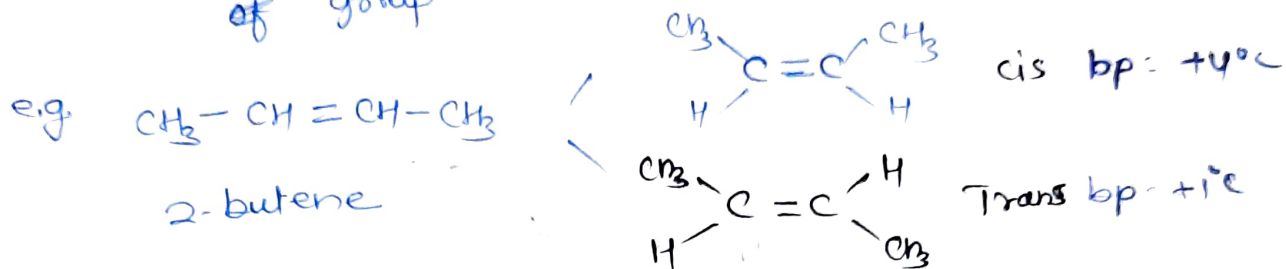


UNIT-II GEOMETRIC ISOMERISM



Stereoisomers -

- # Same Molecular formula
- # Same structural formula
- # Different spatial (space) arrangement of atom/ of group



Stereoisomers

Configurational

Separable

Conformational

Non Separable

Enantiomer

Mirror Image

↳ Optical Isomer

Diastereomers

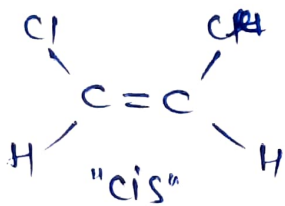
Non Mirror Image

↳ Geometrical Isomer
↳ Optical Isomer

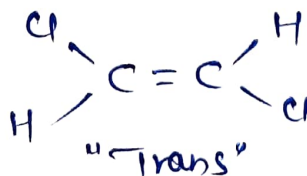
Geometrical Isomers →

"Cis-Trans Isomer"

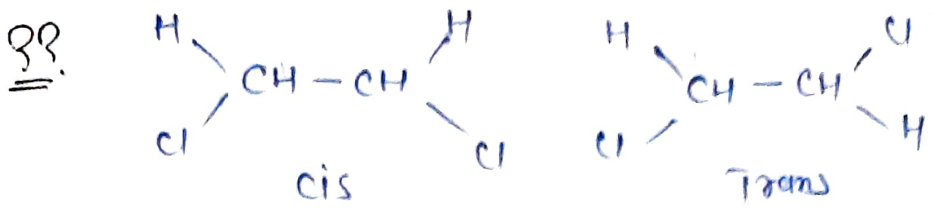
- # Same MF LSF
- # differ in spatial arrangement of atom around the C=C bond



Same atom at
Same side



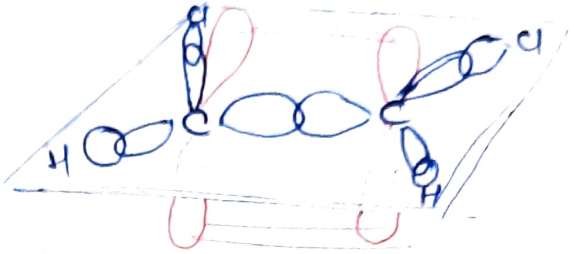
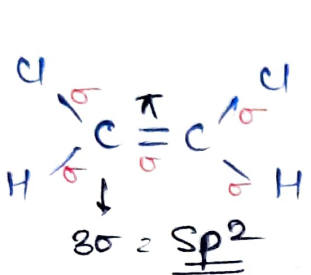
Same atom at
opposite side



= No Geometrical Isomers

Important Condition for Geometrical Isomer

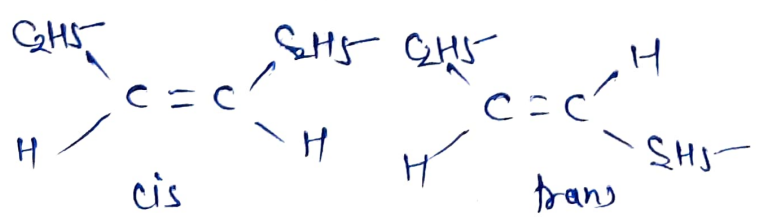
= bond → Restricted Rotation



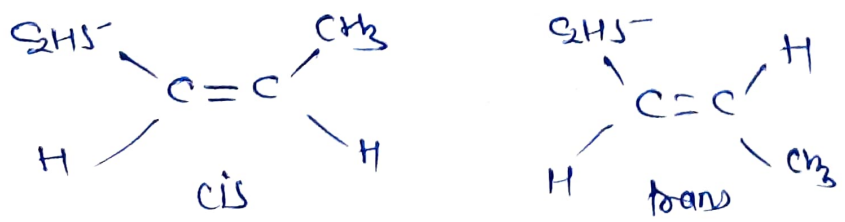
↳ Restricted for Rotation

Cis & trans are different compounds & having different properties.

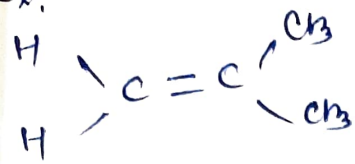
ex. hexene



pent-2ene



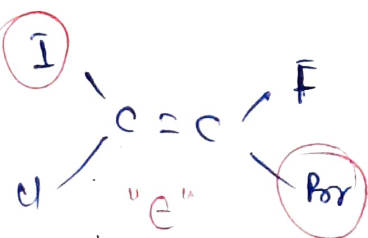
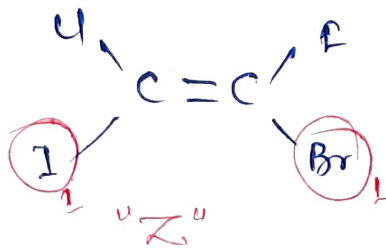
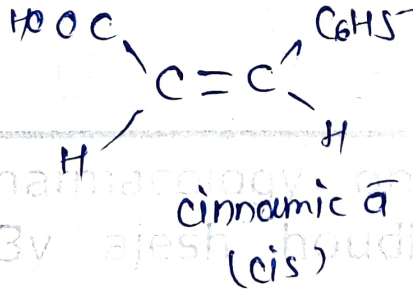
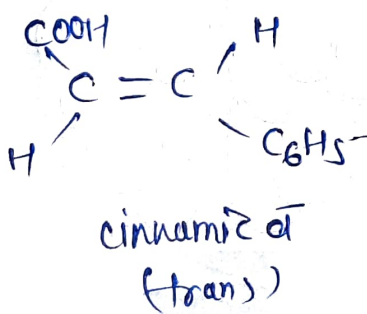
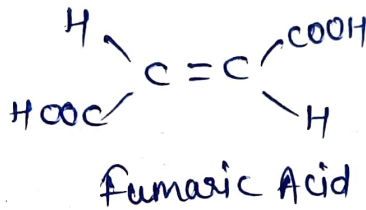
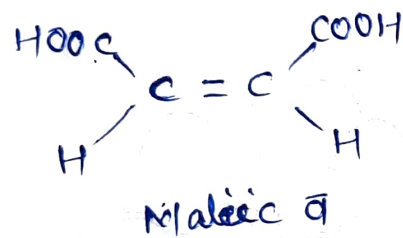
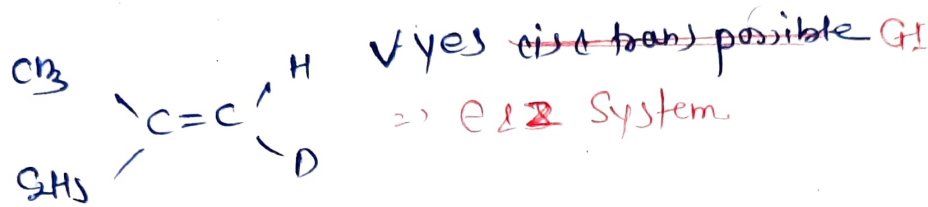
ex.



↳ No cis-trans

↳ Not-to be attached similar group in same C-atom.

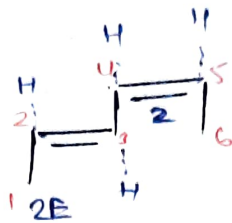
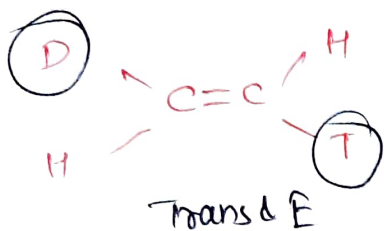
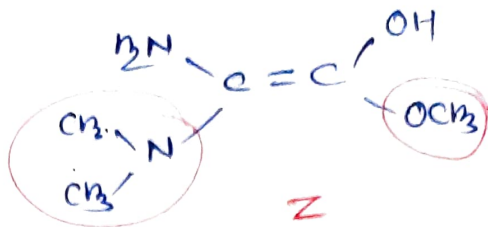
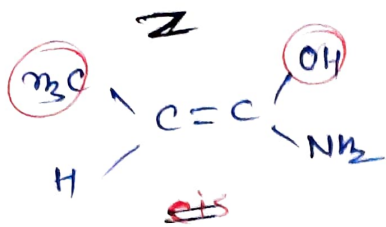
≠ Two atom/group on each C atom must be different


 # Cahn-Ingold Prelog Scheme - Rule

 # Priority assign to both group of each -e of π bond, based on Atomic No./Mass

 E = Entgegen: German word = opposite

 Z = Zusammen: German word = together



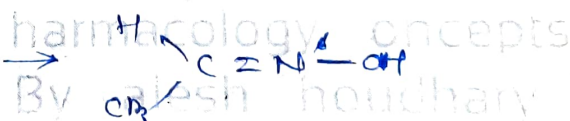
2E, 4E or 2Z, 4E
Hex-2,4-diene

Syn/Anti

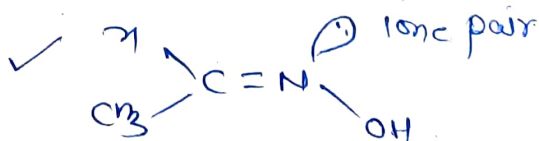
Syn - cis-like

Anti - trans-like

GE about C=N & N=N

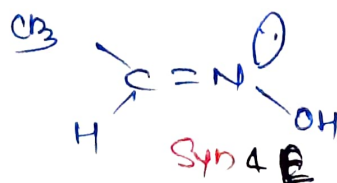
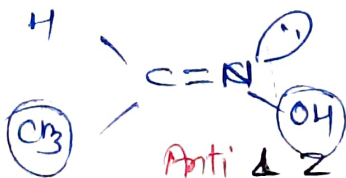


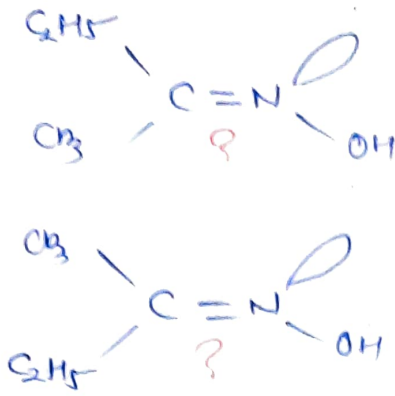
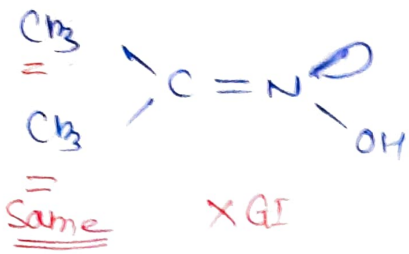
Aldoxime



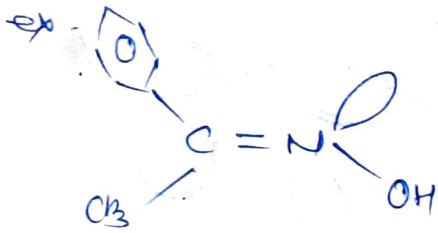
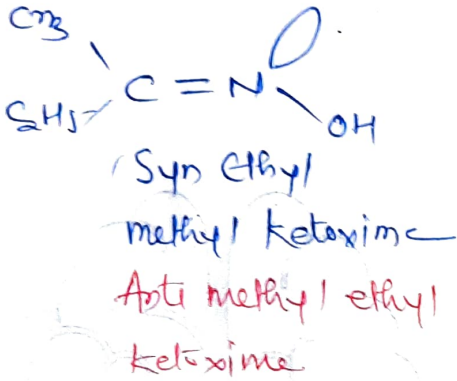
Geometrical Isomerism - Different e⁻ density +nt in c-atoms

↳ in aldoxime → H & OH opposite side - Anti
 → H & OH same side - Syn



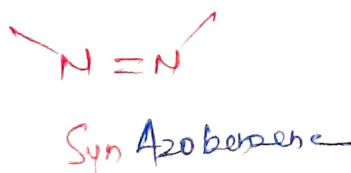
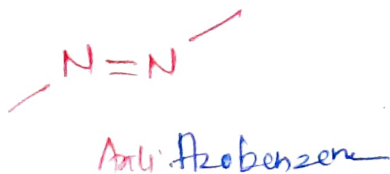
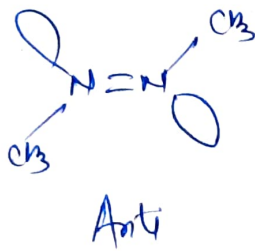
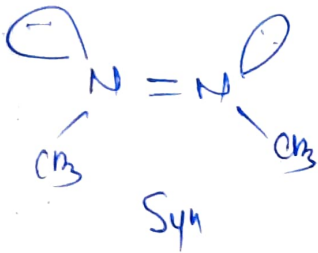


In keto oxime - Syn - Same side group respective to OH



Syn methyl phenyl keto xime
 Anti phenyl methyl keto xime
 pharmacology concepts
 By aiesh houdhary

In Azo Compounds

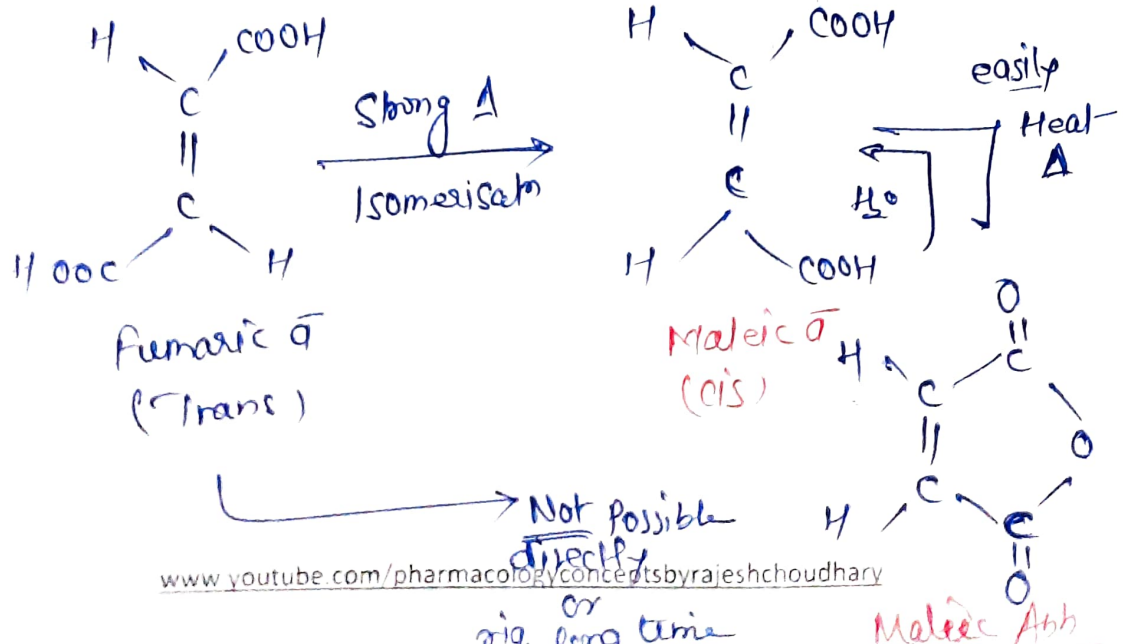


METHODS OF DETERMINATION OF CONFIGURATION OF GEOMETRICAL ISOMERS

- ① Method of Cyclization
- ② Method By converting into the compound of known configuration
- ③ optical activity
- ④ Method based on physical property
- ⑤ By stereoselective addition & elimination reaction
- ⑥ Formation of solid solutions
- ⑦ Method of conversion into less symmetrical product

① Method of Cyclization

It Applied when isomer is capable of forming a ring
 It Basic principle - Intramolecular reaction occur easily when the reacting group are closed together

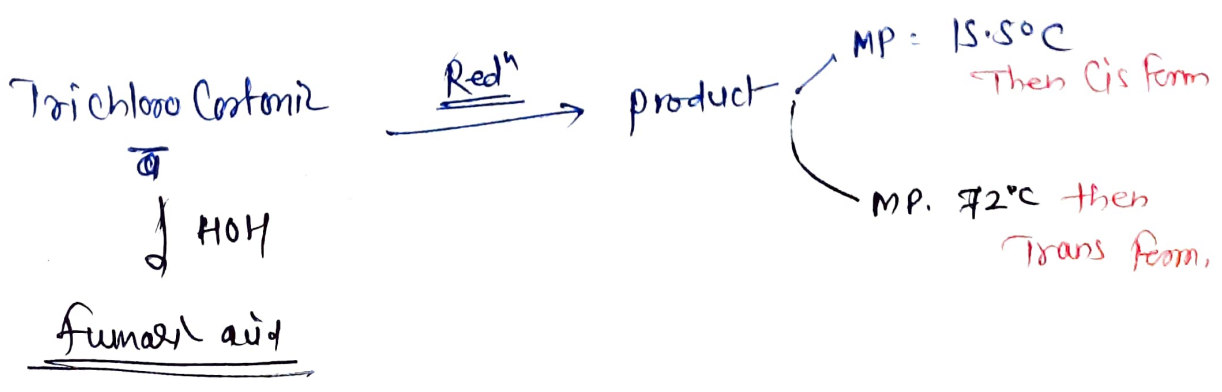
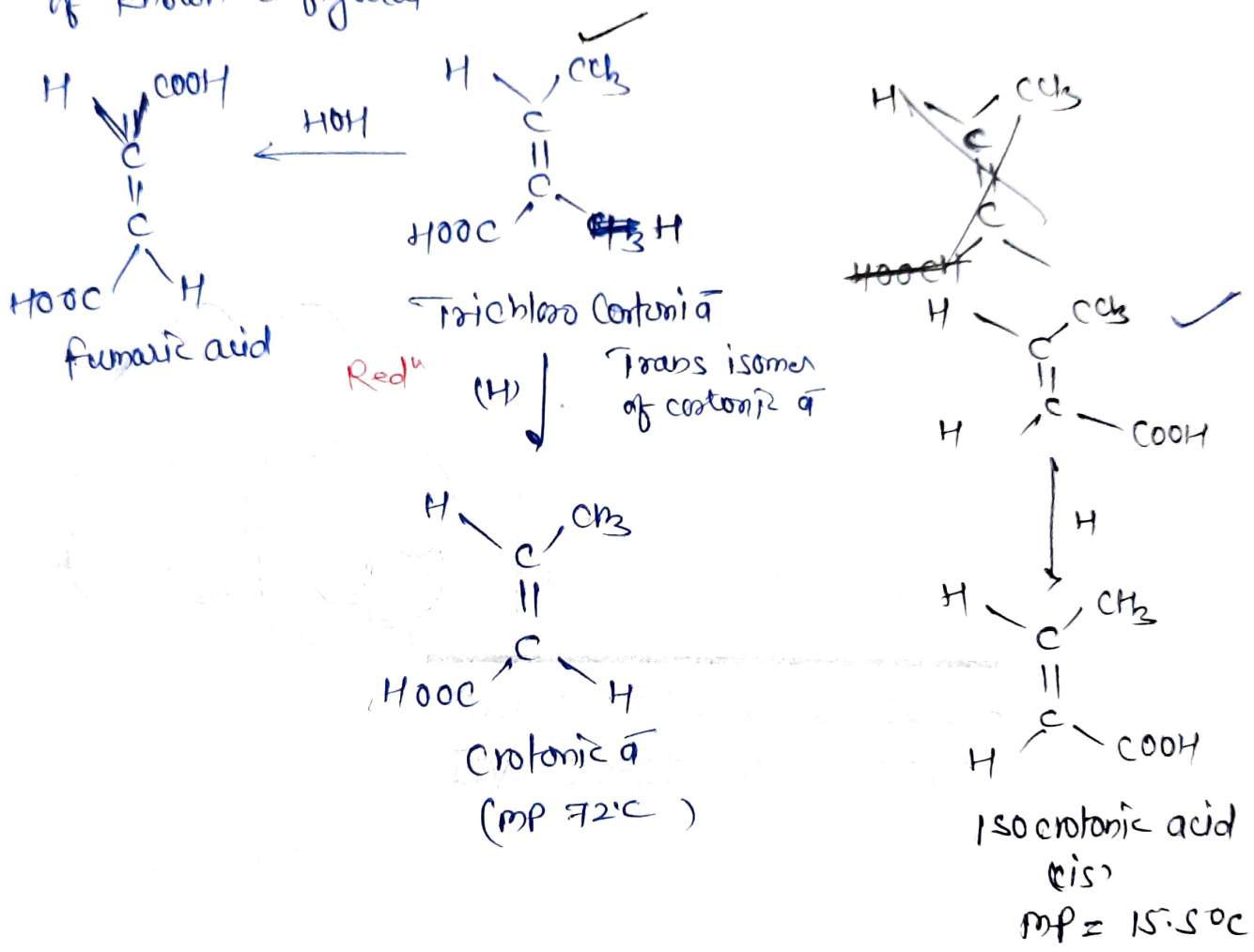




e.g. Maleic acid (cis) Vs fumaric acid (trans)
 citraconic acid (cis)
 mesaconic acid (trans)

② Method of Conversion into Compounds of known configuration

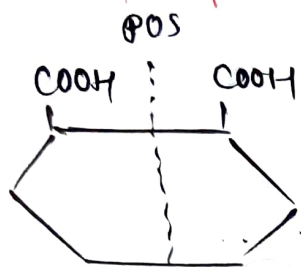
Geometrical isomers of pair can be converted into a compound of known configuration



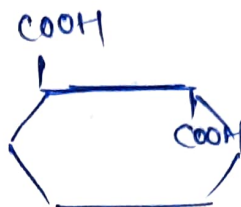
Method of Optical Activity

- # Among two geometrical isomers only one form is optically active & other is optically inactive due to plane of symmetry.
- # Optically active isomer may be resolved & may be used to establish its configuration

ex. Hexahydrophthalic acid, the trans form



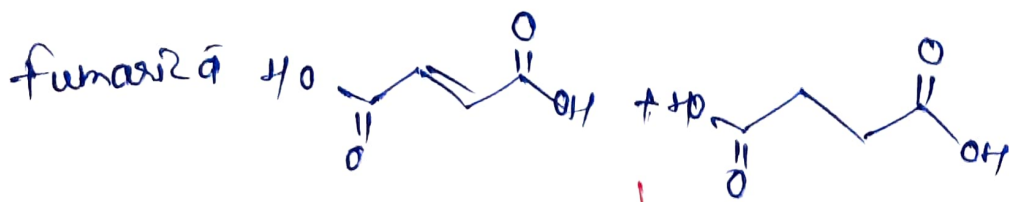
optically inactive



optically active
(trans)

④ Method of formation of Solid Solution

- # Applicable in such compound, whose structure is known & there is saturated derivative available
- # If the ~~same~~ shape of isomer is same to that of corresponding saturated compound, it can form solid solution with it



Solid Solution

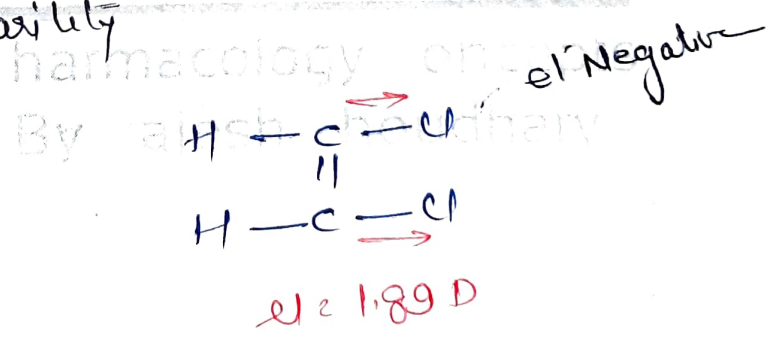
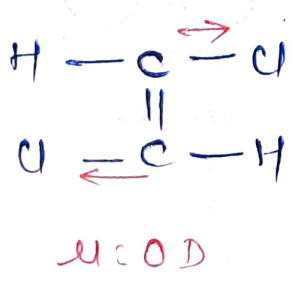
⑤ Method Based on Physical Properties



Parameter	Cis	Trans
Polarity	more	lower
B.P.	Higher due to high attraction forces	Lower due to absence of strong attraction force
Symmetry	less	High
MP	lower (due to loose packing of molecule)	Higher (tight packing)
Solubility in inert solvent	Higher	Lower
Stability in acyclic system	unstable	Stable

• Cis has higher density, refractive index, K_a , heat of combustion, heat of hydrogenation.

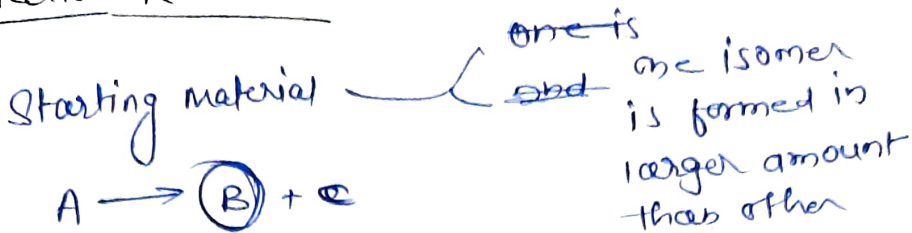
• Dipole moment \propto polarity



• UV-Spectroscopy - Trans isomer \rightarrow ~~in~~ higher λ_{max} because of resonance

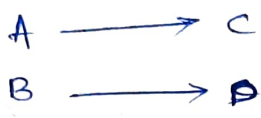
(c) By Stereoselective Addition & Elimination Reaction -

Stereoselective Reaction -



Stereospecific Reaction

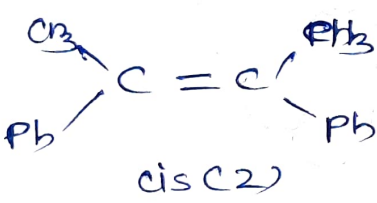
Different stereoisomeric starting material form different product



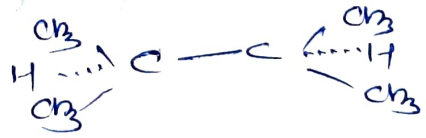
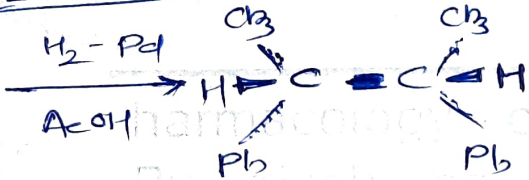
All stereospecific reactions are ^{always} stereoselective but all stereoselective reaction are not stereospecific

Addition \rightarrow

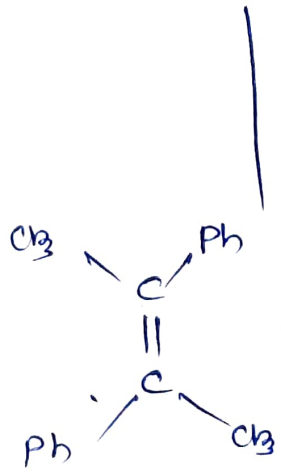
ex. Reduction



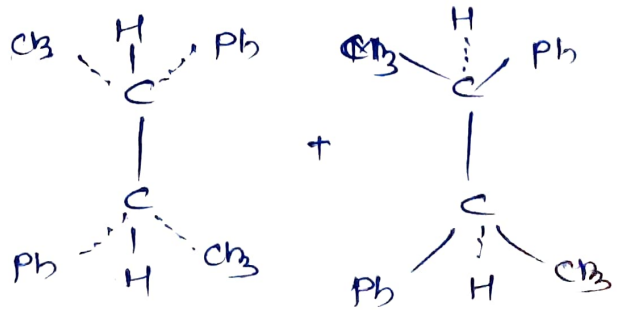
cis addⁿ



- both H₂ are attached in same plane
- + both are same (Meso)



cis addⁿ
 $\xrightarrow[\text{AcOH}]{\text{H}_2 - \text{Pd}}$

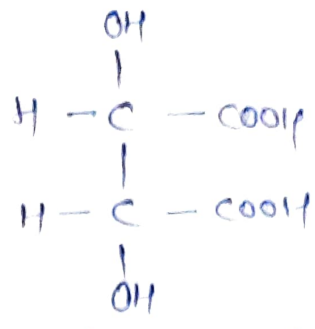
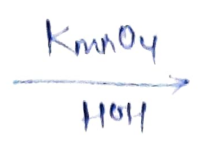
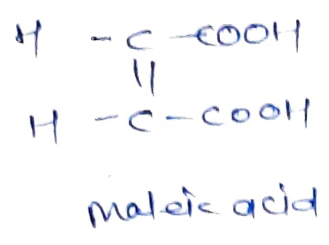


optically active isomers
 enantiomer

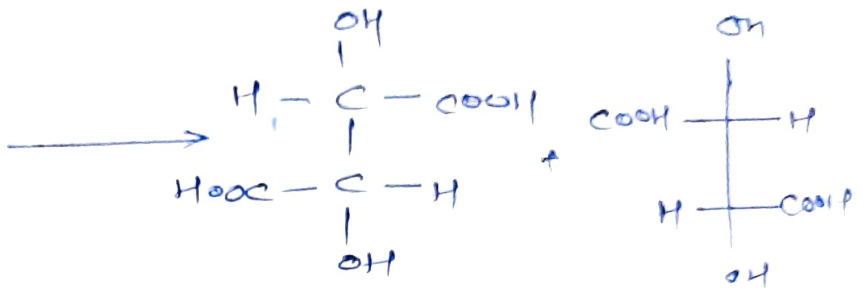
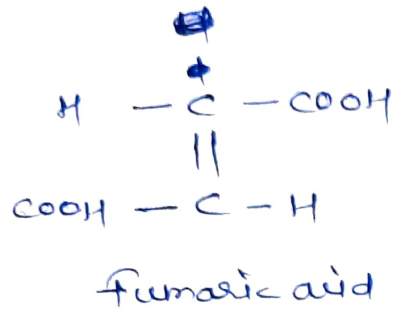


② Hydroxylation

cis addn

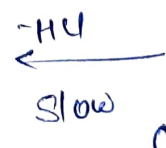
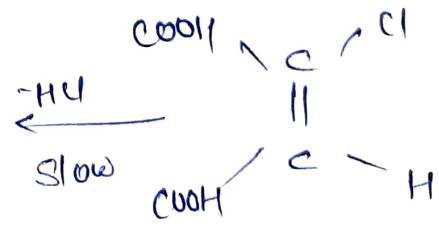
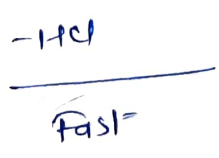
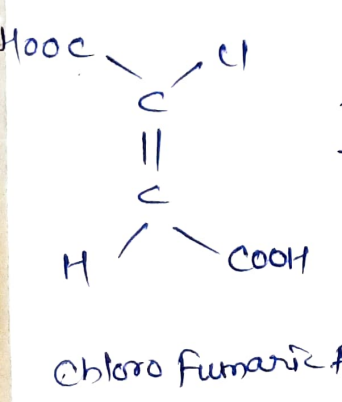
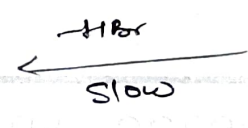
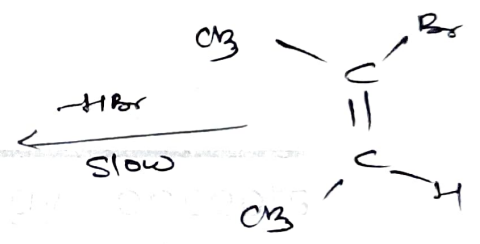
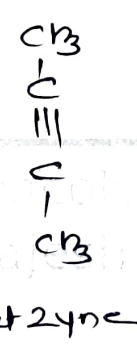
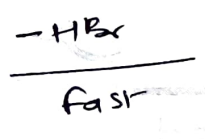
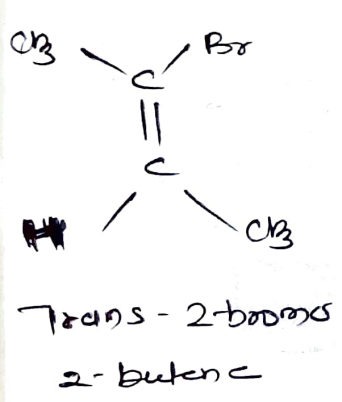


Added in same plane side
(Meso-Tartaric acid)



enantiomer
(± Racemic)

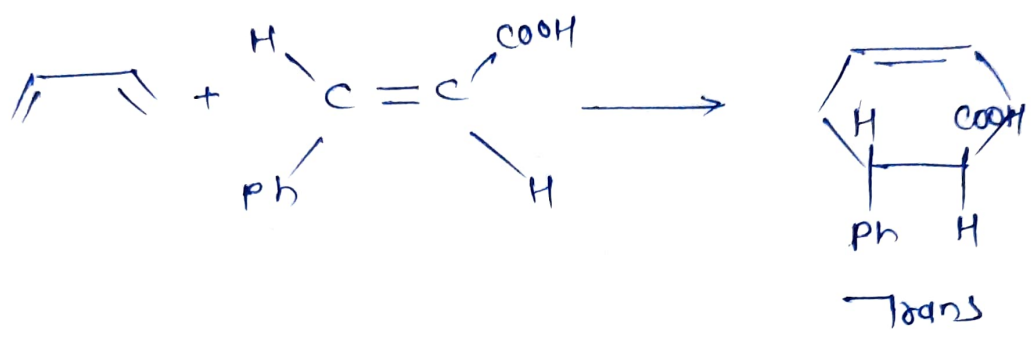
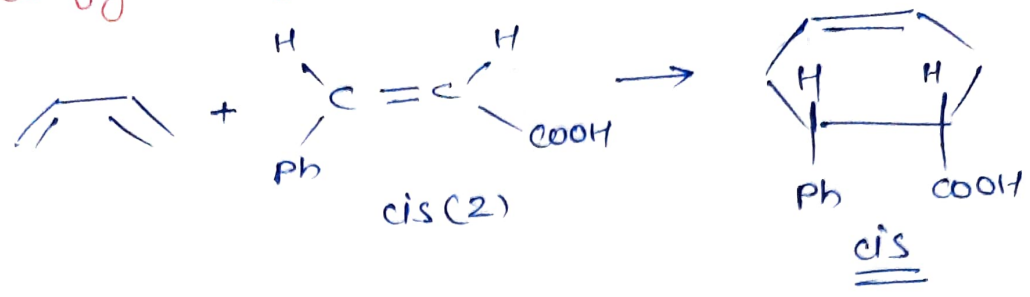
Elimination :- Trans elimination is fast



Chloro Maleic acid

Diels - Alder Reaction

configuration of dienophile is can be determined



* both have much more different physical property



pharmacology concepts
By ajesh houdhary

CONFORMATIONAL ISOMERISM IN →

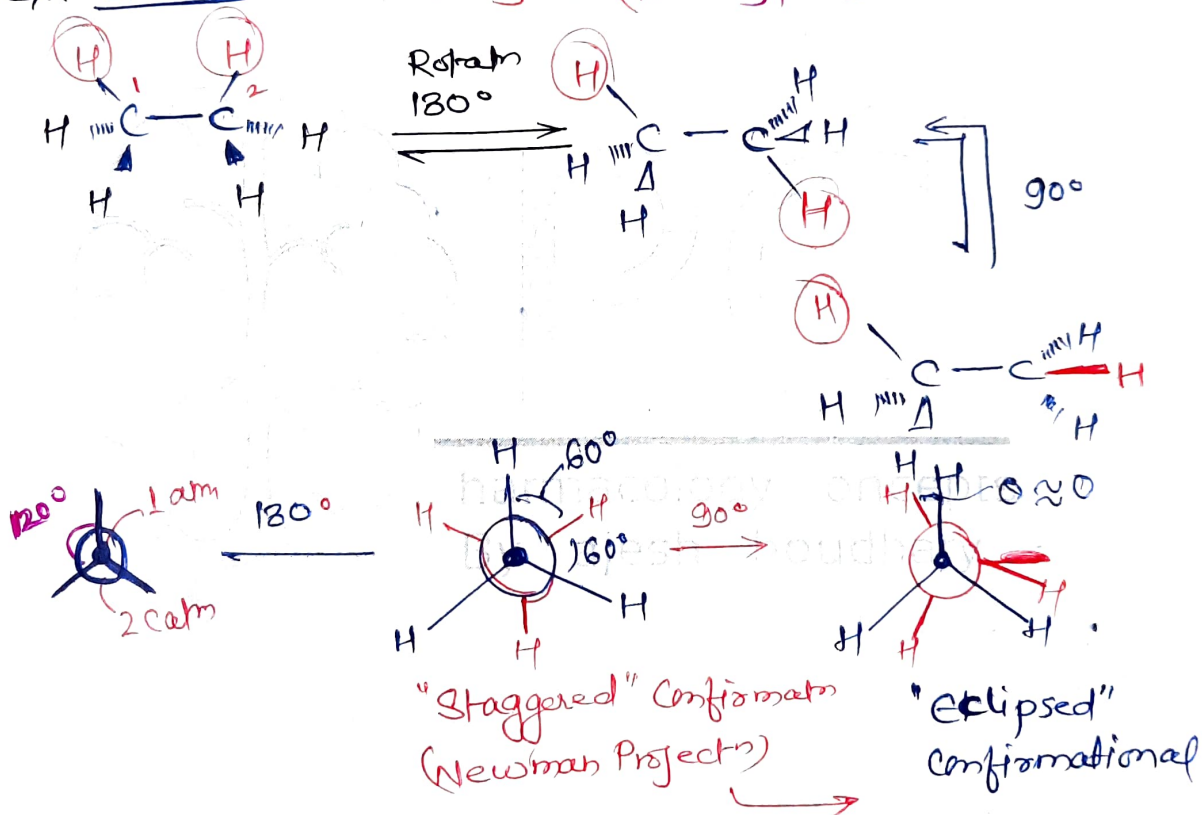


1. Ethane
2. n-Butane
3. Cyclohexane

Conformational Isomerism involves rotation about sigma bond, in which interconversions of isomer are possible by rotation referring to single bond. These isomers are called conformational isomers or conformers

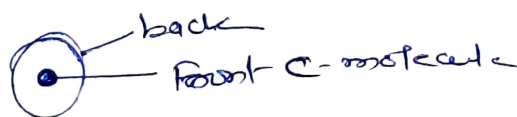
Exact same molecule that differ only in rotation of one or more sigma bond

Riq. energy available at room temp. # There are no. of conformers
 ex. ethane → 1-20 kJ mol⁻¹ (12.5 kJ/mol)

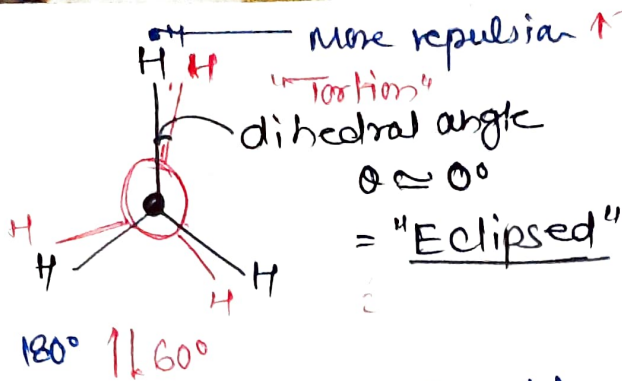


Ethane CH₃-CH₃, C₂H₆,

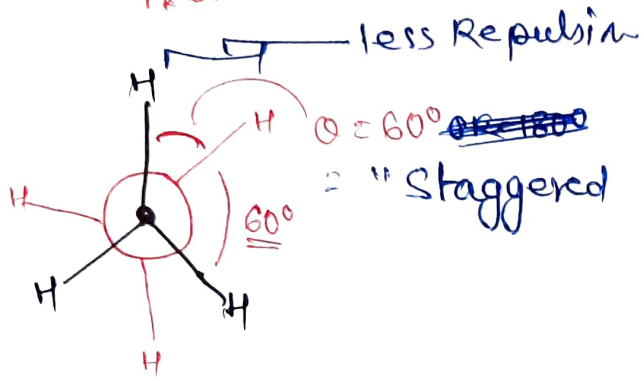
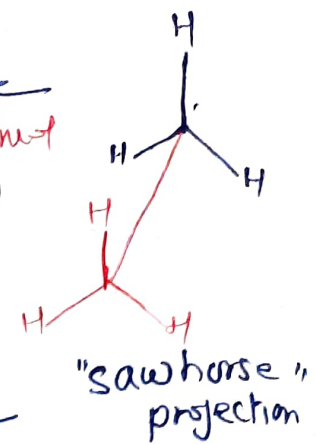
- 7 sigma bond (6 C-H & 1 C-C)
- C-C bond involve in rotation & change conformers
- 2-different conformational ~~states~~ (Major)
- easy to understand by Newman Projection



→ H by solid line
 → H by dashed line
 120° angle



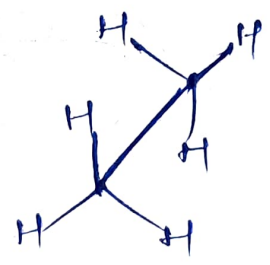
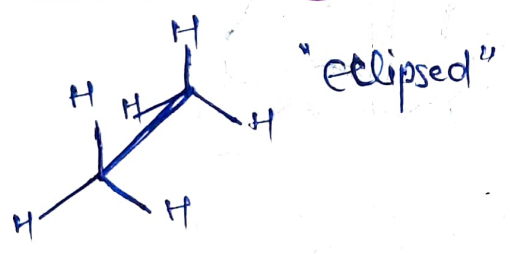
- # Less Stable
- # $E = 2.9 \text{ kcal/mole}$
- # High Torsional Strain



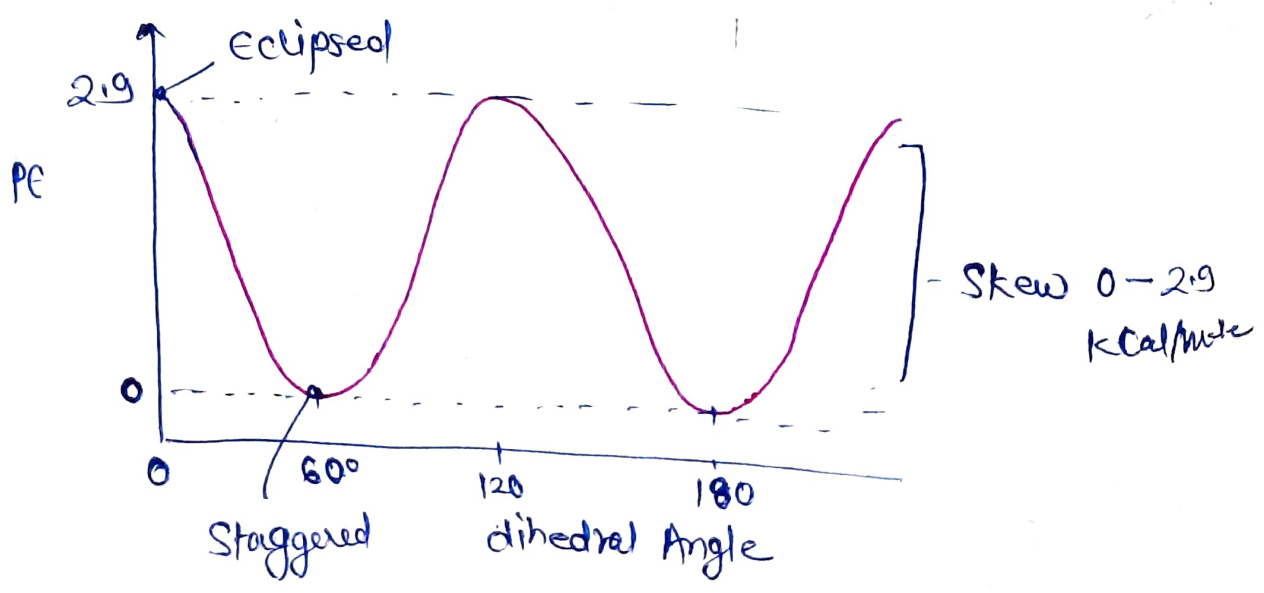
- # More Stable
- # $E = 0.0 \text{ kcal/mole}$
- # Low Torsional Strain

→ All form other than E & S are known as Skew

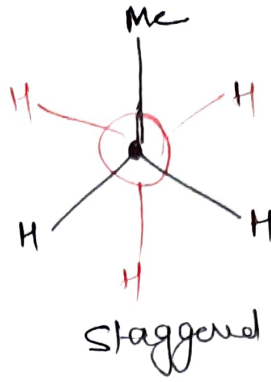
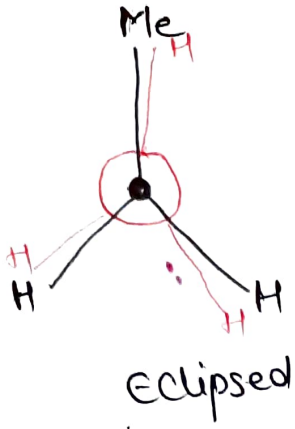
Sawhorse Projection



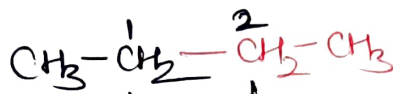
Energy Profile



Propane

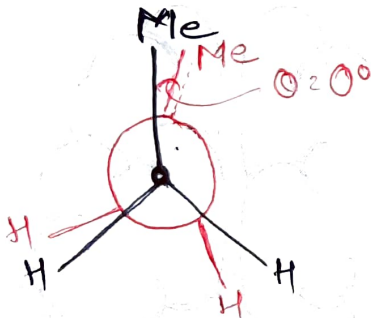


Butane



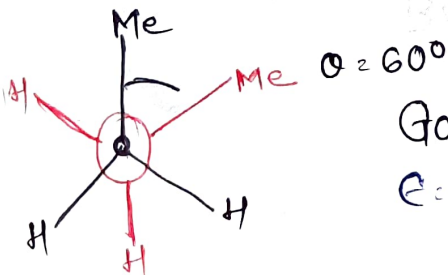
↳ more stable / symmetry

↳ Major 4 Conformers



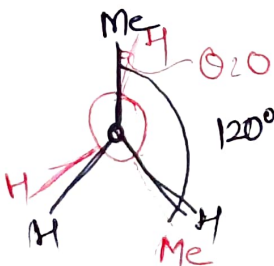
fully eclipsed
 $E = 3 \text{ kcal/mol}$

$\updownarrow 60^\circ$



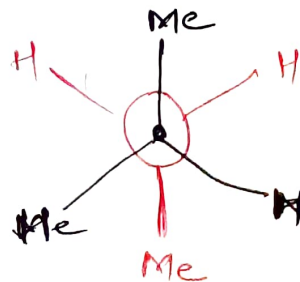
Gauche (Staggered)
 $E = 0.9 \text{ kcal/mol}$

$\updownarrow 60^\circ$



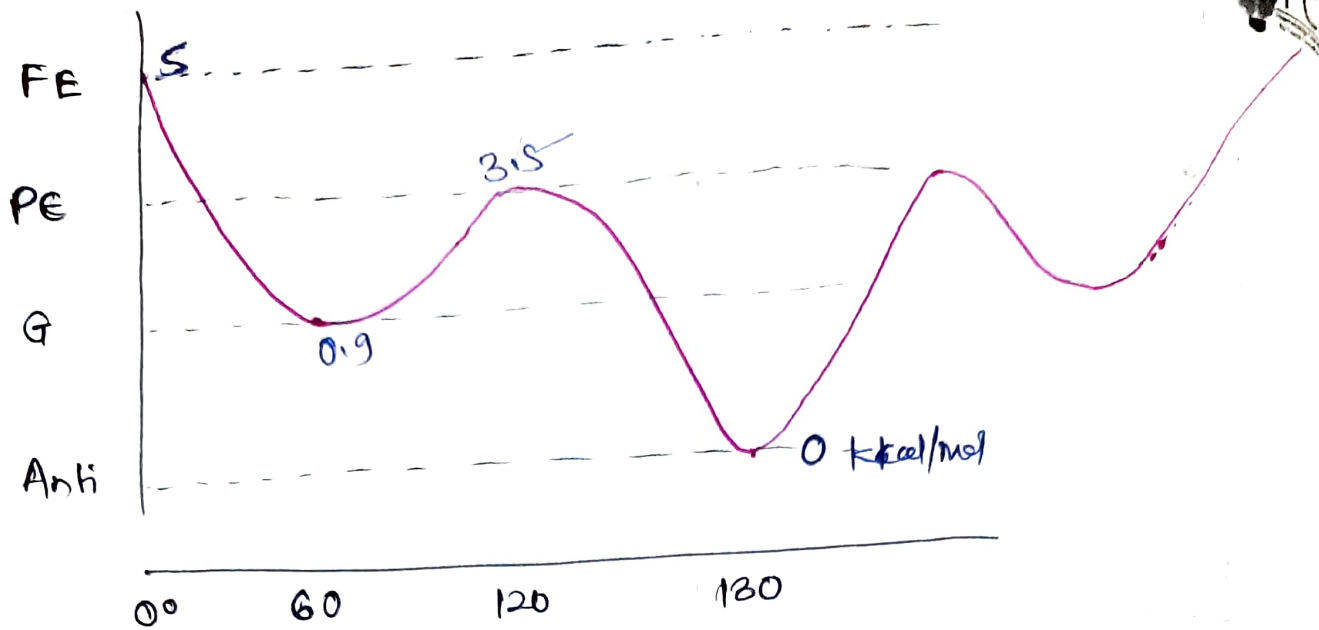
Partially eclipsed

$E = 3.5 \text{ kcal/mol}$



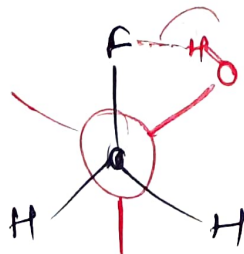
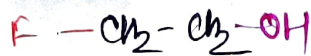
Anti (Staggered)

$E = 0 \text{ kcal/mol}$



Stability: Anti > Gauche > PE > FE
Energy: FE > PE > Gauche > Anti

* Gauche Effect: Stability of Gauche form is more than Anti if H-bond is present



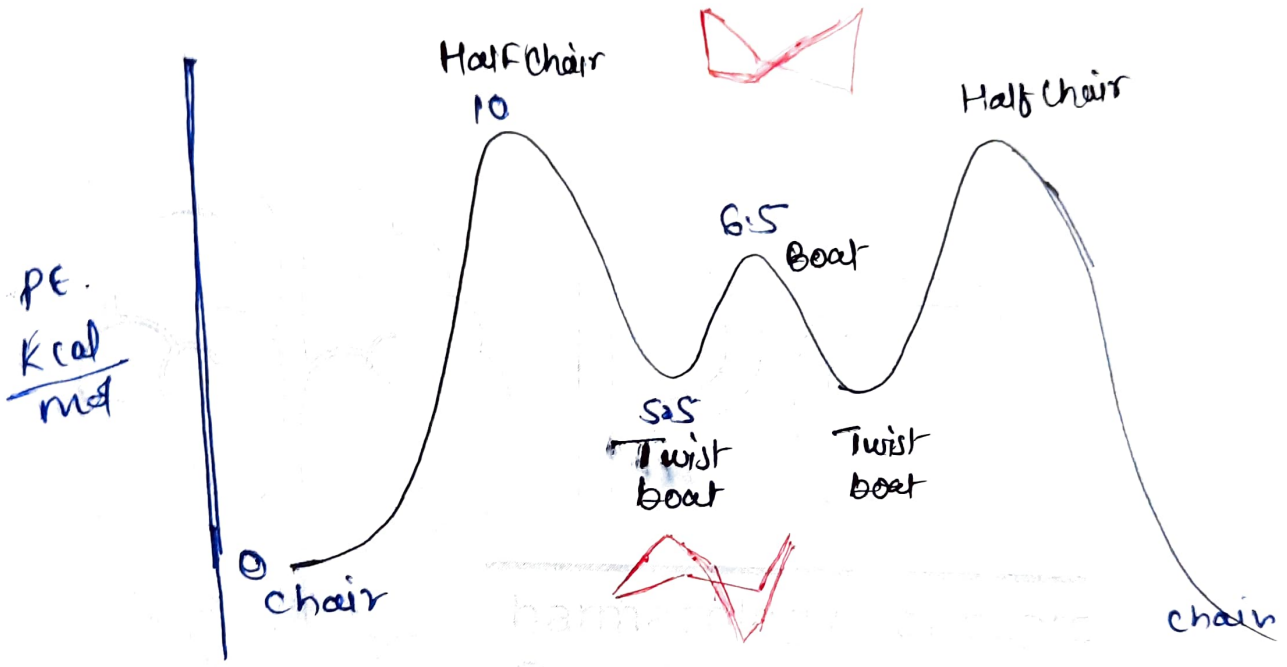
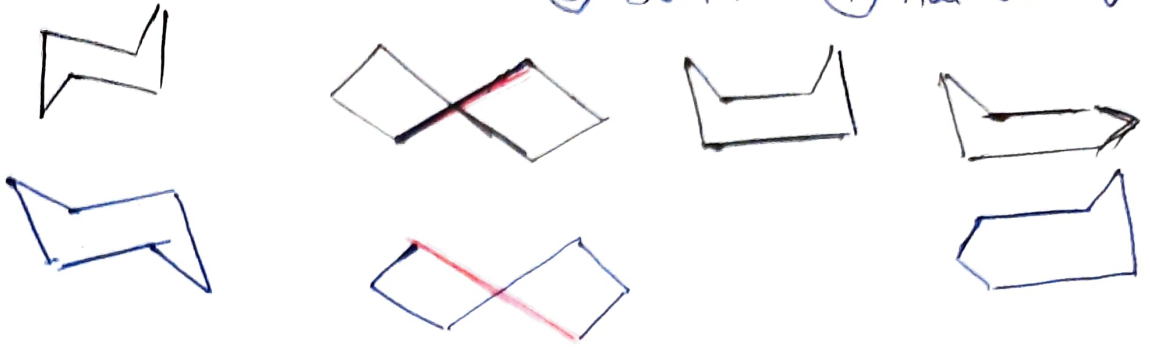
Intramolecular H-bonding

G > A > PE > FE

Cyclohexane

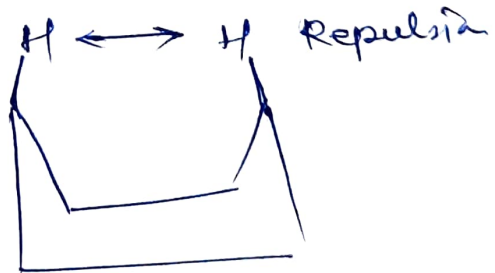


- ① chair form ② Twist form ③ Boat form ④ Half chair form



Stability = Chair > Twisted boat > Boat > Half chair

* Flag Pole hydrogen

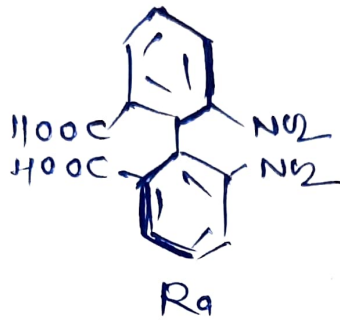
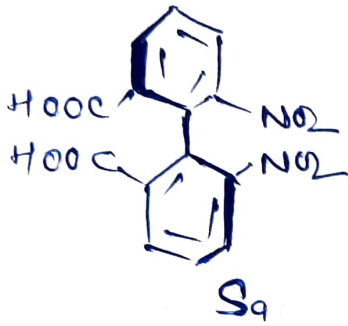


Twist Boat = optically active

STEREOMERISM IN BIPHENYL COMPOUND

ATROPISOMERISM

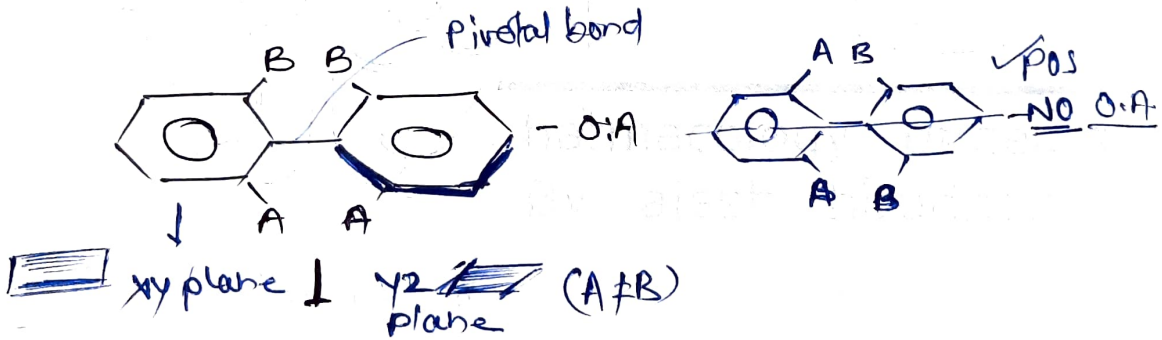
Arising because of hindered rotation about a single bond, where energy differences due to steric strain or others create a barrier to rotation.



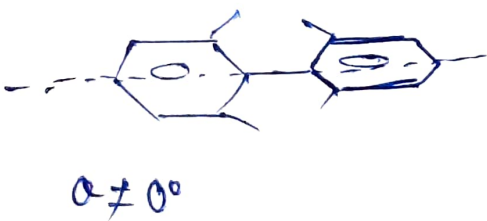
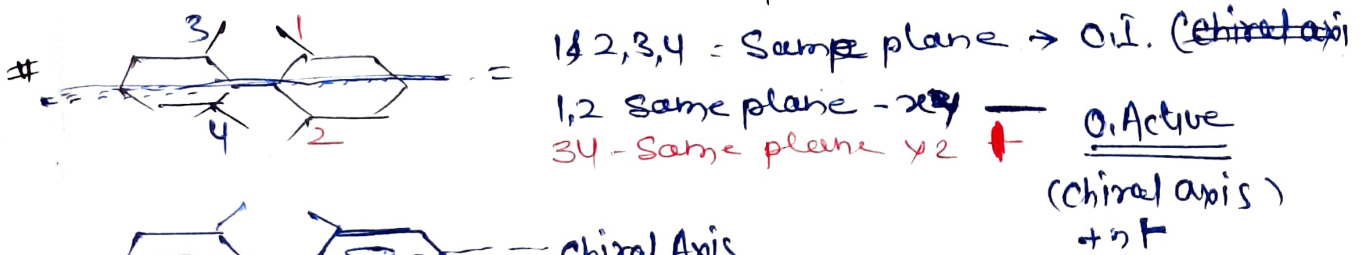
Christe & Kenner
in 1922
observed in
6,6'-dinitro-2,2'-diphenyl
acid

Condⁿ for OA

① both ring must be substituted at ortho-position
in unsymmetrical manner

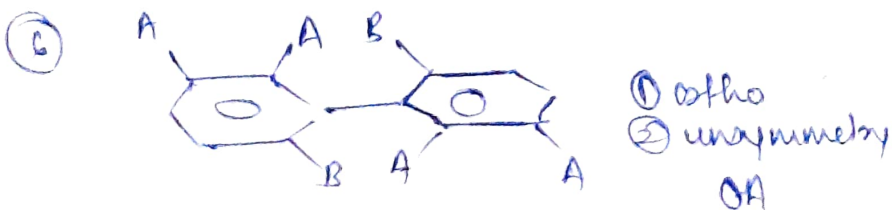
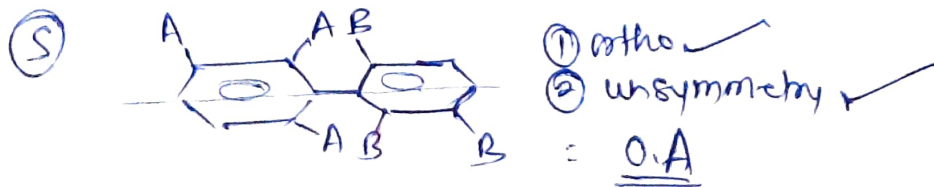
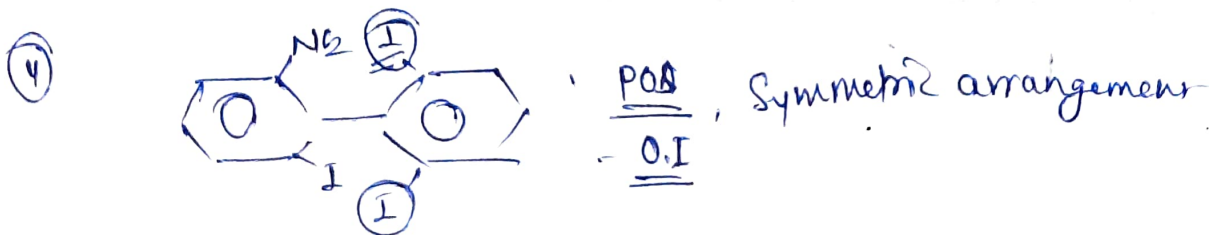
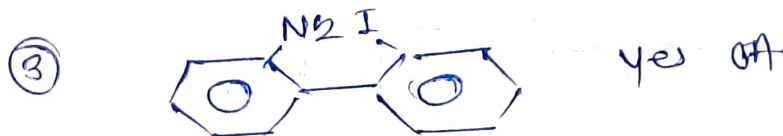
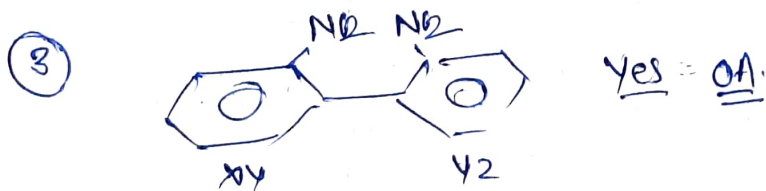
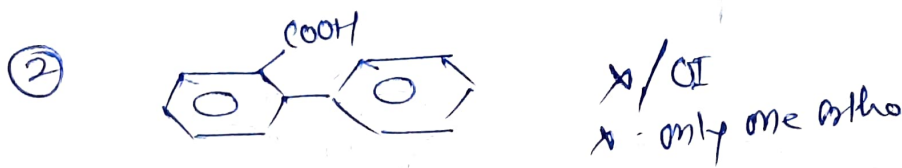
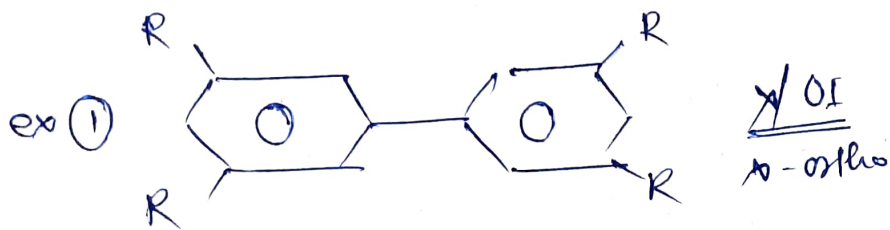


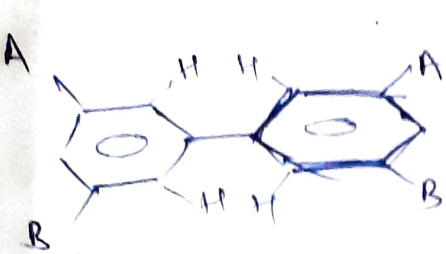
If same plane → Repulsion → arranged in perpendicular ⊥ plane



- ② along the axis individual molecule in same plane but differ in each other (planes)
- ③ unsymmetric arrangement of atom

- Condⁿ
- (I) ortho Substitution
 - (II) unsymmetric arrangement
 - (III) Two ring at different plane (perpendicular to each other) 90°
 - (IV) Not have centre of Symmetry & plane of Symmetry



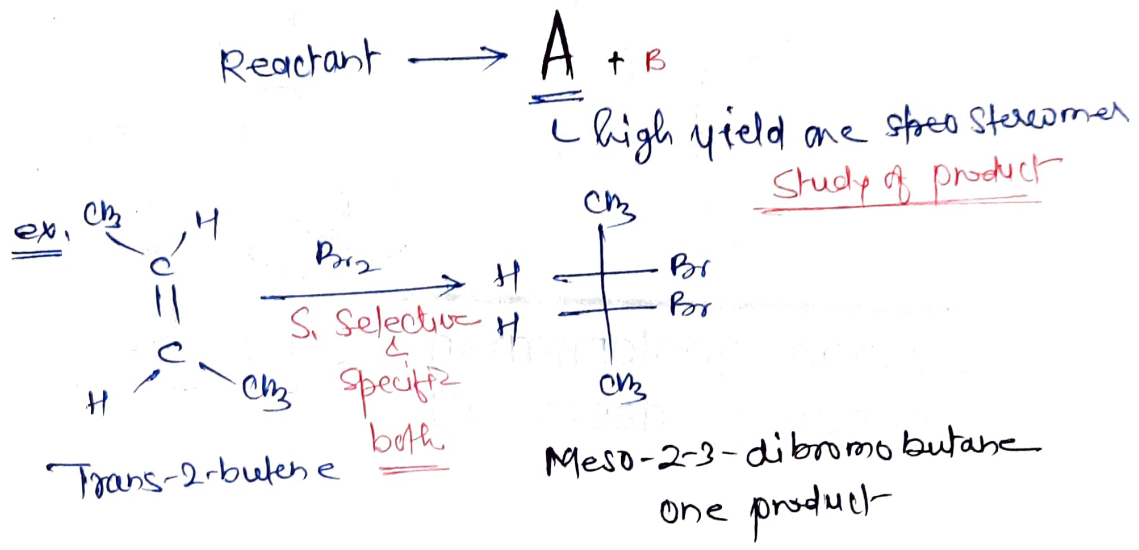


- * 0° possible
- * Same plane
- * POS
- * 0.1.

STEREOSPECIFIC & STEREOSELECTIVE REACTION

StereoSelective Reaction

The reaction that yield predominantly one stereoisomer (or one pair of enantiomers) of several possible diastereomers is a called a stereoselective reaction.



StereoSpecific Reaction

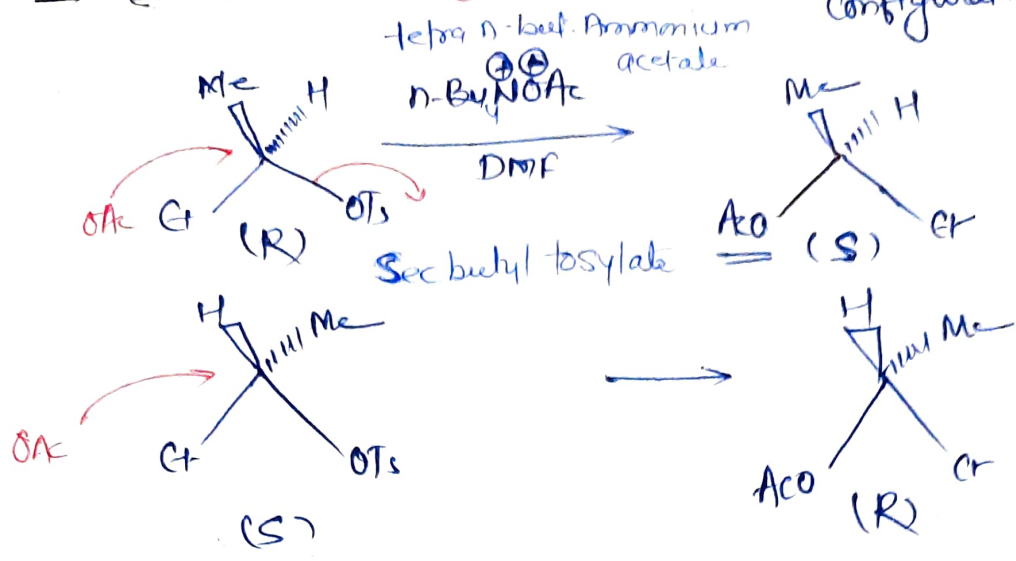
A reaction in which stereochemically different reactants gives stereochemically different product



* All stereospecific reactn are stereoselective but all stereoselectives are not stereospecific

Reactn of both :-

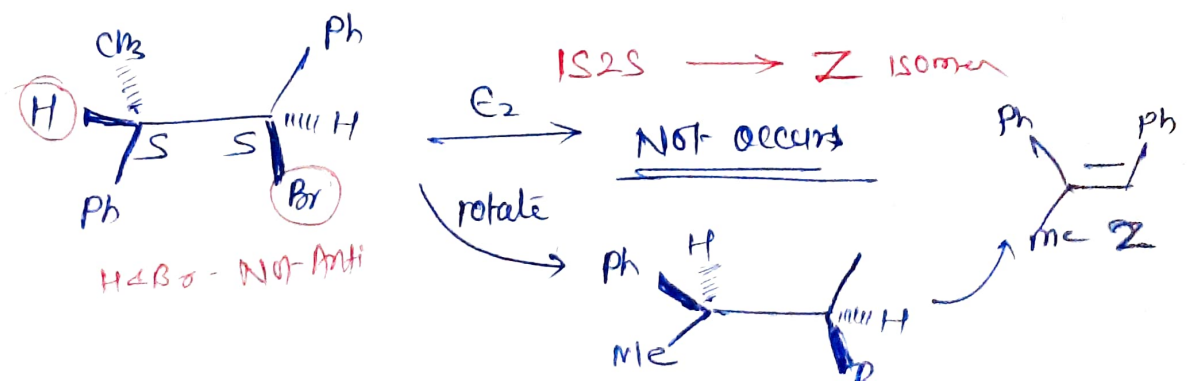
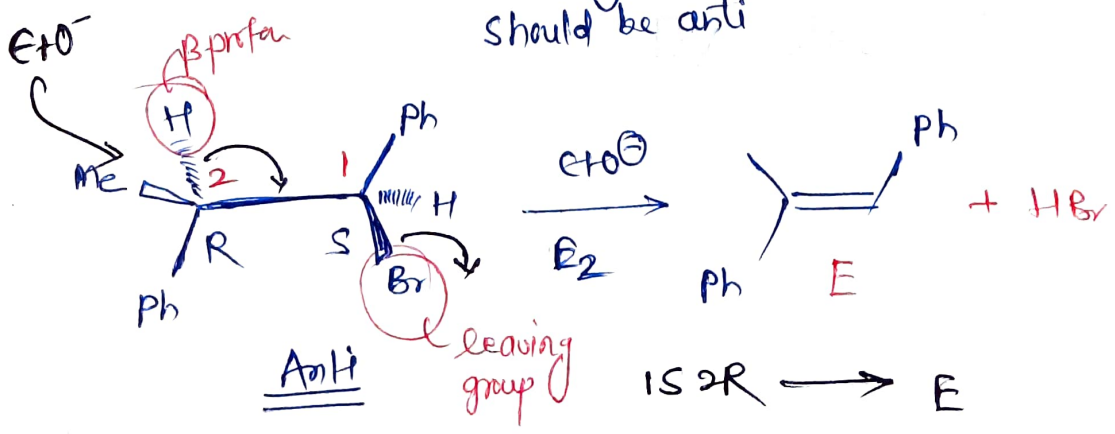
ex. stereoselectivity (1) SN² Reactn - Inversion of Configuration



* different stereoisomer produce different product
 # Also a Stereoselective Reaction

(2) E₂ Reaction

Bimolecular Reactn
 # proton abstraction & elimination of leaving group occurs simultaneously
 # leaving group & the proton on β -carbon should be anti

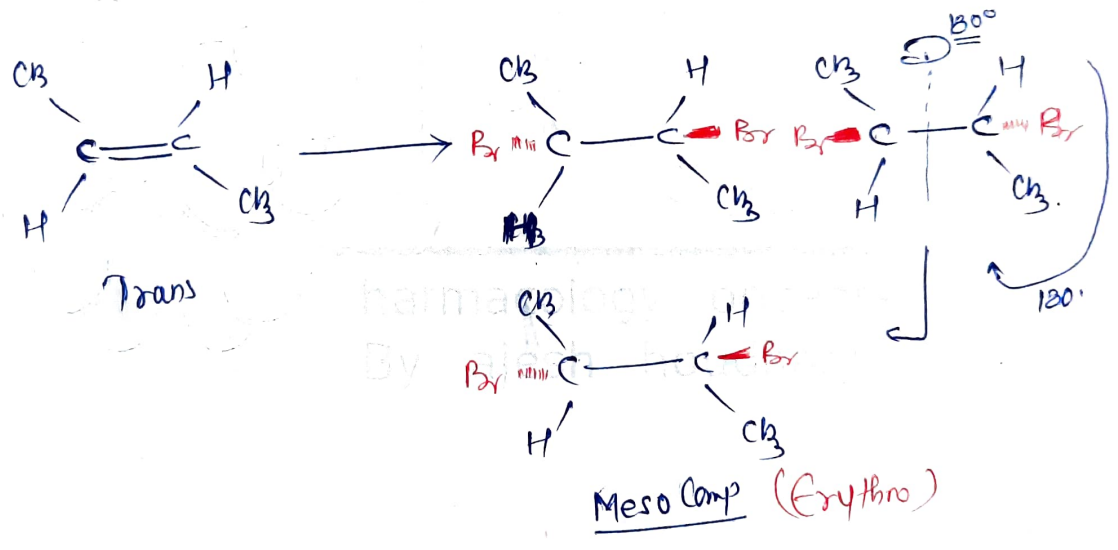
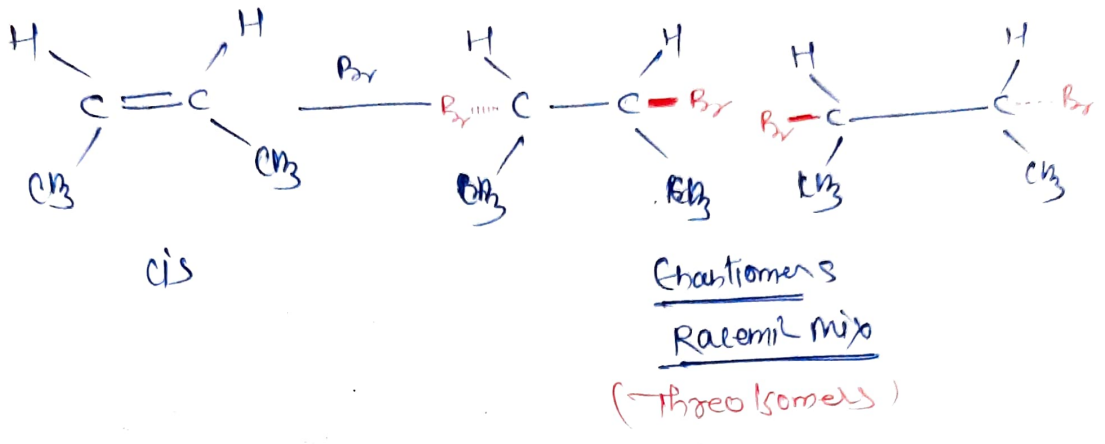


③ Electrophilic Addition Reaction of Alkene

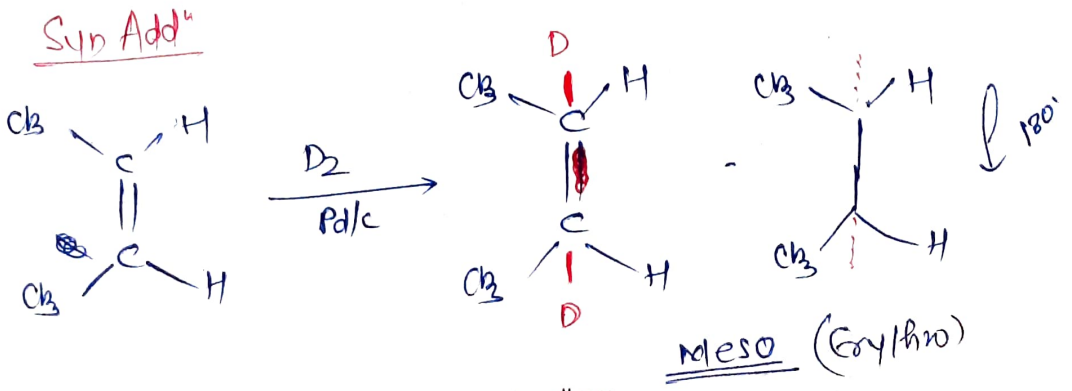


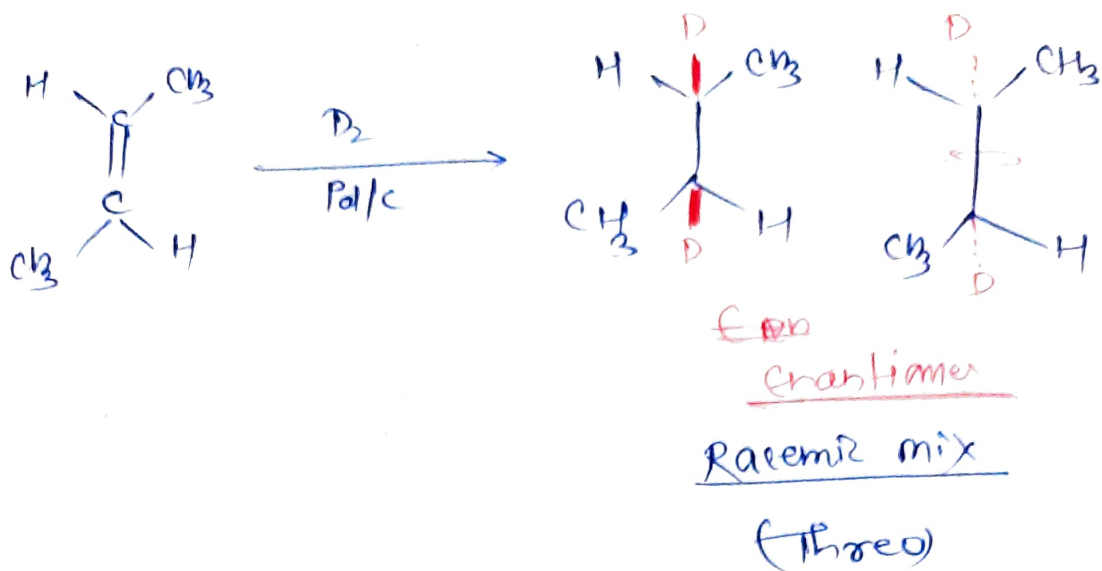
Cis or Syn Addⁿ - In Same plane
 Trans or Anti Addⁿ → In opposite plane

Anti Addition

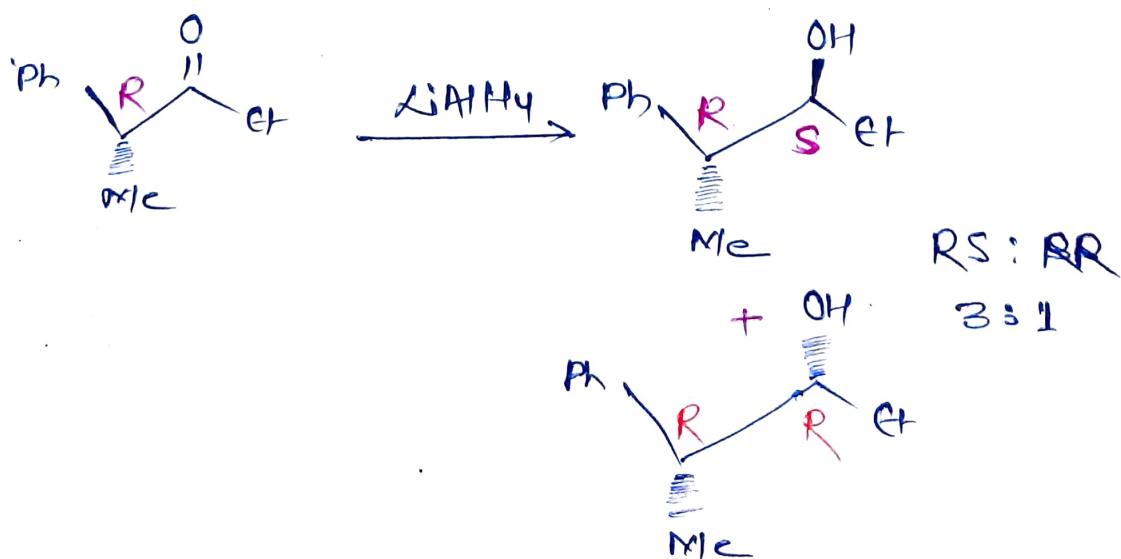
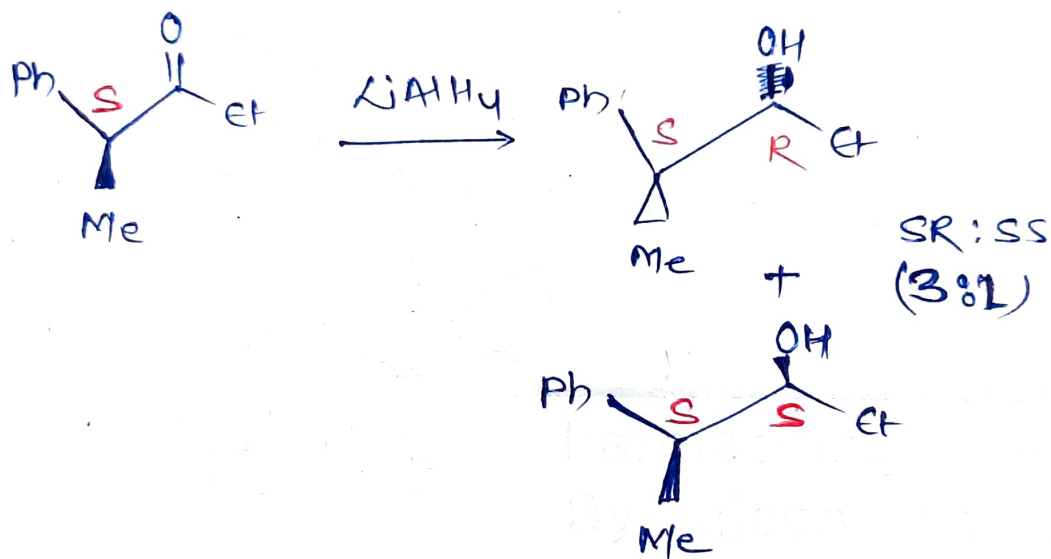


④ Deuteriation of cis-2-butene & trans-2-butene





⑤ Nucleophilic Addⁿ of chiral Aldehyde/Ketone



Stereoselective Reaction but not stereospecific

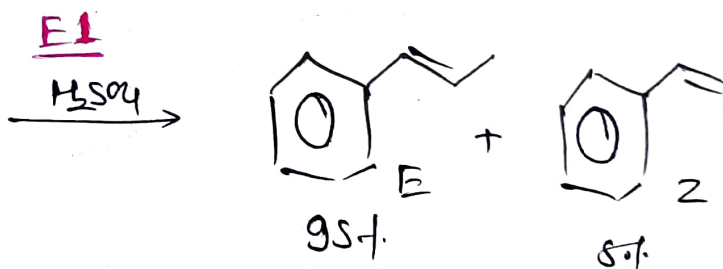
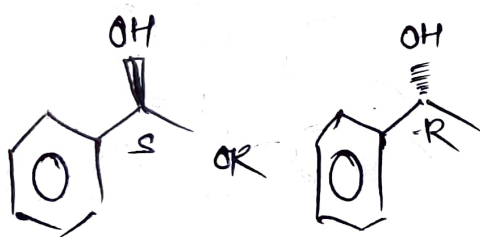
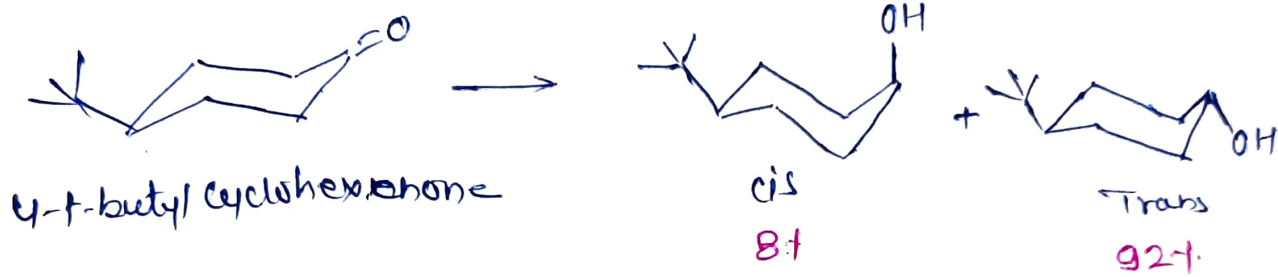


Acetophenone



↳ Not show stereoisomer

↓



both Enantiomers can give same product