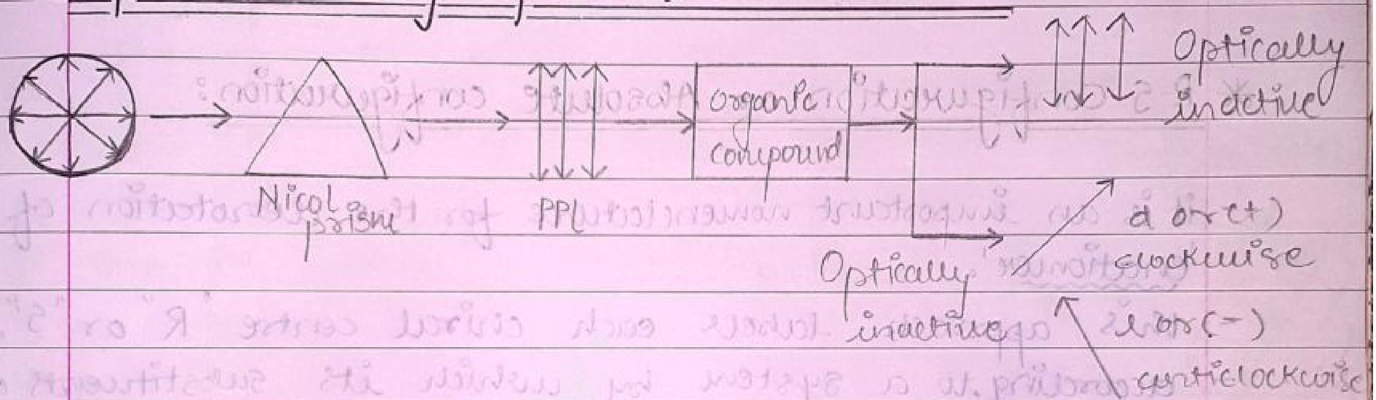
Optical Isomerism:

- two or more than two compounds having same molecular and Structural formulae but different behaviour towards plane polarised light (PPL).

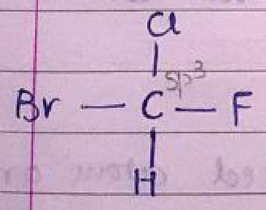
* Optical Activity Experiment (Polarimeter):



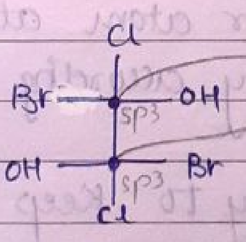
- tendency to rotate 'PPL' in a particular direction, if a compound rotates 'PPL' in clockwise-direction then it will be "Dextrorotatory (d)" or if it rotates 'PPL' in anti-clockwise direction then it will be "Laevorotatory (l)".

* Chiral Carbon (asymmetric carbon) & Chiral molecule:

- Carbon atom which is bonded to 4 different atoms or group are 'Chiral carbon' and following molecule is 'Chiral molecule'.

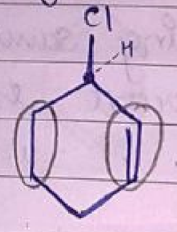


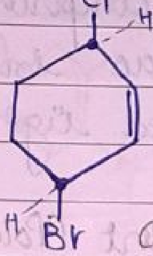
chiral centre
=01



chiral centres
02

→ In cyclic compound we can check the path instead of group.





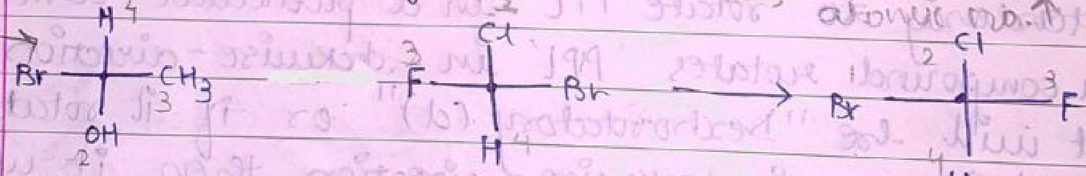
C. centre = 1 C centre = 2

* R-S configuration or Absolute configuration:

Fischer projection

- It is an important nomenclature for the derotation of 'enationer'. (enantiomer)
- this approach labels each chiral centre "R" or "S".
- according to a system by which its substituents are assigned a priority according to CIP rule. → atomic no. ↑

eg:



↺ S [anticlockwise] ↺ S. ↻ R [clockwise]

R = rectus (clockwise)
S = sinister (anticlockwise).

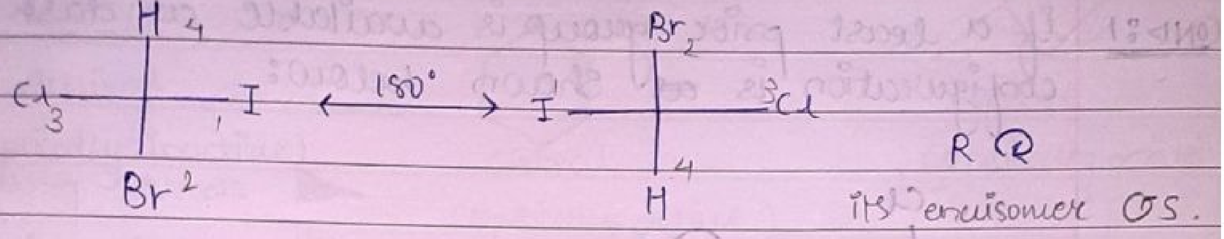
* RULES:

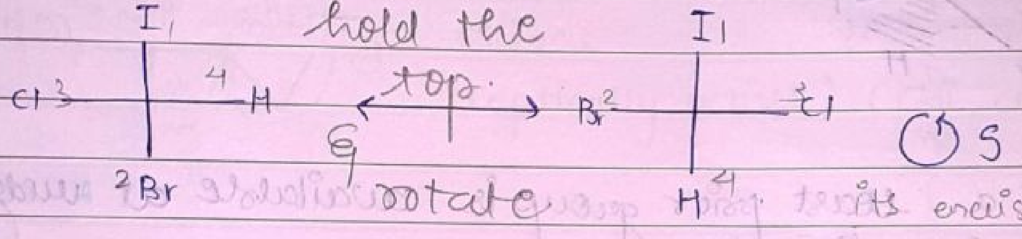
Rule: 1 each group or atom attached with a chiral carbon are given priority according to CIP rule.

Rule: 2 always try to keep the least priored atom or group at bottom

Rule:3 The rotation should be floated to ^accept the least prior number.

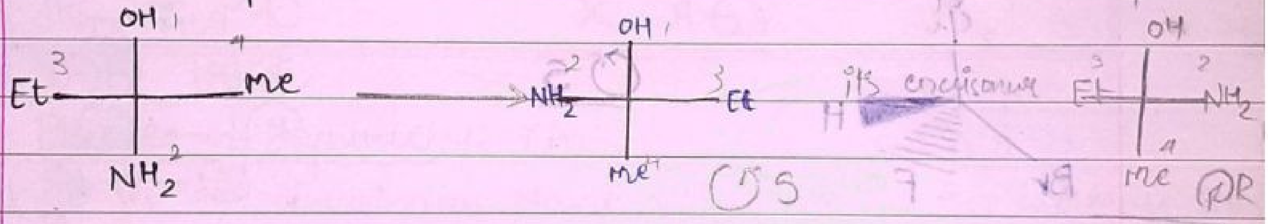
Rule:4



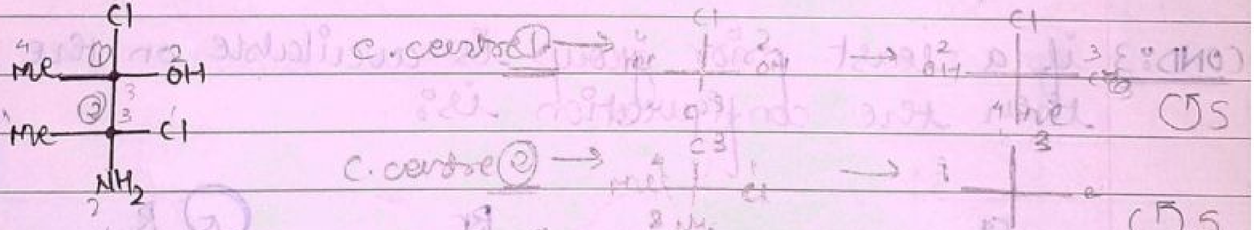


Q:1 Show its optical enantiomer:

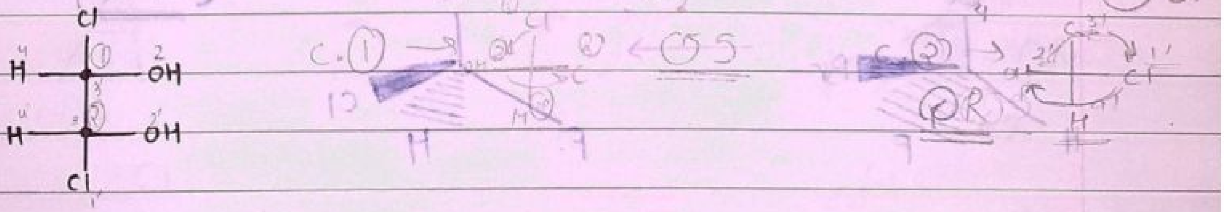
(A)



(B)



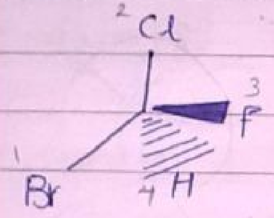
(C)



priority group

⟹ R-S configuration in Wedge-dash molecule:

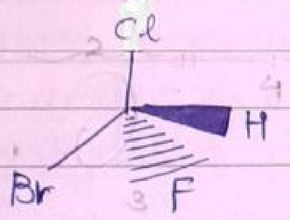
COND:1 if a least prior group is available at dash, then configuration is ~~at~~ shown below:



↻R.

◀ above plane
|||| below plane
— on the plane

COND:2 if a least prior group is available at wedge, then configuration is :

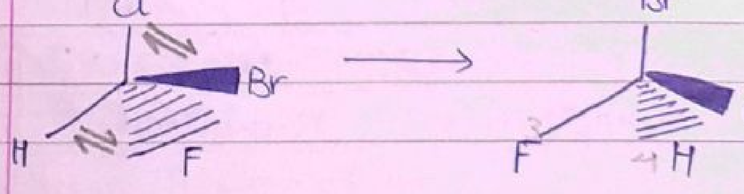


↻R X

↺S. ✓

[illegible]
ઉલટા (ઉલટો) કરવો
Ⓡ → Ⓢ
Ⓢ → Ⓡ

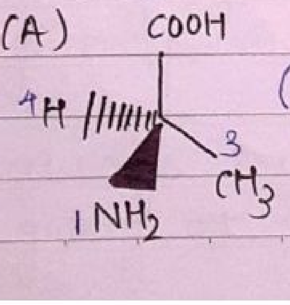
COND:3 if a least prior group is available on the plane, then the configuration is:



↻R.

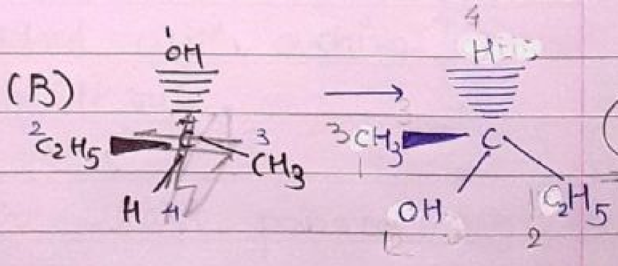
Q:2 Show R-S configuration:
⟶

(A)



↻R

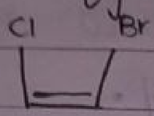
(B)



↺S.

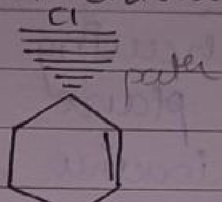
Q:3 Identify chiral and non-chiral compound:

→ (A)



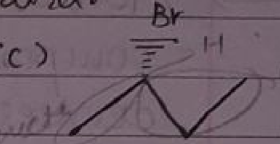
Achiral
(optically inactive)

(B)



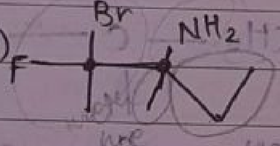
Chiral
(optically active)

(C)



Chiral
(optically active)

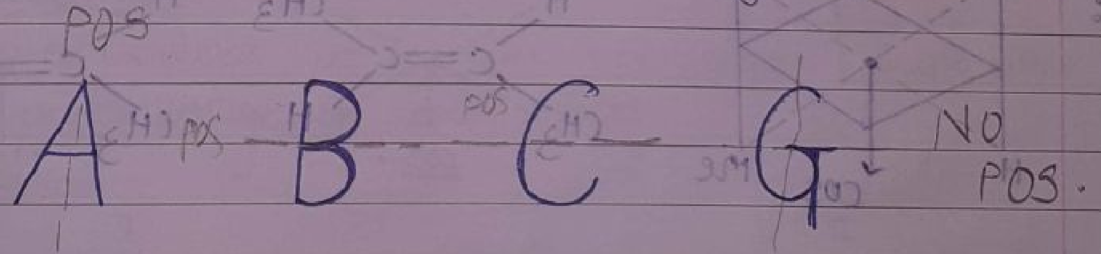
(D)



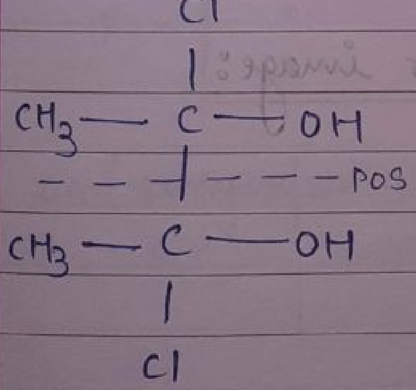
Chiral
(optically active) (chi. centre = 02)

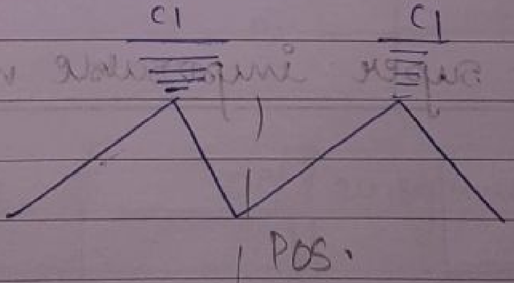
*** NOTE:**
- single chiral centre is always optically active.

⟹ Plane of symmetry: (POS)
- it is an imaginary plane which bisects the molecule in two equal halves in such a way that each half of the molecule is the mirror image of the other.



eg:

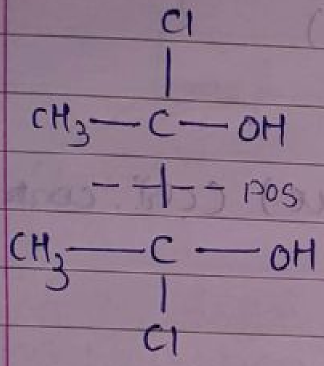




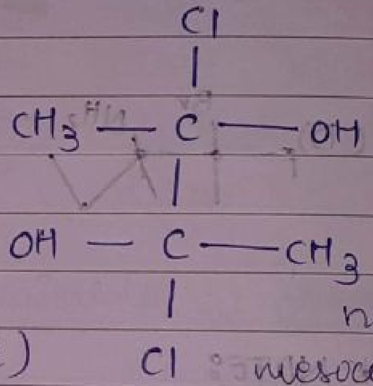
A)★⟹ Mesocompound:

- compound having atleast two chiral centres and plane of symmetry.
- it is optically inactive due to internal compensation.

eg:



(optically inactive)



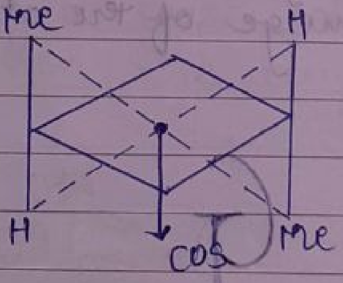
(optically active)

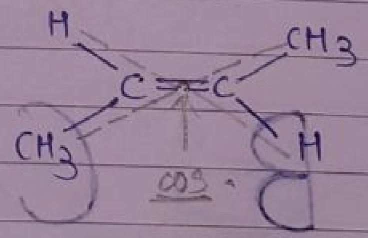
not mesocompound

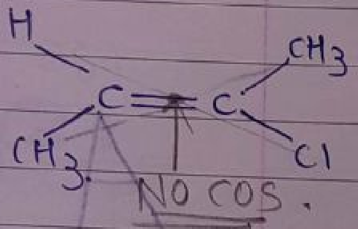
B)★⟹ Centre of symmetry:

- a point in a molecule through which if a straight line is drawn from any part of molecule this line encounters identical groups at equal distances in opposite direction.

eg:

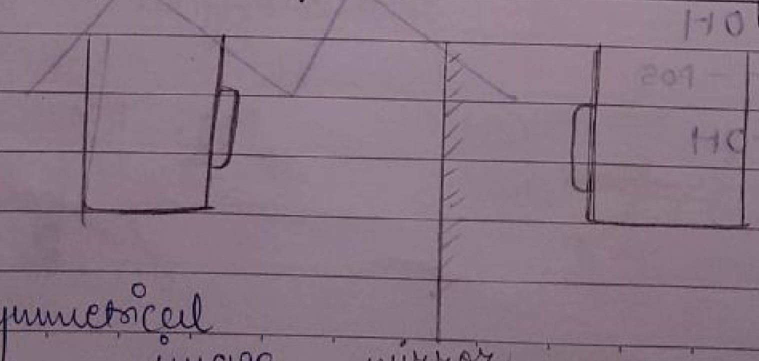




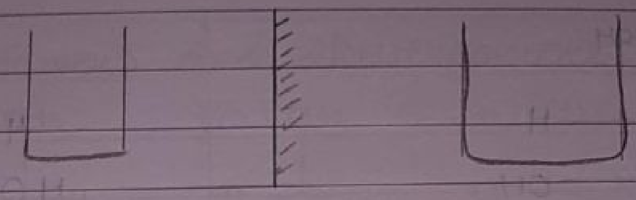


✳ Non- super imposable mirror image:

-



- Symmetrical image.



⇒ Condition for optical activity:

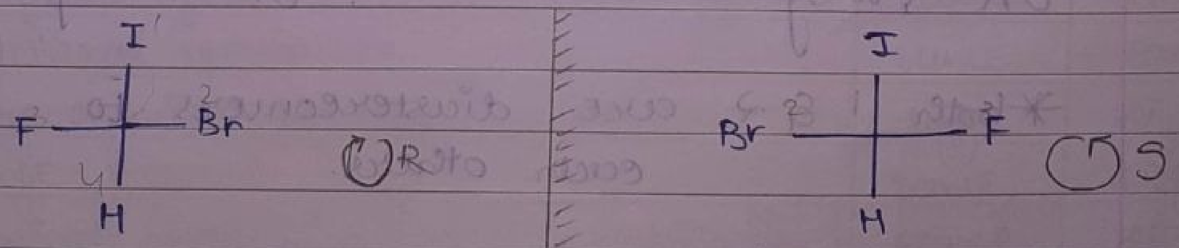
Conditi⇒1.) molecule should be chiral.
⇒2.) molecule should be asymmetrical. (POS coau symm.)
⇒3.) molecule should have non-super imposable mirr. img

COMPOUND		POS	COS	
OIA	optically in active	✓	✓	symmetrical
OIA		✓	X	
OIA		X	✓	
OA	optically active	X	X	unsymmetrical

* Relation between compounds:

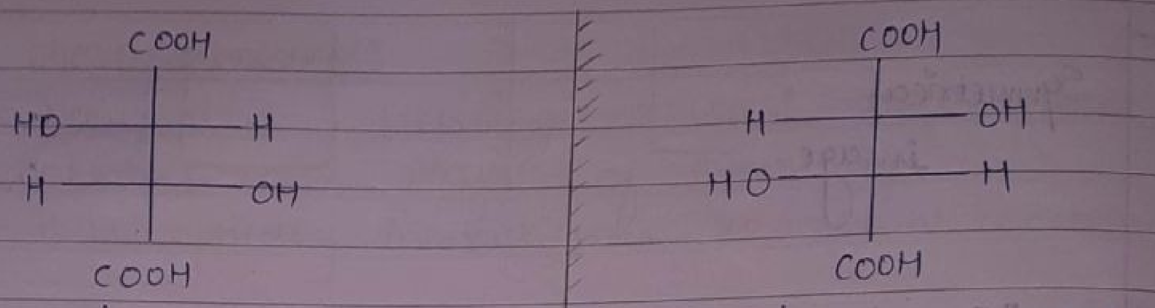
1.) Enantiomer:

- stereo isomers which are non-super imposable mirror image of each others.



OA / unsymmetrical

OA / unsymmetrical.



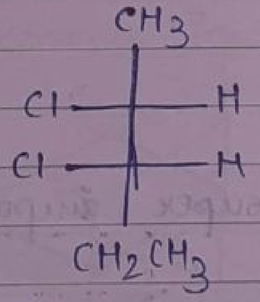
OA / unsymmetrical   OA / unsymmetrical.

↻ R	↺ S	Enantiomer
S	R	✓
SS	RR	✓
RR	SS	✓
RS	SR ?	~~✓~~

2.) Diastereomers:

- stereo isomers which aren't mirror images of each other.

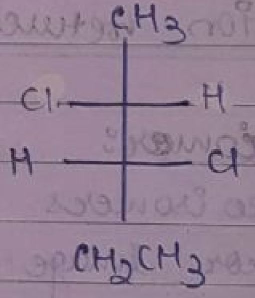
eg: ①



OA ~~(unsymmetric)~~

I

②

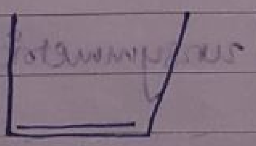


OA ~~(unsymmetric)~~

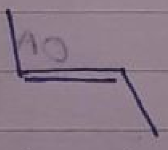
mirror img में changes हुआ)

*both 1 & 2 are diastereomers to each others.

eg:



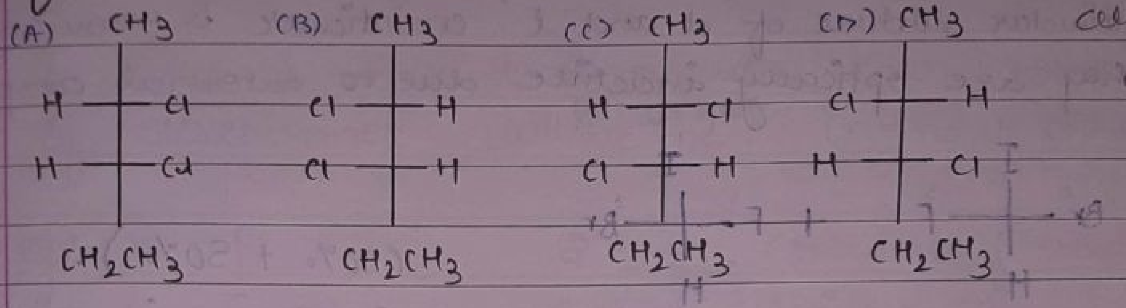
cis (OIA)



trans (OIA)

they're diastereomers of each others.

Q:4 find out enantiomers and diastereomers:

→ 

all are OA'S

⟹ (A) — (B) E

(B) — (C) D

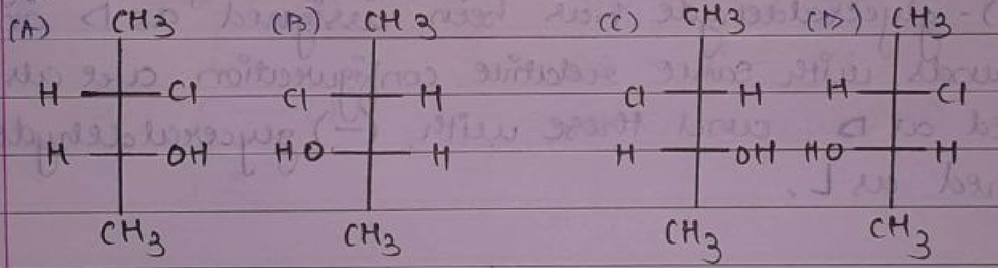
(C) — (D) E

(A) — (C) D

(A) — (D) D

(B) ~~—~~ (C) D *

Q:5 find E and D:

→ 

⟹ (A) — (B) E

(B) — (C) D

(C) — (D) E

(A) — (C) D

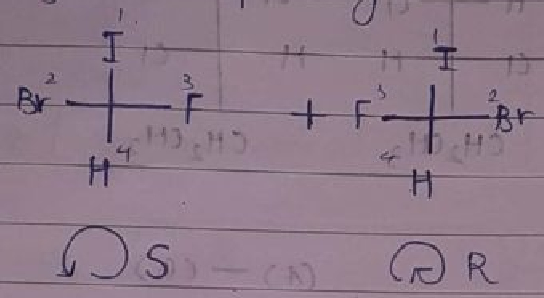
(A) — (D) D

(B) — (C) D.

	Properties	Enantiomer	Diastereomer
1.)	molecular formulae	same	same
2.)	structural formulae	same	same
3.)	stereochemical formulae [struc form. with orientation]	diff.	diff.
4.)	dipole moment.	same	diff.
5.)	physical property [mp, bp, density, solubility, refr. index]	same	diff.
6.)	specific rotation.	sign diff same magnitude	diff.
	Chemical properties		
1.)	(A) with optically inactive compound	same	diff
	(B) with optically active compound,	diff	diff

* Racemic mixture:

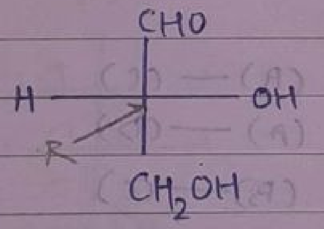
- equimolar mixture of 'd' and 'l' enantiomer is Racemic mix.
- they are optically inactive due to external compensation



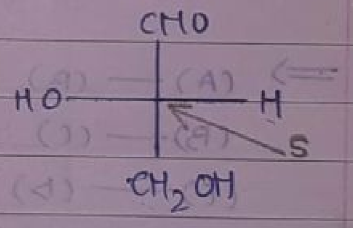
(50% + 50%)
(optically inactive)
compulsory ek R & ek S

* D-L nomenclature:

- this method is used to relate configuration of sugars and amino acids by help of enantiomers of glyceraldehyde. Configuration of (+)-glyceraldehyde has been assigned as D and compounds with same relative configuration are also assigned as D, and those with (−) glyceraldehyde are assigned as L.

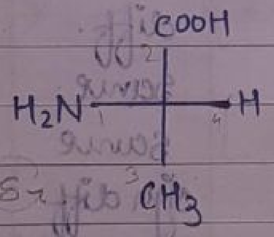


D-(+) glyceraldehyde
(OH on right side).

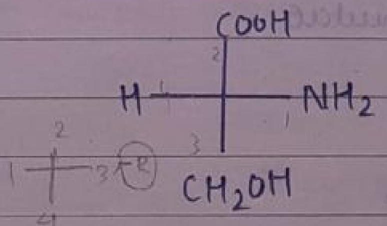


L-(−) glyceraldehyde
(OH on left side)

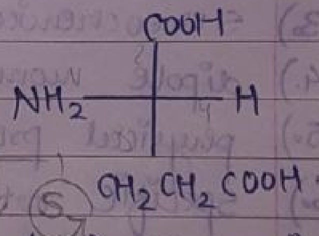
eg:



L-Alanine



D(+)-serine

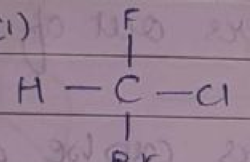


L(+)-Glutamic acid.

* Calculation of stereoisomers: *

Case 1. If there is no kind of symmetry then total number of stereoisomer will be '2^n'. (n = no. of chiral centre)

eg: (1)



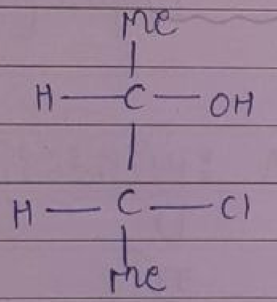
$2^1 = 2$ (total no. of stereo isomer)

Optically Active = 02.

Racemic mix = $\frac{OA}{2} \rightarrow 01$.

as there is no symmetry ← Meso compound = 0.

(II)



$2^2 = 4$

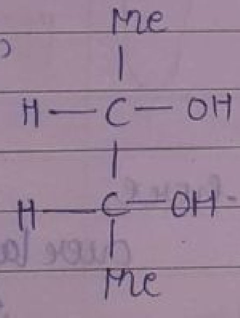
$RM = 4/2 \rightarrow 02$.

$OA = 2^2 = 4$.

meso compound = 0.

Case 2 symmetrical molecule (even chiral centre): $\underbrace{2^{n-1}}_{OA} + \underbrace{2^{n/2-1}}_{meso}$.

eg: (1)



$OA = 2^{2-1} \longrightarrow 2$.

$Meso = 2^{2/2-1} \longrightarrow 1$.

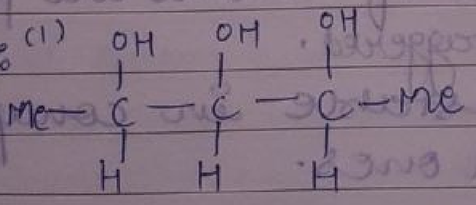
$RM = 2/2 \longrightarrow 1$

$Total = 2+1 = 3$.

Case 3 symmetrical molecule (odd chiral centre): '2^{n-1}'.

O.A isomer: '$2^{n-1} - 2^{n-1/2}$' Mesocompound: '$2^{n-1/2}$'.

eg: (1)



$Total = 2^{3-1} \longrightarrow 4$.

$OA = 2^{3-1} - 2^{3-1/2} \longrightarrow 4-2 \rightarrow 2$.

$MC = 2^{3-1/2} \rightarrow 2^{2/2} \rightarrow 2$.

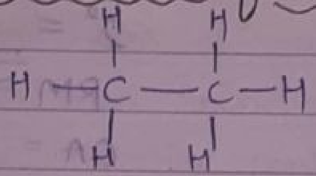
here, RM = 1.

* Confirmational isomerism:

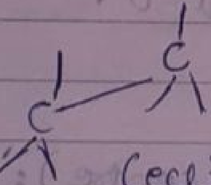
- infinite 3-D forms formed by rotation across the single bond are confirmational isomers.
- energy required is quite low which is easily available at room temperature.
- the stable confirmational isomers out of the infinite forms are **CONFIRMERS**.
- the representation of confirmers can be drawn by 'Newmann projection' and 'Sawhorse projection'.

→ Sawhorse and Newmann for ethane:

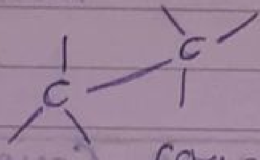
1.) $CH_3 - CH_3$ ←



Sawhorse ⇒

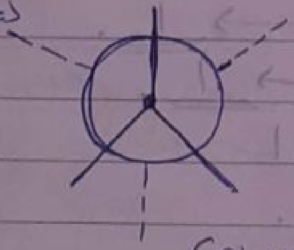


(eclipse).



(staggered).

Newmann ⇒



(staggered).

(eclipse)

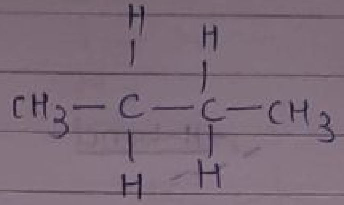
here, overlapping is shown.

- In this process two types of extremes are present:
  (A) Eclipse (B) Staggered.

→ eclipse is less stable in compare to staggered ones.

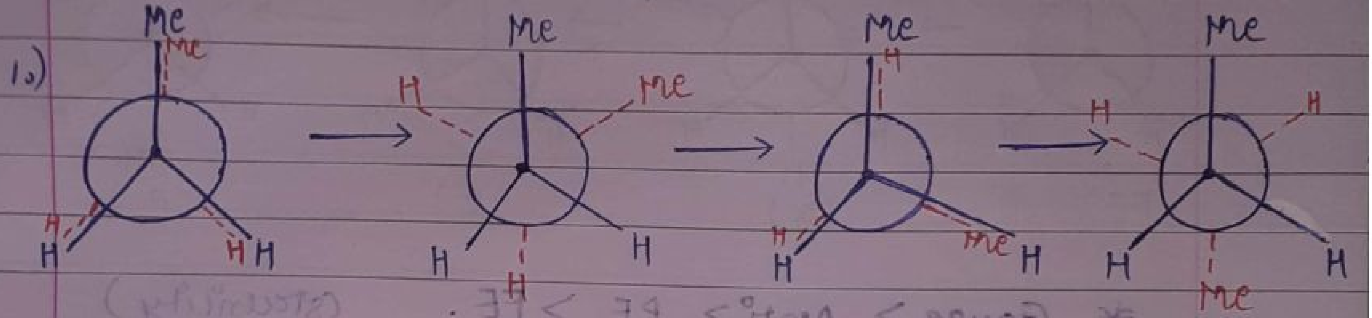
→ for butane:

$CH_3CH_2CH_2CH_3$



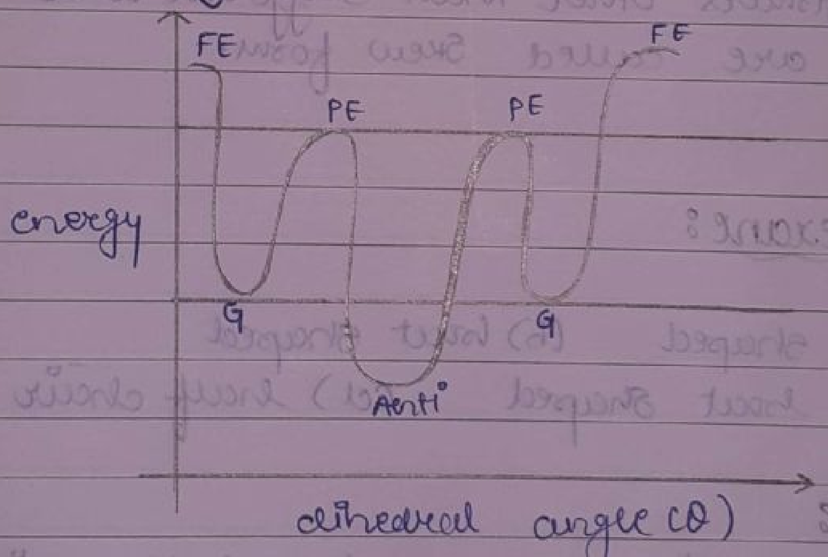
$CH_3-CH_2-CH_2-CH_3$

1.)



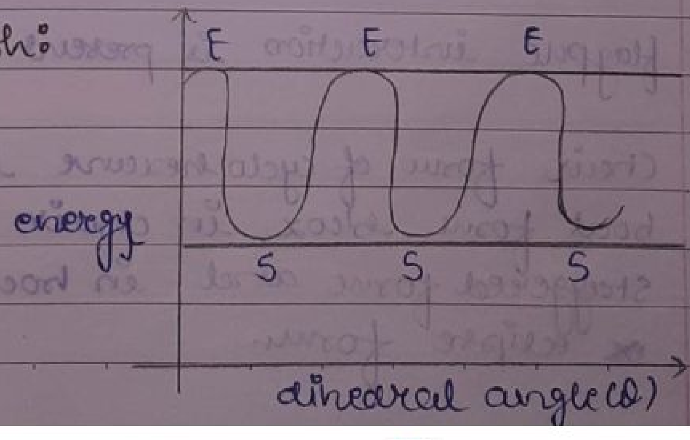
[fully eclipse] [Gauche] (staggered) [partial eclipse] [Anti] (staggered)

Stability: Anti > Gauche > P.E > F.E.

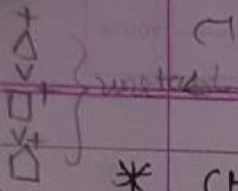


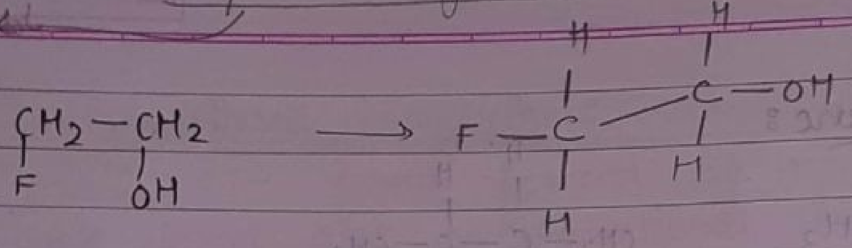
Energy profile graph.

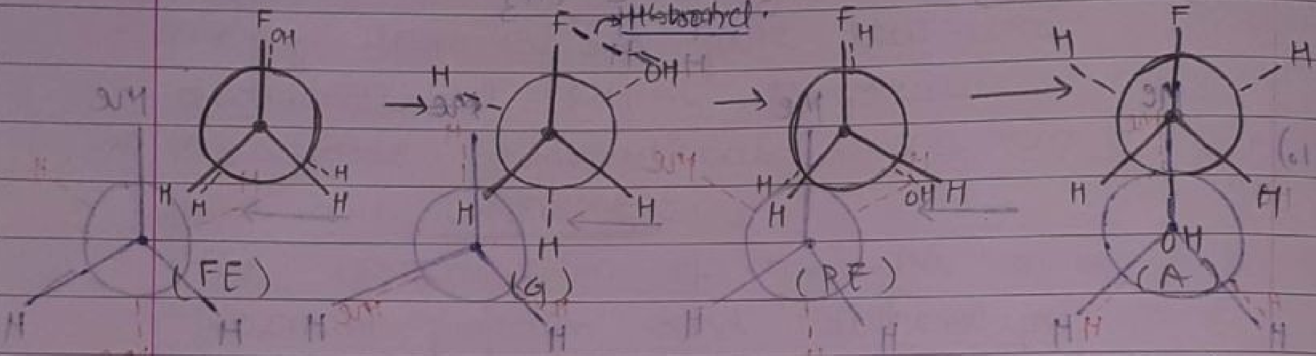
—* Energy profile graph:



* upto 4-carbon chain પર + 5 eg: △ ; □
તો Baeyer's angle strain છે. (unstable)







* Gauge > Anti > PE > FE. (stability)
(due to H-bond) intramolecular.

***NOTE:**
- all confirmers other than staggered and eclipse are called Skew form.

→ In cyclohexane:

(a) Chair shaped (b) boat shaped
(c) twist boat shaped (d) half chair shaped

* **Stability:**
chair > twist boat > boat > half chair.

* flagpole interaction is present in boat form of cyclohexane

* Chair form of cyclohexane is more stable than boat form b'coz in chair form carbons are in staggered form and in boat form carbon are in eclipse form.