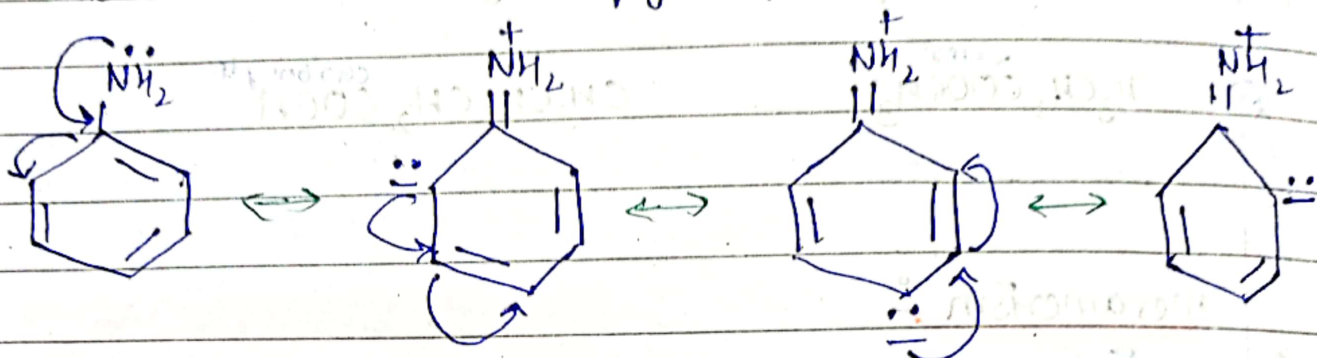


Types of R-effect

→ electron giving group $\Rightarrow$ δ^+ effect

+R-effect [or electron releasing or δ^+ shift $\Rightarrow$ δ^+ effect]

when electrons move away from atom of functional group and move towards conjugate part.

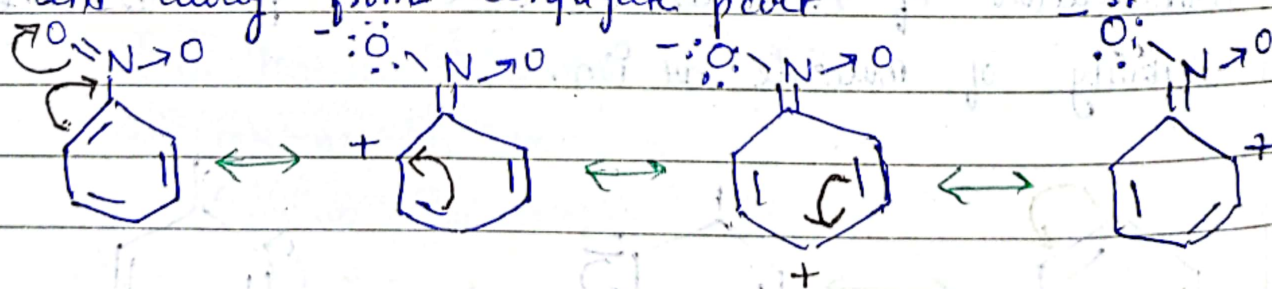


Aniline, Halobenzene, phenol and other molecules which show +R-effect are ortho-para directors for electrophiles.

electron
releasing.

-R effect

when electrons move towards atom of functional group and away from conjugate part.

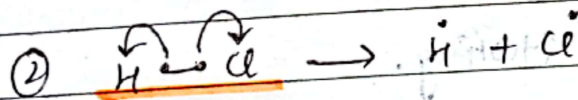
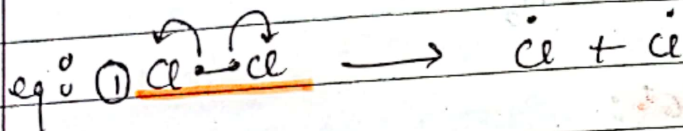


Benzaldehyde, benzoic acid & other molecules which show -R effect are meta directors for electrophiles.

* Bond cleavage :

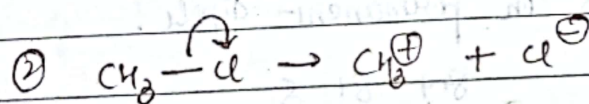
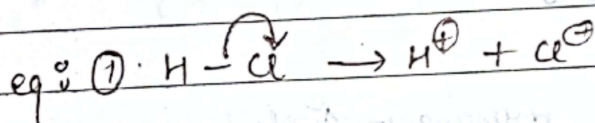
1) **Homolytic cleavage** : [जब bond के दो एककी बराबर electrons] में

⇒ cleavage of bond when single e⁻ from shared pair is received back by the bonded atoms.



2) **Heterolytic cleavage** :

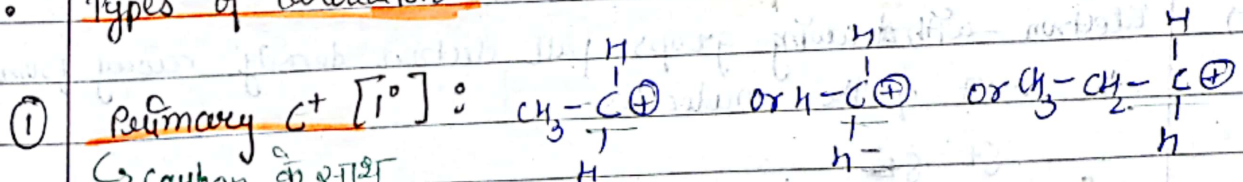
⇒ Both shared pair is received by one of the atom.



* Carbocation [C⁺]

⇒ Carbon atom having '+' charge in an ion.

• **Types of carbocation :**

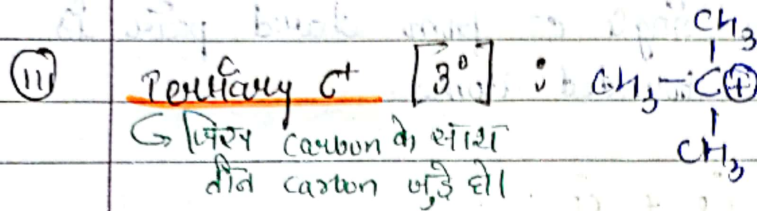
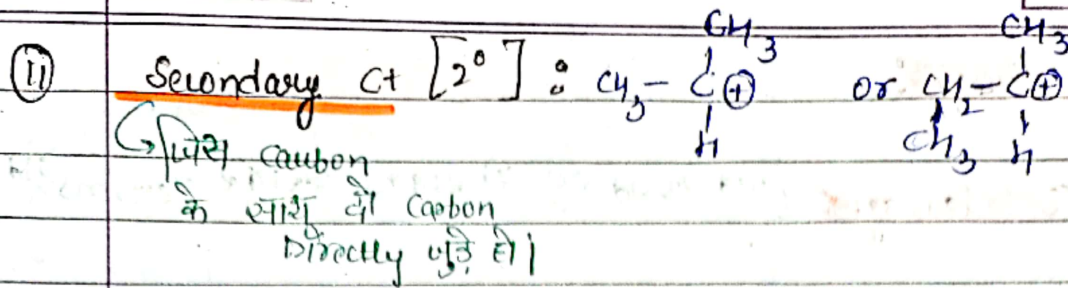


↳ Carbon के साथ

Directly या तो एक

Carbon जुड़ा होगा या

एक भी नहीं।

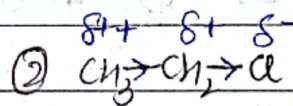
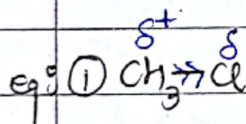


* Stability of Carbocation C⁺ :
 Primary < Secondary < Tertiary.

* Inductive effect : [I-effect]

⇒ Partial charge developed on atoms due to unequal [non-uni] sharing of electron pairs.

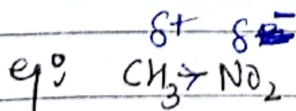
⇒ Inductive effect results in permanent dipole.



• Types of Inductive effect :

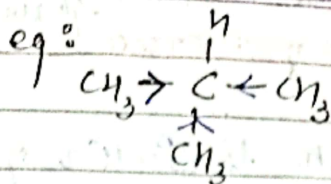
① Negative Inductive effect [-I] :

⇒ Electron-withdrawing groups pull electron density away from the rest of the molecules.



② Positive Inductive effect [+I] :

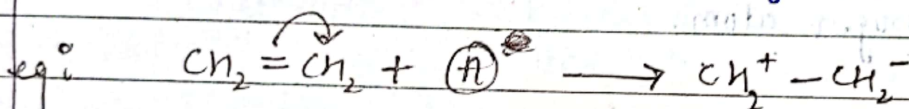
⇒ Electron-donating groups push electron density toward the rest of the molecule.



* Electromerical Effect [E-effect] :

⇒ It is a temporary effect. The organic compounds having a multiple bond [a double or triple bond] show this effect in the presence of an attacking reagent only.

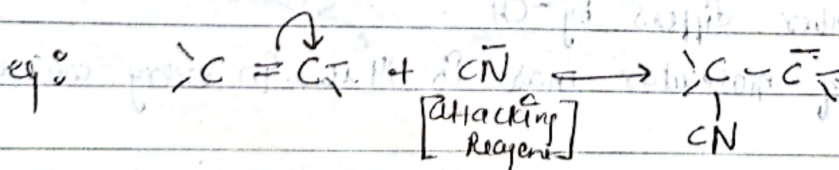
⇒ It is defined as the complete transfer of a shared pair of π -electrons to one of the atoms joined by a multiple bond on the demand of an attacking reagent.



Types of E-effect

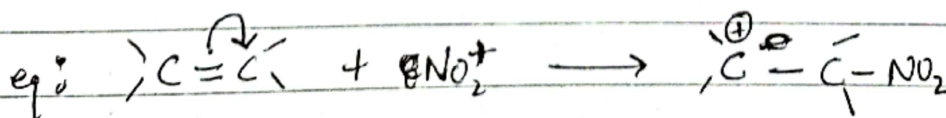
① -E effect

⇒ In this effect the π -electrons of the multiple bond are transferred to the atom to which the attacking reagent does not get attached.



② +E effect

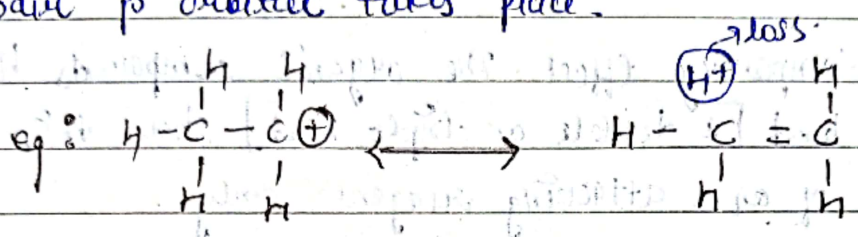
⇒ when electron pair shifts to carbon where attacking reagent attacks.



σ electrons अपतल वाले से Delocalize होते हैं Stability के लिए
 दो ऐसे प्रकार के Resonance हैं Hyperconjugation

* **Hyperconjugation** [Special type of resonance]

⇒ A permanent effect in which localization of σ electrons of C-H bond of an alkyl group directly attached to an atom of the unsaturated system or to an atom with an unshared pair p orbital takes place.



* **Homologous series**

A series of organic compounds in which each member differs by -CH₂ group which means 1 carbon atom & 2 hydrogen atom.

Alkanes H.S.	Alcohol H.S.
CH ₄	CH ₃ OH
C ₂ H ₆	C ₂ H ₅ OH
C ₃ H ₈	C ₃ H ₇ OH
C ₄ H ₁₀	C ₄ H ₉ OH

⇒ **Properties of members of homologous series**

- Each member differs by -CH₂ → 12 + 1 × 2
- Difference of molecular mass is 14u in every consecutive member
- All members follow same general formula.
- Same chemical properties → depends on functional group
- Different physical properties → depends on size or mass

*

Classification of Organic Compounds :

Organic compounds

→ Acyclic or open chain compounds

→ cyclic or closed chain or ring compounds

Alcyclic compounds

Aromatic compounds

Homocyclic or Carbocyclic compounds

Heterocyclic compounds [Non-aromatic]

Benzenoid compounds

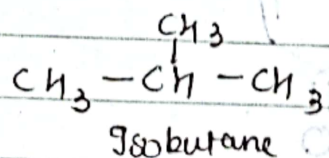
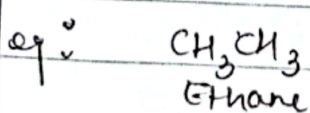
Non-Benzenoid compounds

Heterocyclic aromatic compound

I.

Acyclic or open chain compounds -

⇒ These compounds are also called as aliphatic compounds & consist of straight or branched chain compounds.



II.

Cyclic or closed compounds -

(a)

Alcyclic compounds.

⇒ Alcyclic [aliphatic cyclic] compounds contain carbon atoms joined in the form of a ring [homocyclic].

↳ In this there is carbon in ring.



cyclopropane

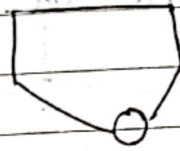


cyclohexane



cyclohexene.

⇒ Sometimes atoms other than carbon are also present in the ring [heterocyclic]. Tetrahydrofuran given below is an eg of this type of compound.

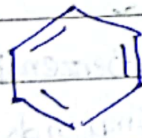


Tetrahydrofuran.

Aromatic compounds.

→ In this every carbon is sp^2 hybridised [Double bond].

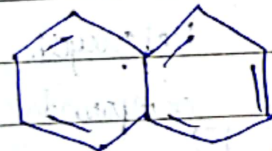
Benzenoid aromatic compounds :



Benzene

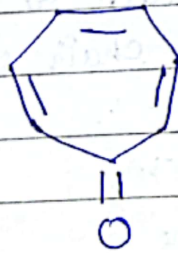


Aniline



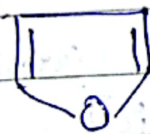
Naphthalene

Non-benzenoid compound.

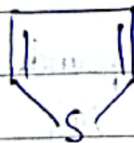


Tropone

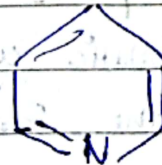
Heterocyclic aromatic compounds.



Furan.



Thiophene



Pyridine

* Separation techniques:

I. Solid + solid mixture

a) Dissolving in suitable solvent:
 eg: sand + salt
 salt + sugar

b) Sublimation:

eg: $\text{NaHCO}_3 + \text{NH}_4\text{Cl}$ → shows sublimation
 Iodine + salt
 → shows sublimation

c) Magnetic separation:

eg: Iron + sand
 Nickel + Al

II. Solid + liquid

a) Filtration

eg: Sand + water
 salt + alcohol

e) Chromatography:

f) Crystallization

b) Evaporation

eg: salt + water

c) Distillation: liquid $\rightleftharpoons$ vapours

d) Centrifugation: eg: cream from milk

→ इसमें घिसी गी

लिकुन की
 मीरे मीरे से चुनाए है।

111.

Liquid + Liquid :

a)

Miscible liquid: liquids which dissolve into each other completely and form homogeneous mixture
eg: alcohol + water, acetic acid + water

separation technique : Fractional distillation

b)

Immiscible liquid: liquids which do not dissolve into each other completely & form layers.
eg: Mustard oil + water, Petrol + water.

Separation technique : separating funnel.

*

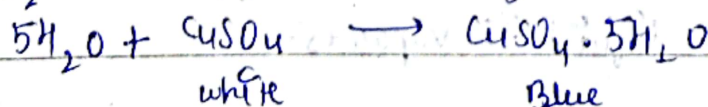
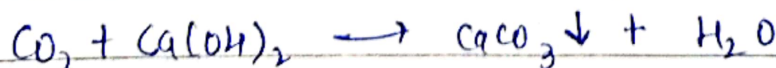
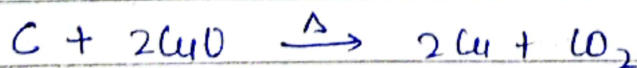
Qualitative Analysis of Organic compounds:

1)

Selection of Carbon and Hydrogen:

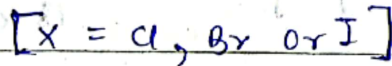
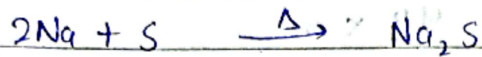
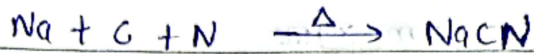
2)

Carbon and hydrogen are detected by heating the compound with copper(II) oxide. Carbon present in the compound is oxidised to carbon dioxide [tested with lime water, which develops turbidity] and hydrogen water [tested with anhydrous copper sulphate, which turns blue].

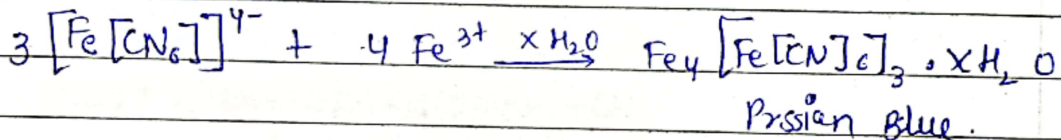
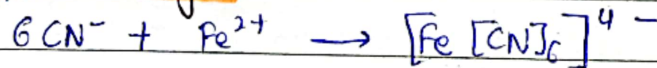


2. Detection of other elements.

Nitrogen, sulphur, halogens and phosphorus present in an organic compound are detected by "Lassaigne's test"

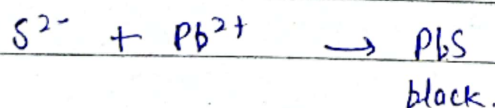


(A) Test for nitrogen.



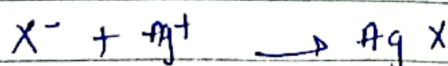
(B) Test for sulphur.

(a) The sodium fusion extract is acidified with acetic acid & lead acetate is added to it. A black precipitate of lead sulphide indicated the presence of sulphur



(C) Test for Halogens.

The sodium fusion extract is acidified with nitric acid & then treated with silver nitrate. A white precipitate, soluble in ammonium hydroxide shows the presence of chlorine, a yellowish precipitate, sparingly soluble in ammonium hydroxide shows the presence of bromine & a yellow precipitate, insoluble in ammonium hydroxide shows the presence of iodine.



Quantitative Analysis

Let the mass of organic compound be m g & mass of CO_2 & carbon dioxide produced be m_1 & m_2 g respectively

$$\% \text{ of carbon} = \frac{12 \times m_2 \times 100}{44 \times m}$$

$$\% \text{ of hydrogen} = \frac{2 \times m_1 \times 100}{18 \times m}$$