PHARM. ORGANIC CHEMISTRY-III

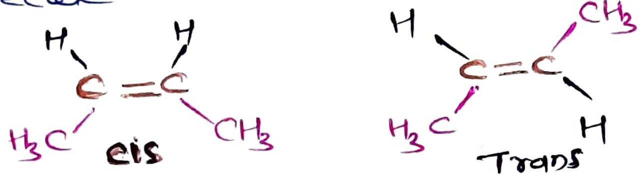
Subject Code :- BP401T & 341451

UNIT I : STEREO CHEMISTRY/ ISOMERISM

ISOMERISM - The compound having "same molecular formula" but "differ in Physiochemical properties", are called Isomers and phenomenon Is called Isomerism

The difference in their properties must be due to different modes of combination or arrangemt of atom with in the molecule

2-Butene



There are two types -

1. Structural Isomerism
2. Stereo isomerism - Configurational & Confirmational

1. Structural Isomerism :-

Isomerism due to structural differences. When ~~two~~ the isomerism is due to difference in the arrangement of atoms within the molecule, without any reference to space, This phenomenon is called structural Isomerism.

" Structural Isomer are compounds that have the same molecular formula but different structural formula.

Types -

① chain isomerism - change in the no. of Carbon in stem,

② Position Isomerism - change in position of functional group

③ Functional isomerism - change in functional group

④ Metamerism - unequal distribution of carbon atom on either side of functional group

⑤ Tautomerism - dynamic equilibrium with each other

2. Stereoisomerism :- When isomerism is caused by the different arrangements of atom or groups in space, is called Stereoisomerism.

" Same Molecular formula but differ in arrangement of atom or group in space"

OR

" Same M.f but differ in configuration"

configuration - reffers to 3-dimensional arrangement of atom that charecterises a particular compound.

Type - ① Geometrical or Cis-Trans Isomerism

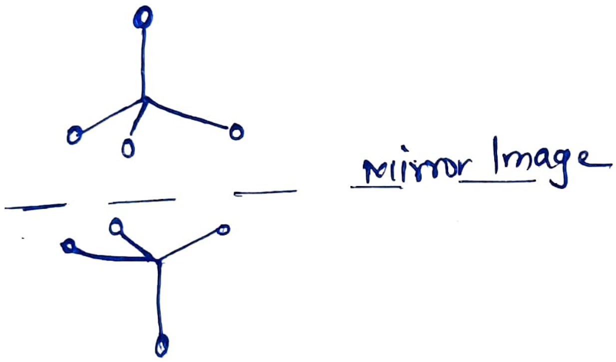
② Optical Isomerism]- Configurational

OPTICAL ISOMERISM (Stereoisomerism)

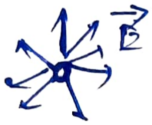
↳ Optical Isomers – Same Molecular formula & Same structural formula, & Same physical & chemical properties. They differ in their behaviour towards light (Plan polarized light)

They have ability to rotate plane-polarised light. This property is often referred as optical activity

* Except optically active chemically reaction. (otherwish Same chemical reaction)

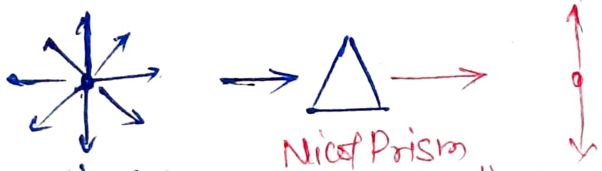


Nature of Light ⇒ Electromegnatic wave (does not required and media) they riquire electric & Magnetic field.



= ordinary light = vibrate in diff plane

= $\vec{E}$ vibrate in all planes perpendicular to direction of propogation of light



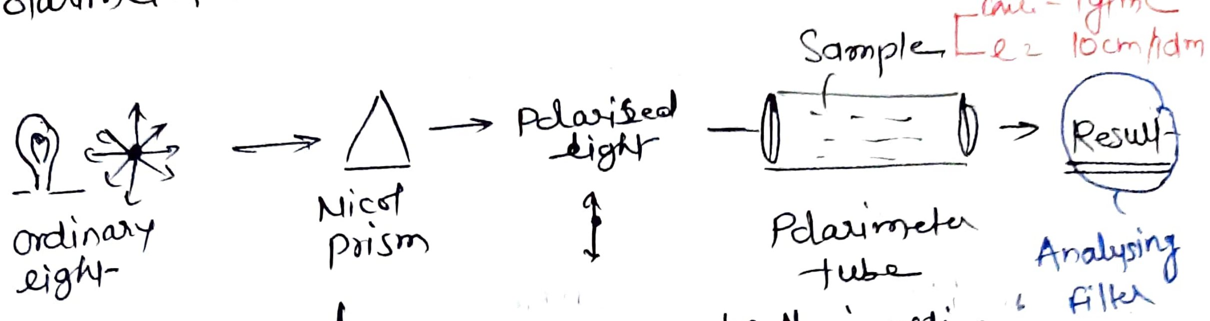
vibratn in one plane

Plane-polarised light – ~~polari~~ (PPL)

↳ cut off all vibratn except of one plane

Optically Active :- Substance which rotate (Clock or Anti clock) Plane plari polarised light. This property of a compound is called optical Activity.

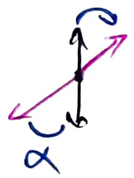
Polarimeter → determine & check optical activity



Result - ①

unaffected → optically inactive

②



clockwise rotatn - optical active
- Dextrorotatory → (+) Sign

③

- Anti clock - Levo-rotatory - (-) Sign

α = Magnitude of rotation in degree

- The degree of rotation depends upon the no. of molecules of compound encountered by light along its path

- **Specific Rotation** :- is defined as the rotation produced by a solution of length 10 cm and unit concentration (1g/ml) for given wavelength of light at the given temp.

$$[\alpha]^{t}_{D} = \frac{100\alpha}{l c}$$

l = length of tube decimeter
c = no. of gm. in 100ml of solutn

- Specific rotatn varies with both the λ & temp.

$$\alpha = \frac{\theta}{l c}$$

θ = rotation per unit length & unit conc.

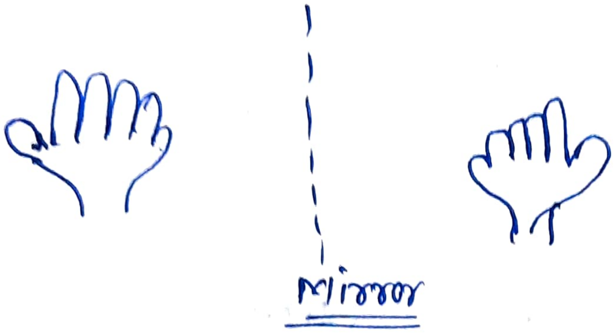
α = radian. ml/dm g

$\alpha \propto$ optical ~~Acti~~ Active

How to know → Optically Active ??

- ↳ Dissymetric compound — OA (Optical Active)
- ↳ chirality compound → OA

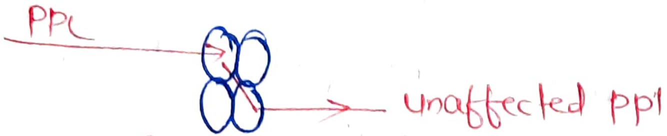
chirality - handed



↳ Non - Super imposble mirror image

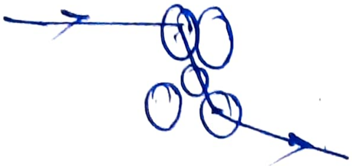
↳ Not cover completely

* A symmetric object reffer to Achiral - OI (Optical Inactive)



Symmetrical Compound - Most aboundent in nature

#

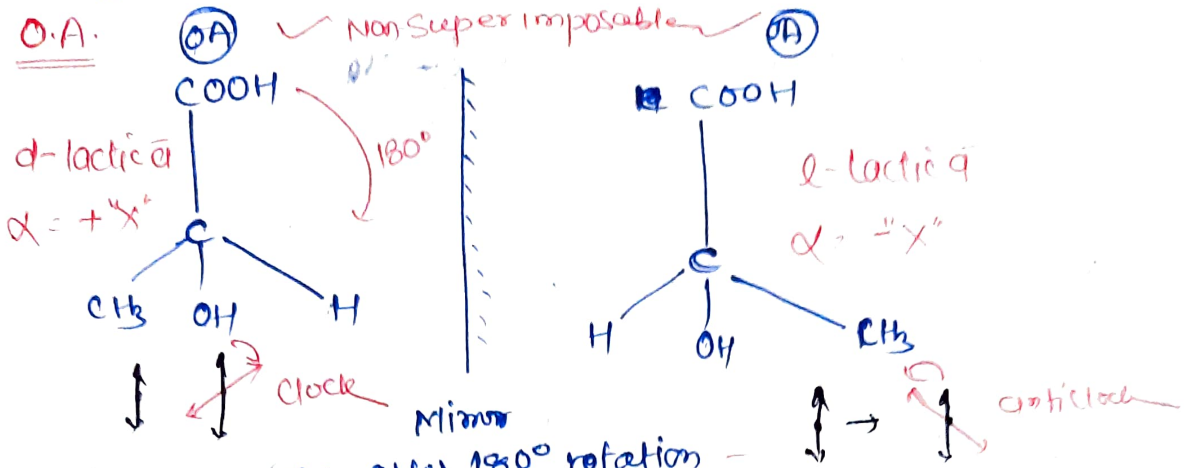


unsymmetrical (Disymmetry)

~~Dysymetri~~

~~(Dysym~~m

ex: ① Lactic Acid - 2-hydroxy propan-1-oic acid



Super-impose after 180° rotation -

⇒ Both pair are Enantiomer

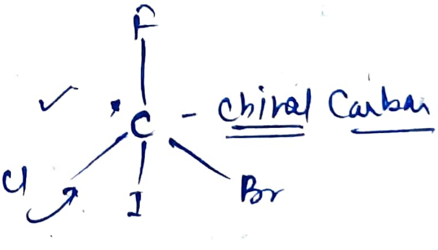
Enantiomer :- pairs of optical isomers, which are non-superimposable mirror images of each other.
They differ in rotation of PPL." Enantiomers rotate PPL equally but in opposite direction.

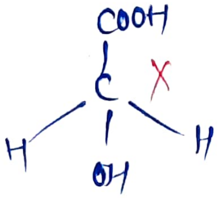
CHIRAL (ASYMMETRIC) CARBON ATOM

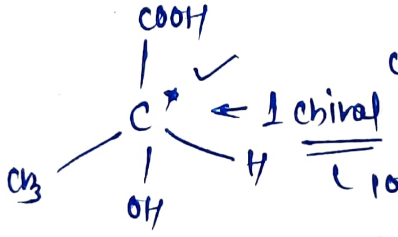
CHILAR CENTRE :- # sp^3 hybridized (4σ bond)

↳ All 4 valencies must be satisfied by 4 different atoms or group of atom

100% OA-X
(Not guaranty)







↳ 100% OA

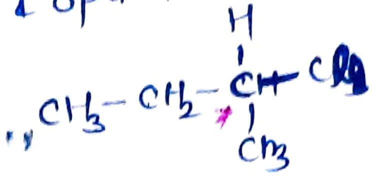
↳ If compound has only One Chiral Centre, then compound is Optical Active

↳ 1 Chiral Centre → chirality

↳ >1 Chiral Centre → Not Sure Chirality

ex. which has chiral Center yes/No & optical Active or Inactive

ⓐ Secondary butyl chloride

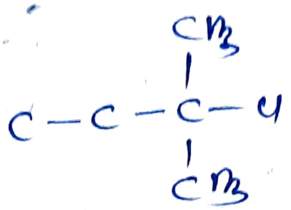


$CH_3-CH_2-\overset{H}{\underset{CH_3}{CH}}-Cl$

✓ O.A.

ⓑ tert-pentyl chloride

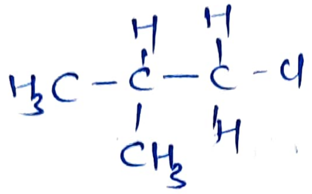
× OI



$C-C-\overset{CH_3}{\underset{CH_3}{C}}-Cl$

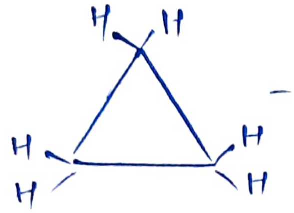
ⓒ Iso-butyl chloride

× OI



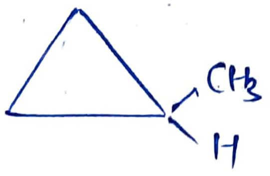
$H_3C-\overset{H}{\underset{CH_3}{C}}-\overset{H}{\underset{H}{C}}-Cl$

ⓓ



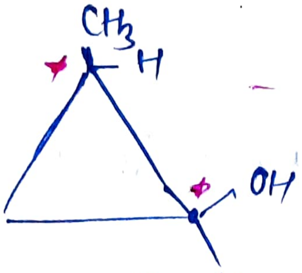
- OI

ⓔ



OI

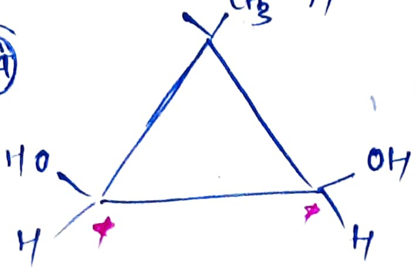
ⓕ



- 2-~~optical~~ chiral Centre

- OA = Not Sure

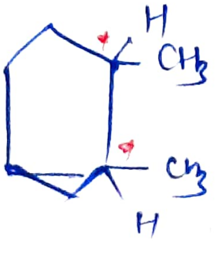
ⓖ



: 2-Chiral Centre

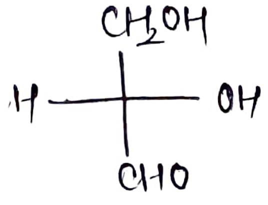
: OA = Not Sure

ⓗ

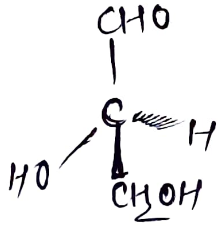


2·Chiral Centre

D & L Configuration

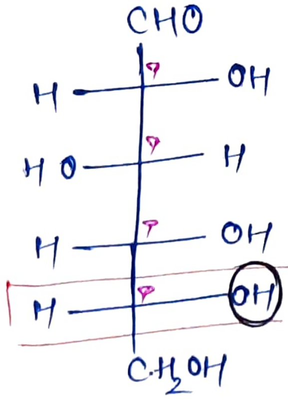


Fischer projection



Wedge & dash

ex



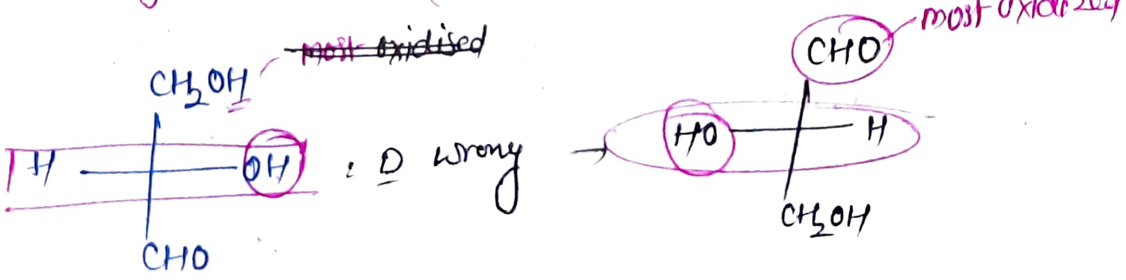
D-glucose

OH = Assign in Right Side = D Configuration
— " — Left Side = L- Configuration

Bottom most asymmetric carbon (Chiral Carbon)

~~most oxidised~~

most oxidized

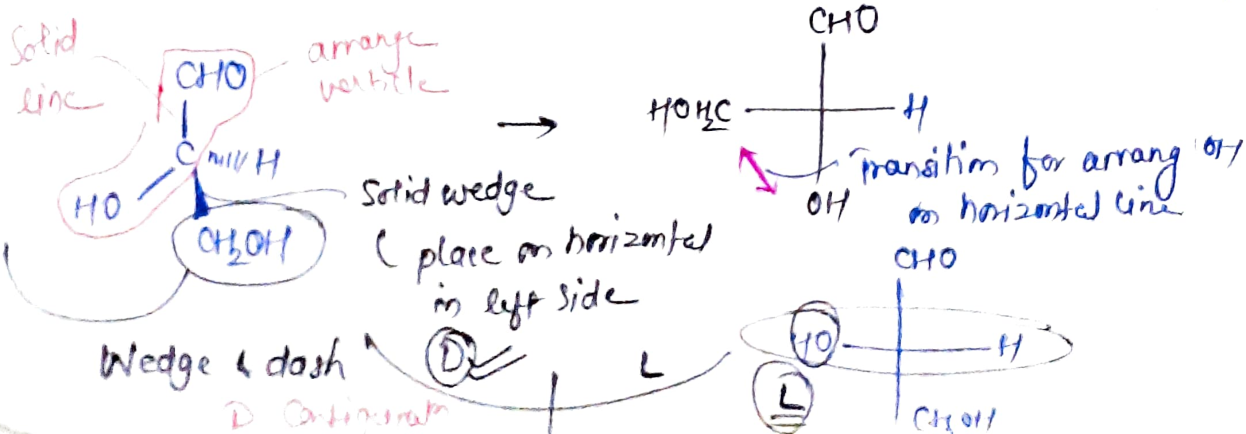


● - glyceraldehyde

L-glyceraldehyde

(Fischer Projection)

- Groups connected by verticle line are above the plane or towards the reader
- Horizontal line = below the plane or away the reader



Solid wedge (place on horizontal in left side

Transition for arrang OH on horizontal line

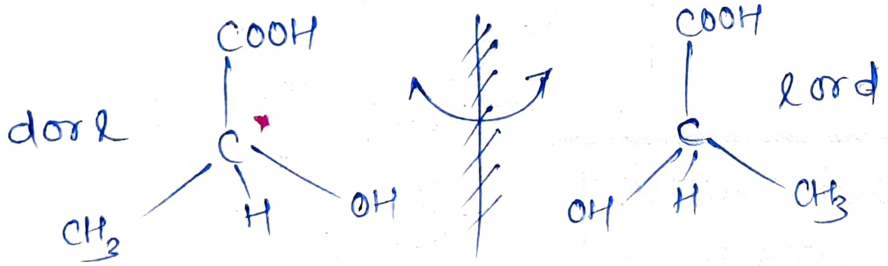
Enantiomer:– are optical isomers that are non-superimposable mirror image.

Diastereomers:– are optical isomers that are not mirror images.

Racemic Mixture – is a mixture of equal parts of enantiomers & Racemic mixture are optically inactive

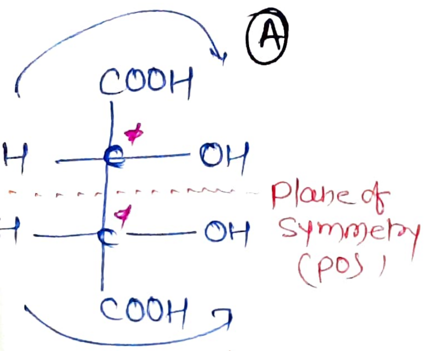
Meso Compound – is a compound that has more than one asymmetric carbon and that is superimposable on its mirror images. Meso compounds are optically inactive

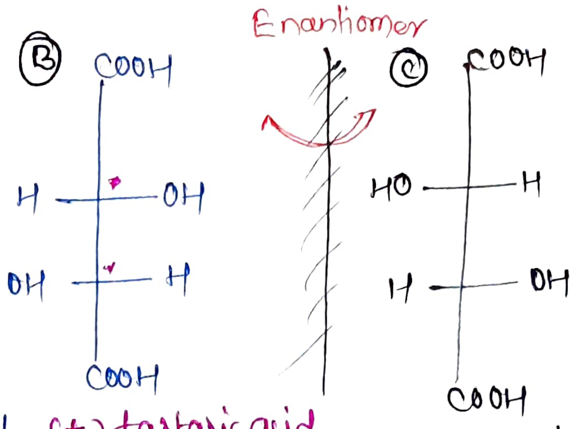
ENANTIOMERS



- Stereoisomers
- optically active
- Non-superimposable mirror images
- They rotate PPL equally in opposite direction
- They have same physical & chemical properties.
- If reaction undergoes ~~under~~ with optically active reagent then they will show different chemical reaction.
- Enantiomers are stable, dificult to seperate, & they can not be interconverted under ordinary condition
- No ~~plate~~ plane of Symmetry & Centre of Symmetry

Ex. Tartaric Acid - 2 chiral Centre





Racemic mixture (equal (+) & (-))

- 2 chiral Centre
- POS
- Optically Inactive
- Meso-compound
- OI due to internal compensation.
- MP = 143°C
- No-mirror image (means identical) superimposable

↳ (+) tartaric acid
↳ optically Active
↳ NO-POS
↳ MP = ~~170~~° 170°C

↳ (-)-t. acid
↳ optically active
↳ NO POS
↳ MP = 170°C

Total optical isomer = 3
optically Active = 2
optically inactive = 1

A, B, C = Stereoisomer
B & C = Enantiomer
A & B] ⇒ stereoisomers
A & C]   Non-mirror image
Diastereomers

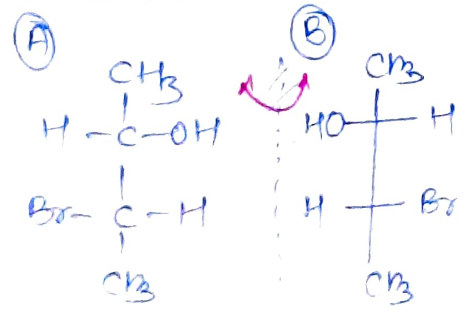
Diastereomers = All geometrical isomers & optical isomer that are non-mirror image are diastereomers

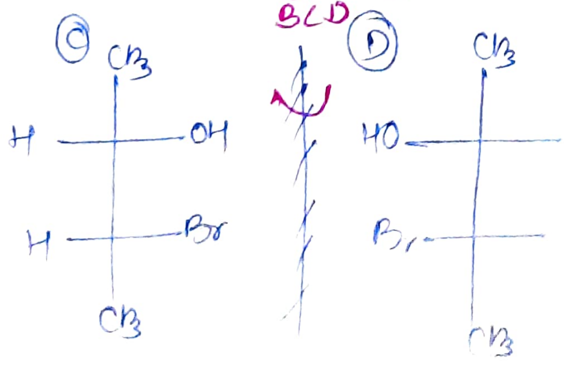
↳ Non mirror image optical isomers
↳ * n-chiral Centre = 2^n stereoisomers
↳ Different physical property - mp, BP, Solubility
↳ Different chemical Reaction,

~~CEMIC~~

A & C
A & D] Diasteromer
B & C
B & D

ex. 3-bromo-2-butanol



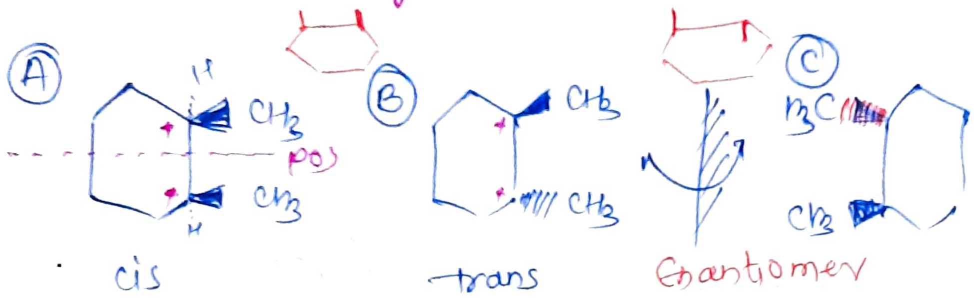


RACEMIC MIXTURE :-

- Equal Conc of equal quantity of d-form & l form
- optically inactive by external compensation.

d-form. + l-form → mixture
+50° -50 0°

Q. Find all isomer of 1,2-dimethyl cyclohexane



- 2-Chiral Centre
- optically inactive
- POS
- Meso-Compound

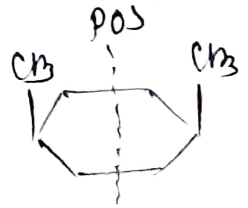
- 2-Chiral Centre
- optically Active
- NO POS

\# Total Isomer : 3
\# optically Active = 2
\# optically inactive = 1

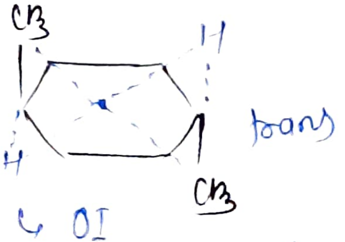
Meso = 1 Ⓐ
Racemic = 1 (B+C)
\# structure iso : 1

A, B, & C = optical isomer
A & B, A & C] : Diastereomers
B & C = Enantiomers

1,4-dimethyl cyclohexane



cis



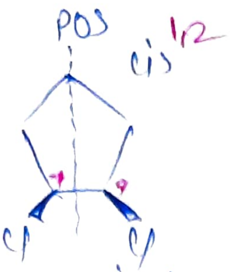
trans

- OI
- POS
- ~~Meso~~ - X
- NO chiral

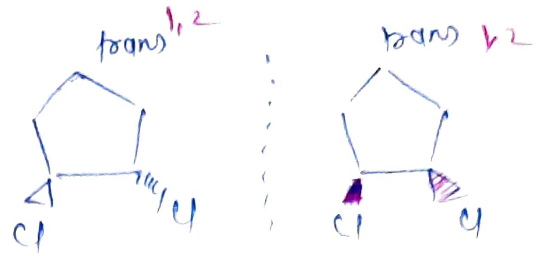
- OI
- COS - opposite directn, same distance Same group

dichloro cyclopentane : Answer : 7

↳ NO Chiral
↳ OI

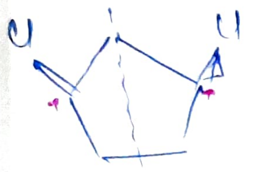


↳ 2-Chiral
↳ POS
↳ Meso



↳ 2chiral
↳ optically Active

1,3

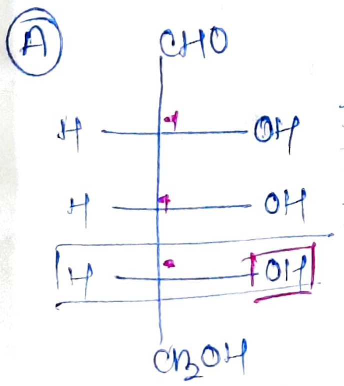


↳ POS
↳ OI
↳ Meso

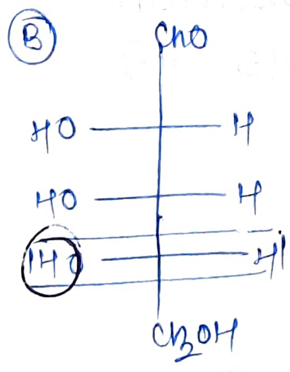
↳ OA
↳ NO POS

Meso : 2
OA = 4

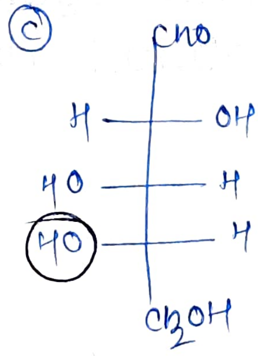
Aldopentose :- 3-chiral centre = 2^3 = 8 stereoisomers

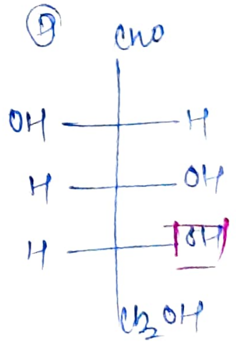


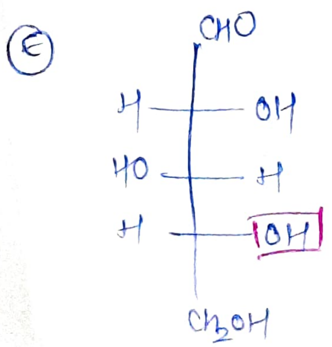
D-Aldopentose

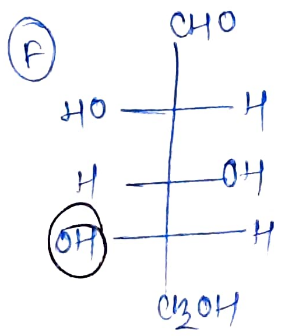


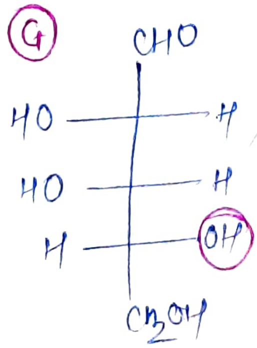
L-Aldopentose

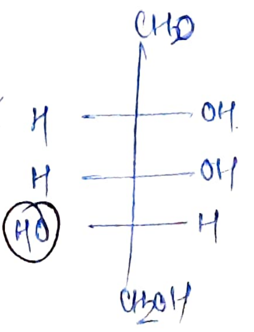












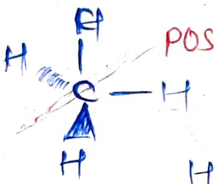
ELEMENT OF SYMMETRY

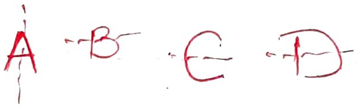
Optical Activity → Disymmetry
→ chirality
→ Non Superimposable mirror image

DISEMMETRY :-

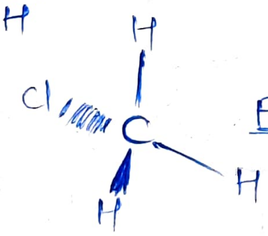
Compound has * NO centre of symmetry (COS) - Inversion Centre
* NO Plane of symmetry (POS) - Mirror Plane
NO Alternate Axis of Symmetry (AAOS)] Improper rotation Axis
may have ~~Atta~~ Axis of Symmetry

ex. ① CH_4 = No chirality
= optical Inactive
POS



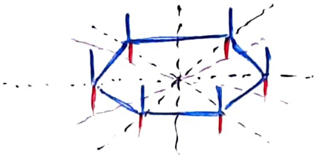


② $CHCl_2$



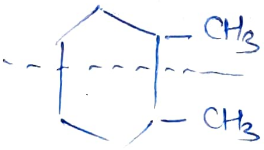
POS → O.I.

③ Cyclohexane



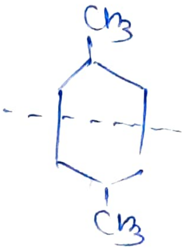
→ POS
- O.I.

⑤



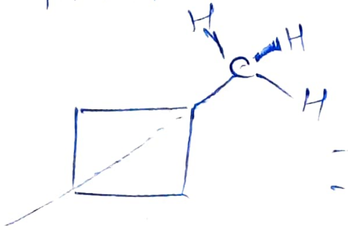
POS
OI

⑥



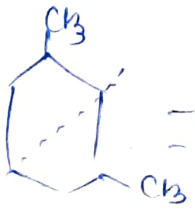
POS

④ methy cyclobutane



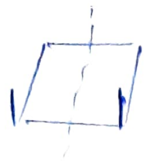
- POS
- OI

⑦

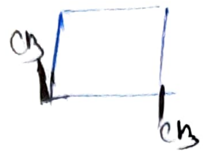


- POS
- OI

⑧ 1,2-dimethyl Cyclobutane ⑨



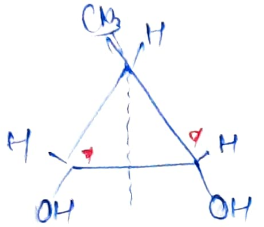
cis
- POS
- OI



- NO POS
- NO COS
- O. Active

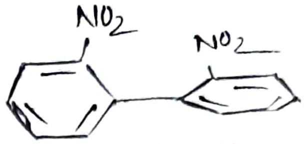
= Disymmetric

⑨



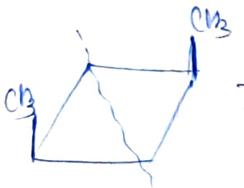
- 2 chiral centre
→ POS
→ O. Inactive

⑪



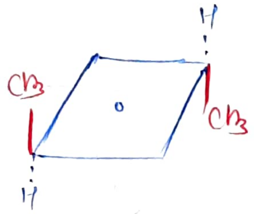
× - POS
× - COS
✓ OA.

⑩



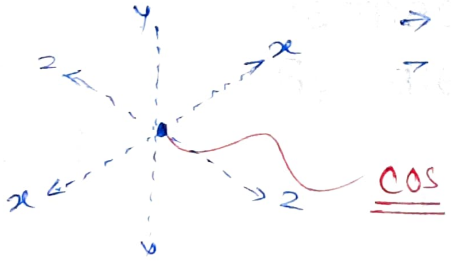
-POS

cis
1,3-dime. cyclobutane



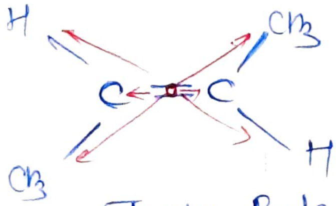
- NO POS
- ✓COS
- OI

Centre of Symmetry

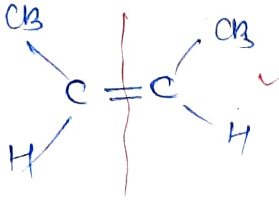


→ Same distance
→ opposite direction
found same group

①



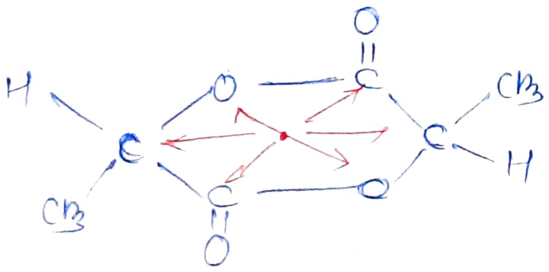
✓ POS
✓ COS
✓ ~~NO~~ O.I.



POS

Trans- Bute-2-ene

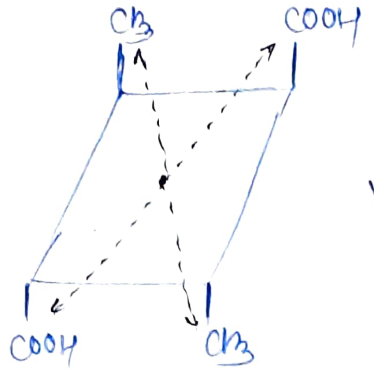
②



→ NO-POS
→ ✓COS
→ OI

Same group found in equal distance in oposite direction

③



- NO POS

✓ COS !

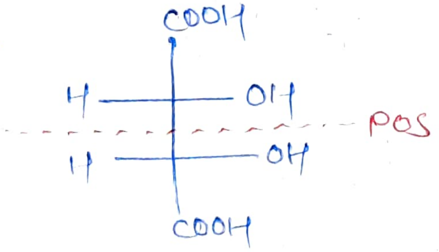
- OI

1. Plane of Symmetry (POS) (Mirror plan)

A plane of symmetry is imaginary plane that passes through a molecule such that atm or group on one side of plane from a mirror image of those on the other side.

It is use for >2 chiral centre

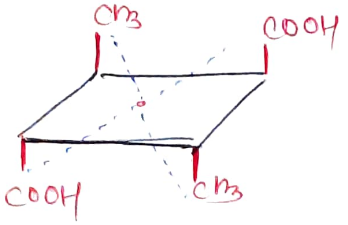
ex:

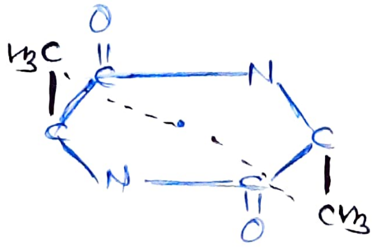


O.I. due to internal compensation that is rotation of one asym. carbon is cancelled by another asymmetry carbon.

2. Centre of Symmetry - Inversion centre.

A point in a molecule from which lines when drawn on opposite side at equal distance, meet exactly similar atm or group in the molecule

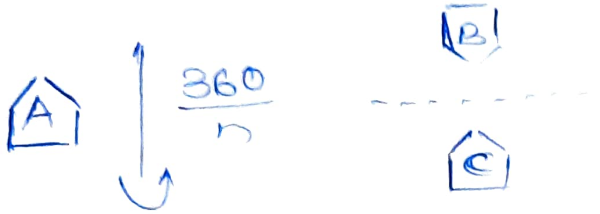




Trans isomer

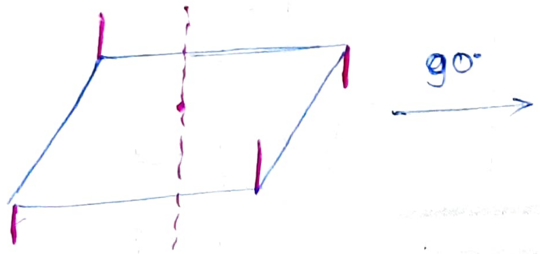
3. Alternate Axis of Symmetry (Improper Rotation axis)

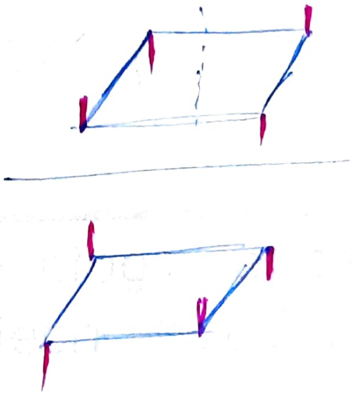
A molecule is said to posses an n-fold alternating axis of symmetry if, on rotating through a angle of 360° about the axis & followed by Reflection of the resulting molecule in a plane perpendicular to the axis, then the mirror image is exactly identical to the original molecule



If A = C then the molecule contains a n-fold axis of symmetry
& if A ≠ C the molecule does not contain n-fold axis of symmetry

ex





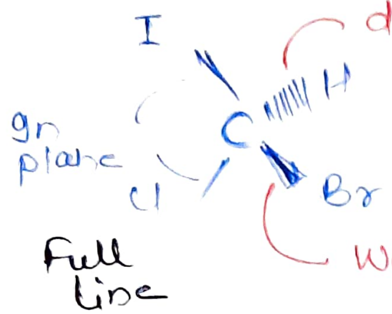
= 4 fold axis of symmetry

Wedges - Dash
Fischer - Projection
R,S Nomenclature

WEDGES - DASH

:- 3D Representation

:- For both chiral & achiral carbon formula



dash - Inside of plane & below the plane

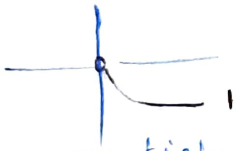
wedge = outside of plane

: above the plane

FISCHER PROJECTION

:- 2-D Representation

: For ~~both~~ chiral ~~&ac~~ carbon

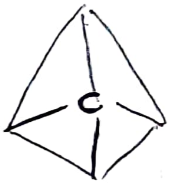


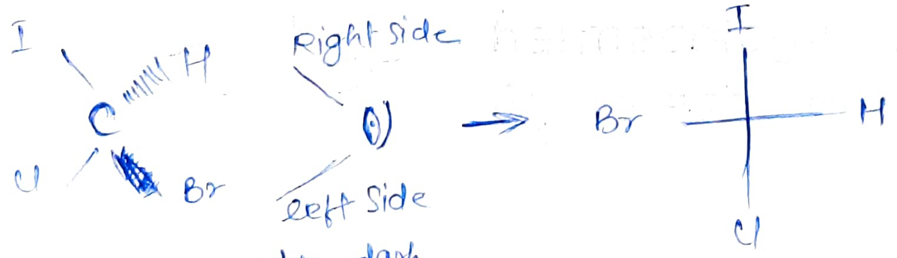
Horizontal → projected above the plane

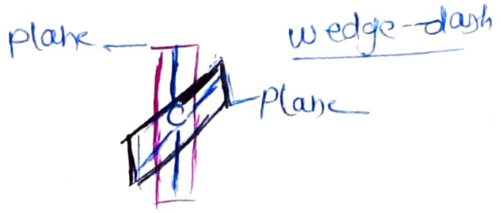
Intercept - chiral carbon (plane of paper)

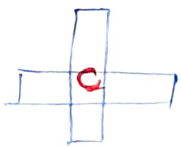
Verticle

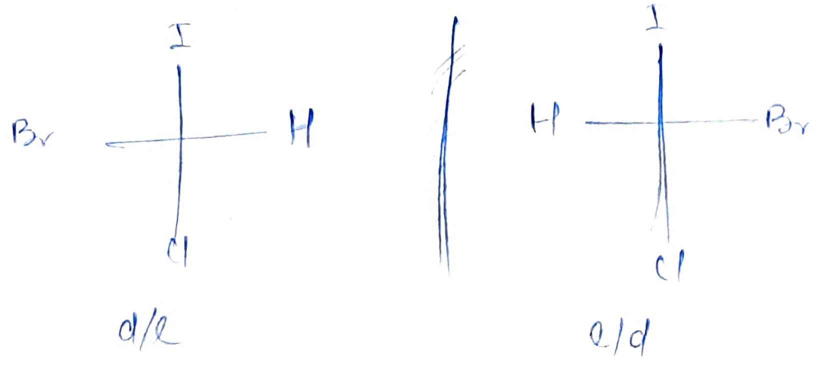
↳ projected below the plane









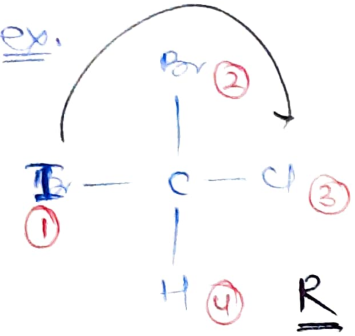


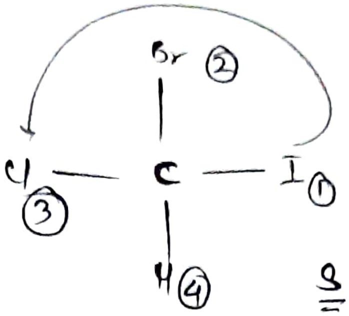
R-S NOMENCLATURE

\# by Fischer projection

\# Priority order - CIP Scheme

ex.





Priority order = Set the priority order of different atom or group based on atomic number, those are directly attached to carbon atom.

~~Chan~~ Cahn Ingold-Prelog Rule

\# Highest atm. no. - 1st priority

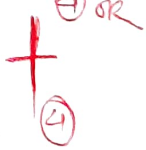
\# 1 → 2 → 3 (you can cross the 4)

↳ Clockwise = R = Rectus - Right

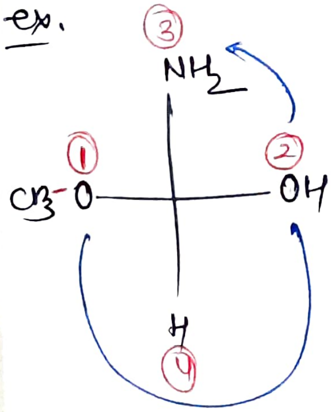
↳ Anticlock = S = Sinister - Left

Cond^n^ 1 -

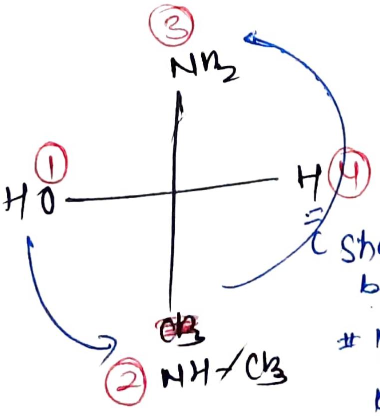
\# Lowest priority should be on verticle bond



ex.



S-configuration

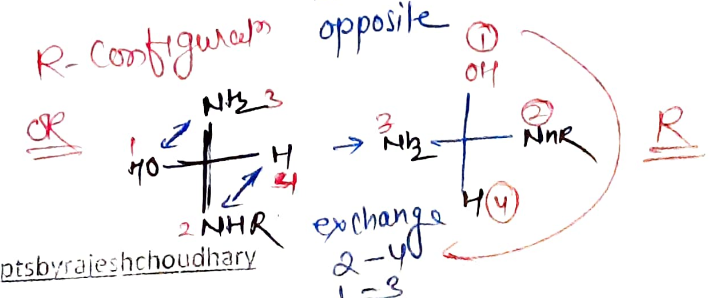


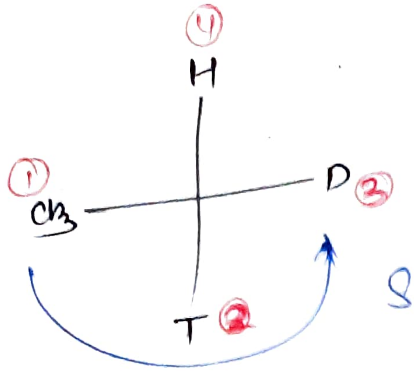
Anticlock = S → R*

should be verticle

\# If not in horizontal then obtained result may be opposite

R-configuration

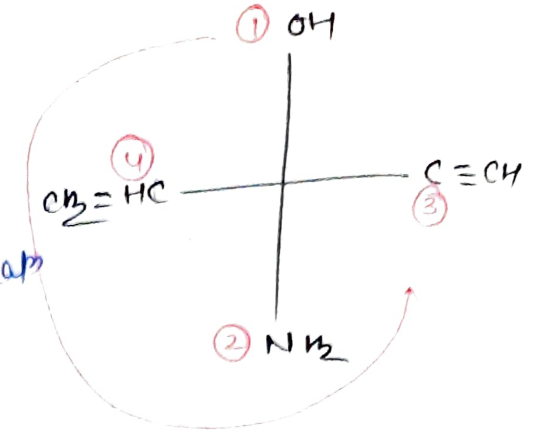




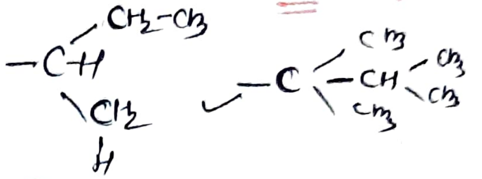
Atomic then Mass

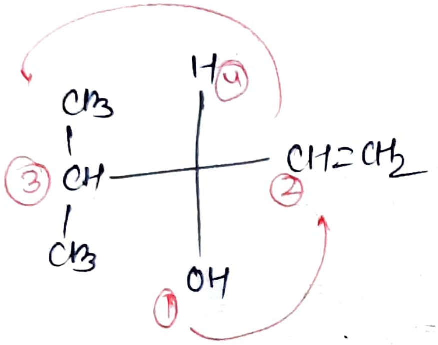
O18 > O17 > O16

S-Configuration

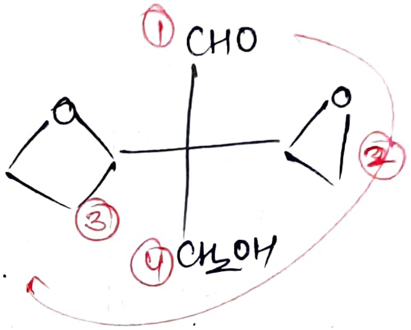


S → R-Configuration



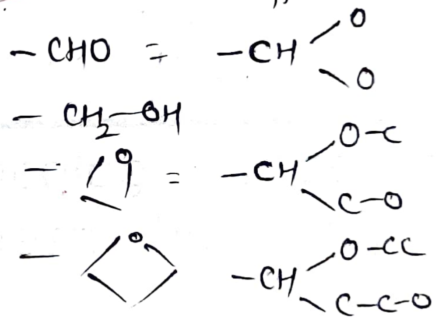


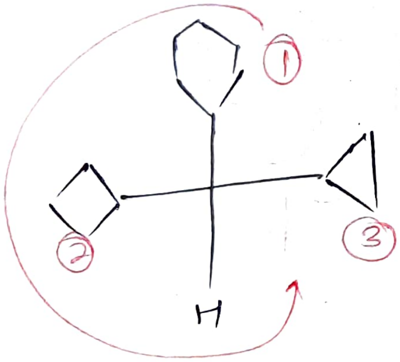
S-Configuration



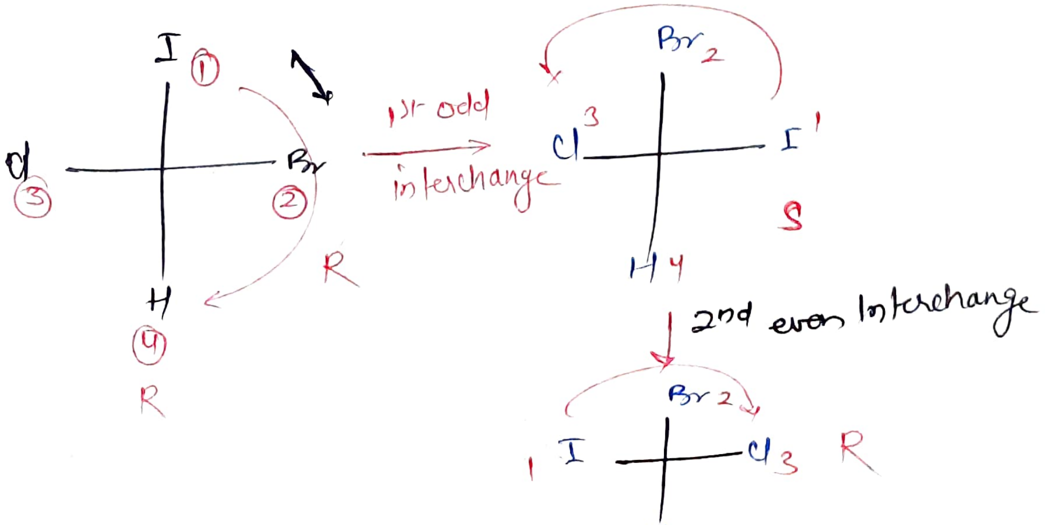
R

hypothetical





S-Configuration



Priority Order Rule

① If attached atom is single, highest atomic no. should give priority

= $I > Br > Cl > F > O > N > C > H$

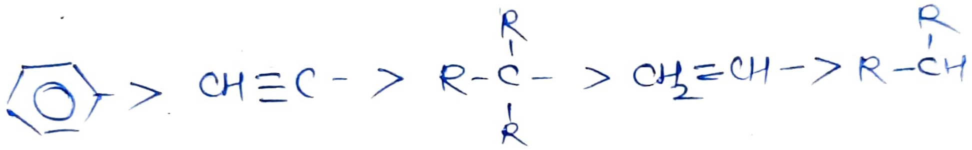
② If attached atom is same then, consider 2nd atom.

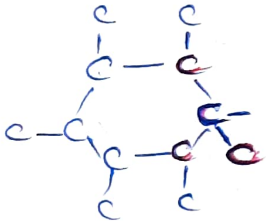
$NR_2 > NHR > NH_2$

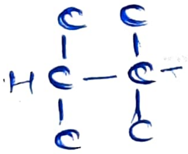
$R_3C > R_2CH > R\text{-}CH_2 > CH_3$

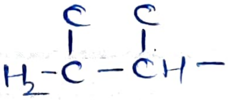
$-OR > -OH$

③ If multiple bonded group is attached, a double bond is treated as through each atom of the double bond were bonded to two atom

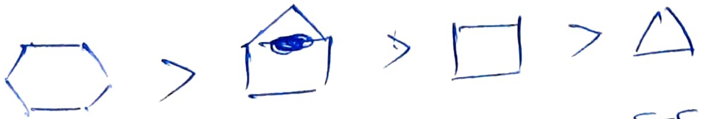


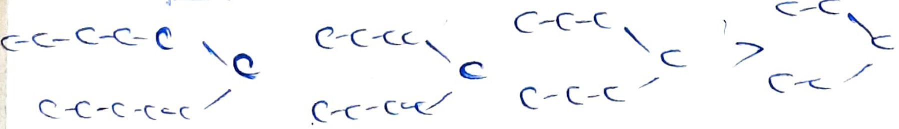


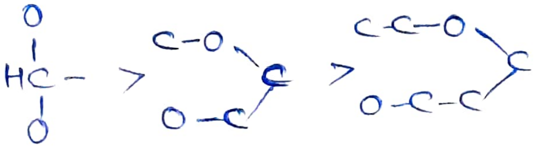




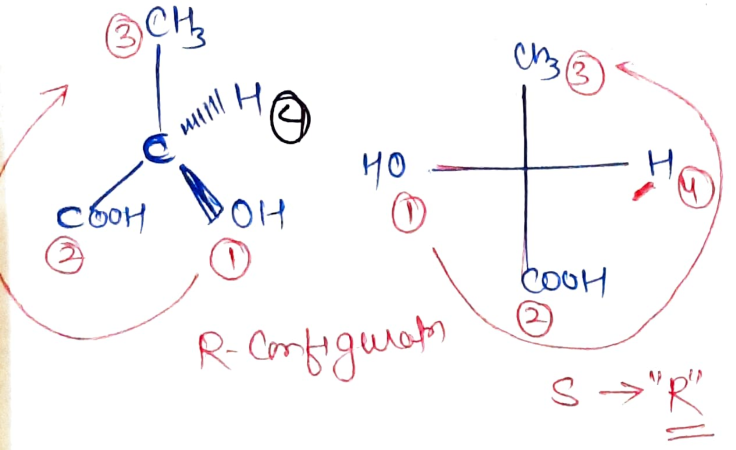
④ If cyclic or heterocyclic atom is attached consider all atom in both side





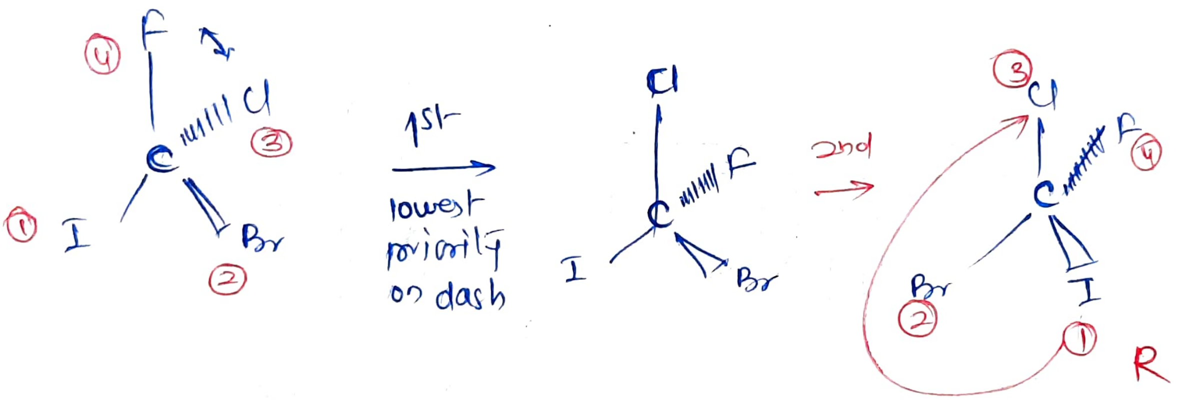


R&S In Wedge& Dash



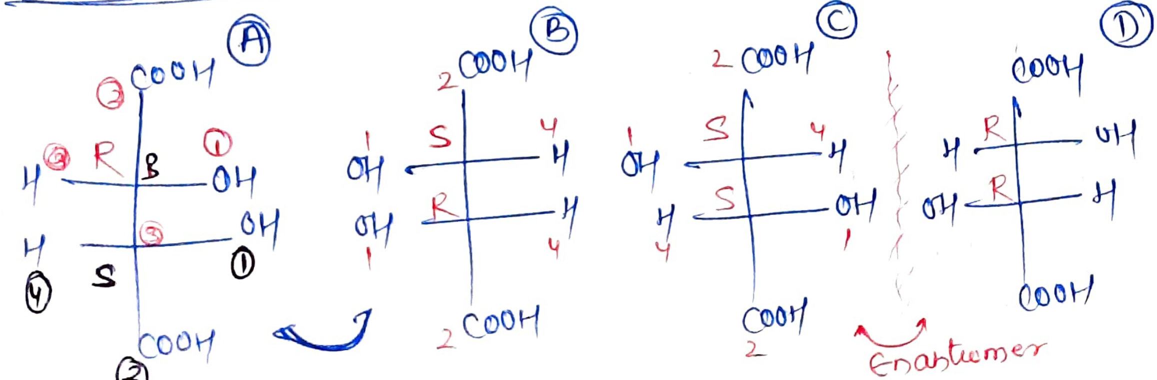
In wedge-das, lowest priority should present in dash

If not present then two even interchanges



R-S Nomenclature in →
- 2-chiral Centre
- Enantiomer
- Identical Compound
- diastereomer

Tartaric Acid



2R3S OR 2S3R

2S3R or 2R3S

2S,3S

2R,3R

A&B = Identical
both are one, O.I,
Meso

A & C/D
B & C/D - No mirror image
= Diastereomer

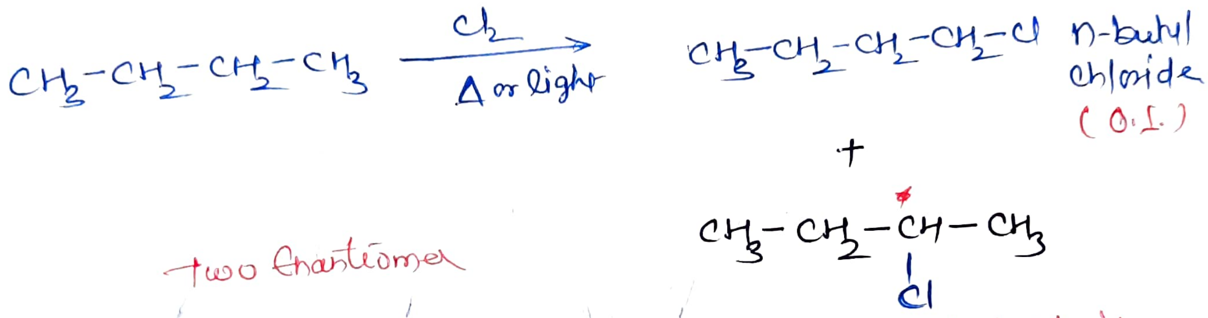
C&D = Enantiomer

REACTIONS INVOLVE IN STEREOISOMERS

- Synthetic Reaction :- Generation of Stereoisomer or chiral centre
- Chemical Reaction - 1) with O. active reagent
  2) with O. inactive reagent

I. Generation of Chiral Centre, Synthesis & Optical Activity = ASYMMETRIC SYNTHESIS

① Chlorination of n-butane



$$CH_3-CH_2-CH_2-CH_3 \xrightarrow[\Delta \text{ or light}]{Cl_2} CH_3-CH_2-CH_2-CH_2-Cl$$

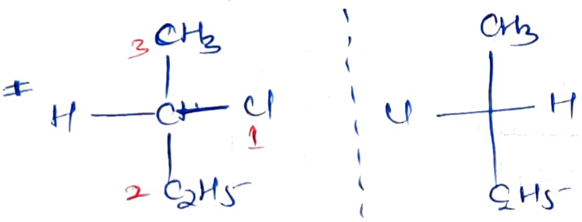
n-butyl chloride (O.I.)

$+$

$$CH_3-CH_2-\overset{*}{C}H(Cl)-CH_3$$

Secondary butyl chloride

two Enantiomer



S(+) Sec butyl chloride

R(−) Sec butyl chloride

\# Reaction product of chlorination of n-butane → Sec butyl chloride shows NO rotation in polarimeter due to equal amount formation of both enantiomer (Racemic mixture)

\# Need to be Resolutate the Racemic mixture → Specific Method

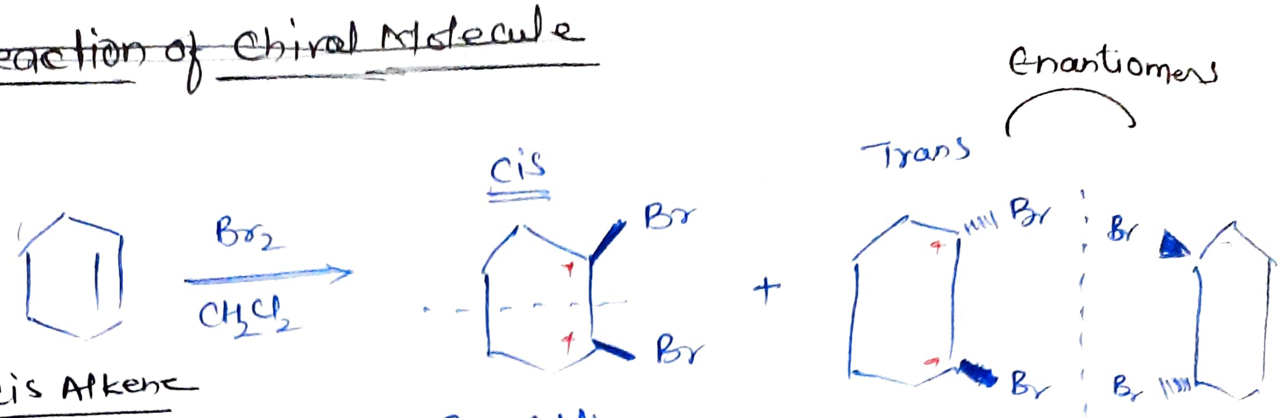
\# Conclusion → Reaction product of achiral or optical inactive compounds, obtain a optical inactive product (May be racemic)

\# Synthesis of chiral molecule from achiral reactants always yeild, the racemic modification

\# Racemic mixture can't be seperated by an ordinary method like fractional distillation or recrystalization due to identical Solubility & Boiling point

II: Reaction of Chiral Molecule

②



cis Alkene

- Syn Addion
- POS
- O.I
- Meso

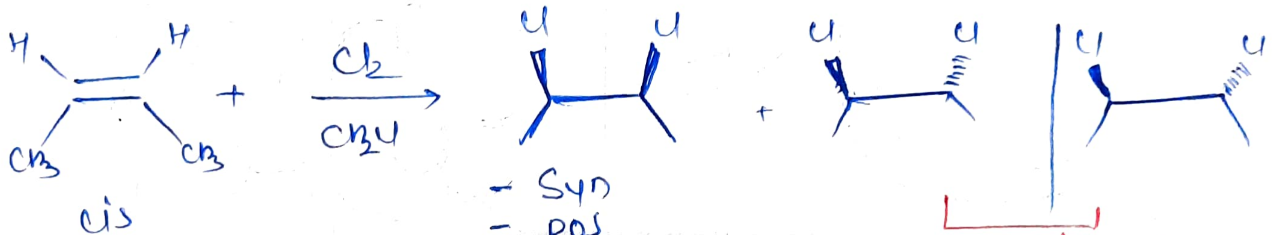
- Anti-add
- NO POS
- O.Active

product

Racemic / O.I.

Cis + Syn – Meso
cis + Anti – Enantiomer
Trans + Syn → Enantiomer
Trans + Anti → Meso

③



cis

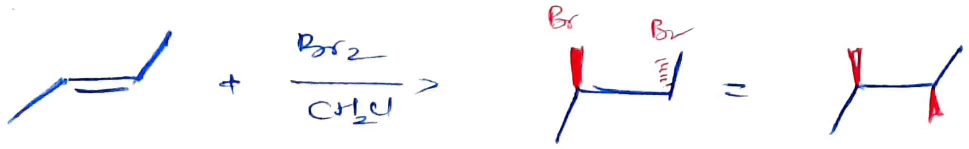
- Syn
- POS
- Meso
- OI

Enantiomer

- Anti Addⁿ
- OA
- Enantiomer

Racemic

③ Trans



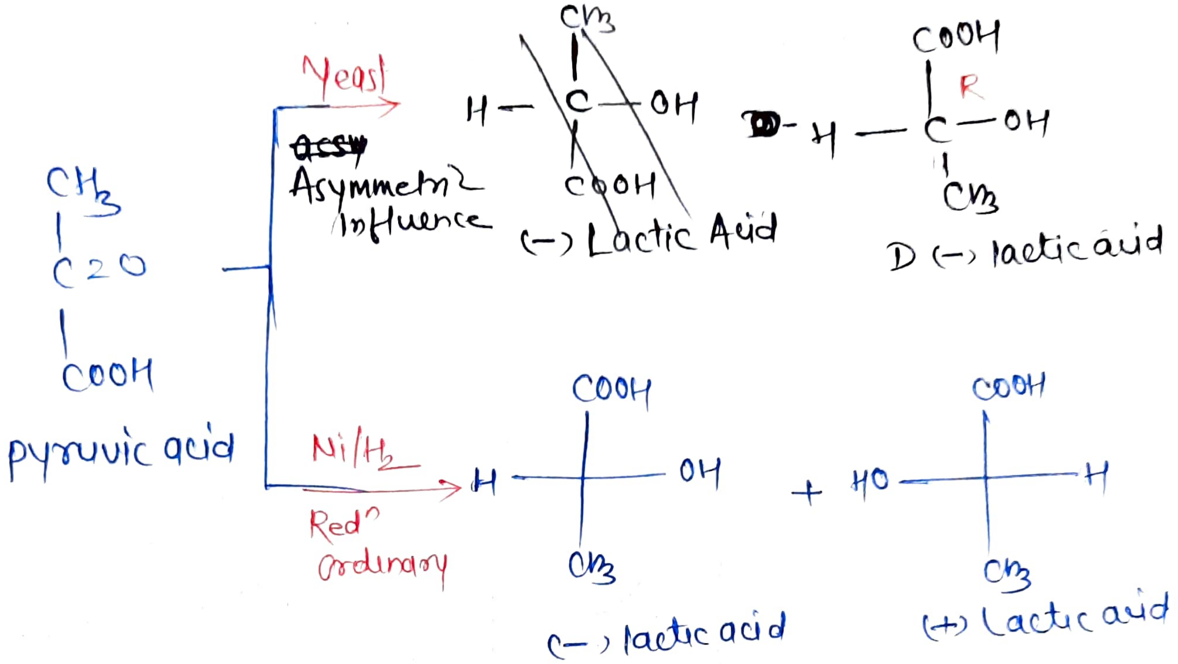
Anti Addⁿ

→ Meso / OI

www.youtube.com/pharmacologyconceptsbyrajeshchoudhary

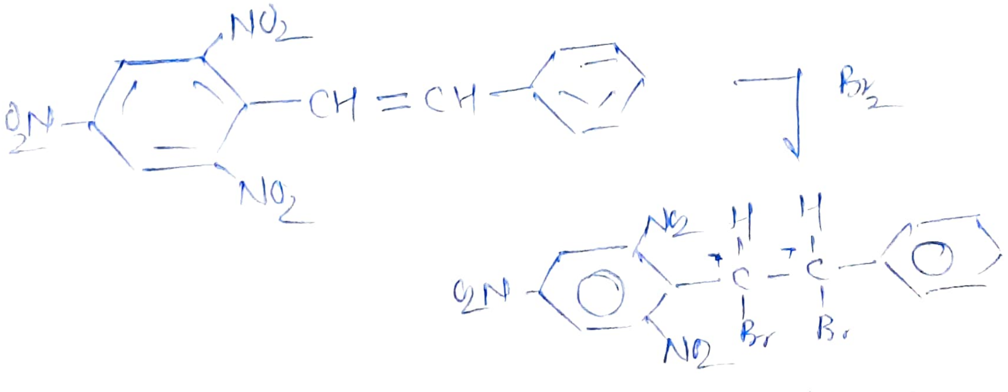
REACTION ~~INVOVE~~ INVOLVE IN CHIRAL MOLECULE

If asymmetric synthesis carried out under the asymmetric influence of a suitable optically active reagent, then only one optically active isomer (+ or −) is formed.



Asymmetric Synthesis — A reaction, in which one or more stereoisomers (Enantiomer or Diastereomers) are produced from an optically inactive substrate with or without using Enan,

Type)- **I Absolute Asymmetric Synthesis :-** Synthesis of a optically active product from optically inactive substance without using enantiomer.

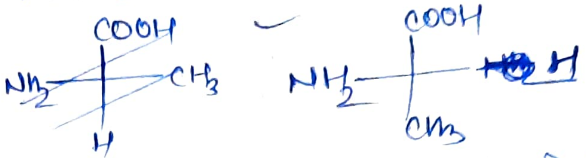


(+) Isomer

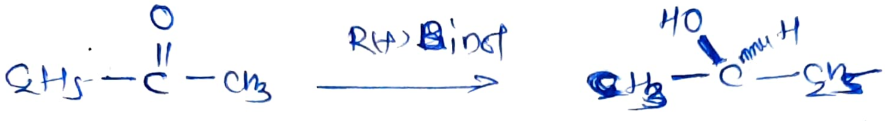
② Partial Asymmetric Synthesis - is synthesis of optically active product from optically inactive substrate by using enantiomer

ⓐ Chiral Substrate - has chiral centre adjacent to reaction site

ex. S(+) Alanine

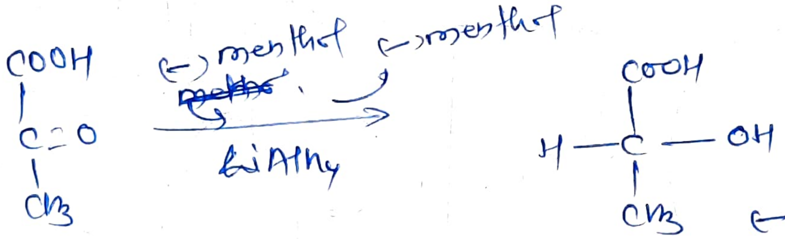


ⓑ Chiral Reagent - remove or add enantiotopic proton



R(+) propanol

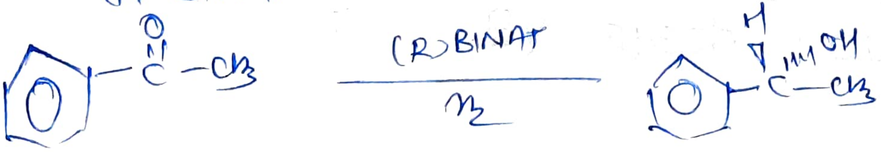
ⓒ Chiral Auxiliary - join to substrate & remove to form product



← lactic acid

ⓓ Chiral catalyst

(R) BINAP



II REACTION INVOLVE IN CHIRAL MOLECULE

As we know that Achiral reaction of achiral substance produces a Racemic mixture (Racemate).

Configuration of a particular enantiomer can be determined directly by a special kind of X-ray diffraction, which was first applied in 1951 by Bijvoet to (+) tartaric acid.

There are Three major Reaction :-

① Inversion :- change in property R → S or (+) → (−)

② Racemisation :- change in Activity Active → Inactive

③ ~~Retein~~ Retention :- Retention is same R → R or S → S

1) INVERSION (WALDEN INVERSION)

↳ After attachment of new group ~~or~~ or atom to the ~~as~~ chiral centre or chiral carbon atom, the new configuration of the chiral compound may be opposite to that of original.

R → S
S → R
\+ → −
− → +

↳ The product looks like a mirror image (Enantiomer)

↳ This phenomenon is known as the "Walden Inversion"

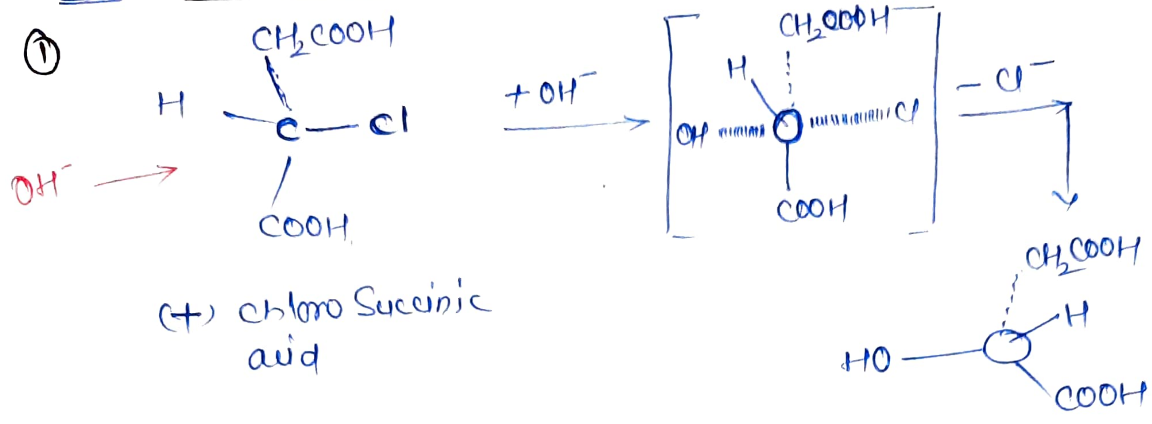
✱ SN2 Reaction — 1. Attacking molecule or group approaches to chiral carbon centre from opposite side of replacing group

2. Formation of an intermediate transition state in which three groups & chiral-C atom lie in one plane

3. Seperation of the group being replaced.

Ex – INVERSION

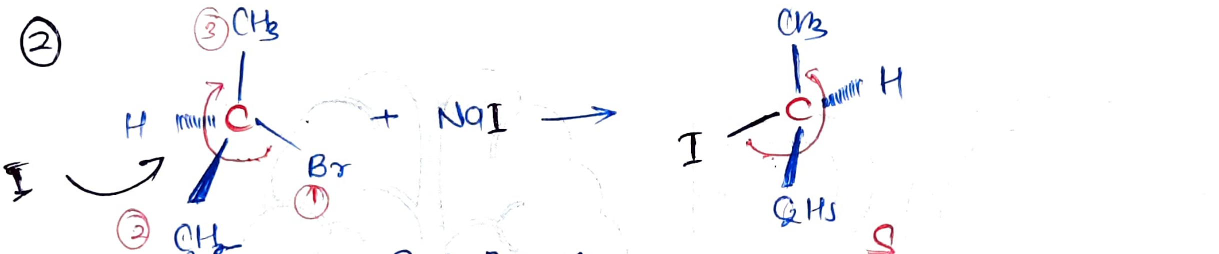
①



(+) chloro Succinic acid

(–) Malic Acid

②



R

R-2-Bromo butane

S

S-2-iodobutane

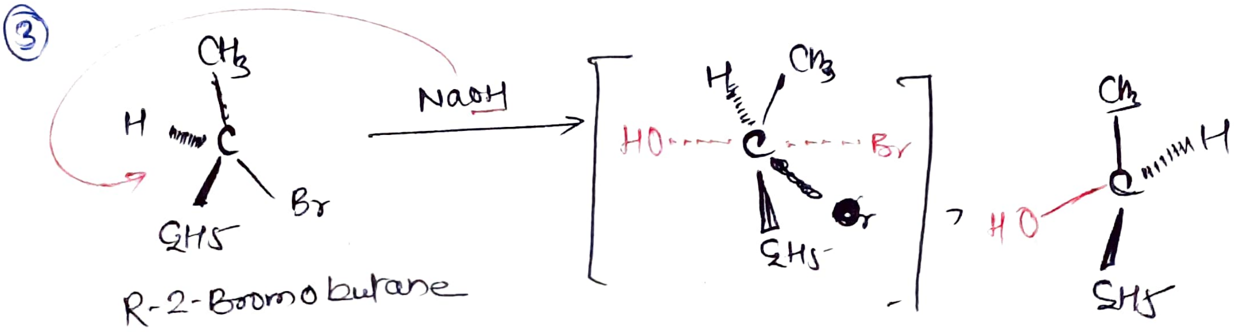
2° Alkyl Halide

R

S

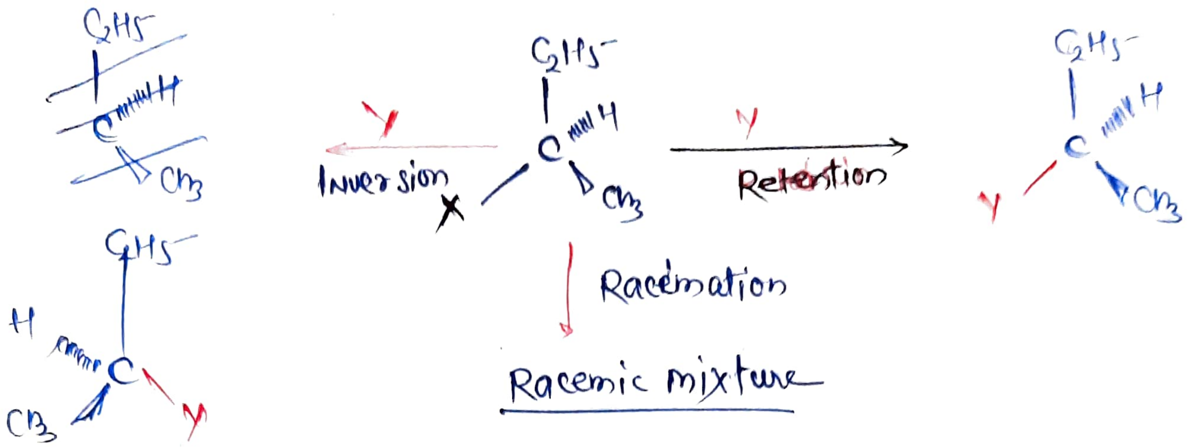
#	3°	2°	1°	methyl
SN 1	Good	Yes	×	×
SN 2	×	Yes	Good	Good

③

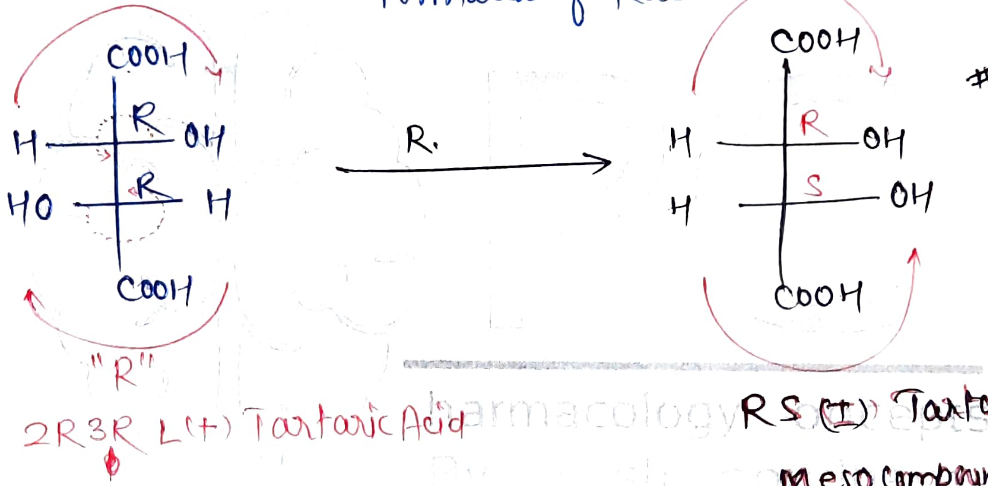


R-2-Bromobutane

S-2-butanol

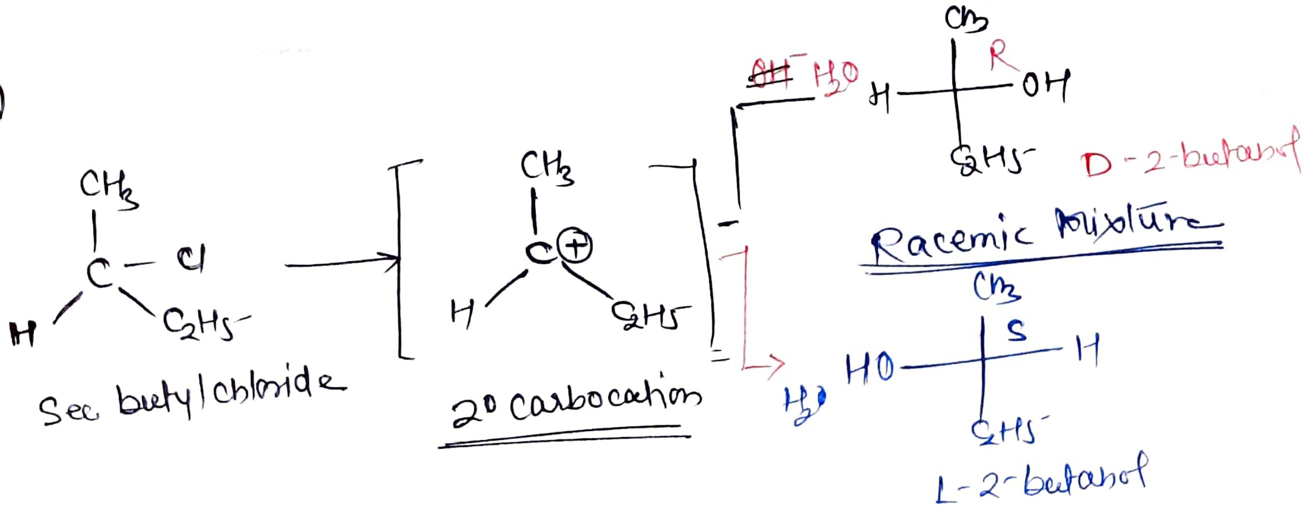


2. **Racimisation** – Occurs mainly in SN1 Reaction
formation of Racemic mixture



Not a Racemic mixture

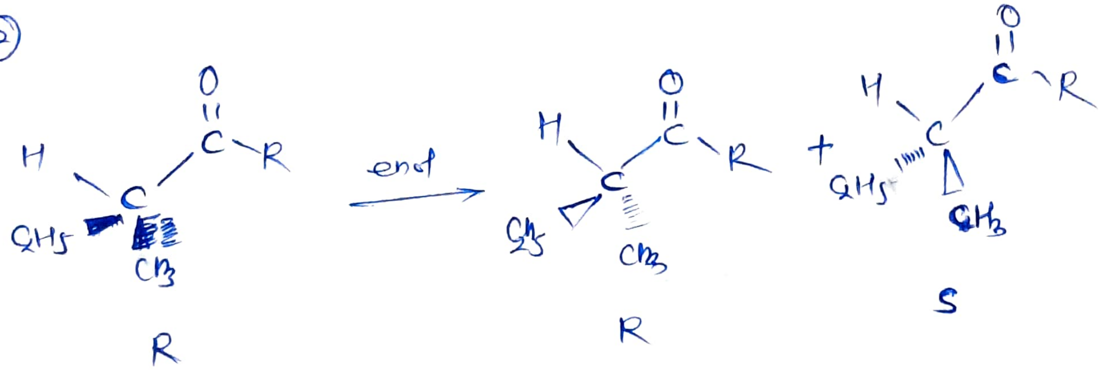
①

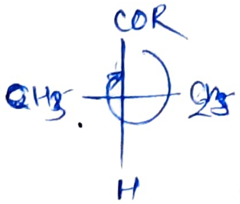


Process of converting an optically active (d/l) compound into the racemic mixture

At the α Carbon

②





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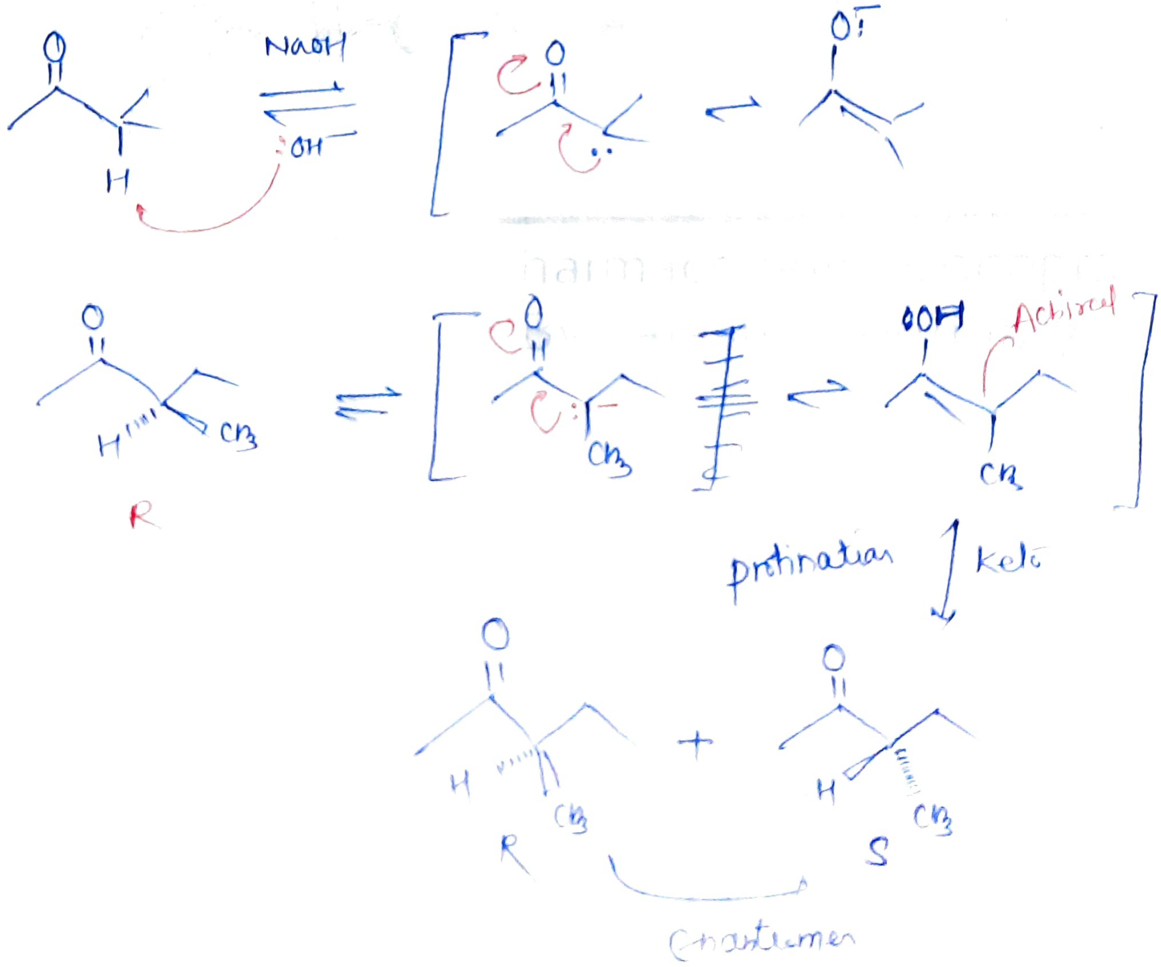
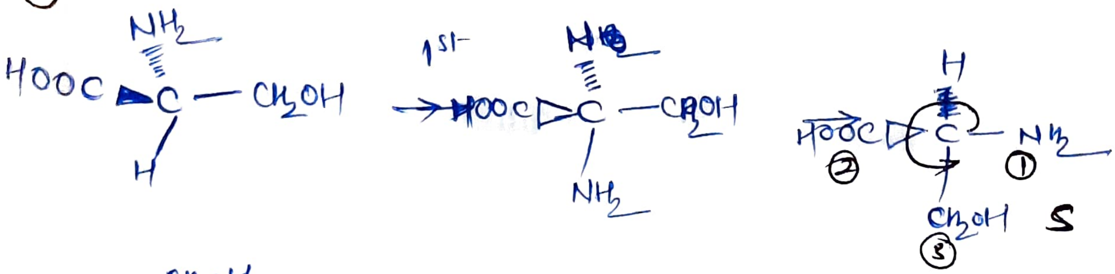
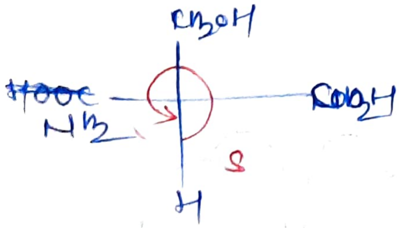


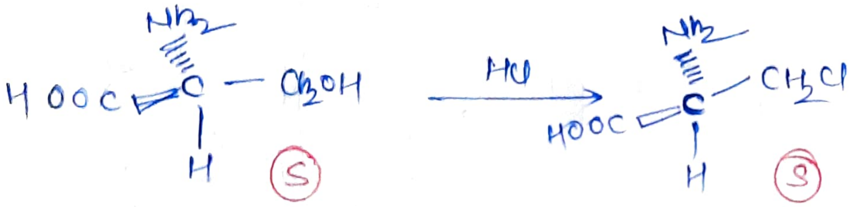
3. Retention :- # Not-change in configuration

Prefered in SN 1 Reaction

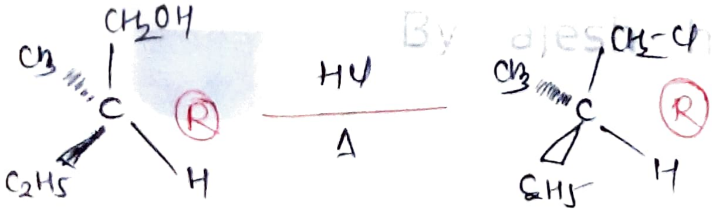
①



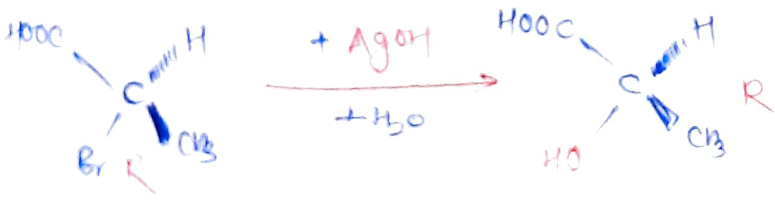




②



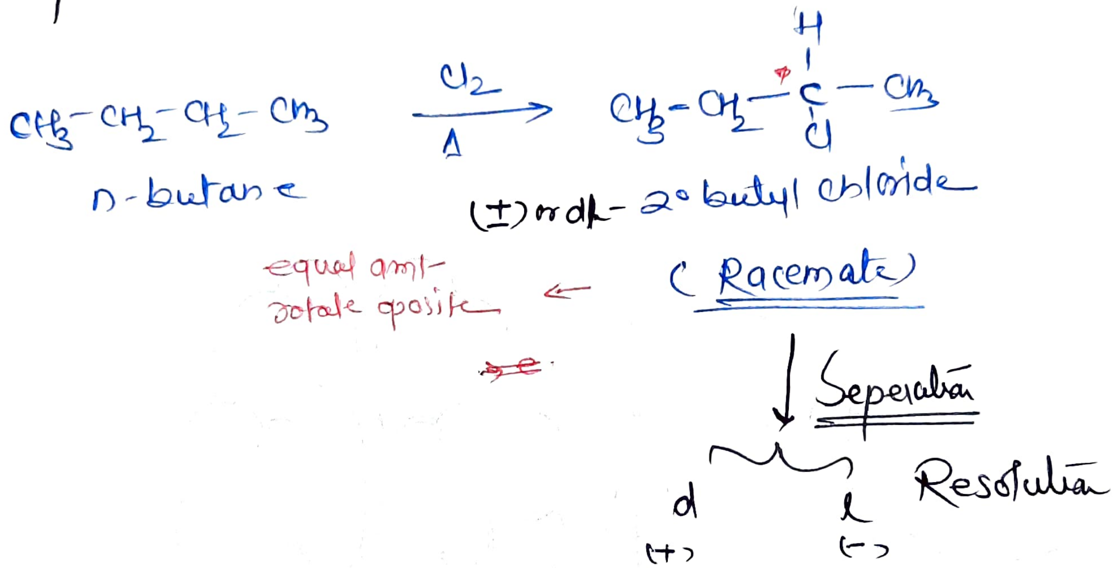
③



RESOLUTION OF RACEMIC MIXTURE

#Synthesis of optical ~~comp~~ active compound from achiral Substances produces a mixture of both (+) & (−) isomer in equal amount. Such Racemic mixture needs to seperation.

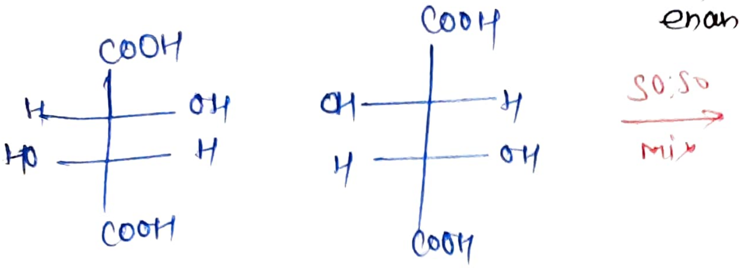
#Seperation of such racemate into its two optically active components (d & l) is known as Resolution



$$CH_3-CH_2-CH_2-CH_3 \xrightarrow[\Delta]{Cl_2} CH_3-CH_2-\overset{H}{\underset{Cl}{\overset{*}{C}}}-CH_3$$

Methods
1. Chemical Resolution
2. Biochemical Resolution
3. Mechanical Method
4. Kinetic Method
5. Preferential Crystalizatn by inoculation/Seeding

Racemic Mixture Modification - formation of Racemic Mixture by mixing both enantiomer



	RR Tartaric Acid	SS Tartaric acid	± Tartaric acid
mp :	168-170	168-170	210-212
α :	-12°	+12°	0

differ in - physio-chemical properties

① Mechanical Seperation or Spontaneous Resolution

1st used by "Pasteur" For resolution of Sod. Ammonium tartarate which crystallizes out in the form of racemic mixture below 27°C

Racemate $\xrightarrow{<27°C}$ two different crystal formed with mirror image

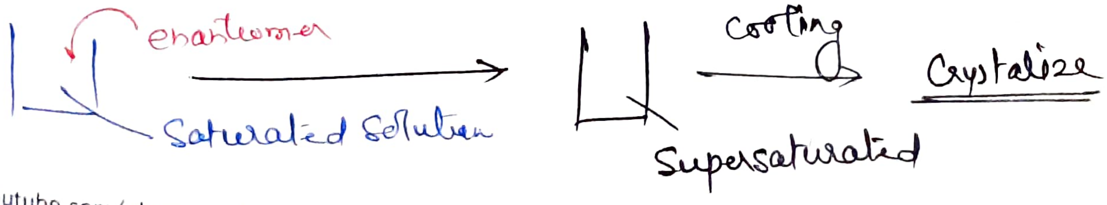
↓

Seperate by Magnifying glass & forceps

disadvantage - Laborious method
with Same crystal Structure

② Seeding or Perferential Crystallization.

↳ Seeding of a saturated solution of racemic mixture with pure crystal of one enantiomer.

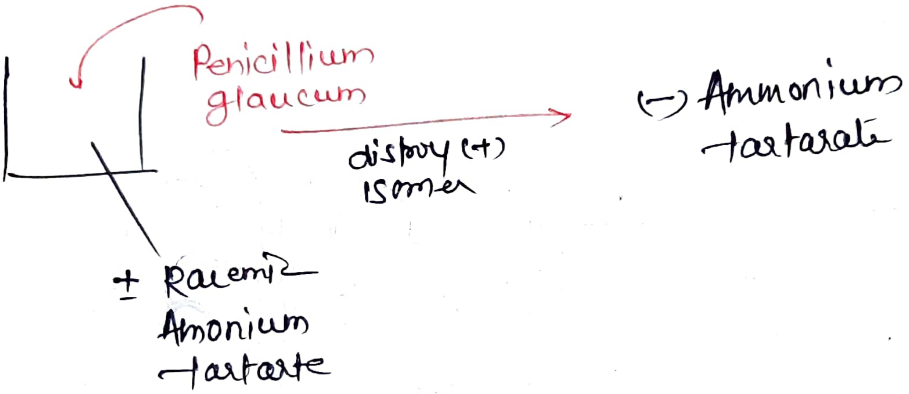


ex. Crystal of (−) asparagine crystallize out (±) Sod. amonium tartarate from solution of Racemic modification.

③ **Biochemical Method**; By using some microorganism like bacteria, yeast, mould, fungi.

when these microorganism are grown in dilute solution of racemic mixture they assimilate one enantiomers rapidly than the others

ex



Disadv − ① Half material is lost
⑪ Can not be used if mixture is toxic to microorganism.

④ Chemical Method (Pasteur 1858)

converting of enantiomers of a racemic mixture to diasteromer by adding of pure enantiomer of other compounds.

$$\pm \text{ lactic acid} \xrightarrow{(-)\text{ strychnine}} \begin{matrix} (-)\text{strychnine } (+)\text{ lactic } \bar{a} \\ (-)\text{ strychnine } (-)\text{ lactic } \bar{a} \end{matrix}$$

diastereomer

Both have different property like solubility

↓ Fractional crystalization

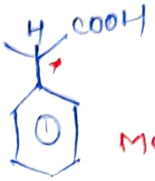
$$(+)\text{ lactic acid} \xleftarrow{\text{acid}} (-)\text{ stry. } + \text{ lactic } \bar{a} \quad\quad (-)\text{ str. } (\;)\text{ lactic}$$

5. Kinetic Method

One enantiomer reacts faster than other with optically active compound.

e.g. ~~Meth~~ menthol reacts faster with (+) mandelic acid than (−) isomer

thus it can be seperated



Mandelic ā