Unit - I

Organic Compound

Date / /
Page

RANKA

Introduction ⇒ An organic Compound is any chemical Substance that Contains Carbon.

The Compounds in Solid, liquid or gaseous State having Carbon in its molecule are known as organic Compounds.

All this living organisms are based on organic Compounds.

In organic Compounds one or more atoms of Carbon are Covalently linked to atoms of other dements, most Commonly, hydrogen, oxygen or nitrogen.

Carbon is the main element in all organic Compounds.

In addition, fluorine, Chlorine, bromine, nitrogen. Sulphur, phosphorous or other elements may also be present.

More than 4 millions organic Compounds have now been Synthesized and isolated in the pure form.

The designation organic is used to indicate that these Compounds have their origin in living Sources like plants and animals.

Organic Compounds

Open Chain (Aliphatic, Acyclic) | Closed chain (Cyclic)

Date / /
Page

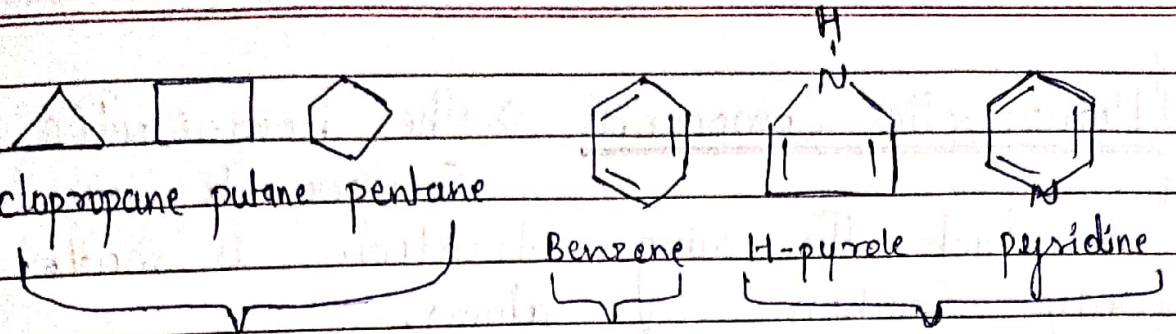
Acyclic Compounds ⇒ Compounds Containing Straight or branched chain of Carbon atom along with hydrogen atom and functional groups.

Closed chain :-

① Homocyclic Compounds ⇒ These Compounds Contain only Carbon ring System

② Heterocyclic Compounds ⇒ These Compounds Contain Carbon ring System along with one or more than one atom other than Carbon.

Homocyclic Compounds	Heterocyclic Compounds
⇒ Alicyclic Compounds	Heteroalicyclic Compounds ⇐
These Compounds are Cyclic, but having Similar properties as that of aliphatic Compounds.	These Compounds are Cyclic and having hetero atom as a part of ring.
⇒ Aromatic Compounds ⇐	
These Compounds are having aromatic Compounds following Hucket rule.	



① Open chain or Acyclic Compounds or Aliphatic Compounds ⇒

Open chain or aCyclic Compounds are those in the which Carbon atom are linked to each other either in linear or branched manner in such as way that the molecule is having open chain structure.

These Compounds are also called aliphatic Compounds

Ex ⇒ CH_3-CH_3 Ethane, $CH_3-CH_2-CH_2-CH_3$ Butane

② Closed chain or cyclic Compounds ⇒ The closed chain or cyclic Compounds are those organic compounds which have closed chain of atoms.

These Compounds are further classified into :-

(a) Homocyclic Compounds (Carbocyclic Compounds)
(b) Heterocyclic Compounds.

Date / /
Page

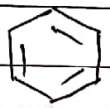
① **Homocyclic Compounds** ⇒ The homocyclic Compounds are those in which the ring structure is made up of only Carbon atoms.

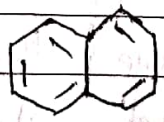
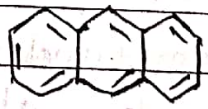
These Compounds are further classified into:-

(i) Aromatic Compounds
(ii) Alicyclic Compound

1. **Aromatic Compound** ⇒ These Compounds Containing one or more benzene ring in their structure are classified as aromatic or benzenoid Compounds.

⇒ Most of these compound have pleasant adour. (Greek - Aroma - Sweet smell).

- Monocyclic aromatic ring -  Benzene

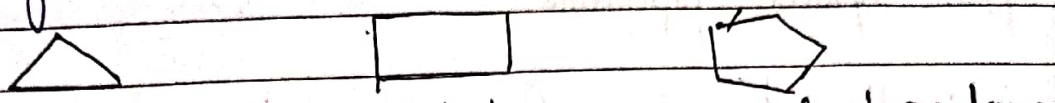
- Polycyclic aromatic ring -  

Naphthalene Anthracene

② **Alicyclic Compounds** ⇒ Cyclic Compounds with ring structure containing only Carbon atoms are called alicyclic Compounds.

- Though these Compounds ~~process~~ possess a ring structure

they behave more like aliphatic Compounds.

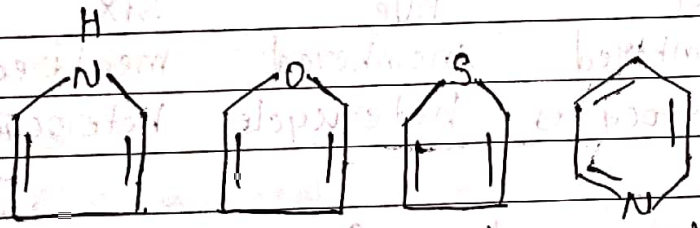
Ex ⇒ 

Cyclopropane Cyclobutane Cyclopentane

(b) **Heterocyclic Compounds** (Non- benzenoid aromatic)=

Compounds in which the ring atoms are made up of heterocyclic atoms like N, O_2 and S in addition to carbon atoms are called heterocyclic Compounds.

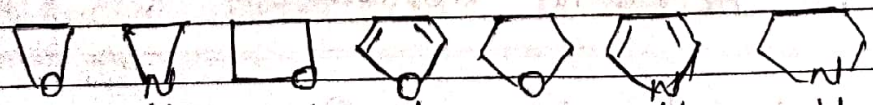
The above Compounds are aromatic non - benzenoid Compounds.

Ex ⇒ 

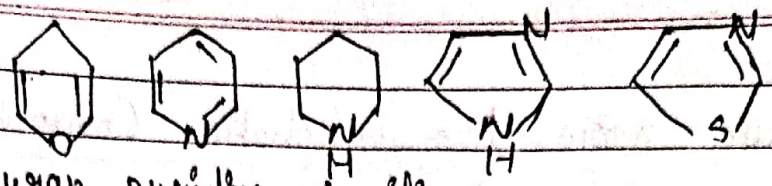
1H pyride furan thiophene pyridine

Classification of heterocyclic Compounds

Trivial or Common Names ⇒ Trivial names of hetero-cyclic nomenclature are preferred. Some Compounds of this kind are as shown below.



Ethylene oxide | Ethylene imine | methylene oxide | furan | Tetra hydro furan | pyrrole | pyrrolidine



pyran pyridine piperidine

According to ring Component these are classified into three types.

Heterocyclic

↓

monocyclic (one ring structure)	Bicyclic (two rings fused with each other)	polycyclic (more than two rings fused together)

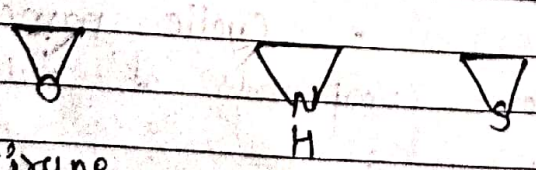
↓

Three membered heterocycles	four membered heterocycles	five membered heterocycles	six membered heterocycles

I. monocyclic heterocyclic Compounds.

(1) Three membered rings ⇒ These rings are having two Carbon atom and one hetero atom.

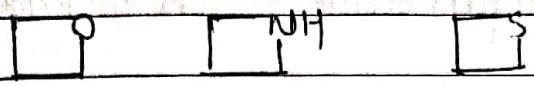
Ex ⇒



Oxirane Aziridine Thirane

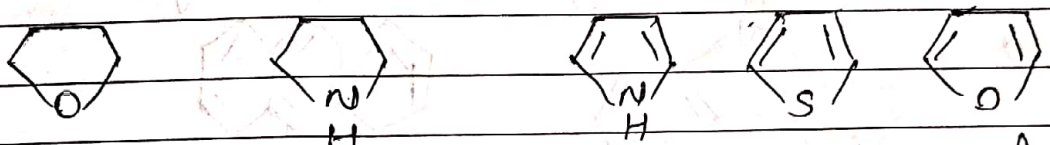
(2) Four membered rings ⇒ These rings are having three Carbon

atoms and one heteroatom. These rings are less Stable due to Strain.

Ex ⇒ 

Oxetane Azetidine Thietane

(3) five membered rings ⇒ These ring are having four Carbon atoms and one hetero atom.

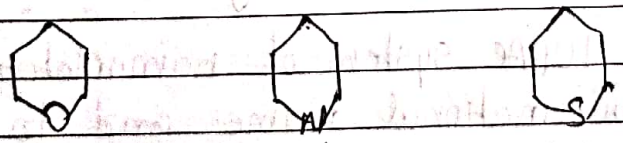
Ex ⇒ 

Tetrahydro furan | pyrroli-dine | 1H-pyrrole | Thiophene | furan

Non - Aromatic

Aromatic

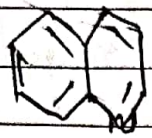
(4) Six membered rings ⇒ These rings are having five Carbon atoms and hetero atom.

Ex ⇒ 

Tetrahydro 2H-pyran | Piperidine | Tetrahydro 2H-Thiopyran

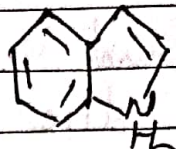
(2) Bicyclic heterocyclic Compounds ⇒ These ring are having two ring System in which at least are ring is having hetero atom.

Ex =>



Quinoline

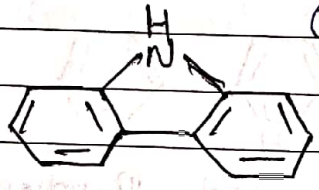
Isoquinoline



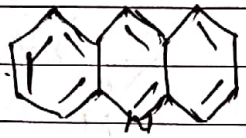
1H - Indole

③ Polycyclic heterocyclic Compounds => These rings are having more than two ring systems, in which at least one ring is having hetero atom.

Ex =>



9H - Carbazole



Acridine.

IUPAC System of Nomenclature.

IUPAC (International union of pure and applied chemistry) is a systematic namenclature system of organic Compounds and used universally.

— The aim of the IUPAC system of namenclature is to establish an international name, and to correlate each name with a nuique and unambiguous structure.

Secondary prefix + Primary prefix + Root word + primary Suffix + Secondary Suffix

It represents the Substituents or branches.

it is used in Cyclic Compounds

It represents no. of carbon atoms in detected Carbon chain.

It represents Saturation or unsaturation in Carbon chain

It represents the main function group.

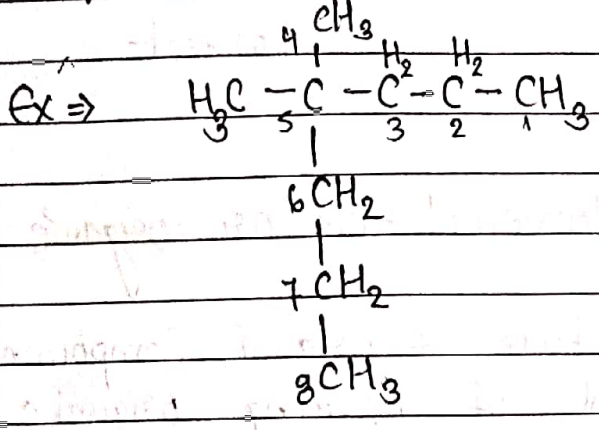
Date / /
Page

Rules of Nomenclatures.

IUPAC Nomenclature of Saturated hydrocarbon.

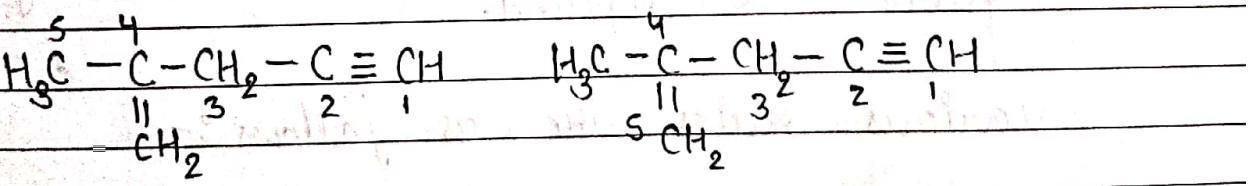
Rule-1. Longest chain rule ⇒ Select the longest chain of Carbon chain.

Ex ⇒



Rule-2. Lowest Number ⇒ Selected principle Carbon chain is numbered from the side where substituent of multiple bond or functional group is nearer (lowest possible number).

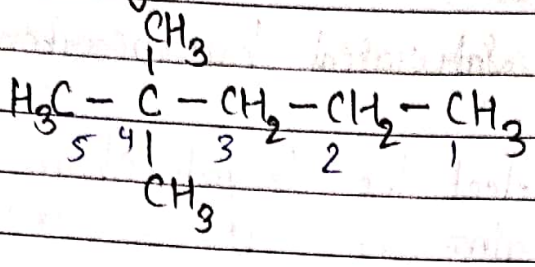
Priority order :- functional group > Double bond > triple bond > substituent.



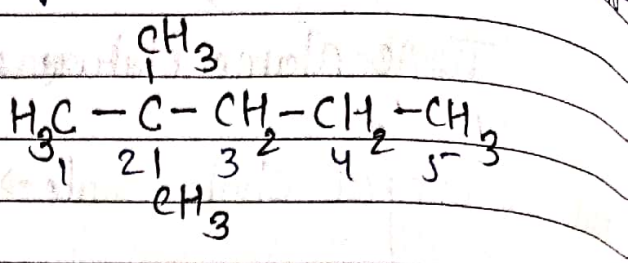
Wrong. Correct

Rule 3. Lowest Sum Number ⇒ In case if more than one substituent are present then choose the chain having maximum number of substituent multiple bonds and functional groups.

Priority order => functional group > multiple bond > Substituent



Wrong.



Correct-

IUPAC System of Nomenclature or organic Compound

The IUPAC namenclature of organic Compounds is a systematic method of naming organic Compounds by the international union of pure and applied chemistry.

— This is organic Compound in on IUPAC name we can at once it structure formula.

IUPAC has given various rules for naming an organic Compound.

Various rules are as follows :-

1. Identify the parent hydrocarbon chain the chain must have following properties.

(a). It should have the maximum number of Substituents.
(b) Should have maximum number of multiple bonds.
(c) Should have maximum number of single bonds.

Date / /
Page

RANKA

(d) should have the maximum length.

(2) Identify the parent functional group with highest order of precedence.

(3) Identify the side chain that Carbon chain which are not in the parent chain, but are branches from.

(4) Identify the remaining functional groups, functional groups will be grouped together in alphabetical order.

(5) Identify double or triple bond.

(6) Numbering of the parent chain is done and follows the rules.

(a) Has the lowest number on the Carbon to which Substituent is directly attached.

(b) Has the lowest number to the Carbon adjacent to the multiple bonds.

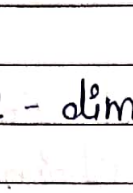
(c) Has the lowest number for prefixes.

(7) Numbering to the various Substituents and bond done. If there is more than one same type or Substituent / double bond is present prefix like di, tri, tetra is added.

(8) The no. of side chain will be grouped in ascending order and written before the name of the side

chain.

If there are two side chains with same carbon the number will be written twice.

Ex = 2,2 - dimethyl 

(g) Double bonds(en) is written before triple bond(yne)

(h) Different ~~punch~~ punchuations are used like.

(a) Commas b/w number (2,5,6)

(b) Hyphens b/w a number and a letter (2,2,5 tri methyl)

(c) Continuous words are merged. are word
eg:- Dimethyl heptane.

Nomenclature of organic Compounds.

There are mainly five types of organic Compounds These are :-

(a) Aliphatic Compounds
(b) Saturated & non Saturated Compound.
(c) Aromatic Compounds
(d) Alicyclic Compounds
(e) Heterocyclic Compounds.

Date / /
Page

RANKA

(a) Aliphatic Compounds :- These Compounds contain open chain of Carbon atoms.

Ex => Ethane — $CH_3 - CH_3$
Propane — $CH_3 - CH_2 - CH_3$
Ethanol — $CH_3 - CH_2 - OH$
Acetic acid — CH_3COOH
Aminopropane — $CH_3 - CH_2 - CH_2 - NH_2$

(b) Saturated & non-saturated Compound :- These may be again of two types.

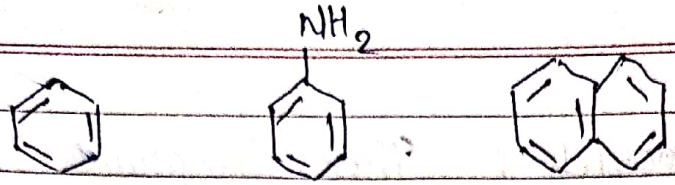
(a) Hydro Carbons
(b) Hydro Carbon with hetero atoms.

=> The hydroCarbon with single bonds only are called saturated hydroCarbons.

=> Those Compounds which have double or triple bonds are called unsaturated Compounds.

Ex => Ethane — $CH_3 - CH_3$ (saturated)
Ethene — $CH_2 = CH_2$ (unsaturated)

(c) Aromatic Compounds :- Benzene and all Compound which resoluble benzene in structural and properties are called aromatic Compounds.

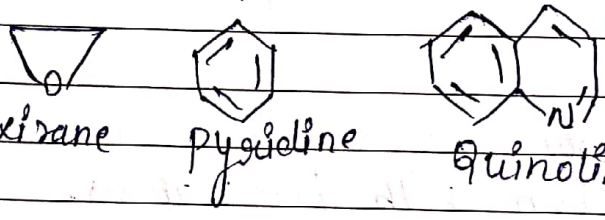


Benzene Aniline Naphthalene

(d) Alicyclic Compounds :- Cyclic Compounds which Contain only Carbon atoms are Called alicyclic or carbocyclic Compounds.

(e) Heterocyclic Compounds :- Cyclic Compounds in which ring atoms are of Carbon and other elements are Called heterocyclic Compounds.

Ex =>



oxirane pyridine Quinoline

	Class	functional group.
(1)	Alkene	$>C=C<$
(2)	Alkyne	$-C\equiv C-$
(3)	Alcohol	$-OH$
(4)	Ether	$>C-O-C<$
(5)	Aldehyde	$-\underset{\displaystyle H}{\overset{\displaystyle |}{C}}=O$
(6)	Ketone	$-\overset{\displaystyle O}{\overset{\displaystyle \|\|}{C}}-$

Date / /
Page

RANKA

(7) Carboxylic acid — $-\overset{\overset{O}{\|}}{C}-OH$

(8) Ester — $-\overset{\overset{O}{\|}}{C}-O-C\equiv$

(9) ~~Amid~~

(9) Amine — $-NH_2$, $-\overset{|}{N}H$, $-\overset{|}{\underset{|}{N}}$

(10) Amide — $-\overset{\overset{O}{\|}}{C}-NH_2$

(11) Halide — $-X$ $(X = F, Cl, Br, I)$

IUPAC System of Nomenclature

In 1957, International union of pure and Applied chemistry (IUPAC) enveloped a Scheme for giving Systematic names to organic Compound on the basis of Structure.

IUPAC naming of Alkanes.

(1) Alkanes Contain Only Single bonds.
Ex - methane, ethane, propane etc.

(2) The prefix indicates the type of branching present in the molecule.

Date / /
Page

Ex ⇒ ① n = normal or straight-chain

$CH_3CH_2-CH_2-CH_2-CH_3$ $CH_3CH_2CH_2CH_2CH_3$

~~Isohexane.~~ n-pentane

② Iso = methyl group attached to second last Carbon atom.

Ex = $CH_3-\overset{\overset{CH_3}{|}}{CH}-CH_2-CH_2-CH_3$

Isohexane.

③ neo - To methyl group attach to second last Carbon atom.

Ex - $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_2-CH_3$

Neoheptane.

④ Alkane structure Contain from types of Carbon.

Primary Carbon - 1°

Secondary Carbon - 2°

Tetiary Carbon - 3°

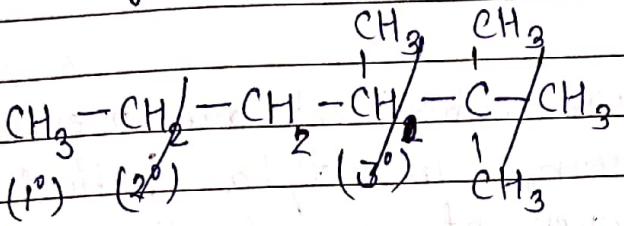
Quaternary Carbon - 4°

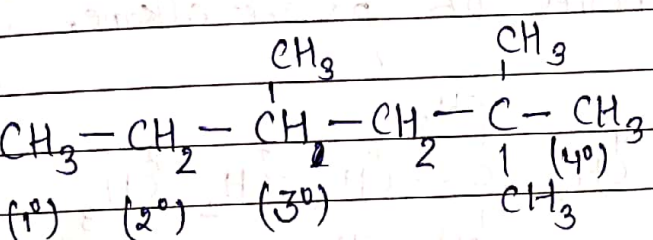
Primary Carbon ⇒ Attach to 1 or number of Carbons.

Secondary Carbon ⇒ Attach to 2 other Carbons.

Tertiary Carbon ⇒ Attach to 3 other Carbons.

Quaternary Carbon ⇒ Attach to 4 other Carbons.

Ex ⇒ 

Ex ⇒ 

(4) The alkane group in a formate by removable of one hydrogen atoms from alkane.

(R = Alkyl group)

Ex ⇒ $R-H \xrightarrow{-H} R^{\circ}$ ——

Alkylgroup

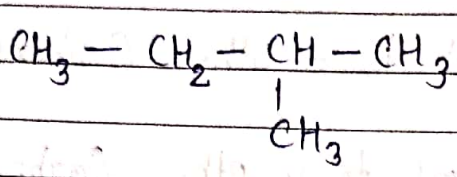
$CH_4 \xrightarrow{-H} CH_3$

⇒ The Symbol R- represent alkyl group. alkyl group is name by topping -ane from the name of Corrroesponding alkane and adding a suffix a 'yl'.

Date / /
Page

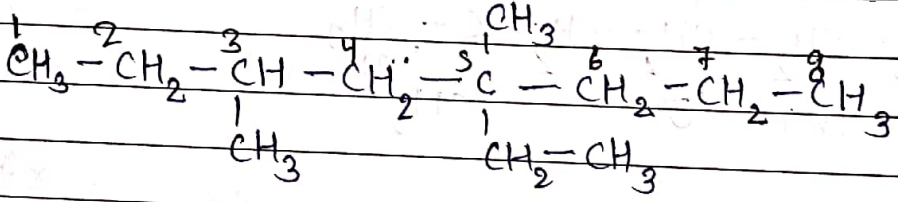
⇒ Number the longest chain in such a way that lowest number is given to the Carbon Carrying Substituent.

Ex ⇒



2-methyl Butane.

⇒ When two or more Substituent are present there names are arrange in alpha betical order and added to the name of parent alkane.



3,5-dismethyl, 5-Ethyl octane.

Alkenes ⇒ These are hydrocarbon which Contain Carbon Carbon double bond. They are name by replacing the suffix -ane by -ene

① Number the chain from the end close to the double bond.

② Indicate the position of the double bond by number of first (lowest number) Carbon atom involved double bond.

Ex => $CH_2 = CH_2$ Ethene

$CH_3 - CH = CH_2$ propene

$CH_3 - \overset{CH_3}{\overset{|}{C}} = CH_3$

2-methyl propene

(3) Alkenes Containing two double bonds are name as. alkadienes.

Ex => $CH_2 = C = CH_2$

1,2 - propadiene

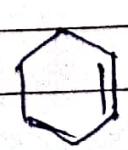
$CH_2 = CH - CH = CH_2$

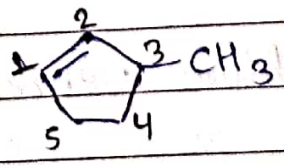
1,3 - Bute dienes.

(4) Naming of cyclo-alkene is done by giving double bonded Carbon gueps lowest number.

(5) Choice the direction of numbering so as to give lowest number to substituent to position of double bond is not written because it is number to be between C-1 or C-2.

Ex =>





Cyclohexene 3-methyl Cyclopentene.

Page

Alkynes ⇒ Alkynes are hydrocarbon that contain Carbon - Carbon triple bond. Indicate the position of triple bond by the numbering from the -ene closer to the triple bond. The position is indicate by the lowest number Carbon atom involve in the triple bond.

⇒ Alkyne halide are the compounds which contains carbon halogen bonds. prefix the name of the alkyne by chloro, bromo, Iodo, fluoro. Number the chain to give the carbon carry the halogen atom the lowest possible number.

Ex ⇒ $CH_3 - \overset{Br}{\underset{|}{C}}H - CH_3$

2-bromo propene

⇒ $CH_3 - CH_2 - \overset{CH_3}{\underset{|}{C}}H - CH_2 - Cl$

1-chloro, 2-methyl butane

⇒ $CH_3 - CH_2 - \overset{Cl}{\underset{Cl}{\overset{|}{\underset{|}{C}}}} - CH_2 - CH_2 - Br$

1-Bromo, 3,3-dichloro pentene.

⇒ For identical halogen substituent preffix dia, tri, tetra its are used.

Date / /
Page

RANKA

Isomerism ⇒ Isomers are the Compounds which have the same molecular formula but different chemical and physical properties and are called isomer and the phenomena is called isomerism. Isomerism is classified in two types.

1. Constitutional or structural isomers
2. Stereoisomers.

1. structural isomers ⇒ will Connectivity among atom.

→ Chain ($CH_3CH_2CH_2CH_3$)

→ Position → $CH_3\underset{\underset{NH_2}{|}}{CH}CH_3$ & $CH_3CH_2CH_2NH_2$

different position of functional group.

→ functional → CH_3CH_2OH & CH_3OCH_3

different functional group.

→ metaisomers.

→ Tautomerism

⇒ Structural isomers ⇒ The isomerism is due to difference in the arrangement of atoms with in the molecule, without any reference to space, the phenomena is called structural isomerism.

Date / /
Page

RANKA

① Chain ⇒ Compounds having the same molecular formula but different arrangement of carbon chain with in the molecule are called chain isomers and phenomena is called chain isomerism.

Ex ⇒ C_4H_{10} has two chain isomers.

$CH_3CH_2CH_2CH_3$ n-butane

$CH_3-\underset{CH_3}{CH}-CH_3$ 2-methyl propane

② Position ⇒ Compounds which have the same structured but different only in the position of the double / triple bond. Are functional groups are called position isomers.

Ex ⇒ But-1-ene — ane
But-2-ene = ene
≡ yne

$\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H=\overset{1}{C}H_2$

$\overset{4}{C}H_3-\overset{3}{C}H_2=\overset{2}{C}H-\overset{1}{C}H_3$

But-1-yne

$CH_3-CH_2C\equiv CH$

But-2-yne

$CH_3-C\equiv C-CH_3$

Date / /
Page

RANKA

③ Functional ⇒ Compounds which have same molecular formula but different functional are called functional isomerism.

Ex ⇒ C_3H_6O

CH_3CH_2CHO Propanol

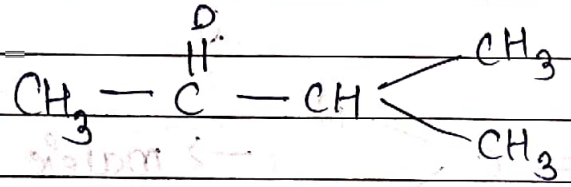
CH_3COCH_3 Acetone

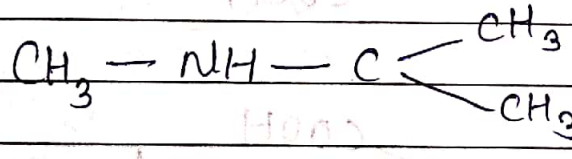
$CH_2 = CHCH_2OH$ alkyl alcohol

$CH_2 = CH - O - CH_3$ methoxethene.

④. Metaisomerism ⇒ Compound having the same molecular formula but different number of Carbon atoms on either side of the functional group and are metaisomers arise different alkyl group attached to same functional group.

Ex ⇒



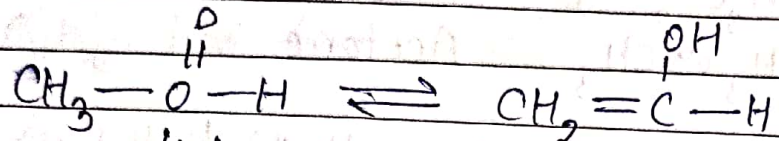


⑤. Tautomerism ⇒ It occurs due to one, three migration of hydrogen atom from 1 polyvalent atom to the other with in the same molecule.

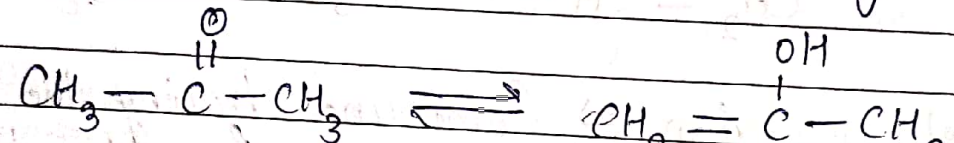
Date / /
Page

Ex ⇒ keto - enol tautemerism

form has keto group (>C =O) with the other Contain the exolic group (>C = C — OH).

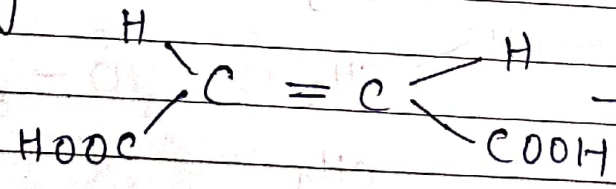


keton (acetaldehyde) exolic (vinyl alcohol)

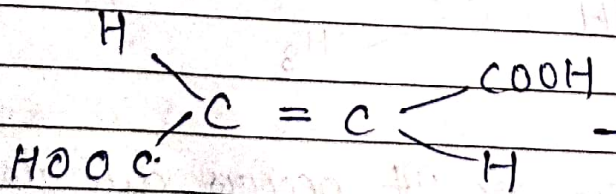


Acetone prop-1-en-2ol

⇒ Stereoisomers ⇒ Compounds with the same molecular formula and of identical Constitutents but different only in the space arrangement.



→ maleic acid



→ fumaric acid

The differ in their physical & chemical properties There isomers is cause by the different special arrangement of two hydrogen atom

and two Carboxylic group about the Carbon Carbon double bond, there Constitutional are identical.

Types

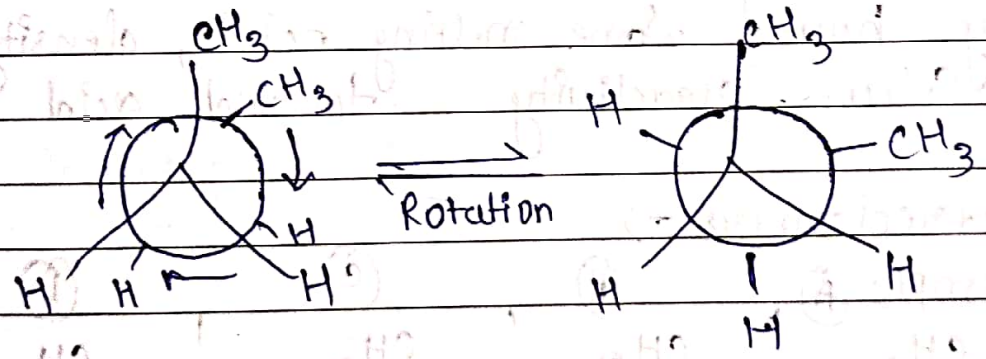
(1). Configurational isomers.
(2). Conformational isomers.

Configurational isomers

(1) optical isomers — Distereoismers
(2) Geometric isomers — Enantioisomerers

cis-trans chiral

(2). Conformational isomers: ⇒ Rotation of a part of the molecule about C–C.



(2). Configurational isomers ⇒ Rotation of a part of the molecule about C=C.

⇒ The Configurational isomers Can be interCoverted only by breaking & making bond.

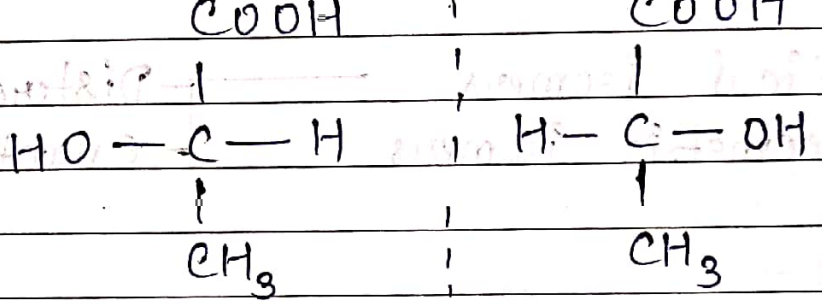
Enantioisomers (optical isomers) => The two ismers are the mirror image of each other this known as enantio-isomers.

Distereoisomers => The isomers are not the mirror image of each other, this are known as distereoisomers.

Enantioisomers =>

Example :-

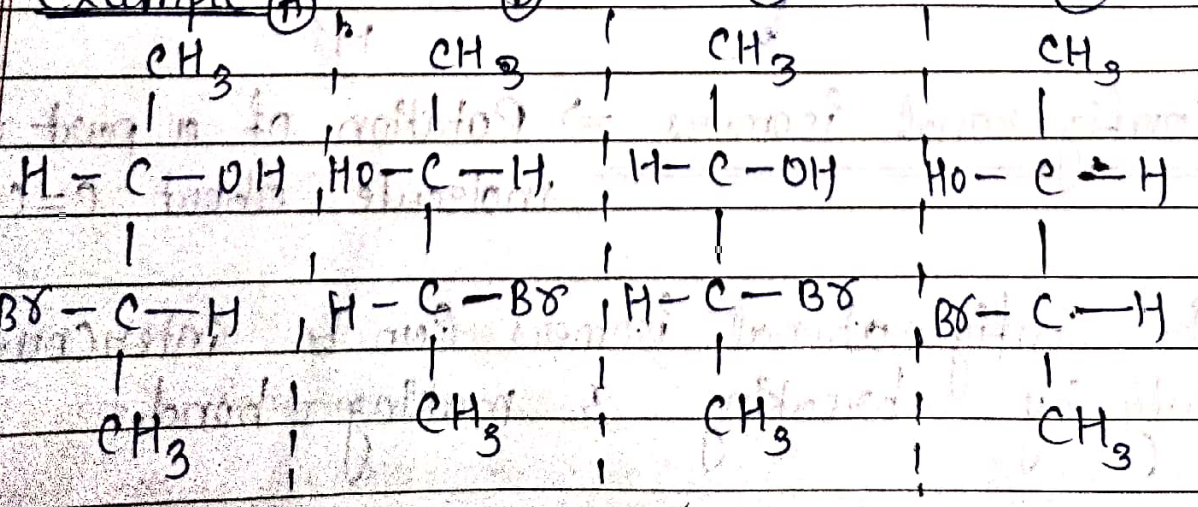
(lactic acid)



=> Enantioisomers are Stable Compounds.
=> They differ one another in three dimensional arrangement.
=> They have same melting point, density, Solubility, Colour, reactivity toward acid & base.

Distereoisomers =>

Example (A) (B) (C) (D)



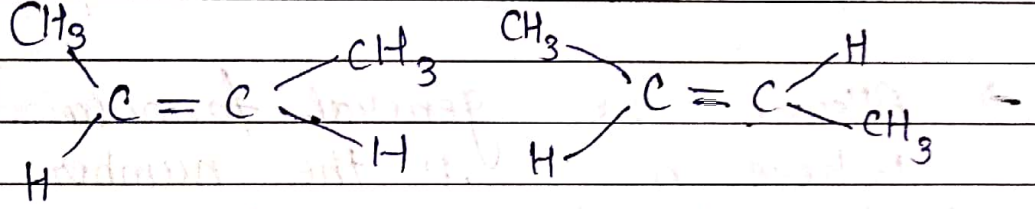
(A) is the mirror image (B)
(C) is the mirror image (D)
(A) is the non mirror image (C)
(B) is the non mirror image (D)

The isomers are two pairs are Enantioisomers two pairs + diastereoisomers while have different, melting, point, Boiling point, Solubility.

Geometric isomers ⇒ It is a result form in a rotation about double bond & about single bond in Cyclic Compound.

⇒ Rotation around the C=C is not possible because rotation could break the π-bond.

Ex ⇒



cis
Boiling point (4°C)

trans
Boiling point (1°C)