TOPIC : IUPAC NOMENCLATURE

Lecture 1: Introduction and classification of organic compounds, Homologas series, M.F., S.F.

Lecture 2: **Degree of unsaturation**, Degree of carbon & hydrogen, Radical & nomanclature of radical

Lecture 3: Nomenclature of alkane

Lecture 4: Unsaturated hydrocarbons (C = C, C ≡ C) Cyclic hydrocarbon (Alicyclic compound)

Lecture 5: Functional group containing compounds (–COOH, $–SO_3H$, –CO–O–CO–, –CO–OR, –CO–X, $–CO–NH_2$)

Lecture 6: Functional group containing compounds (–CN, N≡C, –CHO, >C=O, –OH, NH_2,R–O–R)

Lecture 7: Polyfunctional compounds.

Lecture 8: Aromatic Compounds and discussion

IUPAC NOMENCLATURE

1.1 INTRODUCTION TO ORGANIC COMPOUNDS:-

Organic compounds are compounds of carbon and hydrogen and the following elements may also be present: (Halogens, N, S, P, O). There are large no. of organic compounds available and large no of organic compounds are synthesized every year.The reason for large no of organic compounds lies in the property of catenation (self–linkage) in carbon.

Element	**Bond Energy**	
C	C–C (strongest bond)	
Si	Si–Si	
Ge	Ge–Ge	↓ Decreasing order
Sn	Sn–Sn	
Pb	Pb–Pb	

Bond energy depends on

(i) Size of atom (Inversely proportional)

(ii) E.N difference along period (Directly)

(iii) Bond order (no. of covalet bonds b/w two atoms) (Directly)

Ex:- Size : C–C>Si–Si

E.N Diff : C – H < N – H < O – H < H – F

Bond order : C – C < C = C < C ≡ C

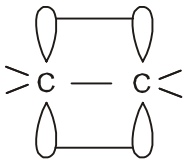
Hybridised state of carbon atom, σ & π bonds bond length between C – C, C = C & C ≡ C, Decreasing order of electronegativity of hybridised atoms.

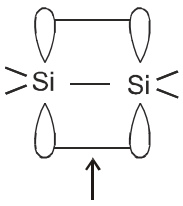
Catenation in carbon:-

→ The element carbon has strongest tendency to show catenation or self–linkage due to –

(a) its tetravalency so that it can form σ bonds with many element as well as carbon itself.

(b) It can form multiple bonds (C = C, C ≡ C). Due to its small size, there is efficient colateral overlapping b/w two P–orbitals.

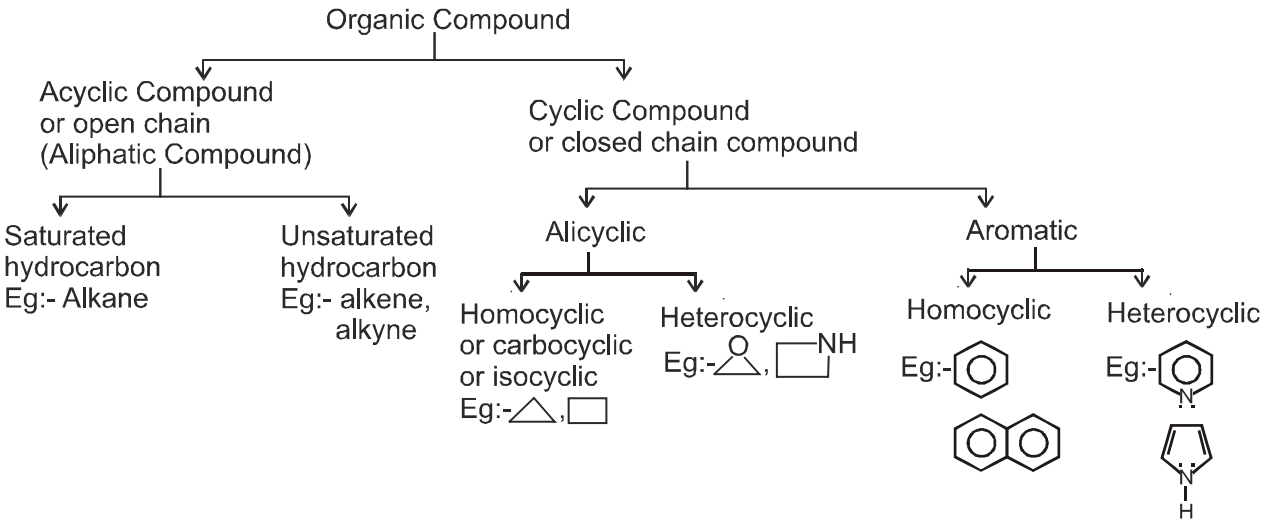


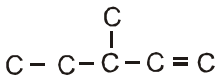
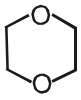
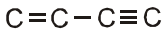
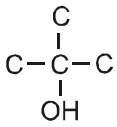


Does not exist

(c) High bond energy of C – C – bond so that it can form strong bonds in long chains and in cylic compounds.

1.2 CLASSIFICATION OF ORGANIC COMPOUNDS :



Ex.1	Compounds	Classification
		Unsaturated
		Heterocyclic , saturated
		Unsaturated
		Saturated
		Saturated, Alicylic

1.3 IMPORTANT TERMS:

Saturated compounds:

When all the valencies of an element are satisfied by σ covalent bonds.

Unsaturated compound:

When a compound contains one or more π bonds (C = C, C = N, N = N, C = O or C ≡ C, C ≡ N, N ≡ N)

Molecular Formula (M.F.) :

The molecular formula of a compound indicates the actual number of atoms of each element present in one molecule.

Structural Formula (S.F.):

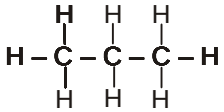
It indicates the linkage due to covalent bond between different atoms in a molecule.

(i) Expanded Structural Formula (E.S.F.)

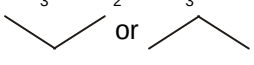
(ii) Condensed Structural Formula (C.S.F.)

(iii) Bondline Structural Formula (B.S.F.)

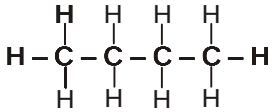
Ex.1:- M.F. C_3H_8

E.S.F. 

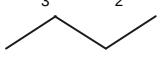
C.S.F. $CH_3 - CH_2 - CH_3$

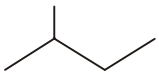
B.S.F. 

Ex.2:- M.F. C_4H_{10}

E.S.F. 

C.S.F. $CH_3 - CH_2 - CH_2 - CH_3$

B.S.F. 

Ex.3:- B.S.F. 

C.S.F. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

M.F. C_5H_{12}

Ex.4 B.S.F. 

M.F. C_6H_{12}

Calculation of Degree of Unsaturation (DU):-

(a) It is the hydrogen deficiency index (HDI) or Double Bond Equivalence (DBE)

(b) $H_3C - H_2C - CH_3 \xrightarrow{-2H} \left[CH_3 - CH = CH_2 \text{ or } \triangle \right] \xrightarrow{-2H} CH_3 - C \equiv CH \text{ or } CH_2 = C = CH_2 \text{ or } \triangle$

(DU = O) (DU = 1) (DU = 2)

That means Deficieny of 2H is equivalent to 1 DU

(c) (i) 1DU = Presence of 1 Double Bond or Presence of 1 Ring closure
(ii) 2DU = Presence of 2 Double bond or 1 Triple bond or two ring closure or 1 double bond + 1 ring.

(d)	**G.F.**	**D.U.**
	(i) C_xH_y	$(x + 1) - \left(\frac{y}{2}\right)$
	(ii) $C_xH_yO_z$	$(x + 1) - \left(\frac{y+o}{2}\right)$
	(iii) $C_xH_yX_s$	$(x + 1) - \left(\frac{y+s}{2}\right)$
	(iv) $C_xH_yN_w$	$(x + 1) - \left(\frac{y-w}{2}\right)$
	(v) $C_xH_yO_zX_sN_w$	$(x + 1) - \left(\frac{y+s-w}{2}\right)$

Ex **Calculate DU of following compounds**

(a) C_6H_6O DU = 4

(b) C_6H_5Cl DU = 4

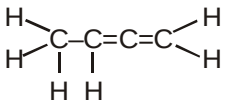
(c) C_6Br_6 DU = 4

(d) $C_5H_{11}OCl$ DU = 0

(e) $C_9H_{12}N_2$ DU = 5

(f) C_6N_6 DU = 10

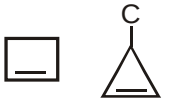
(g) $C_{10}H_8SO_5N_4Cl_2$ DU = 8

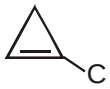
E.g.	M.F.	DU	S.F.
1.	C_4H_6	2	

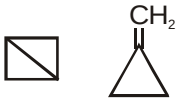
C – C – C ≡ C

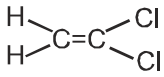
C – C ≡ C – C

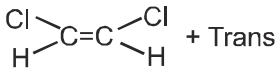
C = C – C = C





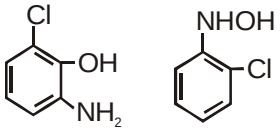


2.	$C_2H_2Cl_2$	=1	



Cis

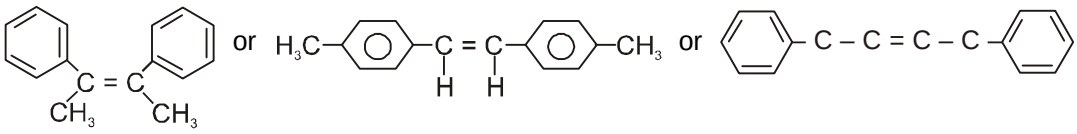
Total isomers = 3

3. C_6H_6ClNO (Aromatic)		= 4	

Note : If the aromatic Compounds have minimum D.E. '4'. That means at least 1 Benzene ring is present.

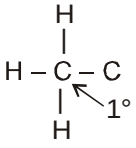
Q. $C_{16}H_{16}$ is symmetrical aromatic alkene. Draw all possible structure.

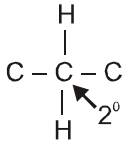
ANS. DU = 9

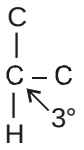


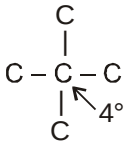
Degree of carbon :

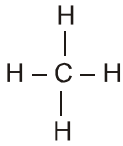
It is defined as the number of carbon atoms attached to carbon atom.

Primary (1°) carbon : 

Secondary (2°) carbon : 

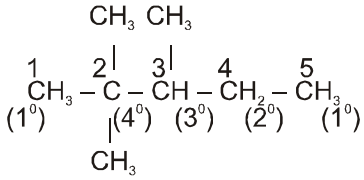
Tertiary (3°) carbon : 

Quaternary (4°) carbon : 

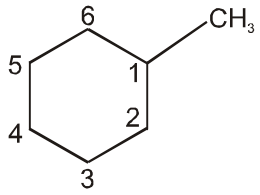
Superprimary : 

(1°)

Ex).



Ex).



1^0 – 1 carbon

2^0 – 5 carbon

3^0 – 1 carbon

***Degree of hydrogen** is same as the degree of carbon to which it is attached.
Type of C – C bonds & type of replaceable H-atoms is saturated hydrocarbon.
Note : Total no. of monosubstituted product does not depend upon type of C-atoms but type of replaceable H-atom.

1.4 IUPAC NOMENCLATURE OF ORGANIC COMPOUNDS:

General Scheme of Naming:-

Secondary Prefix + Primary Prefix _ _Word Root_ _Primary Suffix_ _Secondary suffix

The organic compound is always named according to the general scheme as given by IUPAC. In every compound, two parts, viz, word root and primary suffix, always exist.

Word Root: It indicates the no. of carbon atoms present in the main chain. It is represent as Alk.

Prefix : It is the first part of the name.

(i) Primary Prefix : 'Cyclo'

(ii) Secondary Prefix : If functional group are treated as a substituent than their name is treated as secondary prefix.

The following substituent groups are always cited in the prefix.

(i) R – Alkyl
(ii) R – O – Alkoxy
(iii) X halo (fluoro, chloro, bromo, iodo)
(iv) $–NO_2$ Nitro
(v) –N = O Nitroso
(vi) Junior functional group

→ These are never cited in suffix.
→ The prefixes are always written in alphabetical order (few exceptions exist).
→ The position of substituent group in the main carbon chain is mentioned by writing the number just before the name of substituent by writing a small dash (–).

Suffix :

(i) Primary Suffix:- It indicates saturation or unsaturation existing in the main chain.
ane → single bond (saturated)
ene → one = bond

If two double bond are → diene.
Polyene if plenty of double bond are present.

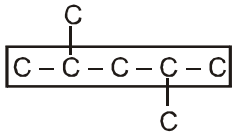
yne → one ≡ bond
two ≡ bond → diyne

(ii) Secondary Suffix:- It is the suffix of principal functional group.

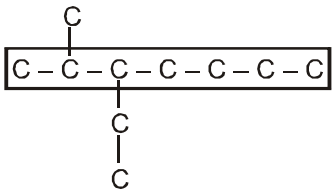
1.5 NAMING OF SATURATED HYDROCARBONS

Rules :(Branched and substituted Alkanes)

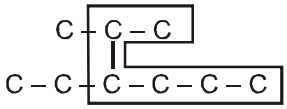
(1) **Selection of parent chain →**
(a) Chain with maximum number of 'C' atoms (longest chain).



(b) If numberof carbon atom are same in more than one longest chain then that will be parent chain having more number of side chain.

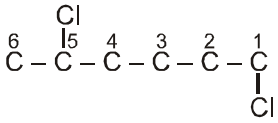


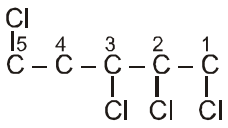
(c) If number of side chain are also same than that will be parent chain having its substituent at lower number.



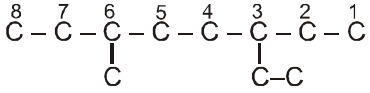
(2) Numbering

(a) Numbering is done from that side of the parent chain having it substituent at lower number (lowest set of locant)

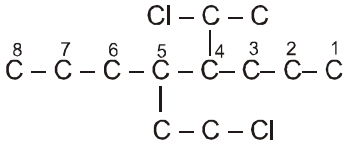


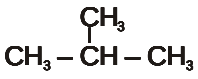


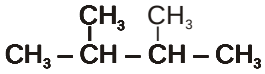
(b) If position of substituent are same from both the end of the parent chain, then numbering is done from alphbetical order.

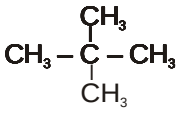


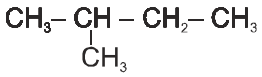
* If alphabets are also same then numbering is done from that side of the parent chain having its substituent of substituent at lower number.

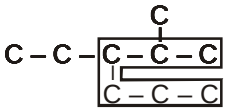


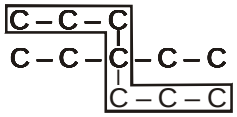
Ex.  Methylpropane

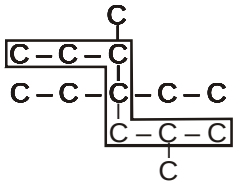
 2, 3-Dimethyl butane

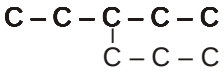
 Dimethyl propane

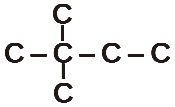
 2-Methylbutane

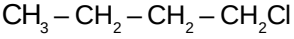
 3-Ethyl-2-methyl hexane

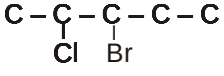
 4, 4-Diethyl heptane

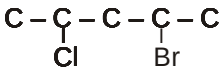
 4, 4-Diethyl-2, 5-Dimethyl heptane

 3-ethyl hexane

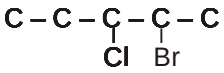
 2, 2-Dimethylbutane

 1-chlorobutane

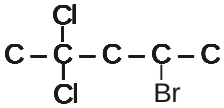
 3-Bromo-2-chloropentane



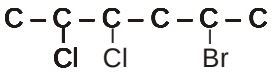
2-Bromo, 4-chloro pentane



2-Bromo, 3-chloro pentane



4-Bromo-2, 2-dichloro pentane



5-Bromo, 2, 3-dichloro hexane

(3) Rules for writing Alkyl Radicals:-

Radicals:- (a) $C_nH_{2n+2} \xrightarrow{-H} C_nH_{2n+1}$ Alkyl Radical

$C_nH_{2n} \xrightarrow{-H} C_nH_{2n-1}$ Alkenyl Radical

$C_nH_{2n-2} \xrightarrow{-H} C_nH_{2n-3}$ Alkynyl Radical

R (structural formula)	**Name**
CH_3-	Methyl
CH_3-CH_2-	Ethyl
C_3H_7-	

$CH_3-CH_2-CH_3$ $\xrightarrow{-H}$ $\overset{3}{C}H_3-\overset{2}{C}H_2-\overset{1}{C}H_2-$ n-propyl

$CH_3-CH_2-CH_3$ $\xrightarrow{-H}$ $\overset{1}{C}H_3-\overset{2}{C}H(-)-\overset{3}{C}H_3$ isopropyl

C_4H_9 (Butyl)

(a) $CH_3-CH_2-CH_2-CH_3$ $\xrightarrow{-H}$ $\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H_2-\overset{1}{C}H_2-$ n – Butyl

(a) $CH_3-CH_2-CH_2-CH_3$ $\xrightarrow{-H}$ $CH_3-\underset{|}{C}H-CH_2-CH_3$ (secondary butyl)

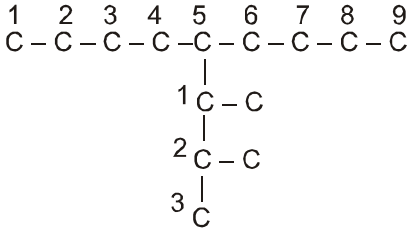
(b) $CH_3-\underset{|}{\overset{CH_3}{C}}-CH_3$ (H) $\xrightarrow{-H}$ $CH_3-\overset{CH_3}{\overset{|}{\overset{2}{C}}}-\overset{1}{C}H_2-$ (H) Isobutyl

(b) $CH_3-\underset{|}{\overset{CH_3}{C}}-CH_3$ (H) $\xrightarrow{-H}$ $CH_3-\underset{|}{\overset{CH_3}{C}}-CH_3$ Tert butyl (Tertiary butyl)

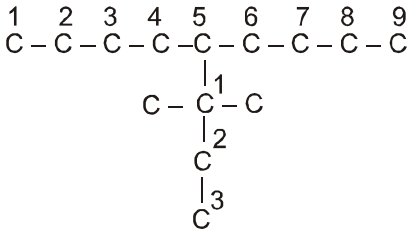
(4) Systematic Names of Radicals :

Complex Radical :

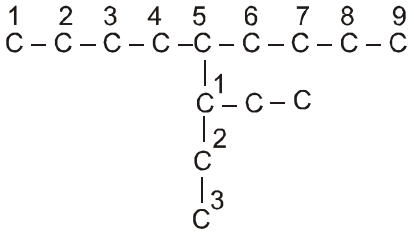
Ex



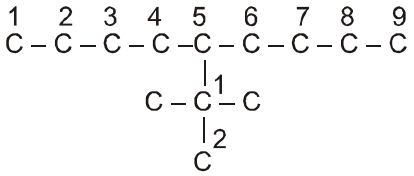
5 – (1,2 – Dimethylpropyl) nonane



5 – (1,1 – Dimethylpropyl) nonane



5 – (1 – ethylpropyl) nonane



5 – (Dimethylethyl) nonane

Alkene / Alkyne radicals

Alkene $\xrightarrow{-H}$ Alkenyl

Alkyne $\xrightarrow{-H}$ Alkynyl

$CH_2 = CH_2 \xrightarrow{-H} CH_2 = CH^-$

ethenyl

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

(a) $\overset{3}{CH_3} - \overset{2}{CH} = \overset{1}{CH} -$ Prop – 1 – enyl

(b) $CH_3 - \underset{|}{C} = CH_2$ Methylethenyl

(c) $\underset{|}{\overset{1}{CH_2}} - \overset{2}{CH} = \overset{3}{CH_2}$ Prop – 2 – enyl

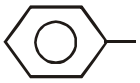
$CH_3 - C \equiv CH \xrightarrow{-H} CH_3 - C \equiv C -$

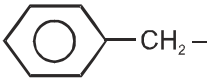
Propynyl

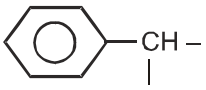
$CH_3 - C \equiv CH \xrightarrow{-H} - CH_2 - C \equiv C - H$

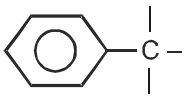
Prop-2-ynyl

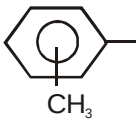
(5) Benzene Radical

1.  Phenyl

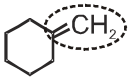
2.  Benzyl

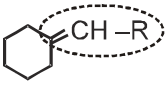
3.  Benzal

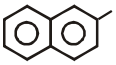
4.  Benzo

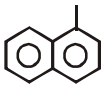
5.  Tolyl

(O, M, P)

6.  Methylene

7.  Alkylidene

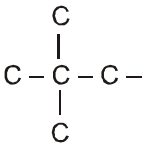
8.  β- naphthyl

9.  α -naphthyl

(6) Numeral Prefixes

(1) Following prefixes are considered for alphabetization :

(a) Iso  Meaning (2-methyl)

(b) neo 

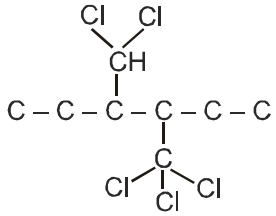
(c) Di, Tri, Tetra only in comlex radicals.

(2) Following are not considered for alphabetization

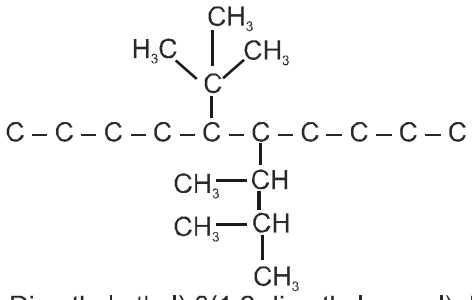
(a) Di, Tri, Tetra for simple radicals.

(b) Sec, Tert are not considered for alphabetization

(c) Bis = 2 , Tris = 3



3(1,1-Dichloro) 4-(1,1,1-trichloro) hexane



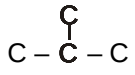
5(1,1-Dimethyl ethyl) 6(1,2-dimethyl propyl) decane

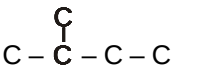
(7) Retained Names of Alkanes:

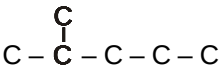
(1) Normal (n) : Radical or hydrocarbon which has straight chain and if it has free valency it must be present at either of ends.

C – C – C – C (n butane)

(2) Iso : Two methyl group at the end of linear chain (unbranched chain)

(i)  Isobutane or methyl propane

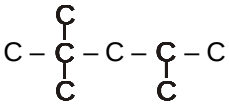
(ii)  Isopentane or methylbutane

(iii)  Isohexane or 2-methylpentane

Condition for application:-

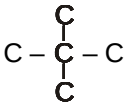
- There should be 4 to 6 carbons.
- There should not be any other alkyl group in the chain.
- Methyl should be at carbon no. 2.

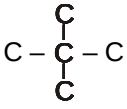
Q. Iso-octane (commercial name) in petroleum industry

Ans.  IUPAC name is 2, 2, 4-trimethylpentane

(3) Neo :

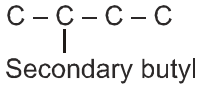
- There should be 5 to 6 carbons.
- 2, 2-dimethyl
- No other substituent.

Ex.  Neopentane

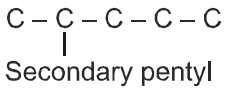
 Neohexane

(4) Secondary : It is applicable only for radical.

Ex.1

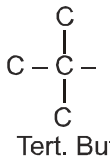


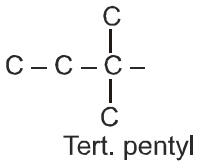
Ex.2



(5) Tertiary :

First member





1.6 NAMING OF UNSATURATED COMPOUND (ALKENES AND ALKYNES) :

(A) General formula:- C_nH_{2n} and C_nH_{2n-2} respectively

(B) Rules for selection of main chain:-

→ Longest carbon chain with a multiple bond.

→ Longest carbon chain with maximum number of multiple bonds.

→ If first and second factor are common then chain with lowest locant (multiple bond) is selected as main chain.

→ Lowest locant Rule is followed till first point of difference. (Multiple bond prior to substituent).

→ Alphabetization.

(C) Rules for Numbering:-

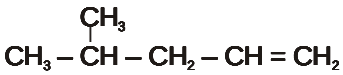
→ Lowest locant Rule till first point of difference (irrespective of double bond or triple bond).

→ Double bond is prior to triple bond in both numbering, naming and longest chain selection.

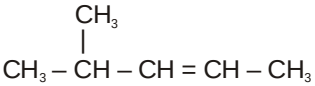
→ C = C > C ≡ C > Max 'C' > substituents > lowest locant (Multiple bond > substituent) > Alphabetization.

Ex. $CH_3 – CH_2 – CH = CH_2$ But-1-ene

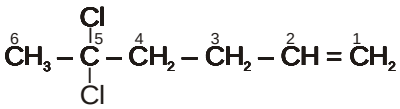
$CH_3 – CH = CH – CH_3$ But-2-ene



4-Methylpent-1-ene



4-Methylpent-2-ene

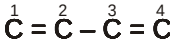


5, 5-Dichlorohex-1-ene

(a) C = C – C = C adiene

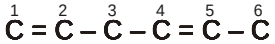
(b) C ≡ C – C ≡ C adiyne

(c) C = C – C ≡ C enyne

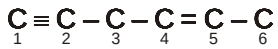


Buta-1, 3-diene

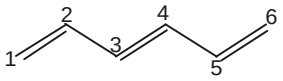
C = C – C ≡ C Butenyne



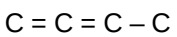
Hexa-1, 4-diene



Hex-4-en-1-yne

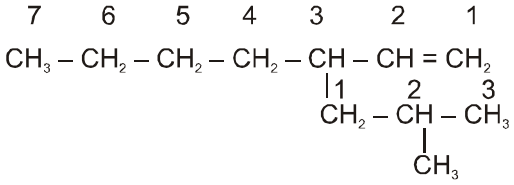


Hexa-1, 3, 5-triene



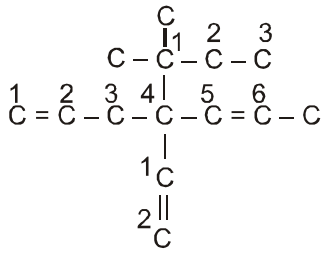
Buta-1, 2-diene

Ex.1



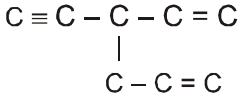
3-(2-methylpropyl) hept-1-ene

Ex.2



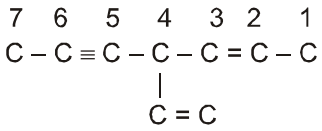
4-(1,1-Dimethylpropyl)-4-ethenyl-hepta-1,5-diene

Ex.3



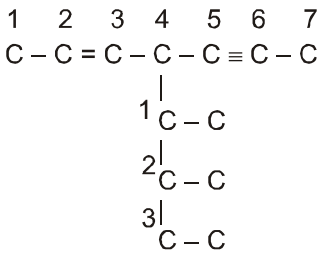
3-ethynylhexa-1, 5-diene

Ex.4



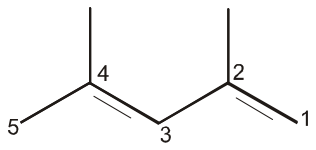
4-Ethenylhept-2-ene-5-yne

Ex.5



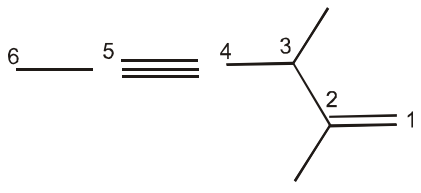
4-(1, 2-dimethylbutyl) hept-2-ene-5-yne

Ex.6



2, 4-dimethylpenta-1, 3 diene

Ex.6



2,3-dimethylhex-1-en-4-yne

1.7 NAMING OF CYCLIC HYDROCARBON (ALICYCLIC COMPOUNDS) :

(A) Main chain selection:

(a) Multiple Bond > No. of carbon atoms > Maximum no. of substituents > Nearest locant > Alphabetization.
(b) If all factors are similar in cyclic and acyclic part, then only.
Cyclic > Acyclic if acyclic has equal no. of substituents.
Otherwise if acyclic > cyclic (if number of substitutent in acyclic > no. of substituent in cyclic)

(B) Numbering:

(a) Lowest Locant (b) Alphabetization

(C) Naming:

→ Prefix 'cyclo' just before the word root if it constitutes the main chain.
→ If cyclic part is the main chain then the prefix 'cyclo' is not considered for alphabetical order.
If cyclic part constitutes the side-chain (substituent) then prefix cyclo is considered for alphabetization:-

Ex:-


Cyclopropane


Cyclobutane

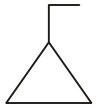

Cyclopentane


Cyclohexane

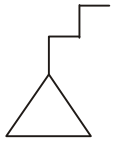

Cycloheptane


Cyclooctane

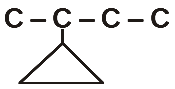

Methylcyclopropane


Ethylcyclopropane

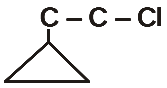

Propylcyclopropane


1-cyclopropylbutane

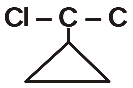

Methylethylcyclopropane or isopropylcyclopropane



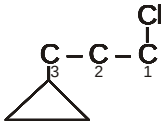
2-cyclopropylbutane



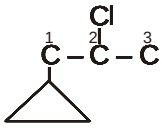
2-Chloroethylcyclopropane



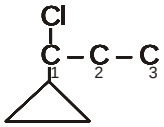
1-chloroethylcyclopropane



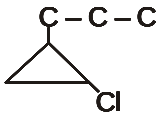
1-chloro-3-cyclopropylpropane



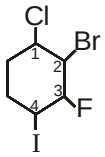
2-chloro-1-cyclopropylpropane



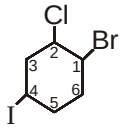
1-chloro-1-cyclopropylpropane



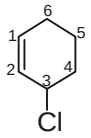
1-chloro-2-propylcyclopropane



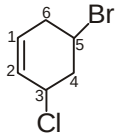
2-Bromo-1-chloro-3-fluoro-4-iodocyclohexane



1-bromo-2-chloro-4-iodocyclohexane

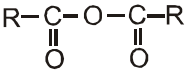


3-chlorocyclohex-1-ene



5-Bromo-3-chlorocyclohex-1-ene

1.8 FUNCTIONAL GROUP TABLE (Seniority order):

F.G.	Sec. Suffix	Name	Prefix
(1) R – COOH	– oic acid	$\overbrace{\text{Alkan}}^{\text{R + C}}$ + oic acid	carboxy
(2) R – SO_3H	– sulphonic acid	$\overbrace{\text{Alkan}}^{\text{R}}$ + sulphonic acid	sulpho
(3) 	– anhydride	Alkan + oic + anhydride	–

(4) $R-\underset{\underset{O}{\|}}{C}-O-R'$ (ester)	– oate	Alkyl (R) + Alkan (R + C) + oate	alkoxycarbonyl
(5) $R-\underset{\underset{O}{\|}}{C}-X$ $(R-COX)$	– oyl halide	Alkan (R + C) + oyl halide	halocarbonyl
(6) $R-\underset{\underset{O}{\|}}{C}-NH_2$ $(R-CONH_2)$	– amide	Alkan (R + C) + amide	Carbamoyl $(-CONH_2)$
(7) $R-C\equiv N$ Cyanide	– nitrile	Alkane (R + C) + nitrile	cyano
(8) $R-CHO$ Aldehyde	– al	Alkan (R + C) + al	Oxo(O) formyl(–CHO)
(9) $R-\underset{\underset{O}{\|}}{C}-R$ Ketone	– one	Alkan (R + C + R) + one (Non – terminal)	Oxo (O) keto$(-C=O)$
(10) R – OH (alcohol)	– Ol	Alkan (R) +Ol	hydroxy
(11) R – SH	– thiol	Alkane + thiol	mercepto
(12) $R-NH_2$	–amine	Alkan (R) + amino	amino

1.9 NAMING OF FUNCTIONAL GROUP CONTAINING COMPOUNDS :

(A) Selection of Main Chain:

Senior F.G. > Max. no. of F.G. (Similar group) > Multiple bond > Max. no. of 'C' atoms > Max. no. of locants > lowest locant > alphabetization

(B) Numbering (See F.G. + Sub.):

The carbon – atom bearing functional group (or C – atom of terminal functional group is given lowest number)
(i) Lowest locant (F.G. > M.B. > substituent > Alphab)

(C) Naming:- General scheme :

The senior most functional group constitutes secondary suffix. Other junior F.G.'s are written in prefix in alphabetical order.

1.9.1

F.G.	Prefix	Suffix	IUPAC name
– COOH	Carboxy	Oic acid - 'C' of COOH considered in the parent chain	Alkanoic acid
		Carboxylic acid - 'C' of COOH is not considerd in parent chain	Alkane carboxylic acid

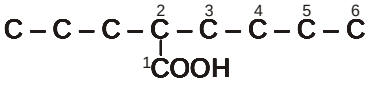
Rule : If first alphabet of sec. suffix is begin from a, i, o, u, y then 'e' of primary suffix will be dropped.

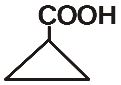
Ex. (1) $H-\underset{\underset{O}{\|}}{C}-OH$ Methanoic Acid

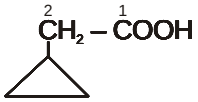
(2) $CH_3 - COOH$ — Ethanoic Acid

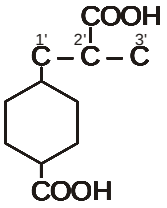
(3) C – C – COOH — Propanoic Acid

(4) C – C – C – COOH — Butanoic Acid

(5)  — 2-propylhexanoic acid

(6)  — Cyclopropanecarboxylic acid

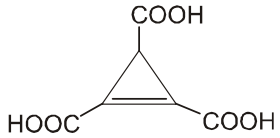
(7)  — Cyclopropylethanoic acid

(8)  — 4-(2-carboxypropyl) cyclohexanecarboxylic acid

(9) HOOC – COOH — Ethanedioic acid

(10) $HOOC - CH_2 - COOH$ — Propanedioic acid

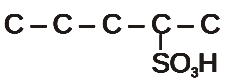
(11) $HOOC - CH_2 - CH_2 - CH_2 - CH_2 - COOH$ — Hexanedioic acid

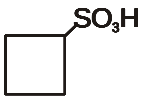
(12)  — Cycloprop-1-ene-1, 2, 3-tricarboxylic acid

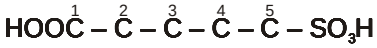
1.9.2 Sulphonic acid

F.G.	Prefix	Suffix	IUPAC name
$-SO_3H$	Sulpho	Sulphonic acid	Alkanes sulphonic acid

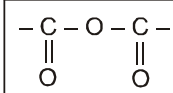
Ex. (1) $CH_3 - SO_3H$ — Methanesulphonic acid

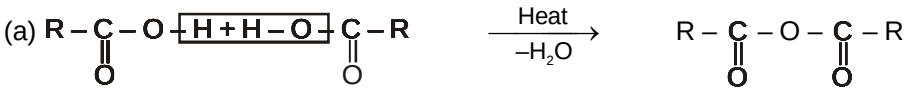
(2)  — Pentane-2-sulphonic acid

(3)  — Cyclobutanesulphonic acid

(4)  — 5-Sulphopentanoic acid

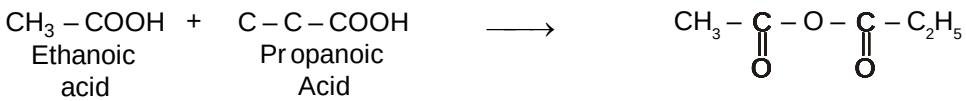
1.9.3 Anhydride

F-Group	Prefix	Suffix	IUPAC name
	–	Oic anhydride or carboxylic anhydride	Alkanoic anhydride or alkane carboxylic anhydride

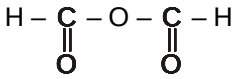
(a) 

Alkanoic anhydride

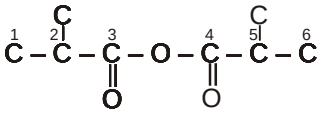
(b) Mixed Anhydride (according to alphabet)



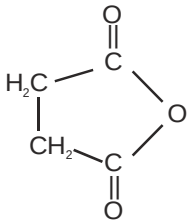
Ethanoic propanoic anhydride

Ex. (1) 

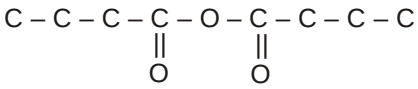
Methanoic Anhydride (unstable)

(2) 

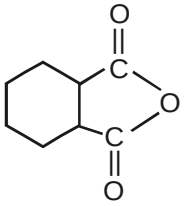
2-methylpropanoic anhydride

(3) 

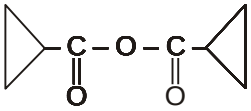
Butanedioic anhydride

(4) 

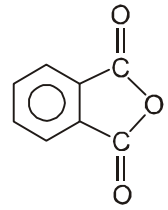
Butanoic anhydride

(5) 

Cyclohexane-1, 2-dicarboxylic anhydride

(6) 

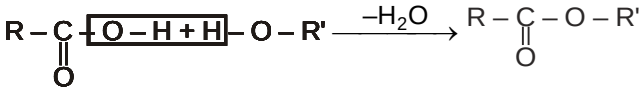
Cyclopropane carboxylic anhydride

(7) 

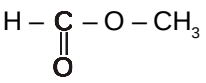
Benzene dicarboxylic anhydride

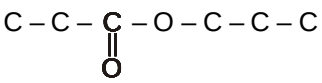
1.9.4 Ester :

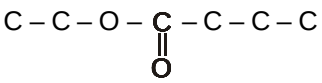
F.group	Prefix	Suffix	Name
– C(=O) – OR	Alkoxy Carbonyl	Oate	Alkyl....alkanoate
(Ester)		or carboxylate	or Alkyl.....Alkanecarboxylate

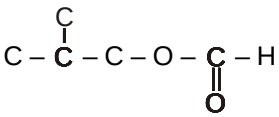


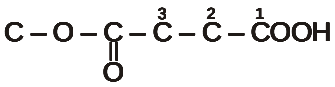
Example:-

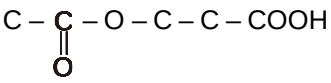
(1)  Methyl Methanoate

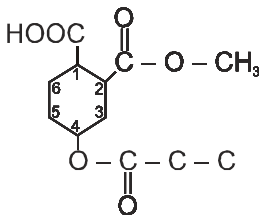
(2)  Propyl Propanoate

(3)  Ethyl Butanoate

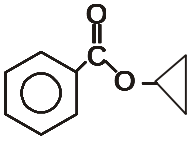
(4)  Isobutyl Methanoate

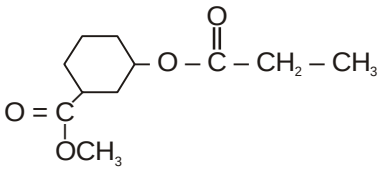
(5)  3-(Methoxycarbonyl) propanoic acid

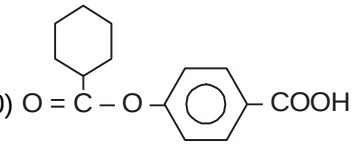
(6)  3-(Ethanoyloxy) propanoic acid

(7) 

2-(Methoxycarbonyl)-4-(Propanoyloxy) cyclohexan-1-carboxylic acid

(8)  Cyclopropyl benzene carboxylate

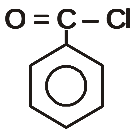
(9)  Methyl-3-propanoyloxy Cyclohexane carboxylate

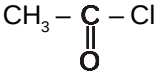
(10)  4-Cyclohexanecarbanoyloxy benzene carboxylic acid

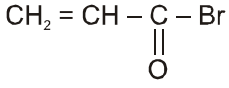
1.9.5 Acid halide:-

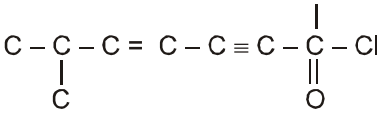
F.Group	Prefix	Suffix	Name
	Halo Carbonyl	Oyl-halide or Carbnylhalide	Alkanoyl halide or Alkane Carbonyl halide

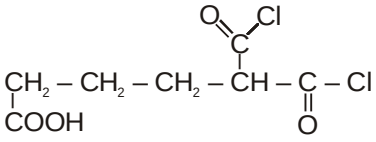
Example:-

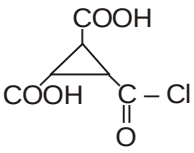
(1)  Benzene Carbonyl Chloride

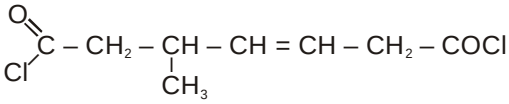
(2)  Ethanoyl Chloride

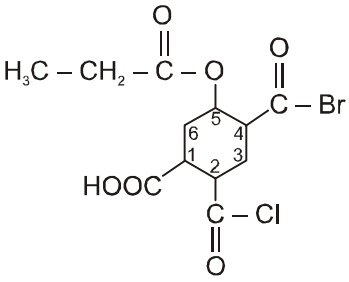
(3)  Prop-2-enoyl bromide

(4)  6-Methyl hept-4-ene-2-enoyl chloride

(5)  5, 5-Dichlorocarbonylpentan-1-oic acid or pentanoic acid

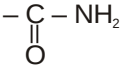
(6)  3-Chlorocarbonyl Cyclopropane-1, 2-dicarboxlic acid

(7)  5-Methylhept-3-ene-1, 7-dioyl Chloride

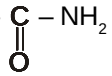
(8) 

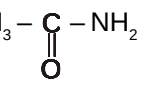
4-Bromocarbonyl-2-chlorocarbonyl-5-propanoyloxycycloexane carboxylic acid

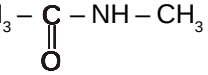
1.9.6 Amide:-

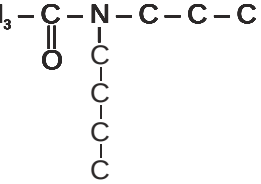
F.Group	Prefix	Suffix	Name
	Carbamoyl	amide or Carboxamide	Alkanamide or Alkane Carboxamide

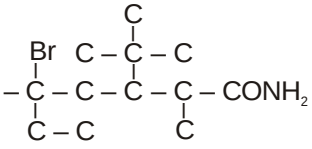
Example:-

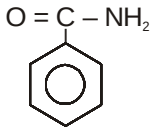
(1)  Methanamide (Formamide)

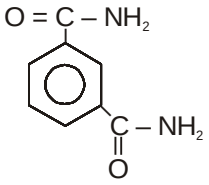
(2)  Ethanamide (Acetamide)

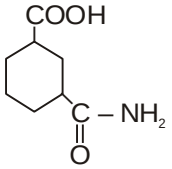
(3)  N-methylethanamide

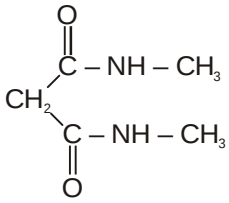
(4)  N-butyl-N-propylethanamide

(5)  5-Bromo-3-(1, 1-dimethylethyl)-5-ethyl-2-methyl heptanamide

(6)  Benzene Carboxamide

(7)  Benzene-1, 3-dicarboxamide

(8)  3-Carbamoyl Cyclohexane Carboxylic acid

(9)  N, N'-dimethyl propane-1, 3-diamide

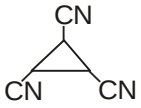
1.9.7 Nitrile:-

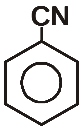
F.Group	Prefix	Suffix	Name
$-C \equiv \dot{N}$	Cyano	Nitrile or Carbonitrile	Alkane nitrile or Alkancarbonitrile

Example:- (1) $H-CN$ Methanenitrile

(2) CH_3-CN Ethanenitrile

(3) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CN$ 3-Methyl butanenitrile

(4)  Cyclopropane-1, 2, 3-tricarbonitrile

(5)  Benzene Carbonitrile

(6) $\underset{\underset{CN}{|}}{CH_2}-CH_2-COOH$ 3-Cyano propanoic acid

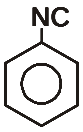
(7) $\underset{\underset{CN}{|}}{CH_2}-\underset{\underset{CN}{|}}{CH}-\underset{\underset{CN}{|}}{CH_2}$ Propane-1,2,3-tricarbonitrile

1.9.8

F.Group	Prefix	Suffix	Name
– N ≡ C	Isocyano	Isocyanide	Alkyl Isocyanide

Example:- (1) $CH_3 - N \equiv C$ Methyl isocyanide

(2) $CH_3 - CH_2 - N \equiv C$ Ethyl isocyanide

(3)  Phenyl isocyanide

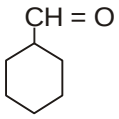
1.9.9 Aldehyde:-

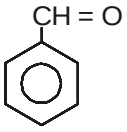
F.Group	Prefix	Suffix	Name
– CH = O	Formyl/oxo	al/carbaldehyde	Alkanal/Alkane Carbaldehyde

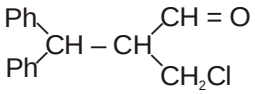
Example:- (1) HCHO Methanal

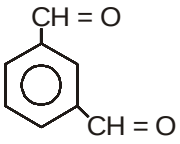
(2) $CH_3 - CH_2 - CH = O$ Propanal

(3) $CCl_3 - CH_2 - CH_2 - CH_2 - CH = O$ 5, 5, 5-trichloro pentanal

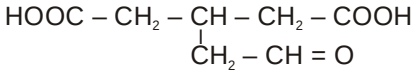
(4)  Cyclohexane Carbaldehyde

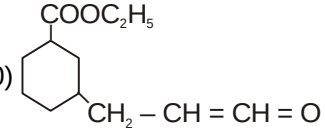
(5)  Benzaldehyde/Benzene Carbaldehyde

(6)  2-Chloromethyl-3, 3-diphenyl propanal

(7)  Benzene-1, 3-dicarbaldehyde

(8) $HOOC - CH_2 - CH_2 - CH_2 - CH = O$ 5-Oxopentanoic acid

(9)  3-(2-Oxoethyl) pentane-1, 5-dioic acid

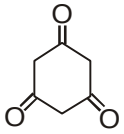
(10)  Ethyl, 3-(3-oxopropyl) Cyclohexane carboxylate

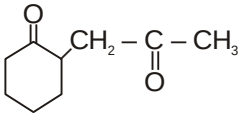
1.9.10 Ketone:-

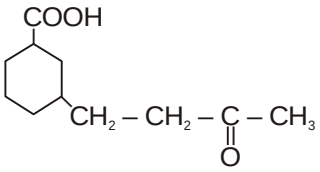
F.Group	Prefix	Suffix	Name
$\diagup C = O$	Keto/oxo	one	Alkanone

Example:- (1) $CH_3 - \underset{\underset{O}{\|}}{C} - CH_3$ Propanone

(2)  Cyclohexanone

(3)  Cyclohexane-1, 3, 5-trione

(4)  2-(2-Oxopropyl) Cyclohexanone

(5)  3-(3-Oxobutyl) Cyclohexane Carboxylic acid

(6) $OHC - CH_2 - \underset{\underset{O}{\|}}{C} - CH_3$ 3-Oxobutanal

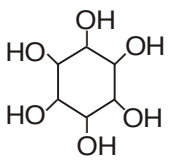
(7) $CH_3 - \underset{\underset{O}{\|}}{C} - CH - CH_2 - \underset{\underset{O}{\|}}{C} - O -$  2-(Oxocyclopropyl)-4-oxo pentanoate

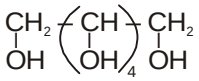
1.9.11 Alcohol:-

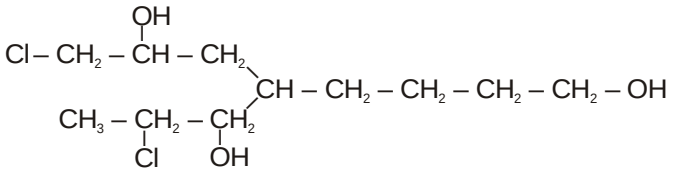
F.Group	Prefix	Suffix	Name
–OH	Hydroxy	ol	Alkanol

Example:- (1) $CH_3 - \underset{\underset{CH_3}{|}}{CH} - CH_2 - OH$ 2-Methyl Propanol

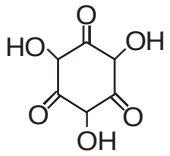
(2) $CH_3 - \underset{\underset{CH_2 - OH}{|}}{CH} - CH_2 - CH_2 - \underset{\underset{CH_2 - OH}{|}}{CH} - CH_3$ 2, 5-Dimethylhexane-1, 6-diol

(3)  Cyclohexane-1, 2, 3, 4, 5, 6-hexaol

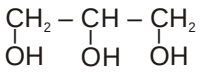
(4)  (Sorbital); Hexane-1, 2, 3, 4, 5, 6-hexaol

(5) 

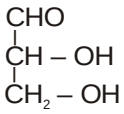
7-Chloro-5-(3-Chloro-2-hydroxy propyl) Octane-1, 6-diol

(6) 

2, 4, 6-trihydroxy Cyclohexane-1, 3, 5-trione

(7) 

(Glycerol) Propane-1, 2, 3-triol

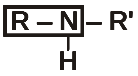
(8) 

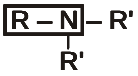
(Glyceraldehyde) 2, 3-Dihydroxy propanal

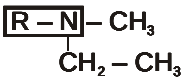
1.9.12 Amines:-

F.Group	Prefix	Suffix	Name
$-NH_2$	amino	amine	Alkan amine

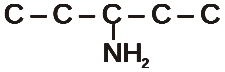
(a) $R-NH_2$ 1^o = amine Alkanamine

(b)  2^o = amine N – Alkylalkanamine (R') (R)

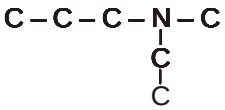
(c)  3^o = amine N, N-Dialkylalkanamine

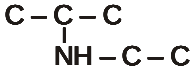
(d)  N-Ethyl-N-methylalkanamine

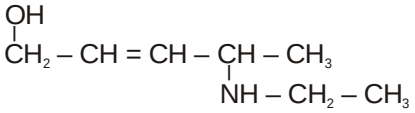
Ex:- (1) CH_3-NH_2 Methanamine

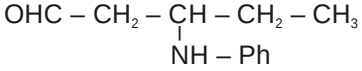
(2)  Pentan-3-amine

(3) C – C – C – NH – C – C N-Ethylpropan-1-amine

(4)  N-Ethyl-N-methylpropan-1-amine

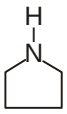
(5)  N-Ethylpropan-2-amine

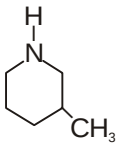
(6)  4-(N-ethyl amino) pent-2-en-1-ol

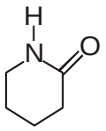
(7)  3-(N-phenyl amino) pentanal

If hetero atom's are count as a 'C' atom in the parent chain then they are written as
(1) –NH– $\rightarrow$ Aza
(2) –O– $\rightarrow$ Oxa
(3) –S– $\rightarrow$ thia
(4) –Se $\rightarrow$ Selena

Example:- (1) $HOOC - CH_2 - NH - CH_2 - CH_3$ 3-Aza pentanoic acid

(2)  Aza Cyclo pentane

(3)  3-Methyl aza cyclo hexane

(4)  2-oxo aza cyclo hexane

1.10 ETHERS (R – O – R'):-

F.Group	Prefix	Suffix	Name
R – O – R'	alkoxy	–	Alkoxy alkane

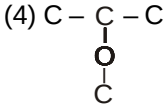
Alkoxy + Alkane
↓ ↓
less no. of 'C' more no. of 'C'

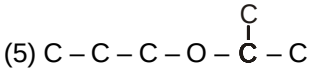
(i) Acyclic Ethers:-

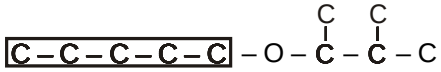
(1) C – O – C Methoxymethane

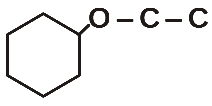
(2) C – O – C – C Methoxyethane

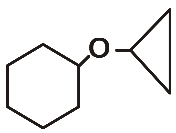
(3) C – O – C – C – C 1-Methoxypropane

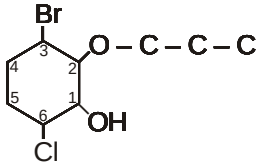
(4)  2-Methoxypropane

(5)  1-Isopropoxypropane
1-(Methylethoxy) propane

(6)  1-(1, 2-Dimethylpropoxy) pentane

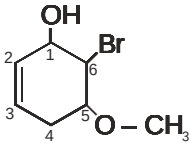
(7)  Ethoxycyclohexane

(8)  Cyclopropoxycyclohexane

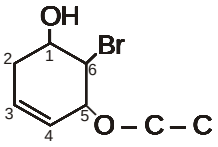
(9) 

3-Bromo-6-chloro-2-propoxycyclohexan-1-ol

∗ In cyclic system, numbering always starts from senior most functional group.

(10) 

6-Bromo-5-methoxycyclohex-2-en-1-ol

(11) 

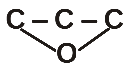
6-Bromo-5-ethoxycyclohex-3-en-1-ol

(ii) Cyclic Ether: (3-membered Ring)

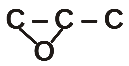
Hetero cyclic compounds

(1) 

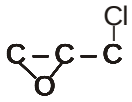
Oxirane or Epoxyethane

(2) 

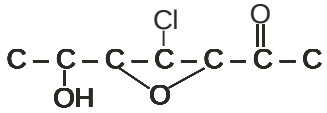
1, 3-Epoxypropane

(3) 

1, 2-Epoxypropane

(4) 

1-Chloro-2, 3-Epoxypropane

(5) 

4-Chloro-3, 5-Epoxy-6-hydroxy-heptan-2-one

∗ Polyethers:-

(1) C – C – O – $\overset{1}{C}$ – $\overset{2}{C}$ – O – C – C

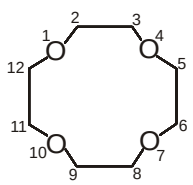
1, 2-Diethoxyethane

(2) $\overset{1}{C}$ – $\overset{2}{C}$ – $\overset{3}{O}$ – $\overset{4}{C}$ – $\overset{5}{C}$ – $\overset{6}{O}$ – $\overset{7}{C}$ – $\overset{8}{C}$ – $\overset{9}{O}$ – $\overset{10}{C}$ – $\overset{11}{C}$

3, 6, 9-Trioxaundecane

(3) $\overset{1}{C}$ – $\overset{2}{O}$ – $\overset{3}{C}$ – $\overset{4}{C}$ – $\overset{5}{C}$ – $\overset{6}{O}$ – $\overset{7}{C}$ – $\overset{8}{C}$ – $\overset{9}{O}$ – $\overset{10}{C}$ – $\overset{11}{C}$ – $\overset{12}{C}$ – $\overset{13}{O}$ – $\overset{14}{C}$ – $\overset{15}{C}$

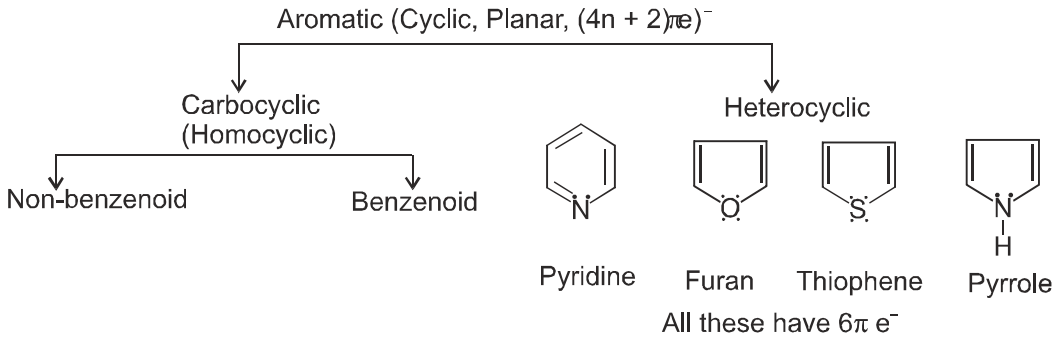
2, 6, 9, 13-Tetraoxapentadecane

(4) 

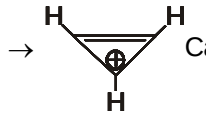
1, 4, 7, 10-Tetraoxacyclododecane

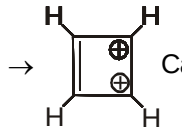
1.11 AROMATIC COMPOUNDS:

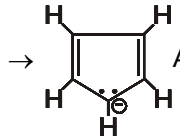
Classification:

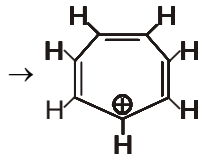


Non-Benzenoid:


Cation $2\pi e^-$ Cyclopropenium ion


Cation $2\pi e^-$ Cyclobutenium dication

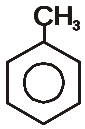

Anion $6\pi e^-$ Cyclopentadienyl anion

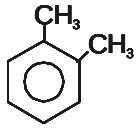

$6\pi e^-$ Cycloheptatrienyl cation (Tropylium cation)

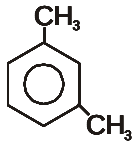
Benzenoid Aromatic Compounds:

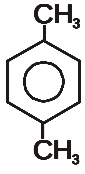
All organic compounds which contain atleast one benzene ring are known as benzenoid aromatic compounds.

Naming of Aromatic Hydrocarbons (Arenes):

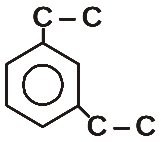
(1)  Methylbenzene (Toluene)

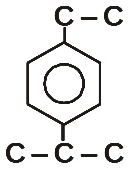
(2)  (Ortho) 1, 2-Dimethylbenzene (Ortho-xylene)

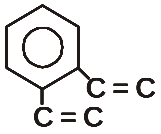
(3)  (Meta) 1, 3-Dimethylbenzene (Meta-xylene)

(4)  (Para) 1, 4-Dimethylbenzene (Para-xylene)

Q. Write structures of

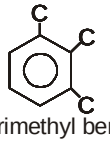
(i) Metadiethylbenzene 

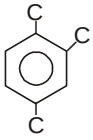
(ii) 1-ethyl-4-isopropylbenzene 

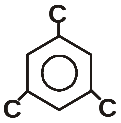
(iii) Orthodiethenylbenzene 

Trialkyl Substituted Benzene:

If all the three substituents are **similar**, then only 3 trisubstituted benzene derivative are possible.

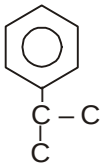

1, 2, 3-Trimethyl benzene
(Vicinal Trimethyl benzene)

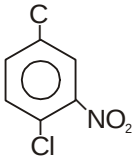

1, 2, 4-Trimethyl benzene
(Unsymmetrical Trimethyl benzene)

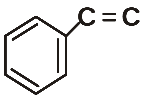

1, 3, 5-Trimethyl benzene
(Symmetrical Trimethyl benzene)

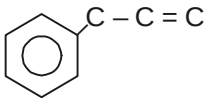
Examples :

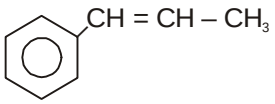
1.  1-Isopropyl-4-methylbenzene (p-cymene)

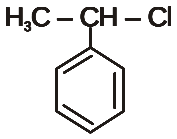
2.  Isopropylbenzene (Cumene)

3.  1-Chloro-4-methyl-2-nitrobenzene

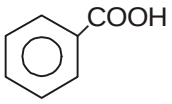
4.  Phenylethene (Double bond > Phenyl) (Common name : Styrene)

5.  3-Phenylprop-1-ene (Allylbenzene)

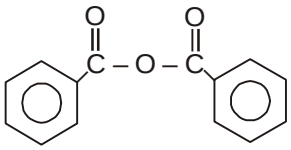
6.  1-Phenylprop-1-ene

7. 

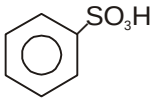
1-chloro-1-phenylethane

8. 

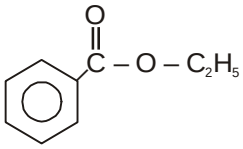
Benzene carboxylic acid (Benzoic acid)

9. 

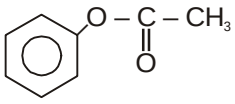
Benzene carboxylic anhydride (Benzoic anhydride)

10. 

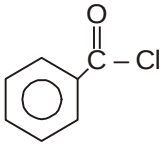
Benzene sulphonic acid

11. 

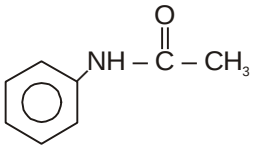
Ethyl benzene carboxylate (Ethyl Benzoate)

12. 

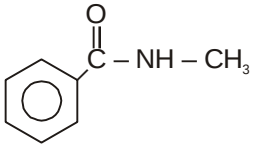
Phenyl ethanoate

13. 

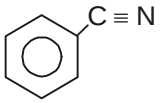
Benzene carbonyl chloride Benzoyl chloride

14. 

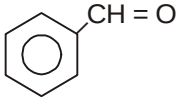
N-phenylethanamide

15. 

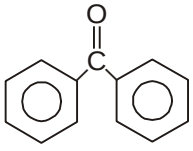
N-methylbenzene carboxamide

16. 

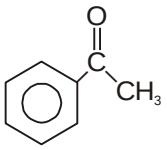
Benzene carbonitrile (Benzonitrile – popular)

17. 

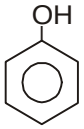
Benzene carbaldehyde (Benzaldehyde – popular)

18. 

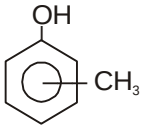
Diphenyl ketone (Benzophenone)

19. 

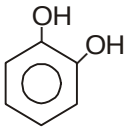
Methyl phenyl ketone (Acetophenone)

20. 

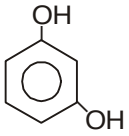
Phenol

21. 

Methylphenol [o-Cresol, m-cresol, p-cresol]

22. 

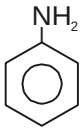
o-hydroxyphenol (Catechol)

23. 

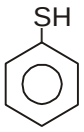
m-hydroxyphenol (Resorcinol)

24. 

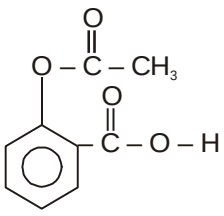
p-hydroxyphenol (Quinol)(Hydroquinone)

25. 

Benzenamine (Aniline)

26. 

Benzenethiol

27. 

2-Ethanoyloxy (Acetoxy) benzene carboxylic acid (Aspirin)