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Where Minds Pollinate

Class 11
Chemistry

Chapter 15
organic chemistry
Handwritten Notes

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15 ORGANIC CHEMISTRY :-

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NOMENCLATURE OF ALKANES :-

Common Names :-

⇒ CH_4 Marsh gas

⇒ Isoalkanes :-

$CH_3-CH(CH_3)-CH_3$ Isobutane

$CH_3-CH(CH_3)-CH_2-CH_3$ Isopentane

⇒ Neoalkanes :-

$CH_3-C(CH_3)_2-CH_3$ Neopentane

$CH_3-C(CH_3)_2-CH_2-CH_2-CH_3$ Neoheptane

IUPAC Names :-

① $CH_3-CH_2-CH_2-CH_2-CH_3$

n-Pentane

② $CH_2(CH_3)-CH_2-CH_2-CH(CH_2CH_3)$ n-heptane

③ $CH_2(CH_3)-CH_2-CH_2-CH(CH_2-CH_2-CH_3)$ n-octane

(4) $CH_3-CH_2-CH(CH_3)-CH_2-CH_3$

3-Methyl pentane

(5) $CH_3-CH(CH_3)-CH(CH_3)-CH_2-CH_3$

2,3-Dimethyl pentane

(6) $CH_3-CH(CH_3)-CH_2-CH_2-C(CH_3)_2-CH_3$

2,2,5-Trimethylhexane

(7) $CH_3-CH_2-CH(CH_3)-C(CH_2CH_3)(CH_2CH_2CH_2CH_3)-CH(CH_3)-CH_2-CH_3$

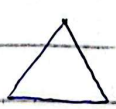
3-Ethyl-4,5-dimethyl-4-propyl heptane

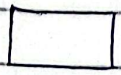
(8) $(CH_3)_3C\cdot(CH_2)_2CH(CH_3)_2$

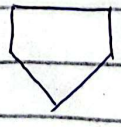
$CH_3-C(CH_3)_2-CH_2-CH_2-CH(CH_3)-CH_3$

2,2,5-Trimethyl hexane

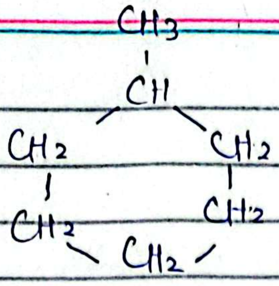
* **CYCLOALKANES :- (C_nH_{2n})**

(1) $CH_2-CH_2-CH_2$ or  cyclopropane

(2)  cyclobutane

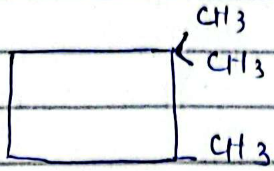
 cyclopentane

(4)



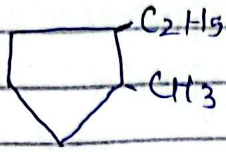
Methylcyclohexane

(5)



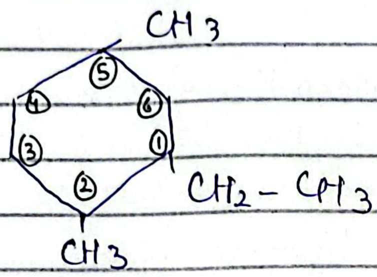
1,1,2- Trimethylcyclobutane

(6)



1 - Ethyl - 2-methylcyclopentane

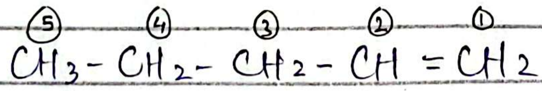
(7)



1-Ethyl - 2,5-Dimethylcyclohexane

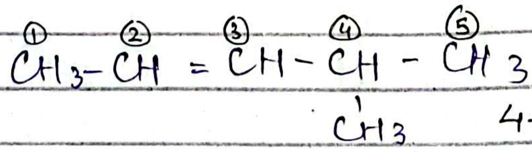
ALKENES :-

(1)



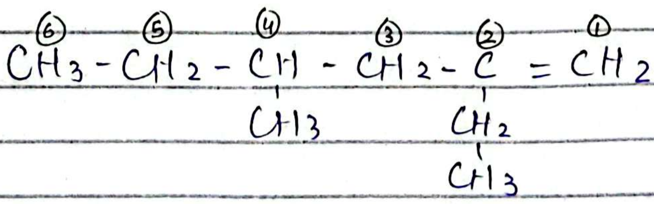
1- Pentene

(2)



4-Methyl-2-pentene

(3)



2- Ethyl - 4- methyl- 1 - hexene

④ $CH_3-\underset{CH_3}{\underset{|}{C}}(CH_3)-CH=CH-CH_3$

2,2-Dimethyl-3-hexene

⑤ $CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_2-\underset{CH_2-CH_3}{\underset{|}{CH}}-\underset{CH_2-CH_3}{\underset{|}{C}}=CH-CH_3$

3-Ethyl-5-methyl-4-propyl-2-heptene

⑥ $CH_3-CH_2-CH=CH-CH=CH_2$

hexa-1,3-diene or 1,3-Hexadiene

⑦ 2,3-Dimethyl-1,4-Hexadiene

$CH_2=\underset{CH_3}{\underset{|}{C}}-\underset{CH_3}{\underset{|}{CH}}-CH=CH-CH_3$

⑧ $CH_2=CH-CH=CH-\underset{CH_3}{\underset{|}{CH}}-CH=CH_2$

5-Methyl hepta-1,3,6-triene

ALKYNES:-

① $CH_3-CH_2-CH_2-C\equiv CH$

1-pentyne

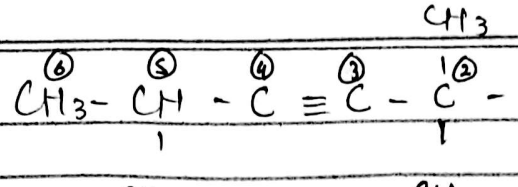
② $CH_3-C\equiv C-\underset{CH_3}{\underset{|}{CH}}-CH_3$

4-Methyl-2-pentyne

③ $CH_3-CH_2-\underset{CH_3}{\underset{|}{CH}}-\underset{CH_2-CH_3}{\underset{|}{CH}}-C\equiv CH$

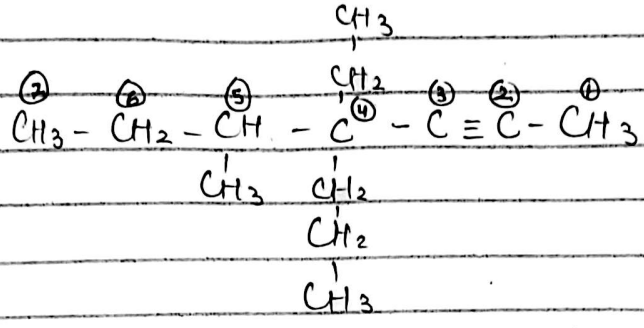
3-Ethyl-4-methyl-hex-1-yne

(4)



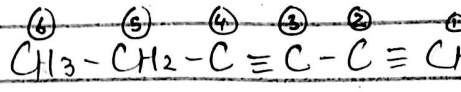
2,2,5-Trimethyl-hex-3-yne

(5)



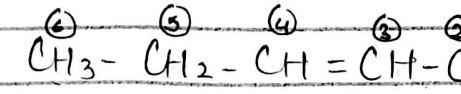
4-Ethyl-5-methyl-4-propyl-hept-2-yne

(6)



Hexa-1,3-diyne or 1,3-Hexadiyne

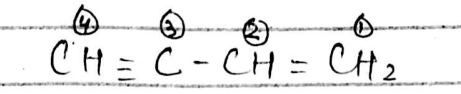
(7)



Hex-3-ene-1-yne

or 3-Hexene-1-yne

(8)



But-1-ene-3-yne

ALKYL HALIDES or HALOALKANES

C.N → ALKYL HALIDES

IUPAC → HALOALKANES

R-X

R → alkyl group

X → halogroup.

(1) CH_3-CH_2-Cl Ethyl chloride (C.N)
1-Chloroethane (IUPAC)

(2) $CH_3-\underset{Cl}{\underset{|}{CH}}-CH_3$ 2-Chloropropane (IUPAC)
Iso propyl chloride (C.N)

(3) $CH_3-\overset{CH_3}{\underset{Cl}{\underset{|}{C}}}-CH_3$ Ter-butyl chloride (C.N)
2-Chloro-2-methyl propane (IUPAC)

(4) $CH_2(Cl)-CH(CH_3)-CH(Br)-CH_3$ 3-Bromo-1-chloro-2 methyl butane

(5) $CH_3-\overset{Cl}{\underset{CH_3}{\underset{|}{C}}}-CH(Br)-\overset{Cl}{\underset{F}{\underset{|}{C}}}-CH_3$
3-Bromo-2,4-chloro-2-flouro-4methyl pentane

(6) $CH_3-\overset{Cl}{\underset{CH_3}{\underset{|}{C}}}-CH(Br)-CH_3$
3-Bromo-2-chloro-2-methyl butane

* ALCOHOL or ALKANOL :-
↓ ↓
common name IUPAC name

① CH_3-CH_2-OH — Ethyl alcohol (C·N); Ethanol (IUPAC)

② $CH_3-CH_2-CH_2$ with OH — Propyl alcohol (C·N); 1-propanol (IUPAC)

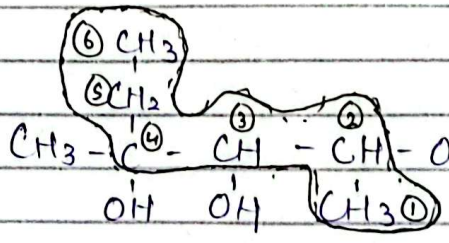
③ $CH_3-CH(OH)-CH_3$ — Isopropyl alcohol, sec-propyl alcohol (C·N); 2-propanol (IUPAC)

④ $CH_3-C(CH_3)_2-OH$ — ter-butyl alcohol; 2-Methyl-2-propanol

⑤ $CH_3-C(OH)(CH_3)-CH(CH_3)-CH_3$ — 2,3-Dimethyl-2-butanol

⑥ $CH_2(OH)-CH_2(OH)$ — Glycol (C·N); Ethane-1,2-diol

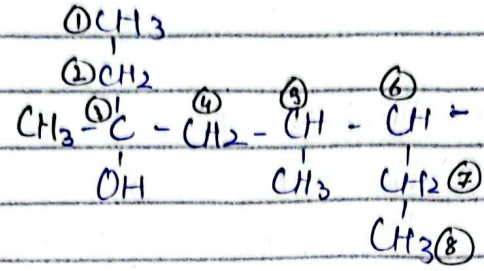
⑦ $CH_2(OH)-CH(OH)-CH_2(OH)$ — Glycerene or Glyoxal (C·N); Propane-1,2,3-triol

⑧ 

4-Methyl-hexane-2,3,4-triol

⑨ $CH_3-\underset{Br}{\overset{|}{CH}}-\underset{Br}{\overset{|}{C}}=CH_2$

2,3-Di bromo but-1-ene



6-chloro-3,5-Dimethyl-3 octanol

* **ALDEHYDES or ALKANALS ::**

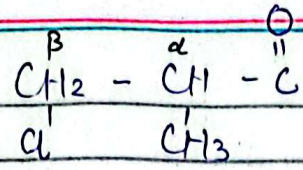
① $H-\overset{O}{\overset{\|}{C}}-H$ Methanal (IUPAC)
Formaldehyde (C.N)

② $CH_3-\overset{O}{\overset{\|}{C}}-H$ Ethanal (IUPAC)
Acetaldehyde (C.N)

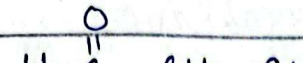
③ $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H$ Propanal (IUPAC)
Propionaldehyde (C.N)

④ $CH_3-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-H$
Butanal (IUPAC)
Butyraldehyde

⑤ $CH_3-CH_2-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-H$
Pentanal (IUPAC)
Valeraldehyde (C.N)

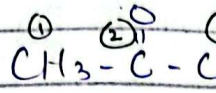
(6) 

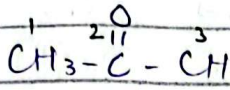
3-Chloro-2-methyl propanal
β-Chloro-α-methyl propionaldehyde

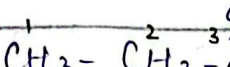
(7) 

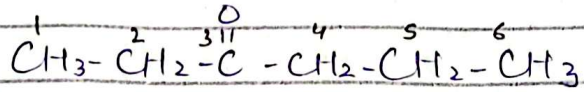
Butane-1,4-dial

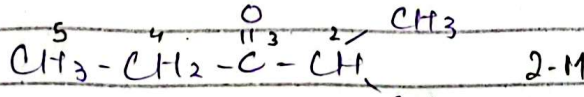
KETONES :- or ALKANONE :-

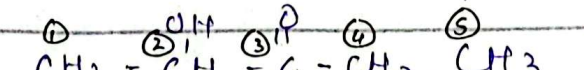
(1)  Acetone or Dimethyl ketone (C.N)
2-Propanone (IUPAC)

(2)  2-Butanone (IUPAC)
Ethyl methyl ketone (C.N)

(3)  3-Pentanone (IUPAC)
Diethyl ketone (C.N)

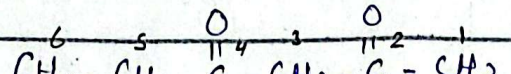
(4) 
(IUPAC) 3-hexanone
(C.N) Ethyl propyl ketone

(5)  2-Methyl-3-Pentanone
Ethyl isopropyl ketone (C.N)

(6) 

1-chloro-2-hydroxy-3-pentanone

(7)-



2,4- Hexadione

Ethers :- or Alkoxyalkane

(1) CH_3-O-CH_3 Dimethyl ether (C.N)
Methoxy methane (IUPAC)

(2) $CH_3-O-CH_2-CH_3$ Ethyl methyl ether (C.N)
Methoxy ethane (IUPAC)

(3) $CH_3-CH_2-O-CH_2-CH_3$
Diethyl ether (C.N)
ethoxy ethane (IUPAC)

(4) $CH_3-CH_2-O-CH_2-CH_2-CH_3$
Ethyl propyl ether (C.N)
1- ethoxy propane

(5) $CH_3-CH_2-O-CH(CH_3)_2$
ethyl isopropyl ether

Amines :-

(1) CH_3-NH_2 Methyl amine (C.N)
Amino methane (IUPAC)

(2) $CH_3-CH_2-NH_2$ Ethyl amine (C.N)
Amino ethane (IUPAC)

③ $CH_3-NH-CH_2-CH_3$ Ethyl methyl amine (C·N)
N-methyl amino ethane

④ $CH_3-CH_2-NH-CH_2-CH_3$
Diethyl amine (C·N)
N-ethyl aminoethane

⑤ $CH_3-N(CH_3)-CH_3$ Trimethyl amine (C·N)
N,N-Dimethyl aminomethane

⑥ $CH_3-N(CH_2CH_2CH_3)-CH_3$ Ethyl methyl propyl amine (C·N)
N-Ethyl-N-methyl amino propane

Nitrile :-

① $CH_3-C\equiv N$ Ethane nitrile (IUPAC)
Acetonitrile

② $CH_3-CH_2-C\equiv N$ Propanenitrile (IUPAC)
propionnitrile

③ $CH_3-CH_2-CH_2-C\equiv N$ Butanenitrile (IUPAC)
Butyrnitrile

Carboxylic Acids:- or Alkanoic Acids:-

① $H-\overset{\overset{O}{\|}}{C}-OH$ — Methanoic acid (IUPAC), Formic acid (C.N)

② CH_3COOH — Ethanoic acid (IUPAC), Acetic acid (C.N)

③ CH_3-CH_2-COOH — Propanoic acid (IUPAC), Propionic acid (C.N)

④ $CH_3-CH_2-CH_2-COOH$ — Butyric acid (C.N), Butanoic acid (IUPAC)

⑤ $CH_3-CH_2-CH_2-CH_2-COOH$ — Pentanoic acid (IUPAC), Valeric acid (C.N)

⑥ $CH_3-CH_2-CH_2-CH_2-CH_2-COOH$ — Hexanoic acid (IUPAC), caproic acid (C.N)

⑦ $\overset{3}{CH_3}-\overset{2}{CH}(OH)-\overset{1}{COOH}$ — 2-Hydroxy propanoic acid, lactic acid

⑧ $(COOH)_2$ — Ethanedioic acid (IUPAC), oxalic acid (C.N)

⑨ $CH_2(COOH)_2$ — Propanedioic acid (IUPAC), Malenic acid (C.N)

10- $HOOC-CH_2-CH_2-COOH$

Butanedioic acid
(succinic acid)

11- $HO-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$

Pentanedioic acid
(Glutaric acid)

12- $HO-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$

hexanedioic acid
(Adipic acid)

Esters :- $R-\overset{O}{\overset{\|}{C}}-OR$

(1) $H-\overset{O}{\overset{\|}{C}}-OCH_3$ Methyl methanoate (IUPAC)
Methyl formate (C.N)

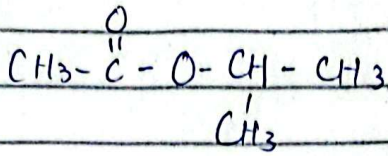
(2) $CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5$ Ethyl ethanoate (IUPAC)
Ethyl Acetate (C.N)

(3) $\overset{3}{CH_3}-\overset{2}{CH_2}-\overset{1}{\overset{O}{\overset{\|}{C}}}-OC_2H_5$ Ethyl propanoate (IUPAC)
Ethyl propionate (C.N)

(4) $\overset{3}{CH_3}-\overset{2}{CH}(CH_3)-\overset{1}{\overset{O}{\overset{\|}{C}}}-OC_2H_5$ Ethyl-2-methyl propanoate (IUPAC)

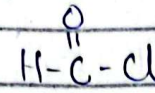
Ethyl-2-methyl propionate

(5)

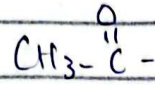


Isopropyl acetate (C.N)
1-methyl ethyl ethanoate

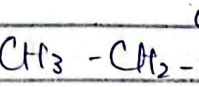
Acid Halides:-



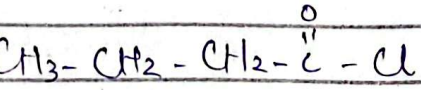
Formyl chloride (C.N)
Methanoyl chloride (IUPAC)



Acyl chloride (C.N)
ethanoyl chloride (IUPAC)

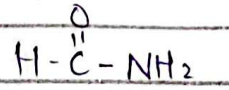


Propanoyl chloride (IUPAC)
Propionyl chloride (C.N)



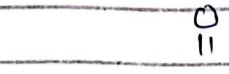
butanoyl chloride
butyryl chloride

Amide:-

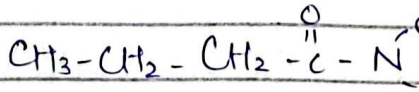


Formamide (C.N)
Methanamide (IUPAC)

Acetamide (C.N)
Ethanamide (IUPAC)



Propionamide (C.N)
propanamide (IUPAC)



N,N-Dimethyl butanamide (IUPAC)

Synthesis of Organic compounds

A German chemist Friedrich Wohler, wanted to prepare ammonium cynate (NH_4OCN) from the following reaction.

$$AgOCN + NH_4Cl \longrightarrow NH_4OCN + AgCl$$

Wholes synthesized urea ($NH_2-CO-NH_2$) which is an organic compound, in laboratory by heating ammonium cynate (NH_4CNO) which is an organic compound.

$$NH_4OCN \longrightarrow NH_2-CO-NH_2$$

(inorganic) (organic)

ammonium cynate is urea.

CATENATION

The word catenation comes from a Greek word 'Catena' which means 'chain'. The ability of carbon atoms to form long chains & rings is called catenation.

- **Importance of catenation in organic chemistry :-**

1- catenation of carbon making single, double & triple bonds.
2- Kinetic stability of organic compounds.
3- attachment of carbon with other elements.

Molecular formula

Definition:-
A molecular formula shows the types of atoms of and the actual whole number ratio between atoms of different elements in a molecule of organic compound.

Examples:-

Compounds	Molecular formula
ethanol	C_2H_6O
ethanoic acid	$C_2H_4O_2$
glucose	$C_6H_{12}O_6$

Empirical formula

Definition:-
Empirical formula is the symbolic representation of organic compounds which shows simplest whole number ratio b/w elements in them.

Examples:-

Compounds	Molecular formula	Empirical formula
benzene	C_6H_6	CH
Ethyne	C_2H_2	CH

Determination of Empirical & Molecular formulae from combustion Analysis

→ Determination of Empirical formula:-
- Mole of each elements.
- Atomic ratio of each element.

→ Determination of Molecular Formula:-

- Mole of each elements.
- Atomic ratio of each elements.
-

- Molecular formula = n x Empirical formula.

$$n = \frac{\text{Molecular mass of compound}}{\text{Empirical formula mass}}$$

Example 1

An organic compound has percentage composition by mass C = 38.4%, H = 4.8%, and Cl = 56.8%. Calculate empirical formula of this compound.

1) Mole of $C = \frac{38.4}{12} = 3.2$.

2) Mole of $H = \frac{4.8}{1.008} = 4.76$

3) Mole of $Cl = \frac{56.8}{35.5} = 1.6$

Divide least value to all ratios.

Atomic ratio of $C = \frac{3.2}{1.6} = 2$

Atomic ratio of $H = \frac{4.76}{1.6} = 3$

Atomic ratio of Cl = 1

Empirical formula = C_2H_3Cl

Example 2

An organic compound has empirical formula 'CH' and molecular formula 78 amu. Calculate its molecular formula.

Empirical formula = CH.
Molecular mass of compound = 78 amu.
Molecular formula = ?

$$n = \frac{\text{Molecular mass of compound}}{\text{Empirical formula mass.}}$$

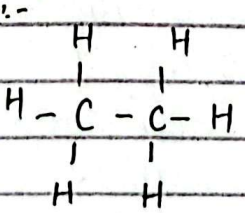
$$n = \frac{78}{13} = 6$$

Molecular formula = n × Emp. formula.
= 6 × CH
= C_6H_6

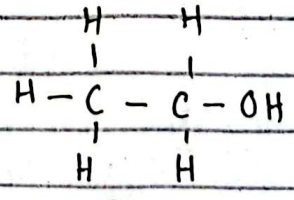
Structural Formula

1- **Condensed Structural Formula:-**
A condensed structural formula tells us about the relative positions of all atoms in a molecule without showing single covalent bonds.
The branches, functional groups and repeating methylene groups in the middle of molecules are shown in brackets.
Example:- Acetic Acid (CH_3COOH)

2- **Full Structural Formula:-**
This formula indicates all atoms & bonds among them in a molecule. It is 2-dimensional formula and also called 2D displayed formula.
Example:-



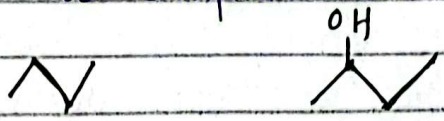
ethane



Ethanol

Skeletal Formula :-

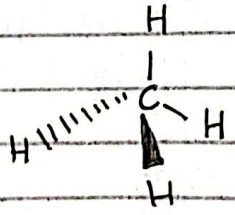
In this formula only lines are drawn where each end and vertex of the line is assumed to represent carbon atoms, unless another atom like oxygen or halogen etc. Each carbon atom is assumed to be bonded to enough hydrogen atoms to complete its valency.



butane butan-2-ol

1- Stereochemical formula :-

Stereochemical formula gives structure of molecules in space with atoms in x, y and z planes.



along the plane (——)
out of plane (▬)
inside the plane (||||||)

:- (Functional Group) -:

(reactive site of any molecule)

An atom or group of atoms, double bond or triple bond which give characteristic properties to a molecule is called functional group.

Example :-

$-Cl$, $-Br$, $-I$, $-OH$, $-NH_2$, $-COOH$, $-\overset{O}{\overset{\|}{C}}-H$, $C \equiv C$, $C = C$

* **Importance :-**

1- **Chemical reactivity :-** Functional group determines how a molecule will react in a chemical reaction. For e.g. hydroxyl group (-OH) in alcohols make them reactive in dehydration reactions.

2- **Molecular Properties :-** They influence the physical properties of a molecule.

3- **Nomenclature :-** They provide a systematic way to name organic compounds.

4- **Biological Activity :-** Functional group play a vital role in determining the biological activity of a molecule.

Homologous Series (h.s)

- **Definition :-** The group of organic compounds which have same functional group but different length of carbon chain is called homologous series.
- **Important points / features :-**

1- Each homologous series has its own functional group.

2- Each member of the homologous series differ from next member by one methylene $(-CH_2)$ group.

3- Each h.s has its own general formula. For example the general formulae of alkane, alkenes and alcohols are C_nH_{2n+2}, C_nH_{2n} and $C_nH_{2n+1}OH$ respectively.

4- All members of h.s has similar chemical properties.

5- A h.s has gradual change in their

physical properties with changing size of carbon chain.

6- They have similar method of preparation.

Hydrocarbons

The compounds which have only carbon and hydrogen elements in their molecules are called hydrocarbons.

→ They are least reactive organic compounds due to 2 reasons:-

1- the C-C and C-H bonds are very strong and difficult to be broken.

2- the C-C and C-H bonds are non-polar so cannot be attacked by other polar reagents, like acids, bases, oxidizing & reducing agents etc.

Differ saturated & unsaturated hydrocarbons.

→

Saturated hydrocarbons	Unsaturated hydrocarbons.
These are the hydrocarbons in which carbon atoms are attached with each other through single bond. Each carbon is sp^3 hybridized.	These are the hydrocarbons which contain double or triple bonds e.g alkenes & alkynes. Alkenes or olefins: These are the unsaturated hydrocarbons which contain carbon-carbon double bond (C=C). Carbon is sp^2 hybridized. Alkynes:- They contain carbon-carbon tripple bond and are sp hyb.

3)	They give substitution reactions.	They give addition reactions.
4)	These are less reactive than alkenes & alkynes.	These are more reactive than alkane.
5)	Example:- CH_3-CH_3 Ethane	Example:- $CH_2=CH_2$ ethene $CH\equiv CH$ ethyne.

Alkyl Group.

It is obtained by removing any one hydrogen atom from alkanes.

$CH_4 \xrightarrow{-H} -CH_3$

methane. methyl

$CH_3-CH_3 \xrightarrow{-H} CH_3-CH_2-$

ethane ethyl

Terminologies:-

1- **Free Radicals:-** An atom or molecule which contain unpaired electron is called free radical.

- Radicals are unstable and highly reactive
- They are formed by homolytic fission.

E.g:- $\dot{Cl}$, $\dot{C}H_3$

2- **Electrophile:- (E^+)**

- Electrophile means electron loving
- Substance which is electron deficient is called electrophile.
- It may be neutral or positively charged.

E.g:- H^+, NO_2^+, SO_3, BF_3, PCl_5

3. Nucleophile (Nu^-)

-> Nucleophile means nucleus loving.

-> Substance which is electron rich is called nucleophile.

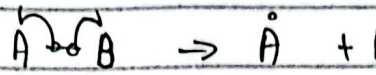
-> It may be neutral or negatively charged.

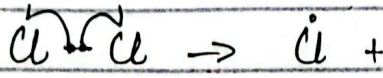
E.g:- Cl^-, OH^-, CN^-, CO_3^{-2}, $\ddot{N}H_3$

Bond fission:-

i) Homolytic fission:- When a chemical bond is broken in such a way that, both of the bonded atoms acquire same electron is called homolytic fission

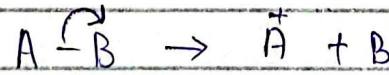
E.g:-

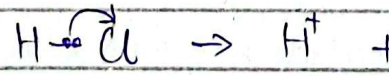




ii) Heterolytic fission:- When a chemical bond is broken in such a way that both of the bonded e^- acquire in one of the bonded atom is called heterolytic fission.

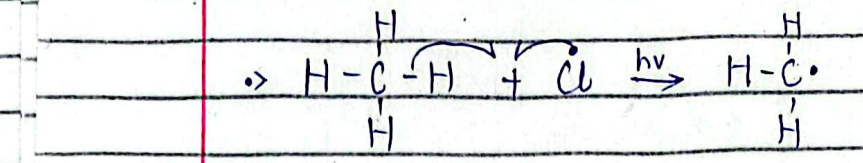
E.g:-

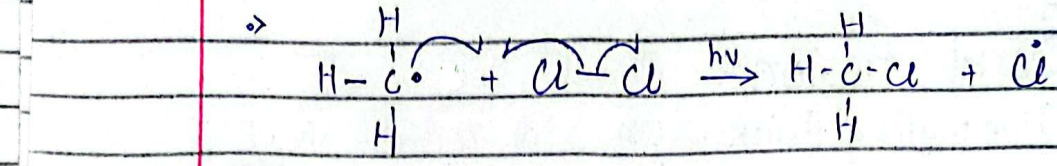




Types of Organic Chemical Reactions:-

i- Free Radical Substitution reaction of Alkanes:

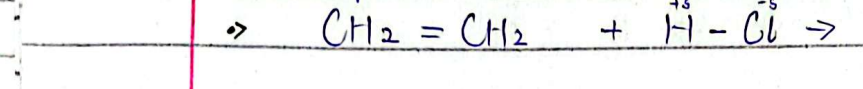


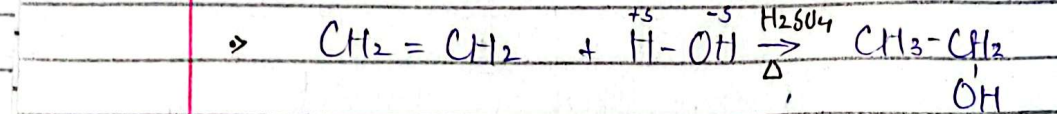


Or

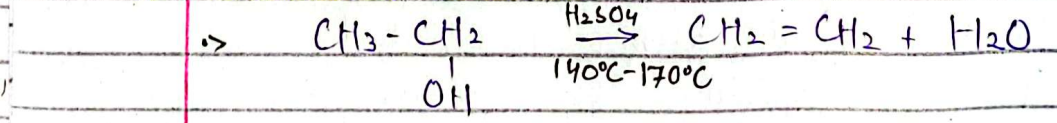
$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

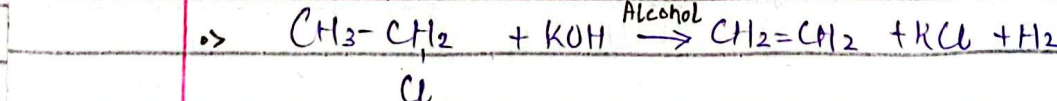
ii- Electrophilic Addition Reactions:-





iii- Elimination Reactions:-





iv- Nucleophilic Substitution Reactions:-

$$CH_3-Br + NaOH_{(aq)} \rightarrow CH_3OH + NaBr$$

v- **Nucleophilic Addition Reactions:-**

$$CH_3-\overset{O}{\overset{\|}{C}}-H + HCN \rightarrow CH_3-\underset{CN}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-H$$

Acetaldehyde cyanohydrin

vi- **Hydrolysis:-**

$$CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H-OH \xrightarrow[\Delta]{H_2SO_4} CH_3-\overset{O}{\overset{\|}{C}}-OH + C_2H_5OH$$

vii- **Condensation:-**

$$CH_3-\overset{O}{\overset{\|}{C}}-OH + C_2H_5OH \underset{\Delta}{\overset{H_2SO_4}{\rightleftharpoons}} CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H_2O$$

viii- **Oxidation Reaction:-**

$$CH_3-OH + [O] \xrightarrow[\Delta]{K_2Cr_2O_7+H_2SO_4} H-\overset{O}{\overset{\|}{C}}-H + H_2O$$

$$H-\overset{O}{\overset{\|}{C}}-H + [O] \xrightarrow[\Delta]{K_2Cr_2O_7+H_2SO_4} H-\overset{O}{\overset{\|}{C}}-OH$$

ix- **Reduction Reaction:-**

$$CH_3-\overset{O}{\overset{\|}{C}}-H + 2[H] \xrightarrow{LiAlH_4} CH_3-\underset{OH}{CH_2}$$

$$CH_3-C\equiv N \xrightarrow{LiAlH_4} CH_3-CH_2-NH_2$$

Free Radical Substitution Reaction of Alkanes:-

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

Mechanism:-

Initiation:- $Cl-Cl \xrightarrow{h\nu} Cl^{\cdot} + Cl^{\cdot}$

Propagation:-

$H-CH_2^{\cdot} + Cl-Cl \rightarrow H-CH_2-Cl + Cl^{\cdot}$

$H-CH_2^{\cdot} + Cl-Cl \rightarrow H-CH_2-Cl + Cl^{\cdot}$

$H-CH_2-Cl + Cl^{\cdot} \rightarrow H-CH^{\cdot}-Cl + HCl$

$H-CH^{\cdot}-Cl + Cl-Cl \rightarrow H-CH(Cl)-Cl + Cl^{\cdot}$

$Cl-CH_2-H + Cl^{\cdot} \rightarrow Cl-CH^{\cdot}-H + HCl$

$Cl-CH^{\cdot}-H + Cl-Cl \rightarrow Cl-CH(Cl)-H + Cl^{\cdot}$

$Cl-CH(Cl)-H + Cl^{\cdot} \rightarrow Cl-C^{\cdot}(Cl)-H + HCl$

$Cl-C^{\cdot}(Cl)-H + Cl-Cl \rightarrow Cl-C(Cl)_2-H + Cl^{\cdot}$

Tetrachloromethane

Termination reaction:- $Cl^{\cdot} + Cl^{\cdot} \rightarrow Cl-Cl$

$CH_3^{\cdot} + Cl^{\cdot} \rightarrow CH_3Cl$

$CH_3^{\cdot} + CH_3^{\cdot} \rightarrow CH_3CH_3$

Isomerism:- Different compounds having same molecular formula but structural formula and properties are called isomers and phenomenon is called isomerism

Butane = 2 isomers
Pentane = 3 isomers
Hexane = 5 isomers
Decane = 75 isomers

Types:- 1) Structural isomerism
2) Stereoisomerism

"Structural Isomerism"

i- **Chain isomerism:-**

Different compounds having same molecular formula but different parent/long chain are called chain isomer and phenomenon is called chain isomerism.

E.g:-

$CH_3-CH_2-CH_2-CH_3$ — n-Butane

$CH_3-CH(CH_3)-CH_3$ — Isobutane

ii- **Position isomerism:-**

Different compounds having same molecular formula but different position of the same functional group are called position isomers and phenomenon is called positional isomerism.

E.g:- $CH_3-CH_2-CH_2(OH)$ — 1-propanol

$CH_3-CH(OH)-CH_3$ — 2-propanol

iii- **Functional group Isomerism:-**

Different compounds having same molecular formula but different functional groups are called functional group isomerism.

E.g:-

①	CH_3-CH_2-OH	CH_3-O-CH_3
	Ethanol	Methoxy methane
②	$CH_3-CH_2-\overset{O}{\overset{\|\|}{C}}-OH$	$H-\overset{O}{\overset{\|\|}{C}}-OC_2H_5$
	Propanoic acid	Ethyl methanoate
③	$CH_3-CH_2-\overset{O}{\overset{\|\|}{C}}-H$	$CH_3-\overset{O}{\overset{\|\|}{C}}-CH_3$
	Propanal	Propanone
④	Glucose (Aldehyde)	Fructose (Ketone)

iv- **Metamerism:-**

Different compound having same molecular formula but unequal distribution of carbon atoms on either side of the functional group are called metamer and phenomenon is called metamerism.

E.g:-

$CH_3-CH_2-O-CH_2-CH_3$	$CH_3-O-CH_2-CH_2-CH_3$
Ethoxyethane	Methoxypropane

v- **Tautomerism:-** Type of isomerism in which one isomer is converted into other isomer due to migration of H ion is called tautomer and phenomenon is called tautomerism

E.g:-

$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OC_2H_5 \rightleftharpoons CH_3-\overset{OH}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-OC_2H_5$

Keto form enol form

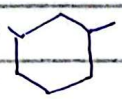
$CH_2=CH \rightleftharpoons CH_3-\overset{O}{\overset{\|}{C}}-H$

$O'H$

Enol form Keto form

MCQs:-

i) A) $CH_3(CH_2)_4CHO$

ii) D) 

iii) B) addition

iv) B) 4

v) B) alcohols

vi) D) C_4H_{10}

vii) C) 15

viii) D) 3-ethyl-4-methylhex-1-ene

ix) C) Succinic acid

x) D) its members have same alkyl groups