SOLVED QUESTIONS ON

MODULE - 6 STEREOCHEMISTRY

Ques-1 Discuss taking examples of Organic molecules type Structural and Stereoisomerism.

Ans-1 STRUCTURAL Isomerism ⇒ It is due to different arrangement of atoms within molecule. It is of following Types

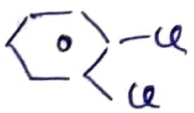
(a) CHAIN Isomersim ⇒ Compounds have same molecular Formola but different arrangement of carbon chain

$CH_3-CH_2-CH_2-CH_2-OH$ $\qquad$ $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-OH$

(b) Position Isomerism - Position of functional group is different. Example

$CH_3-CH_2-CH_2-OH$
1-Propanol

$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$
2-Propanol

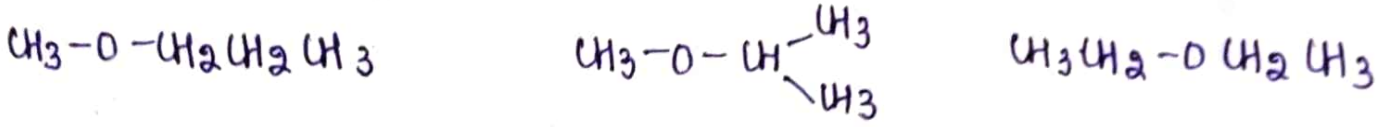

o-chloro-benzene


p-chloro-benzene

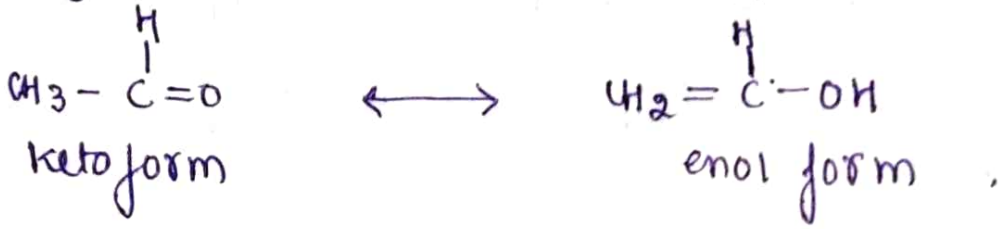
(c) FUNCTIONAL Isomerism ⇒ Same molecular formula but different functional group

Alcohol) CH_3-CH_2-OH $\qquad$ CH_3-O-CH_3 (ether)

(d) Metamerism ⇒ Unequal distribution of carbon atoms on two sides of functional group.



(e) Tautomerism : Structural isomers which are mutually interconvertible & exist in dynamic equilbrium they are called Tautomerism.



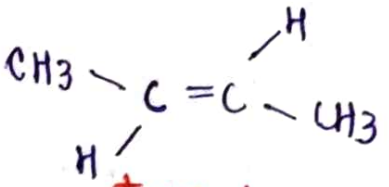
II - STEREOISOMERISM

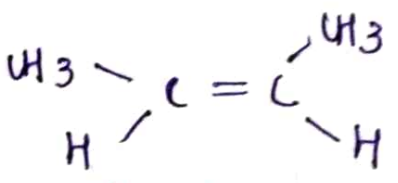
It arises due to difference in arrangement of atoms in space is called stereoisomerism.

It is of Two Types (a) optical (b) Geometrical

(a) Geometrical Isomerism ⇒ It is due to different geometrical arrangement of Two different groups about carbon - carbon double Bond.

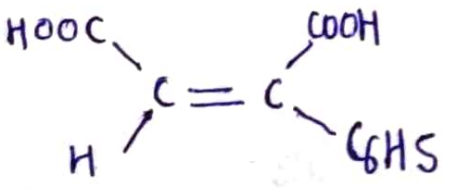
But-2-ene

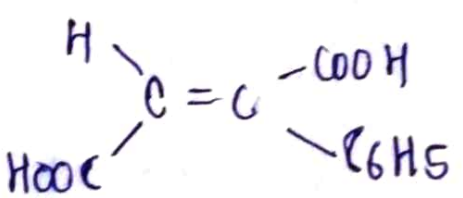

trans- but-2-ene


Cis - but-2-ene

Cinnamic aid

(Cis- form)



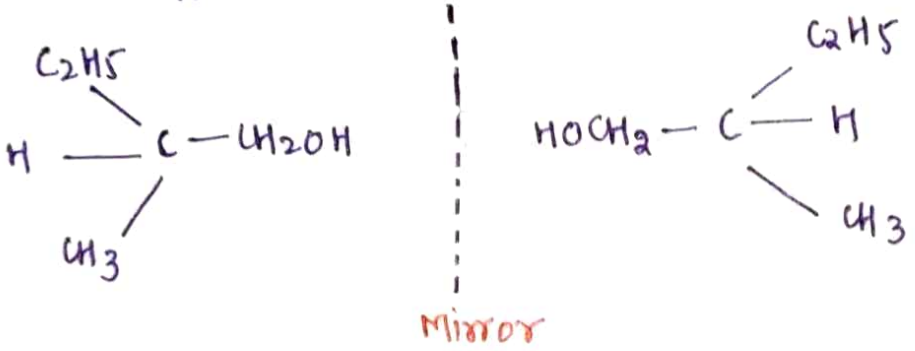

Trans Form

Optical Isomerism → Compounds having identical molecular formula having same chemical & physical properties exhibit different effect on plane-polarised light.

It is of Two Types: (a) Enantiomers (b) Diastereomers

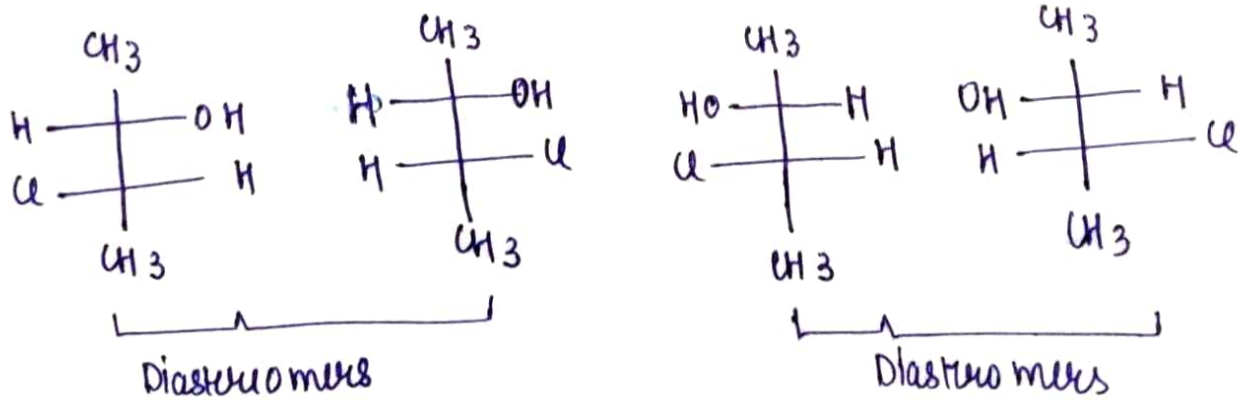
Enantiomers

Molecular structure having Non-superimposable mirror images of each other and rotates the plane-polarised light equally in opposite direction.



Diastereomers

– They are Non-superimposable and They are Not mirror images of each other.



Ques ⇒ Define the following Terms. (YMCA)

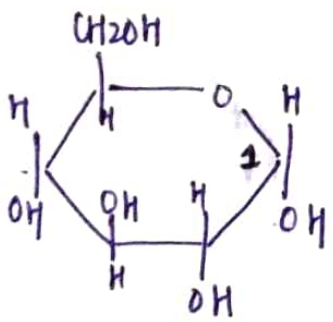
(a) Anomers (b) Chirality (c) Chiral Axis

(d) Resolution (e) Racemic Mixture (f) Meso compounds

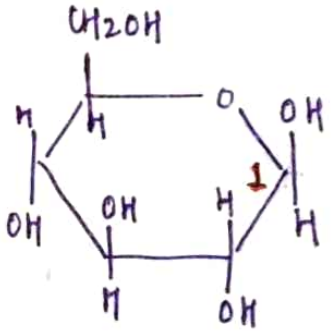
(a) ANOMERS

Anomers are cyclic isomers differing from each other in configuration at anomeric carbon i.e at C1.

α and β are Two Anomeric forms in Carbohydrates



α - Glucopyranose



β - Glucopyranose

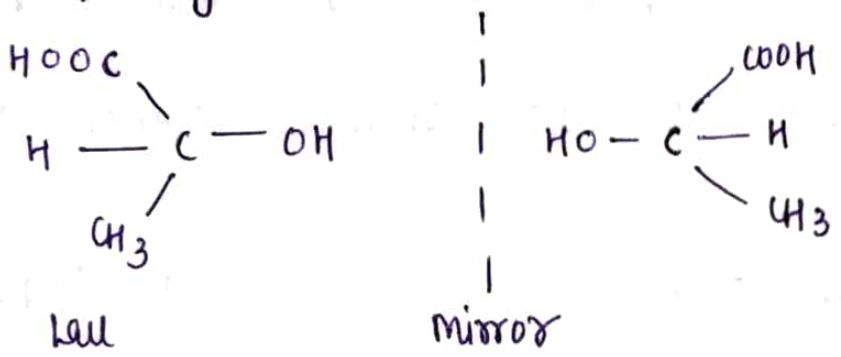
(b) CHIRALITY

* A structure or object is said to be chiral (or disymmetric) if it has No plane of symmetry and is not superimposable on its Mirror Image.

Example ⇒ Human Hands

Many organic molecules such as lactic acid ($CH_3-\overset{*}{C}H(OH)-CH_3$) represent chiral structures.

The substance having chiral structure are said to posses the property of chirality and these substance are optically active.

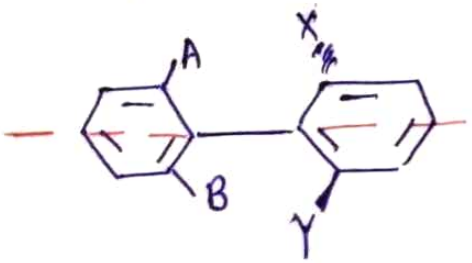


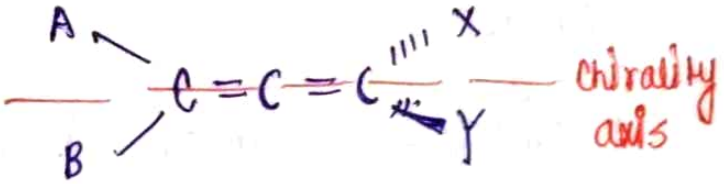
Non-superimposable mirror images.

(c) Chiral Axis

Some molecules are chiral but do not contain a chirality center. Some of these contain an chirality axis ⇒ An axis about which are arranged so that spatial arrangement is Not super-imposable on its mirror image.

Example ⇒ biphenyl and allenes

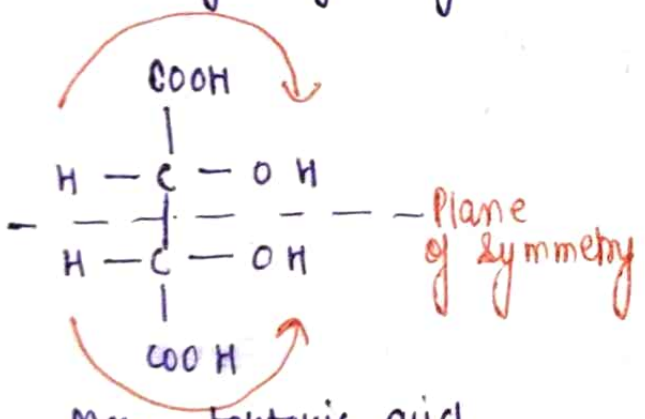




* Meso- Compounds.

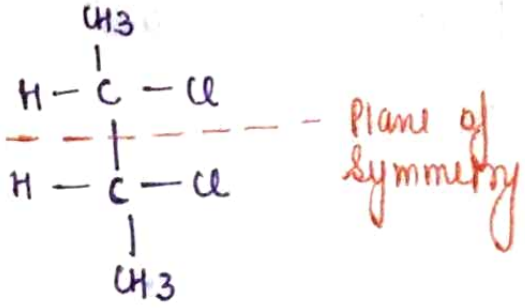
* Meso compounds are optically Inactive compound inspite of presence of chiral carbons (assymetric carbon atoms)

* The molecule of a meso compound usally contains plane of symmetry and Thus lacks chirality.



Meso- tartaric acid
(Net optical Rotation = 0)

Meso-2,3-dichlorobutane



(Net optical Rotation = 0)

The Rotation caused by upper Half portion is compensated by lower half portion and Net Rotation is zero This phenomena is called INTERNAL COMPENSATION

Resolution: The prouss of sepration of enantiomers from a Racemic Mixture is called Resolution.

* Resolution Involve Reation of Racemic Mixture with an optically active Reagent Results in formation of Diastereomers
* Diastereomers exhibit different physical properties and can be easily siprated.

Racemic Mixture : A mixture containing equal amount of pair of enantiomers is Termed as Racemic Mixture. or (racemic modification).

A Racemic Mixture is optically Inactive because Specific Rotation Value of Two Isomers cancel each other Resulting in zero optical activity.

* Represented by (±).

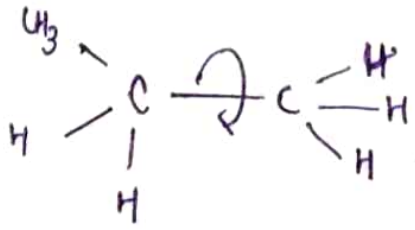
Meso Compounds.

Q- What do you understand by conformation and conformational Isomerism.

A - Different - three dimensional arrangement of atoms that result due to free - rotation about Carbon - Carbon Single Bond are known as conformations.

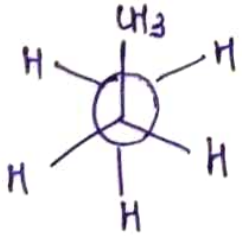
The Individual structure arising due to free Rotation are known as conformers or conformational Isomers.

Ques- Draw and Discuss conformational Isomer of Propane.



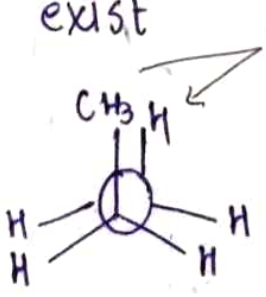
Propane [free Rotation of C-C Bond

Two conformers exist



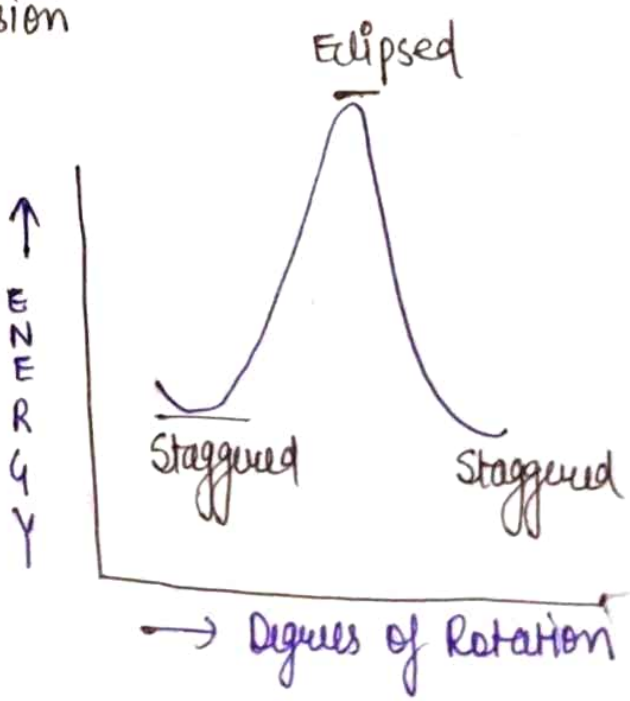
Staggered

No Repulsion



Eclipsed

High Energy due to Repulsion



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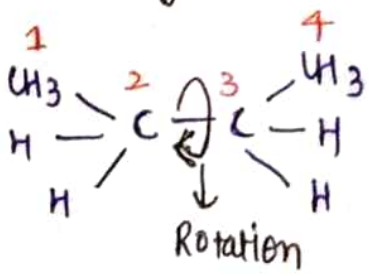
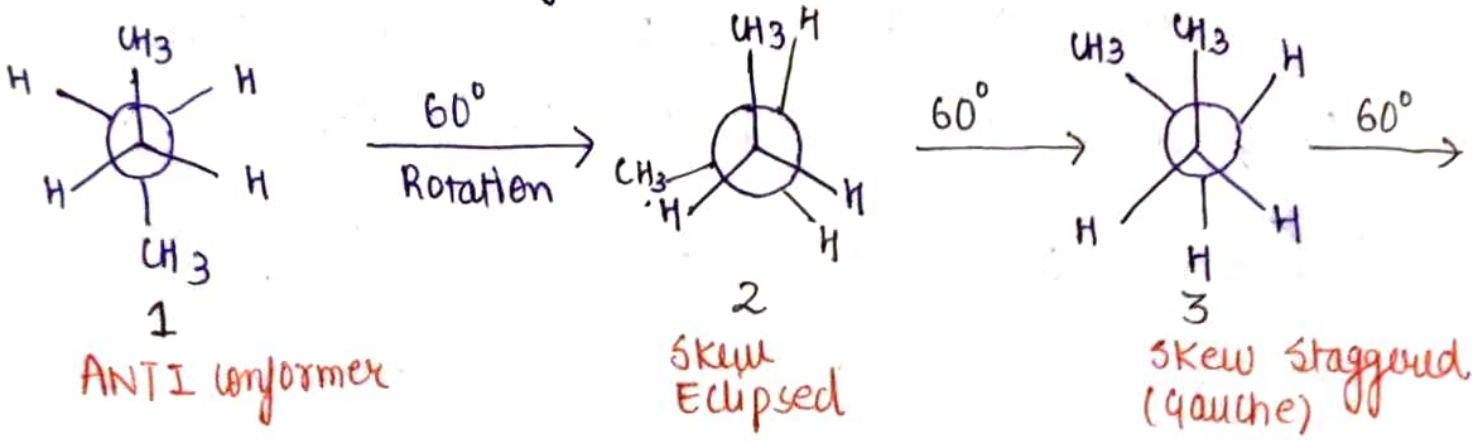
Ques ⇒ Draw and Discuss conformational of Butane (Ym (A)

Ans Butane $CH_3\,CH_2\,CH_2\,CH_3$ (1 2 3 4)



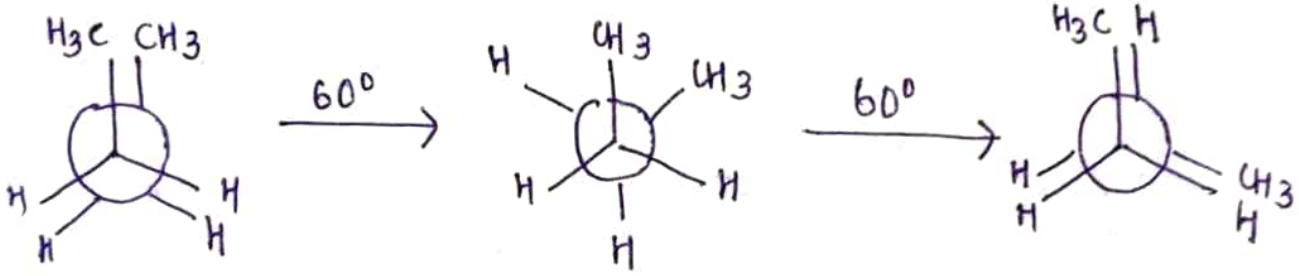
There occurs 6 conformers.



1
ANTI conformer

2
Skew Eclipsed

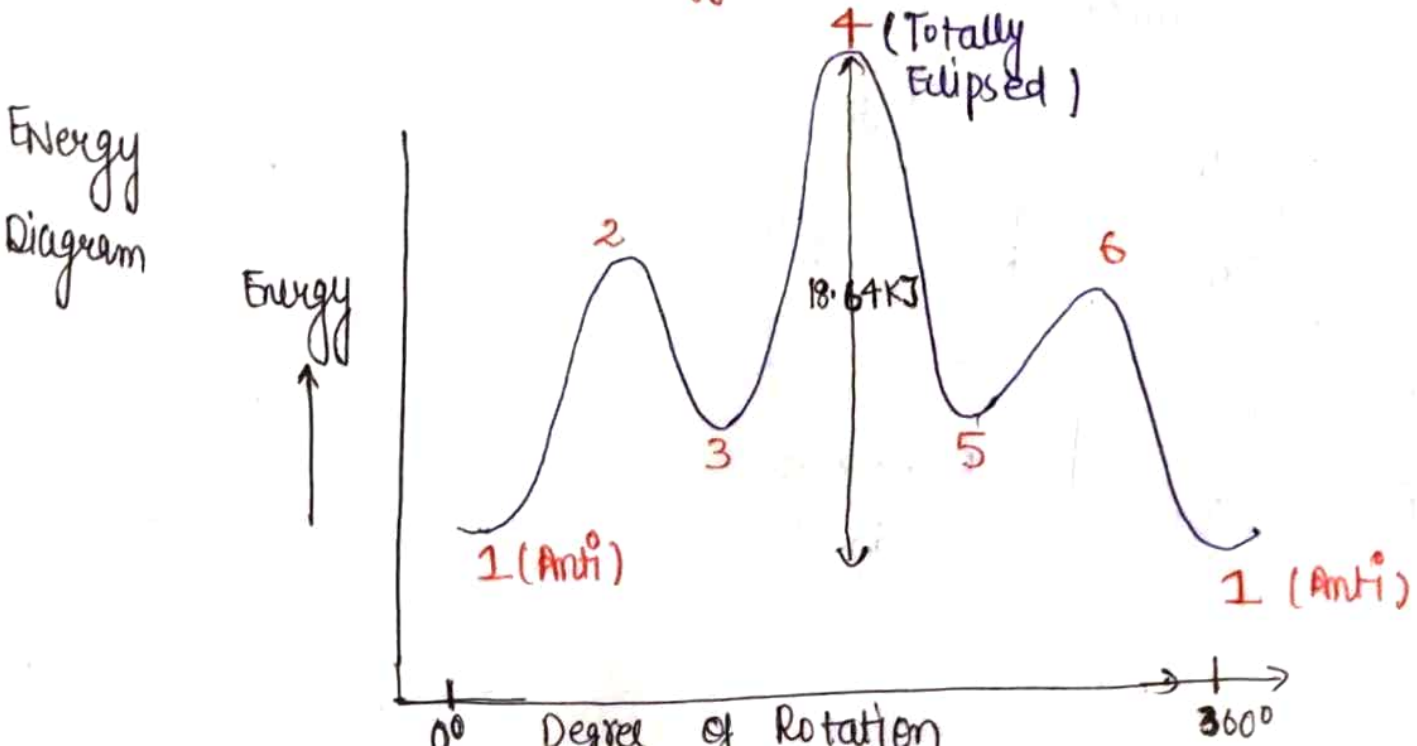
3
Skew Staggered (Gauche)



4
Totally Eclipsed

5
Skew Staggered (Gauche)

6
Skew Eclipsed



Stability order of conformers

ANTI > Gauche (Skew Staggered) > Skew Eclipsed > Totally Eclipsed

* Anti is most stable because two CH_3 group are farthest from each other and have minimum interaction.

Ques ⇒ Discuss Isomerism in Transition Metal Complexes. (Ymca)

Ans ⇒ Werner classified Transition Metal Isomers into
(a) STRUCTURAL ISOMERS (b) STEREOISOMERS

(a) STRUCTURAL ISOMERS TYPE

1) Ionisation Isomerism
2) Hydrate Isomerism
3) Coordinate Isomerism
4) Linkage Isomerism.

(b) STEREOisomers Type

1) Geometrical Isomerism
2) optical Isomerism.

(a) STRUCTURAL Isomers

1. Ionisation Isomerism ⇒ In this exchange of ions occurs b/w the complex ion and ion outside it i.e coordination sphere

Examples (i) $[Co(NH_3)_5 Br]SO_4$ and $[Co(NH_3)_5 SO_4]Br$

(ii) $[Pt(NH_3)_4 Cl_2]Br$ and $[Pt(NH_3)_4 Br_2]Cl_2$

(b) Coordination Isomerism : It occurs in compounds containing Both cationic and anionic complexes. It is caused by Interchange of ligands b/w Two complex ion of same complex.

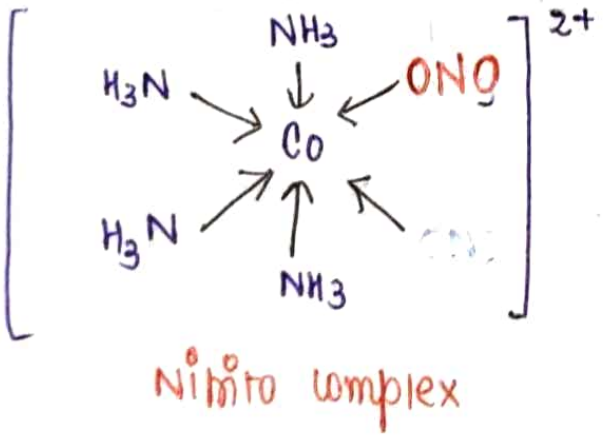
For Example 1.) $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

2.) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$

3.) Linkage Isomerism

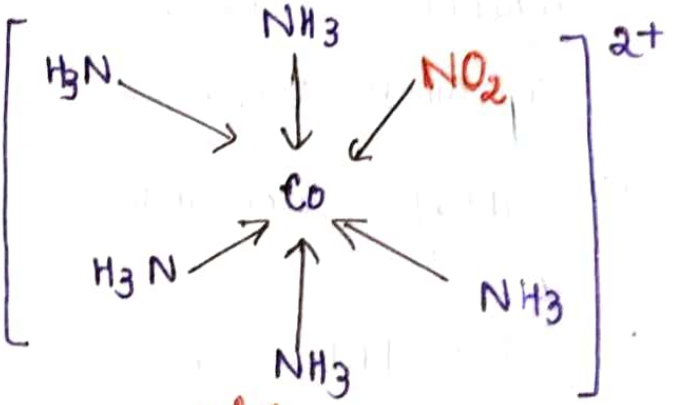
This type of Isomerism occurs in compounds containing ambidentate ligands.

For example : in NO_2^- either N or O may act as Donor



Nitro complex

&



Nitrite complex

Other example ⇒ $[Cr(H_2O)_5(SCN)]^{2+}$ & $[Cr(H_2O)_5(NCS)]^{2+}$

4.) HYDRATE OR SOLVATE Isomerism

In this compound have same composition but differ in Number of solvent molecules present as ligand and as free solvent molecule (outside coordination sphere)

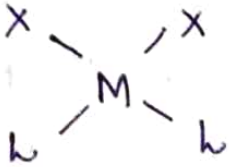
Example ⇒ $[Co(NH_3)(H_2O)Cl]Cl_2$ & $[Co(NH_3)_4Cl_2]Cl \cdot H_2O$

⇒ $[CoCl(NH_3)_4(H_2O)]Br_2$ & $[Co(NH_3)_4Br_2]Cl \cdot H_2O$

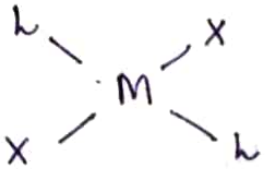
(b) STEREOISOMERISM ⇒ It arises due to different positions and arrangement of ligand in space around metal ion.
(Space Isomerism)

(1) Geometrical or Cis-Trans Isomerism

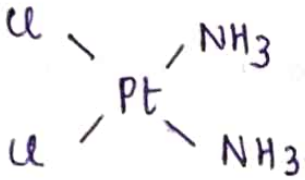
(a) In Square Planar Complexes having Coordination No. = 4



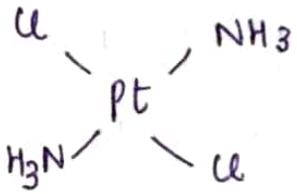
Cis - Isomer



Trans - Isomer



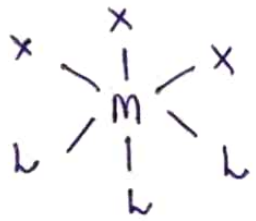
Cis form



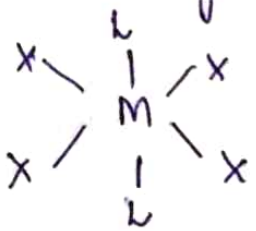
Trans form

(b) In Octahedral Complexes having Coordination No = 6

(i)



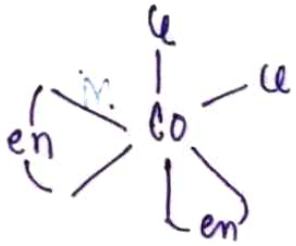
Cis-Isomer



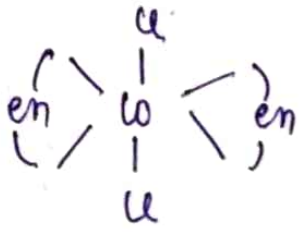
Trans- Isomer

$[Co(NH_3)_4Cl_2]^+$

(ii)



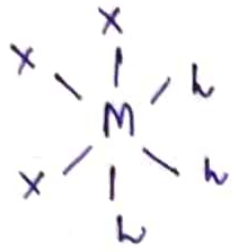
Cis Isomer



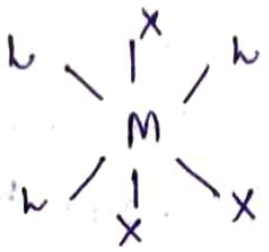
Trans Isomer

en = bidentate ligand

(iii)



Facial Isomer
(fac)



Meridinal Isomer
(mer)

example
$[Rh\ Cl_3(py)_3]$

(b) **Optical Isomerism** ⇒ The Isomers which can Rotate the plane of polarised light equally but in opposite direction are called optical Isomers.

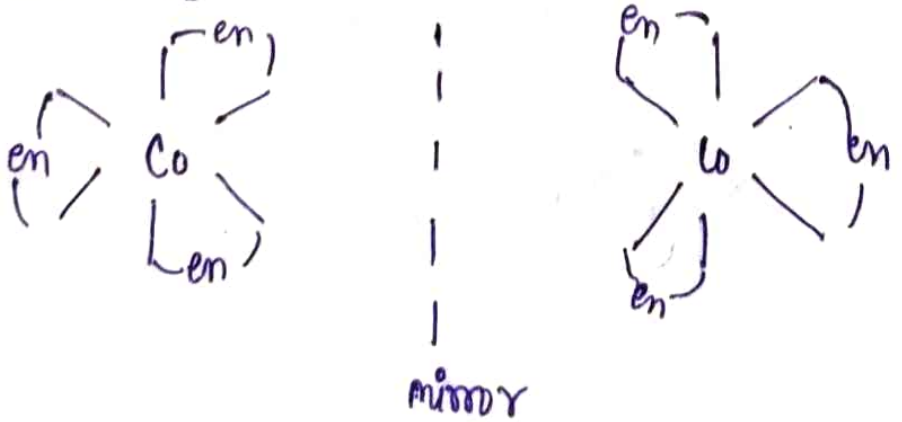
These are NON-superimposable mirror images of each other are called Chiral and This property is called Chirality.

(+) Dextrorotatory ⇒ Rotate light clockwise Direction

(−) Laevorotatory ⇒ " " anticlockwise "

Example M $(AA)_3$ type AA = bidentate ligand.

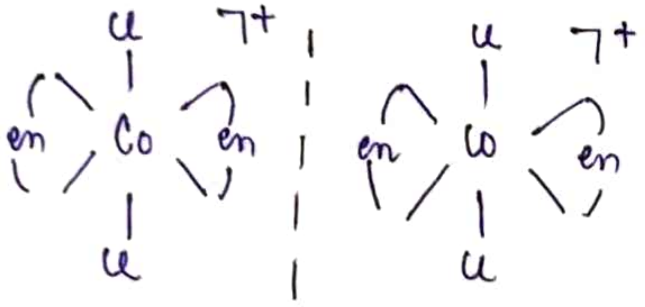
⇒ $[Co(en)_3]^{3+}$



(ii) $[M(AA)_2B_2]$ or $[M(AA)_2BC]$ Type

AA = bidentate symmetrical ligand

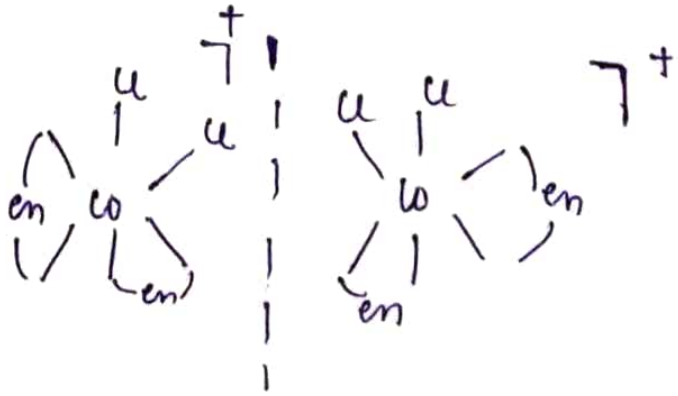
Example ⇒ $[CoCl_2(en)_2]^+$



optically Inative

(Superimposable Mirror image)

Trans-Isomer



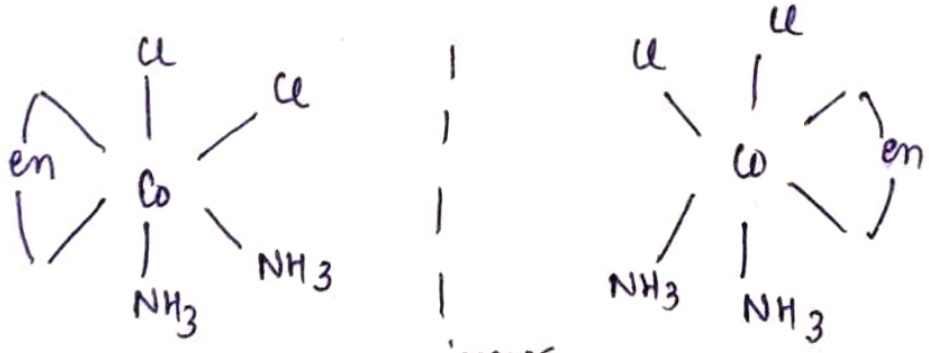
optically Active

(NON-Super imposable Mirror Images]

cis-Isomer

(iii) $M(AA)B_2C_2$ type

Example $[Co(en)(NH_3)_2Cl_2]$

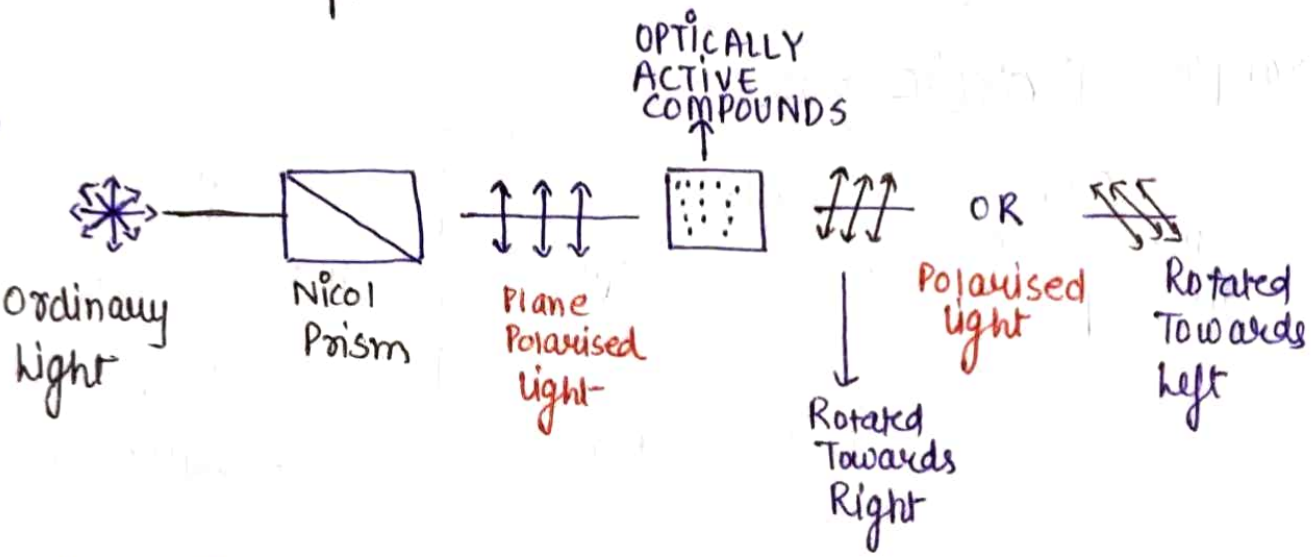


optically active

(YMCA)

Ques ⇒ What are optical active compounds. Discuss essential condensation for optical Isomerism. Elaborate with example.

Ans ⇒

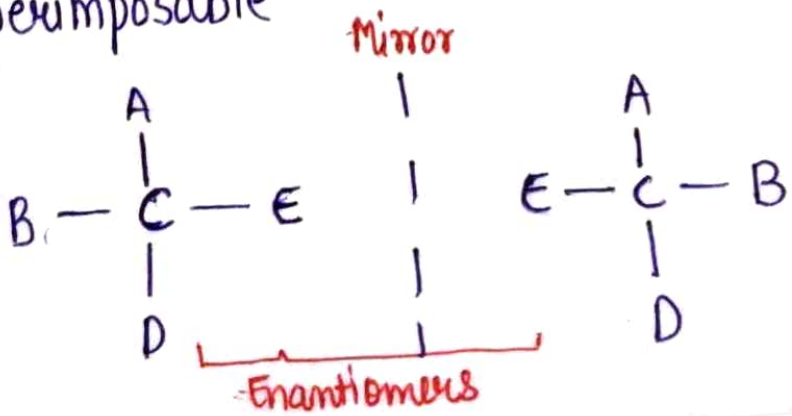


* Compounds which can Rotate the plane polarised light through an certain angle in clockwise (Right) or anticlockwise (Left) direction are called optical active compounds.

* Essential condition for optical Isomerism

(a) molecule should be chiral

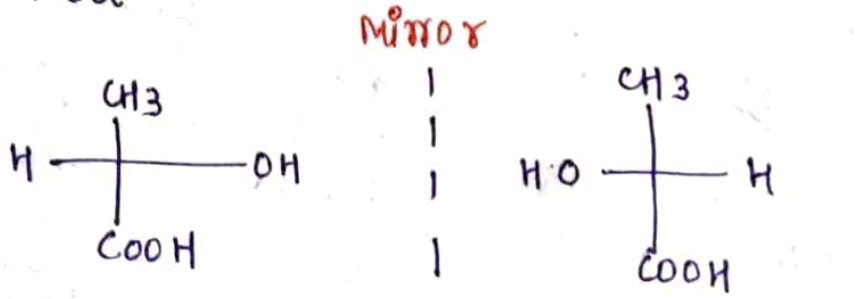
(b) molecule and its mirror image should be NON superimposable



There are Two Types of optical Isomers

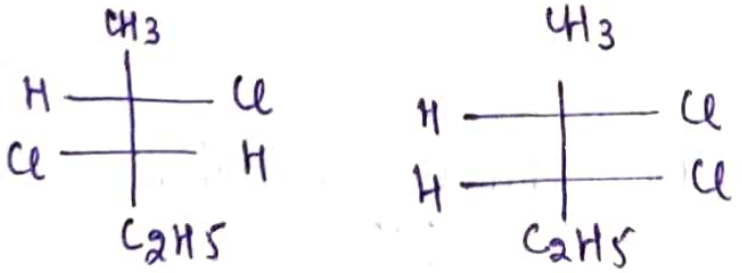
1.) Enantiomers ⇒ Compounds which are mirror images of each other

Example Lactic Acid



D-Lactic Acid L-Lactic acid

2.) Diastereomers ⇒ optical Isomers which are neither mirror images nor superimposable are called Diastereomers.



Diastereomers.

Ques ⇒ Why enantiomer have same Chemical and Physical properties while diastereomers have different ? (YMCA)

Ans ⇒ Since enantiomers posses similar molecular formula and similar chemical structure so they Have same physical and chemical properties Only They differ in optical activity.

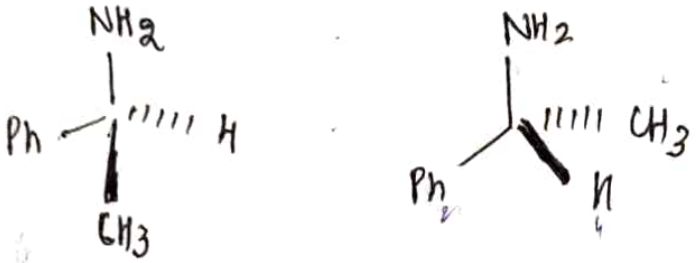
* Diastereomers are Not identical in their configurations Due to difference in connectivity They exhibit different chemical and physical properties. They have different melting Point, density, solubility as well as different rate of Reaction.

Example d-tartartich

(YmCA)

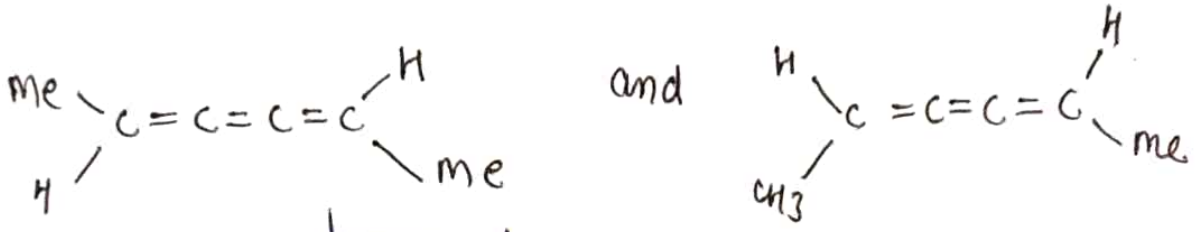
Ques: Indicate the following compounds as /enantiomers/ diastereomers/ identical or none

(i)



Identical Molecule

(ii)



Diastereomers

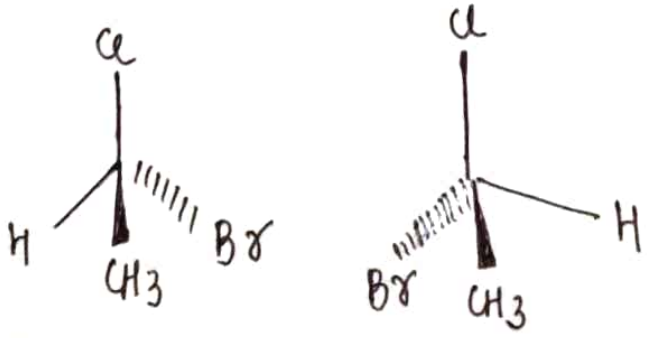
They are Not mirror images

(iii)

Diastereomers because

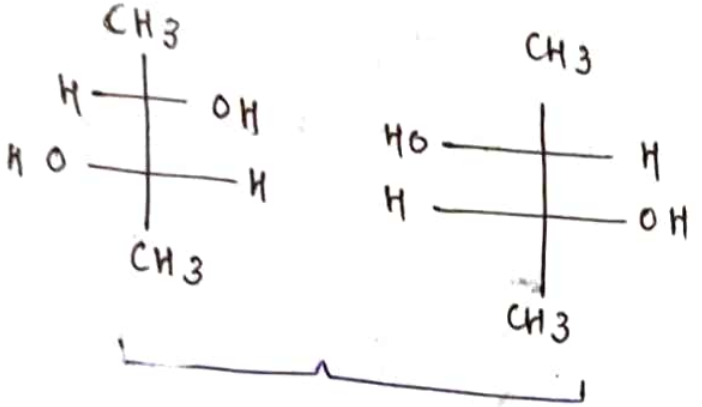
(Neither they are mirror Images Nor - Superimposable)

(iv)



Enantiomers because They are Mirror Images of each other

(v)



Enantiomers [mirror images of each other]