

# Isomerism

Compound having same molecular formula but different structural formula are called as isomers & this phenomena is known as isomerism.

There are two types of isomerism

- 1- Structural isomerism :-
  - a- chain , b. functional c. Position d. Metamerism
  - e- Tautomerism

2. Stereoisomerism:- The isomers having same functional group & atom but their position in space is different, are called as stereoisomers & phenomena is called as stereoisomerism.

a. Configurational :- The stereoisomers which are non superimposable and non interconvertible by rotation around single bonds are known as configurational isomers & phenomena known as configurational isomerism. It can be interconvertible only by breaking & making of bond .

(i) Enantiomers (optical isomers)

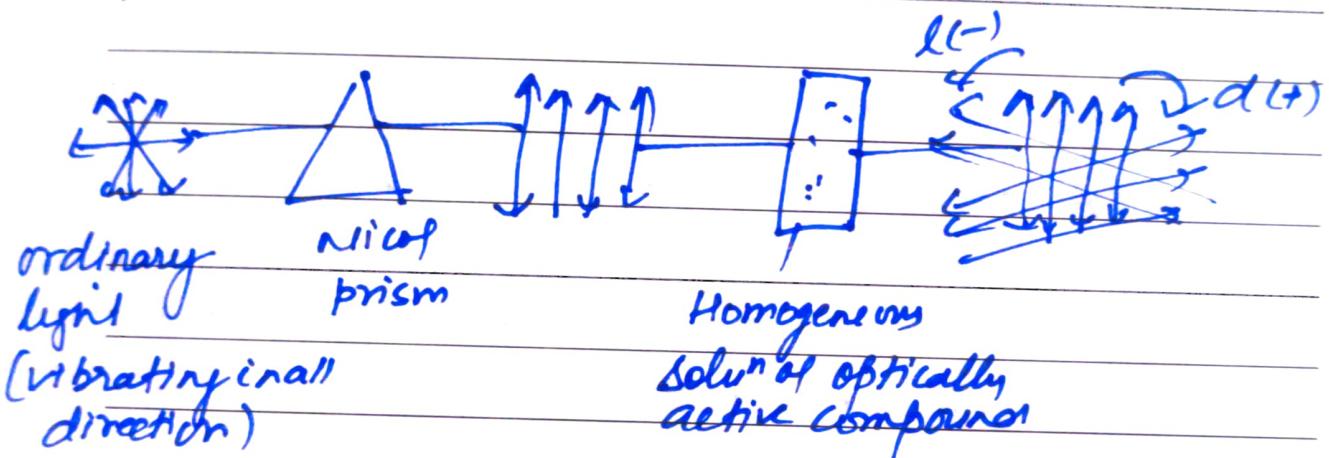
(ii) Diastereomers : when configuration isomers are not mirror image each other , these are known.



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as diastereomers. These also include geometrical isomers.

Optical Isomerism :- Stereoisomers that differ in the direction or magnitude of rotation of Plane of Polarized monochromatic light are called optical isomers and phenomenon called as optical isomerism. Optical isomers are also called enantiomers.

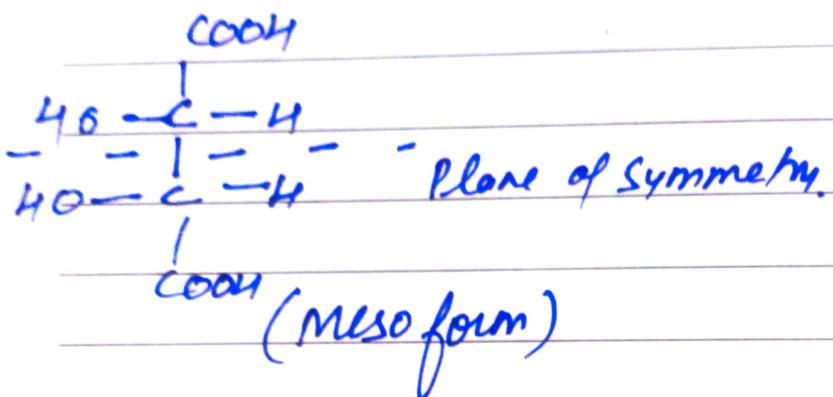


Condition for optical activity :- The compound will show the optical isomerism, if it is devoid of the elements of symmetry.

(i) Plane of Symmetry :- A molecule will be said to possess a plane of symmetry if it can be divided into two equal halves in any plane and thus the atoms or group on one side of the plane form mirror image of those on the other side.

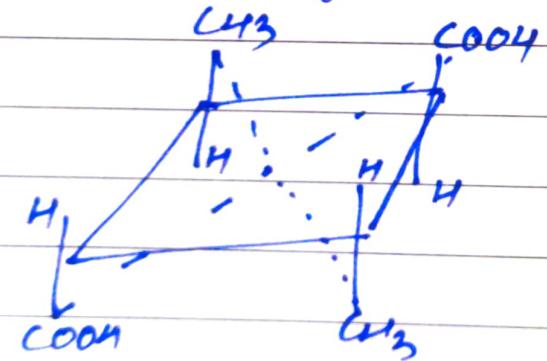
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## Meso form of Tartaric acid



### (iii) A centre (Point) of Symmetry:-

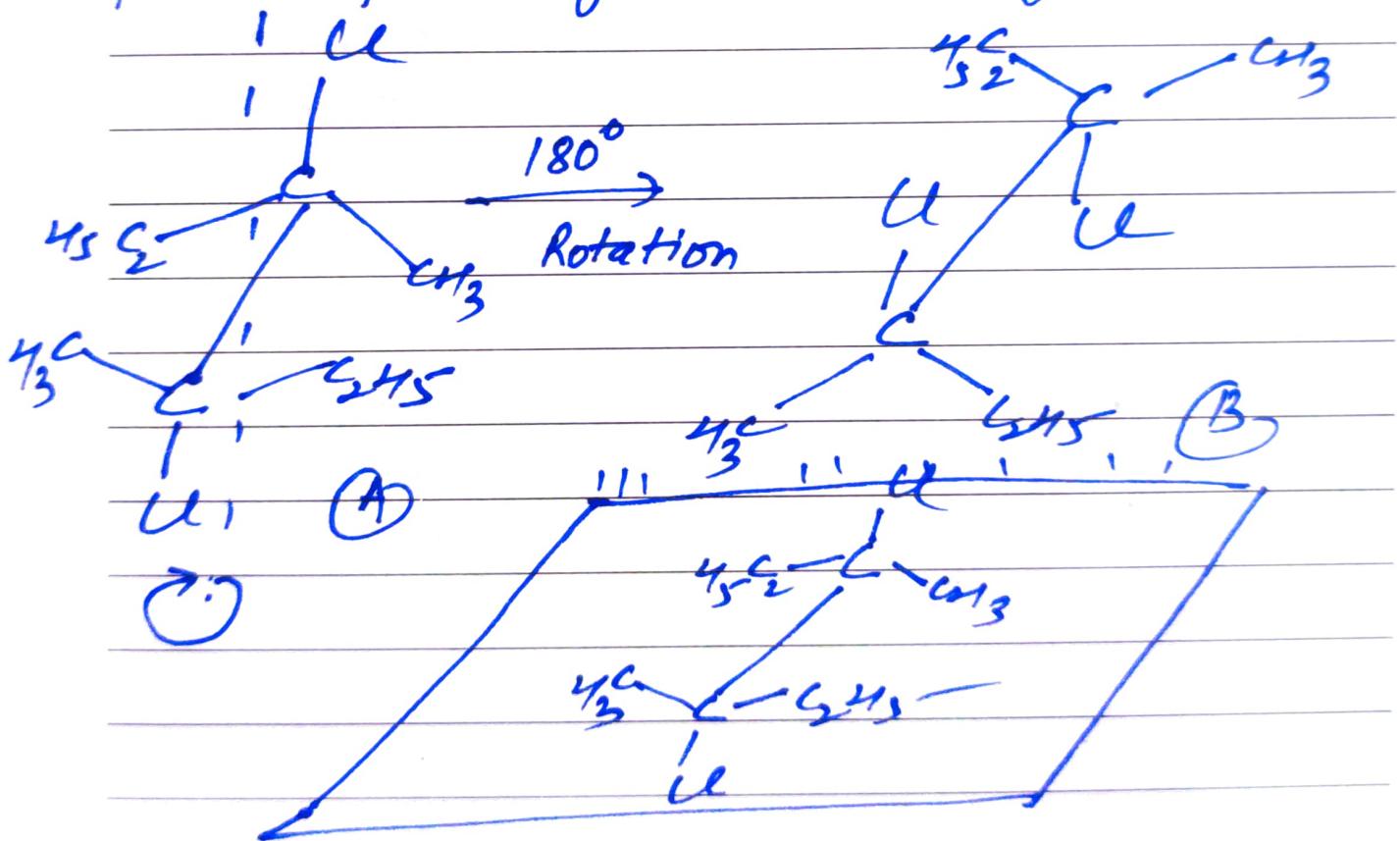
A centre of Symmetry is an imaginary point in the centre of a molecule from which if lines are drawn, on any group, on both sides to an equal distance. It divides the molecule in to two equal halves which are the mirror image of each other.



2,4 dimethyl cyclobutane, 1,3 dicarboxylic acid. Possess centre of symmetry, which is the centre of the ring.

(iii) Alternating axis of symmetry :- A molecule.

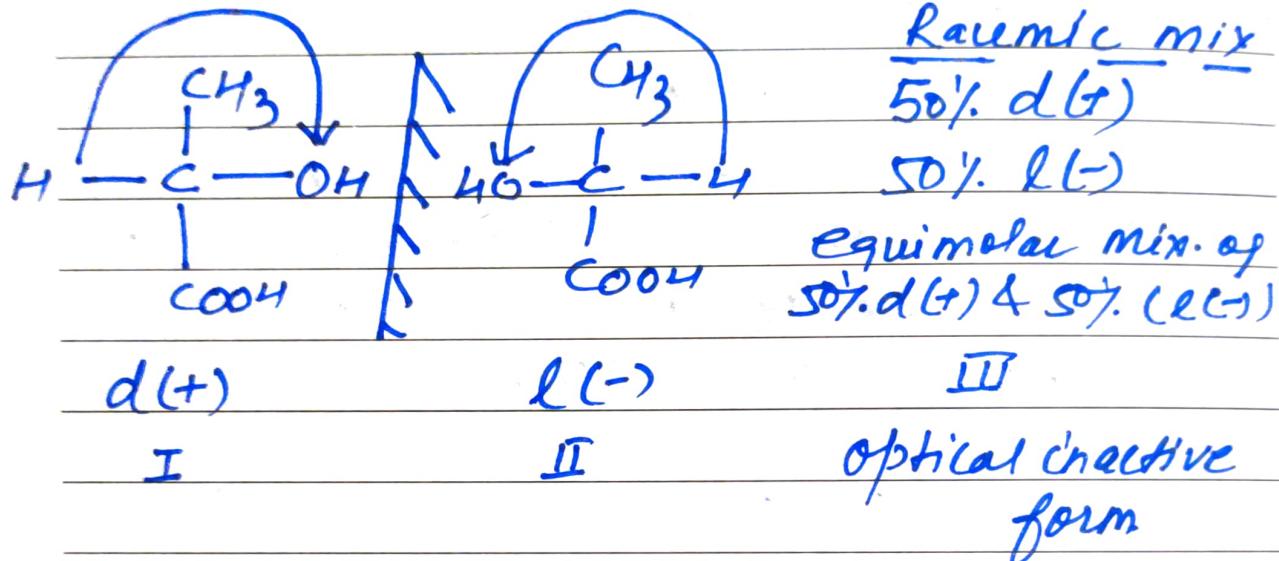
is said to possess an  $n$ -fold alternating axis of symmetry if, when it is rotated through an angle of  $360^\circ/n$  about this axis and then reflected across a plane perpendicular to the axis, an identical structure is obtained.  
ex- 3,4 dichloro - 3,4 dimethyl hexane is found to be optically inactive due to presence of two fold alternating axis of symmetry.



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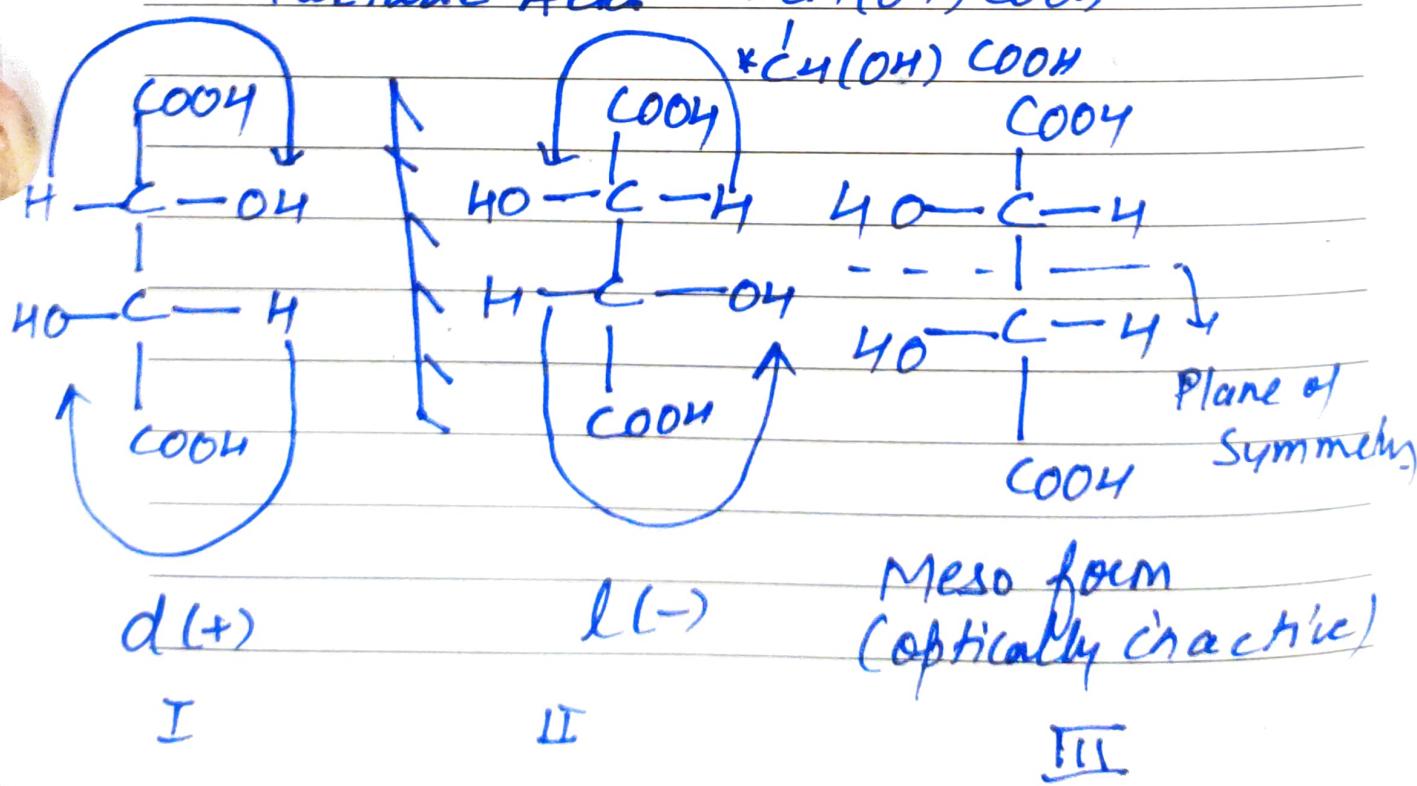
Optical isomerism in one Chiral Carbon atom

e.g. Lactic Acid ( $\text{CH}_3\text{CH}(\text{OH})\text{COO}_4$ )



e.g. optical isomerism in two chiral carbon atoms

Tartaric Acid  $+ \text{CH}(\text{OH})\text{COO}_4$



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(IV) Racemic mix.

50% d(+)-equimolar Mix

50% l(-) (optically inactive)

R-S Nomenclature :-

The priority sequence for the most common group and atoms

greater than

$\begin{matrix} \uparrow & 9 \\ -I, -Br, -Cl, -S\text{H}, -F, > -O\overset{\text{II}}{C}-R, > -OR, > -OH, > -NO_2 \end{matrix}$

$> -NO_2, > -NH\overset{\text{II}}{C}-R, > -NR_2, > -NHR, > -NH_2,$   
 $-CCl_3, > -C^P-Cl, > -C^P-OR, > -C^P-OH,$   
 $-C^P-NH_2, > -C^P-R, > -C^P-H, > -CN, > C_2OH,$   
 $-C_6H_5, > -CR_3, > -C_2H_5R, > -CH_3 > H$

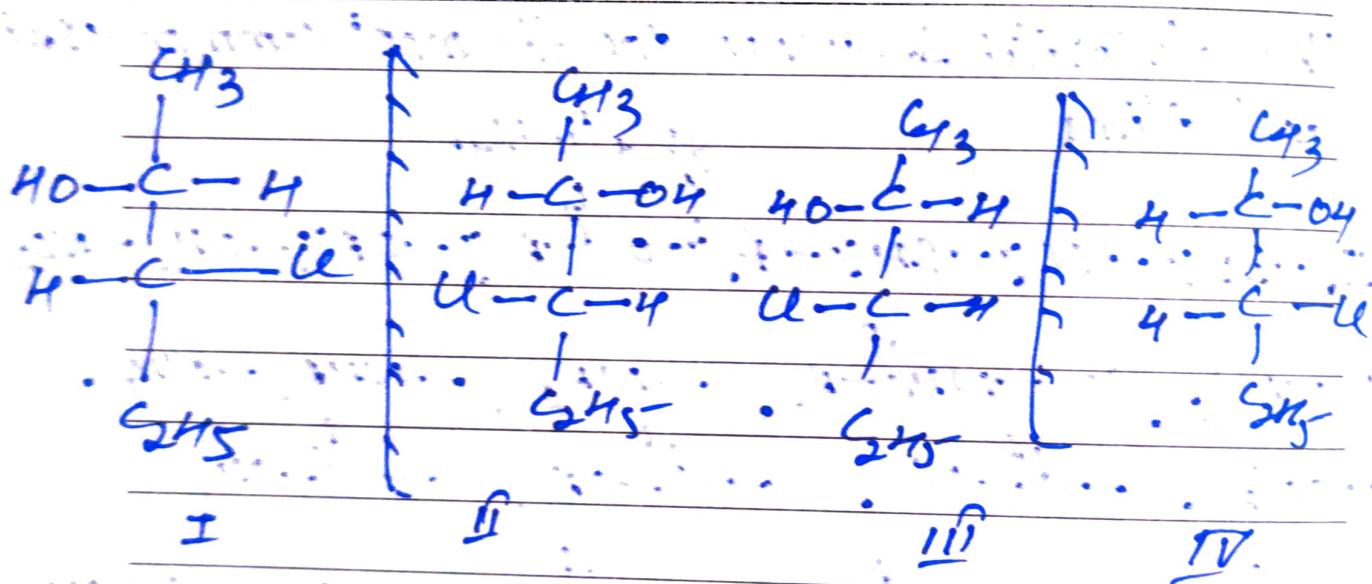
Enantiomers & Diastereomers

Enantiomers:- Pair of stereoisomers which are related to one another as object and its non superimposable to mirror images are called enantiomers/enantiomorph/optical antipodes/Antimers.

No of stereoisomers  $\rightarrow 2^n$  ( $n = \text{No of Chiral}$  ?)  
 No. of pairs of enantiomers  $\rightarrow 2^{n-1}$  Date: \_\_\_\_\_ carbon atom)

**Diastereomes!:-** Diastereomes are stereoisomers that are not enantiomers and have the same configuration at one chiral centre but different configurations at other.

Example - 3 chloro- $\alpha$ -pentanol



Diastereomes :- I & III

pair:      I & IV

II & III

II & IV

## Geometrical isomerism :-

When there is a single bond in b/w carbon - Carbon atoms then free rotation of groups and atoms along carbon - carbon axis is possible but when there is double bond in b/w carbon - Carbon atoms then free rotation of groups and atoms along C-C axis is not possible and thus position of groups and atoms is fixed in the space, such compound are called geometrical isomers and the phenomenon is called as geometrical isomerism.

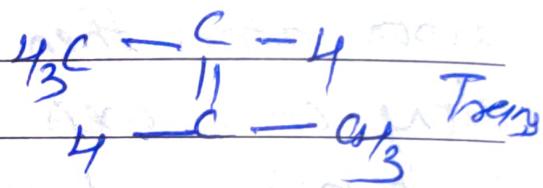
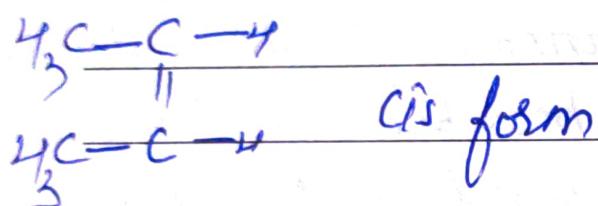
### Condition for Geometrical Isomerism :-

- i) The molecule must have a double bond ( $C=C$ )
- ii) There must be two different atoms or groups attached to each carbon atom of the double bond.

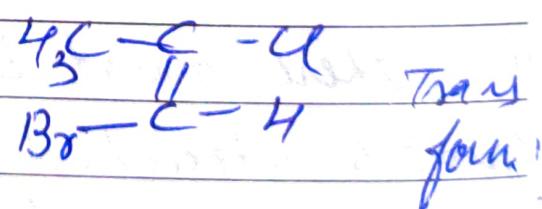
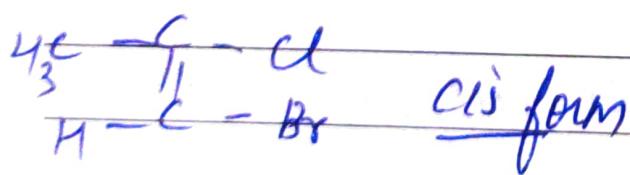
eg When the similar group are on same side then it is called as cis form and,

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Similar groups are on opposite side.  
then it is called as trans form e.g.  
butene - 2



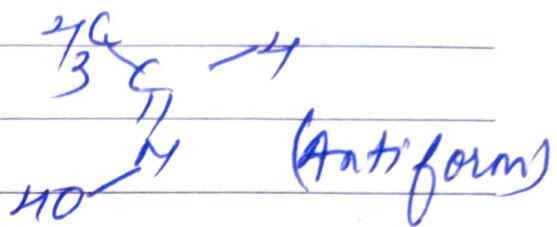
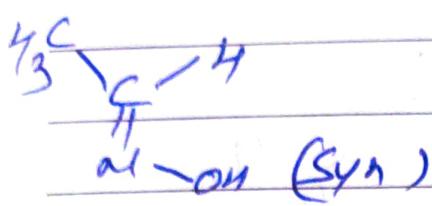
2. When the different groups are present at the double bonded Carbon atom then, if the group or atom possessing less mol. wt. or atomic wt. are at same side then it is called as cis form and when these are on opposite side. it is called as trans form.



- 3) When there is a double bond in b/w carbon & nitrogen atoms then it can be shown geometrically (isomerism) e.g.

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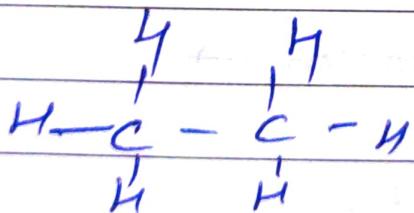
Acetaldehyde  $\text{CH}_3-\text{CH}=\text{CHOH}$



E-Z nomenclature :-

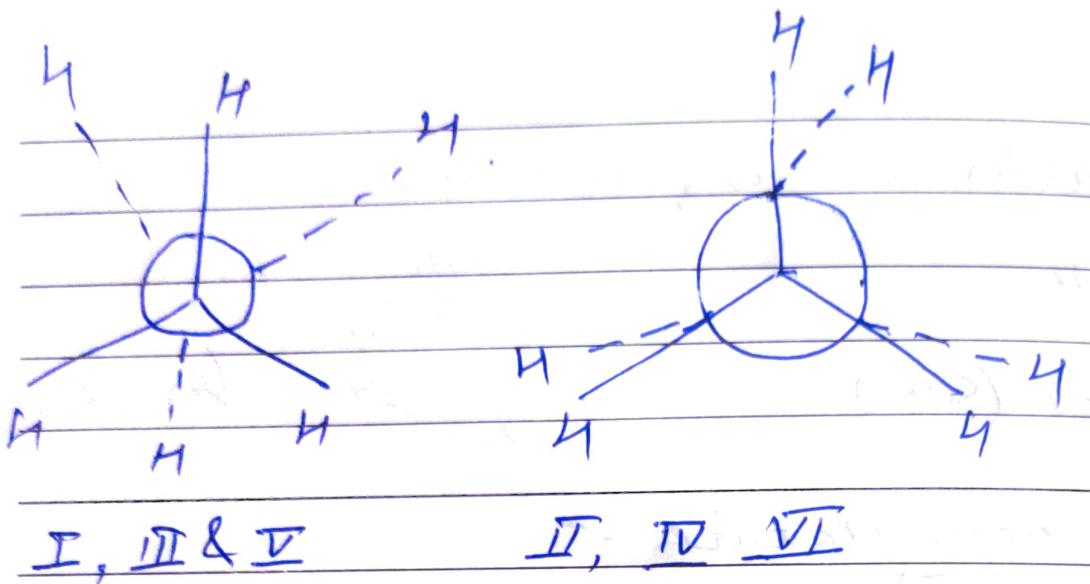
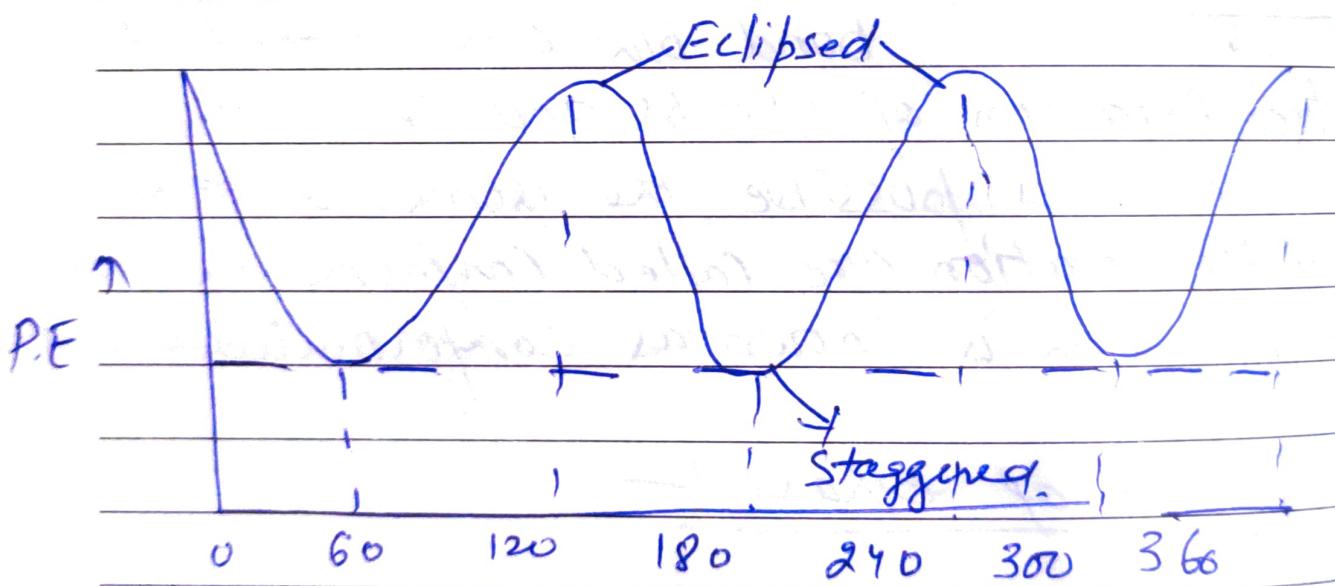
Conformation :- When there is a single bond b/w C-C atoms then free rotation of groups and far atoms along C-C axis is possible, the isomers obtained by the rotation are called conformers and the phenomenon is known as conformational analysis.

Conformers of ethane ! -



The different conformers of ethane are shown by newmann projection.

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StaggeredEclipsed

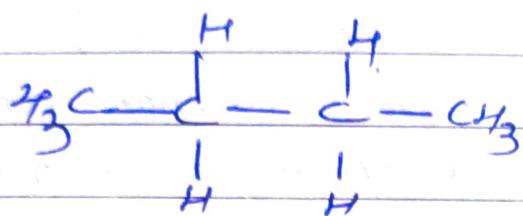
Angle of Rotation →

Stability :-

Staggered &gt; Eclipsed

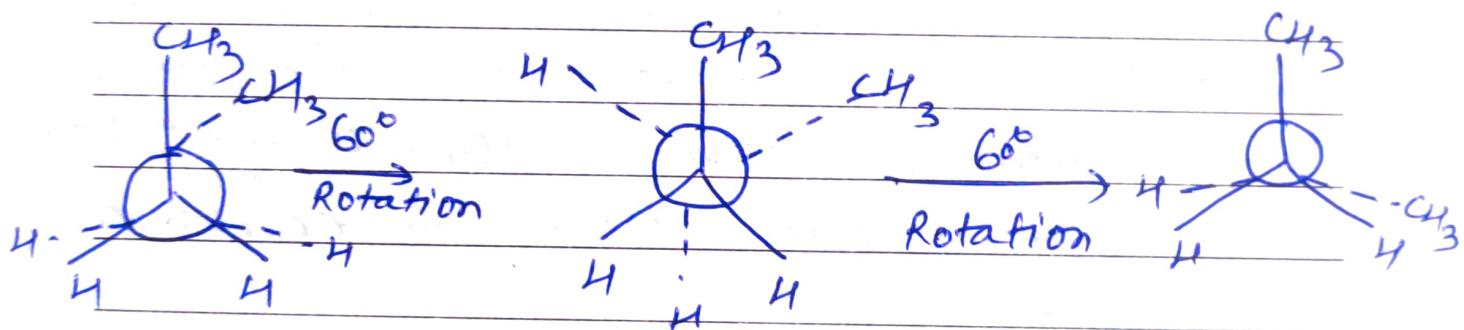
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## Conformers of n-butane



The isomers obtained due to rotation of groups and atoms along C-C axis (in n-butane) are called as conformers.

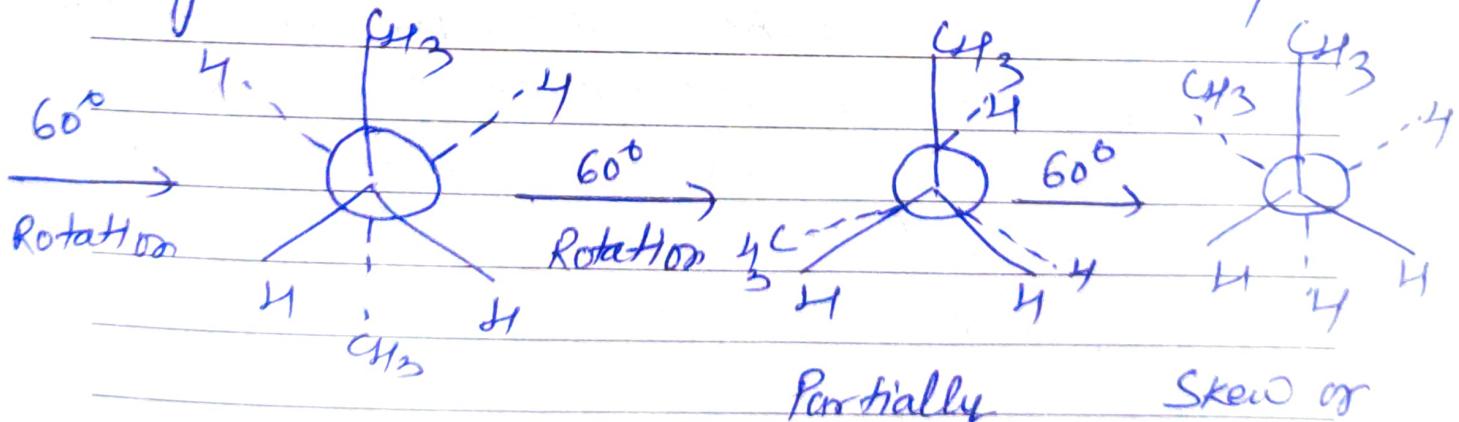
The different conformer of n-butane can be expressed by newmann projection.



Fully eclipsed

Gauche or Skew

Partially eclipsed



Anti OR Staggered

Partially eclipsed

Skew or Gauche

1. Fully eclipsed:- When  $\text{CH}_3$  group of front carbon atom covers the  $\text{CH}_3$  group of back carbon atom then there will be maximum repulsion b/w them due to their large size, hence this form will be least stable.

2- Skew or Gauche:- When the  $\text{CH}_3$  group of front carbon atom remain neither far apart nor cover the  $\text{CH}_3$  group of back carbon atom then this form is called skew conformer. This form is ~~least stable~~ than staggered. more stable than ~~eclipsed~~ conformer.

3. Partially eclipsed:- When  $\text{CH}_3$  group of front carbon atom covers the  $\text{H}$ -atom (smaller group) of back carbon atom then there will be repulsion would be less than fully eclipsed conformer, hence this form will be slightly less stable than fully eclipsed conformer as shown in fig.

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④ Staggered OR Anti conformer :- When  $\text{CH}_3$  group of front carbon atom remain far apart from the  $\text{CH}_3$  group of back carbon atom, then there will be minimum repulsion b/w them & form will be <sup>most</sup> stable as shown

