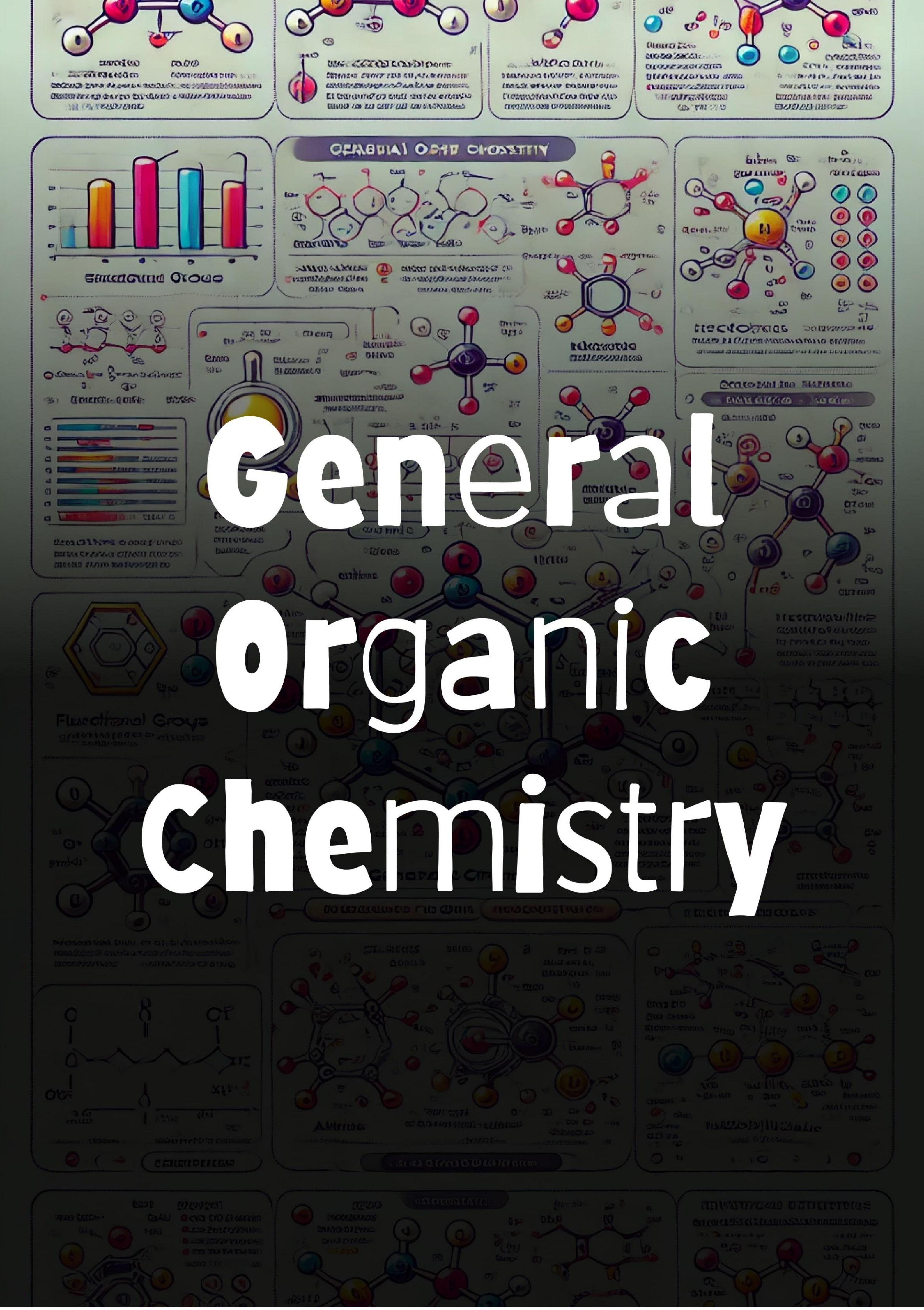
General Organic Chemistry



GOC

- Electronic effect

(motion of paired electron in molecule)

Permanent effect	Temporary effect
① Inductive effect.	① Electro-mergic effect.
② Hyperconjugation	
③ Resonance	
④ Mesomeric	

- Inductive effect :-

① Polar covalent bond. (min 1 bond)

$$\overset{\delta\delta+}{CH_3} \rightleftharpoons \overset{\delta+}{CH_2} \rightleftharpoons \overset{\delta-}{F}$$

CH_2: E.N = 2.5 $\quad$ F: E.N = 4

$\delta\delta < \delta$ – partially charge. $< 1.6 \times 10^{-19}$ C

-I effect	+I effect
C—C—C—(G)	C—C—C—(G)
Electron withdrawing group	Electron Donating group

- -I effect order :

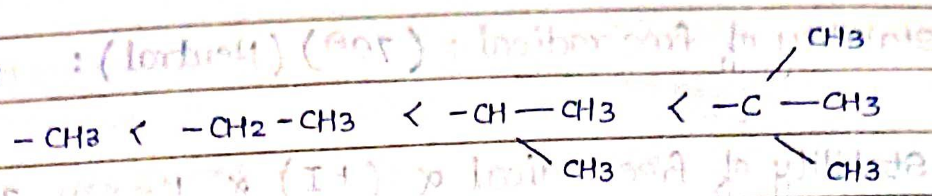
Na Ferrari NO Santro Cyano Ali ko Cat

$NF_3 > NR_3 > NH_3 > NO_2 > SO_3H > CN > CHO > C=O > -COOH$

Driver Halogen Aur Alcohol ne triple Nashe me Bech di

$COCl > CONH_2 > F > Cl > Br > I > OR > OH > -C\equiv CH > NH_2 >$ Benzene $> C=CH_2$

- +I effect :

① 

$-CH_3 < -CH_2-CH_3 < -CH(CH_3)-CH_3 < -C(CH_3)_3$

1° < 2° < 3°

② T > D > H (Isotropic effect)

③ $NHR^- > OR^-$

④ +I effect ∝ No. of c-atom in Alkyl group (same type of Alkyl group)

- Application :

① Acidic strength — Power of Acid or strength of Acid

$HA \rightleftharpoons H^+ + A^\ominus$

Acid conjugate ion (-ve ion)

Acidic strength ∝ stability of conjugate ion ∝ $\frac{1}{\text{charge of conj. ion}}$

Acidic strength ∝ (-I) ∝ $\frac{1}{(+I)}$

check — DNP → Power
Distance
Number

② Carbocation ($6e^\ominus$) (+ve)

Stability of carbocation ∝ (+I) ∝ $\frac{1}{(-I)}$ 3° > 2° > 1° > $CH_3^\oplus$

③ Carboanion ($8e^\ominus$) (-ve)

Stability of carboanion ∝ (-I) ∝ $\frac{1}{(+I)}$ 1° > 2° > 3°

④ Stability of free radical : ($7e^{\ominus}$) (Neutral) :

Stability of free radical ∝ (+I) ∝ $\frac{1}{(-I)}$ $3^{\cdot} > 2^{\cdot} > 1^{\cdot}$

- Hyperconjugation :

- σ – bond ka delocalization.

① $H - \overset{|}{C} - CH_2^{+}$ H → α-Hydrogen ↳ α-carbon.

- Condition :

① $-\overset{|}{C}^{+}-$; $-\overset{\cdot}{\underset{|}{C}}-$; $>C=C<$

② $H - C - CH_2^{\cdot}$ → α-carbon. ↳ α-Hydrogen

② at least one α-Hydrogen / Halogen.

③ α-carbon → sp^3 hybridisation.

③ $C = C - \underset{|}{C} -$ → α-carbon H → α-Hydrogen

- No. of Hyperconjugating = No. of α-Hydrogen

Figure

- Stability of carbocation
Stability of Free radical } ∝ No. of α-Hydrogen.
Stability of Alkene

- Note : H-effect >>> I-effect.

Trans > Cis — Hyperconjugation

- Heat of Hydrogenation ∝ $\frac{1}{\text{No. of } \alpha\text{-Hydrogen}}$.

- Types of Hyperconjugation.

+H-effect

$C - H$ — α-Hydrogen
α-carbon.

-H-effect

$C - X$ — α-Halogen
α-carbon.

- **Bond length:**

$C-H \longrightarrow 1{\cdot}34\ A^{\circ}$

$>C-C< \longrightarrow 1{\cdot}33\ A^{\circ}$

$C=C \longrightarrow 1{\cdot}08\ A^{\circ}$

- **Resonance :**
  - Lone pair / π - bond delocalization in conjugate system.
  - Conjugate system : Alternate σ (single) and double bond arrangement.
  - Condition :

① $\oplus$ —— ==

② $\ominus$ —— ==

③ $\odot$ —— ==

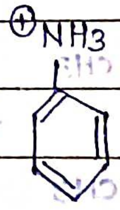
④ $\ddot{\bigcirc}$ —— ==

⑤ == ——

Note : In non cyclic and cyclic conjugate system.
No. of Resonating structures = No. of alternate location till we get on own starting place.

- Note : (+) charge on atoms which doesn't have vacant orbital cannot be localised.

ex :



- Stability of Resonating structures:

Rule ① : Octet complete + Neutral.

Rule ② : octet complete + Charge species.

Rule ③ : If charge present in vacant orbital atom - more stable condition.

Rule ④ : $\left.\begin{matrix}(E.N)^{-ve} \\ (E.P)^{+ve}\end{matrix}\right\}$ stable hota hai $\left\{\begin{matrix}\text{Condition: Absence} \\ \text{of vacant orbital.}\end{matrix}\right.$

Rule ⑤ : $\text{Stability} \propto \dfrac{1}{\text{distance b/w two opposite charges}}$

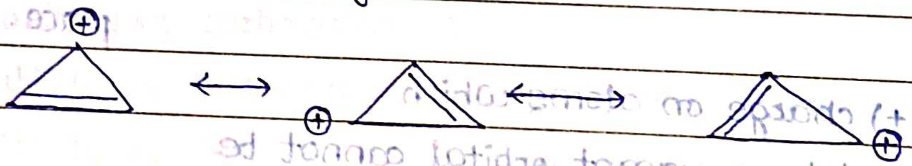
Rule ⑥ : $\left.\begin{matrix}\overset{\oplus}{A} - \overset{\oplus}{B} \\ \overset{\ominus}{A} - \overset{\ominus}{B}\end{matrix}\right\}$ unstable.

Rule ⑦ : More no. of covalent Bond ⟶ More stable.

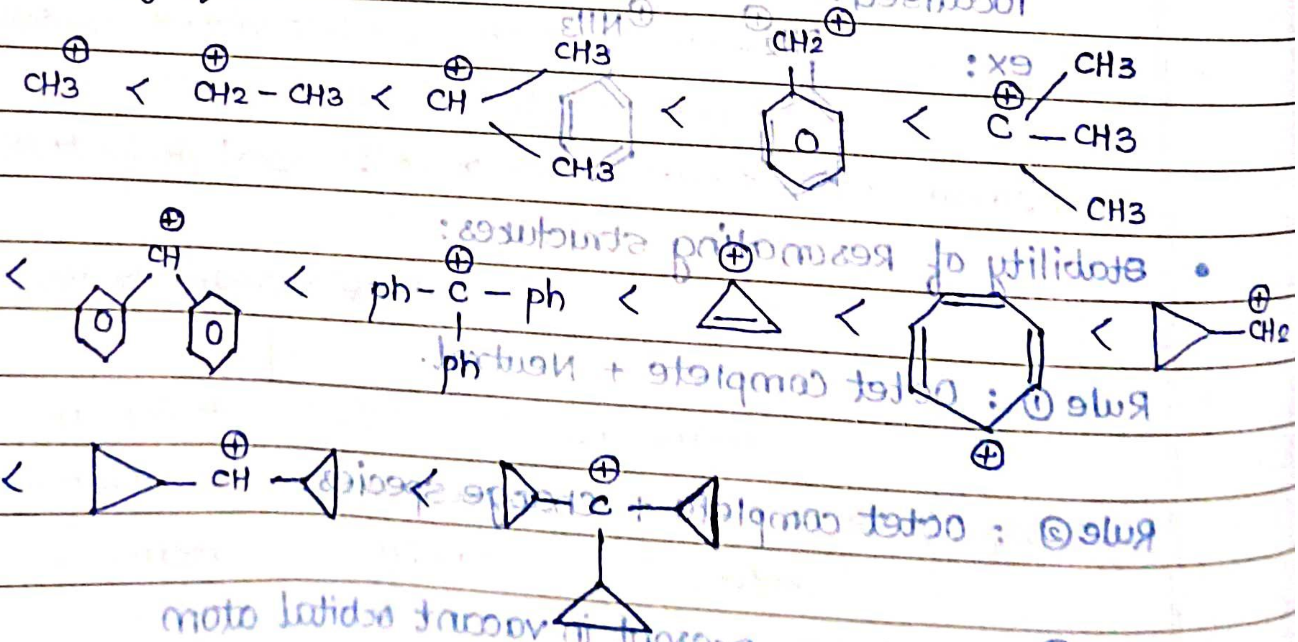
Rule ⑧ : stability ∝ No. of Resonating Figures.

Resonance effect >> Hyperconjugation >> Inductive effect.

Note: equal Resonating effect ⟶ most stable.

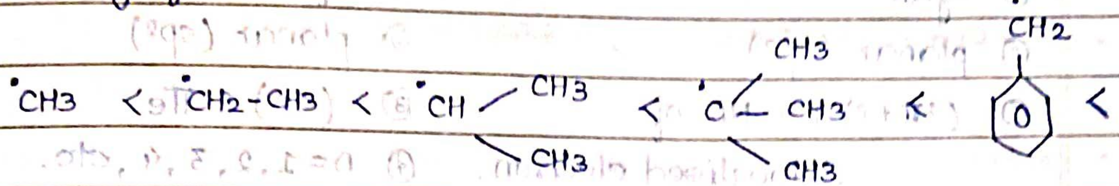


- Stability of Carbocation :

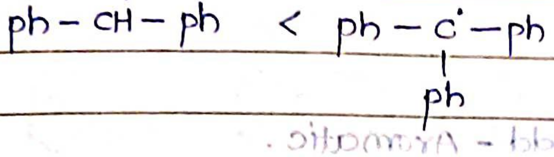


- Note : Aromatic equal Figure > Aromatic > Resonating Figure > Non-Resonating > Anti-aromatic.

- stability of Free-Radical :

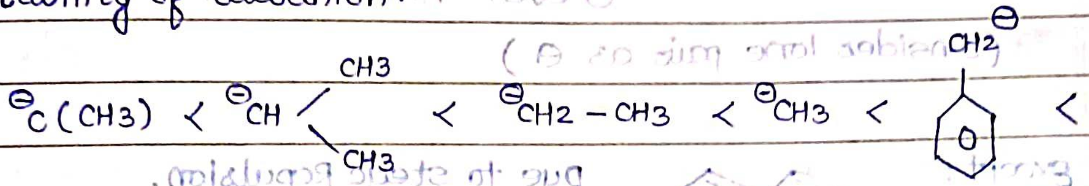


$\dot{C}H_3 < \dot{C}H_2-CH_3 < \dot{C}H(CH_3)_2 < \dot{C}(CH_3)_3 <$ $C_6H_5\dot{C}H_2$ $<$

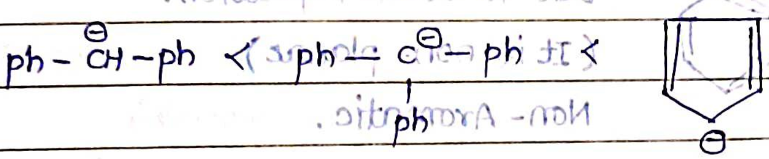


$ph-\dot{C}H-ph < ph-\dot{C}(ph)-ph$

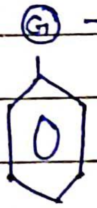
- Stability of carbanion :



$\overset{\ominus}{C}(CH_3) < \overset{\ominus}{C}H(CH_3)_2 < \overset{\ominus}{C}H_2-CH_3 < \overset{\ominus}{C}H_3 <$ $C_6H_5\overset{\ominus}{C}H_2$ $<$



$ph-\overset{\ominus}{C}H-ph < ph-\overset{\ominus}{C}(ph)-ph <$ (Aromatic-equal Resonating Figure)

- Mesomeric effect (Resonance) :
-  Ⓖ — Electron donating (Activating) group
  (+M or +R) The Functional group which have lone pair.

- ortho and para directing group ⟶ $E^{\oplus}$ attack in ortho and para position because of high $e^{\ominus}$ density.

-  Ⓖ — Electron withdrawing group (Deactivating)
  (-M or -R) —— The Functional group which have double bond.

- Meta directing — $E^{\oplus}$ attack in meta because of low $e^{\ominus}$ density.

- **Aromaticity :**

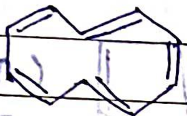
Aromatic	Anti-aromatic
① cyclic	① cyclic
② planar (sp^2)	② planar (sp^2)
③ $(4\pi+2)\pi$ = No. of delocalised electron.	③ $(4n) = \pi e$.
④ n = 0, 1, 2, 3, 4, etc.	④ n = 1, 2, 3, 4, etc.

- ex: Which structure has ⊖ odd - Aromatic.

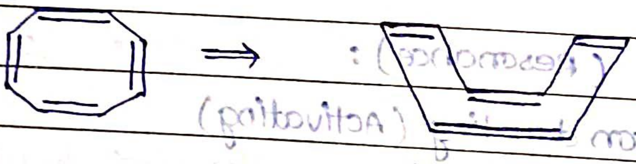
  ⊖ even - Anti-aromatic

  (consider lone pair as ⊖)

- except:

① 

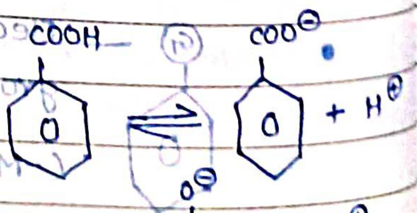
Due to steric Repulsion.
(It is non-planar)
Non-Aromatic.

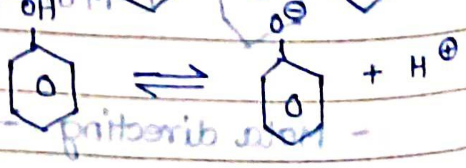
② 

Non-Aromatic
(Non-(planar)+)

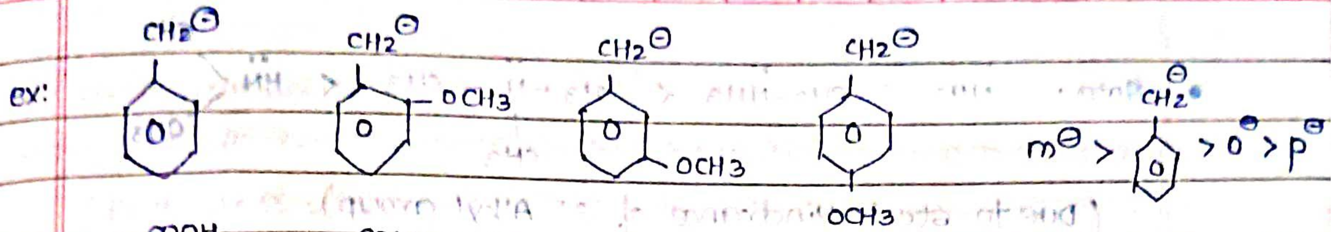
- Stability: Aromatic > Non-Aromatic > AntiAromatic

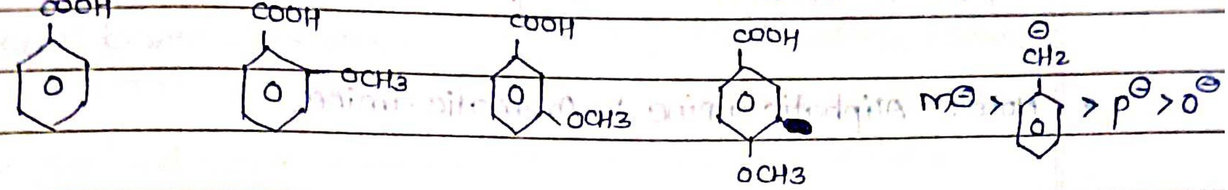
- Stability of Carbanion ⟶ 

Acidic strength of Benzoic acid ⟶ 

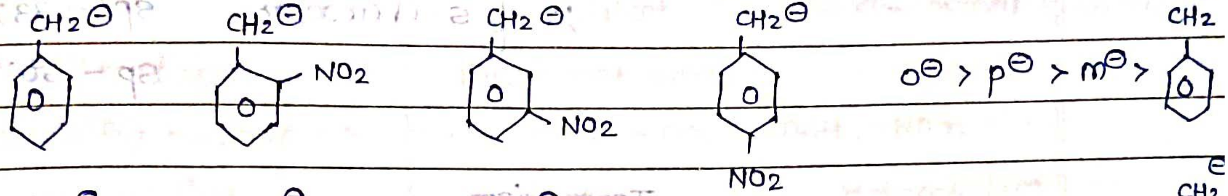
Acidic strength of phenol ⟶ 

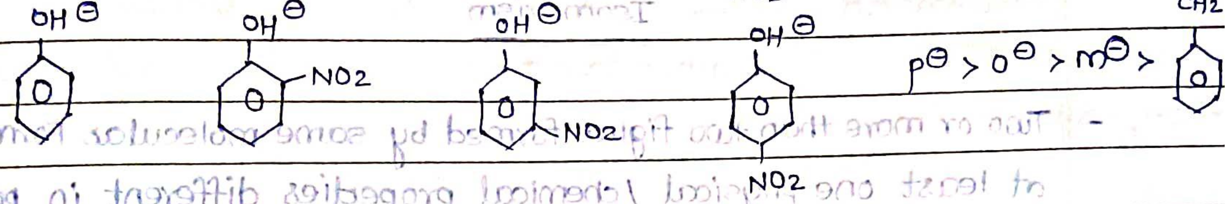
ex:





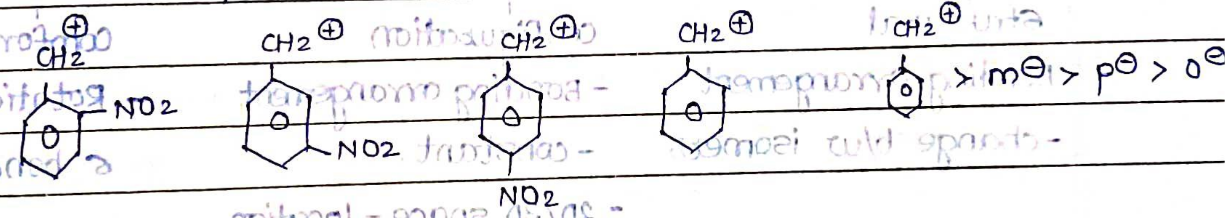
Note: Due to Intra-Molecular H-bonding.

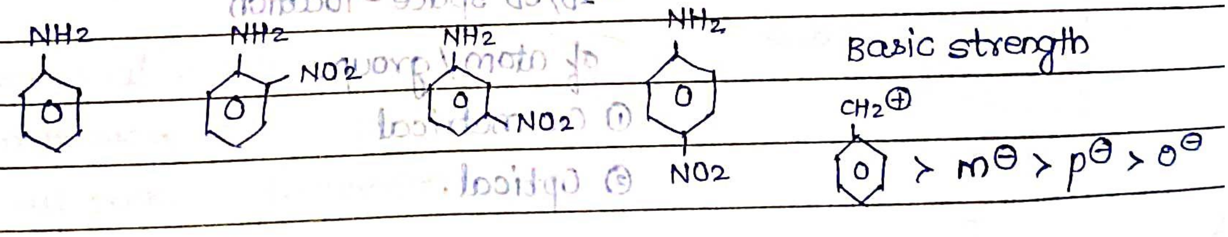




- Note → stability of free radical ⟶ same concept

  (Benzyl Free Radical)

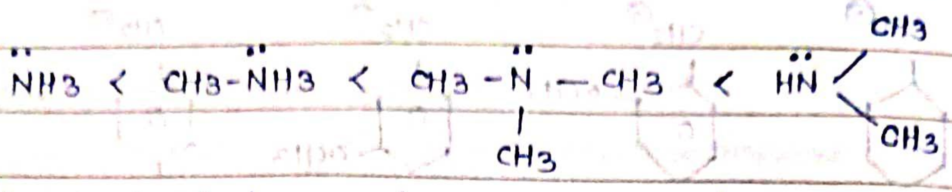




- Basic strength:

Basic strength $\propto$ $e^{\ominus}$ density of $\ddot{N}$ - atom $[(Hyb)_n = \text{Const}]$

$$B.S \propto (+I) \propto \frac{1}{(+I)}$$

- Note : 

$$\ddot{N}H_3 < CH_3-\ddot{N}H_3 < CH_3-\underset{\underset{CH_3}{|}}{\ddot{N}}-CH_3 < H\ddot{N}\begin{matrix} CH_3 \\ CH_3 \end{matrix}$$

(Due to steric Hindrance of 3° Alkyl group)

- Note : Aliphatic amine > Aromatic amine.

- Note : Basic strength $\propto \dfrac{1}{\%\ \text{of s-character}}$

sp^3 - 25%.
sp^2 - 33%.
sp - 50%.

Isomerism

- Two or more than two figure formed by same molecular Formula and at least one physical / chemical properties different in possible isomers.

Structural	Configuration	Conformation
- Bonding arrangement - change b/w isomers	- Bonding arrangement - constant. - 2D/3D space - location of atom / group. ① Geometrical ② Optical.	- Rotation about σ bond.

- Structural Isomerism :

① Chain
② Position
③ Meta-merism
④ Tautomerism
⑤ Ring-chain
⑥ Polymeric

a) Chain Isomerism

2 or more than 2 figure formed by different branch arrangement

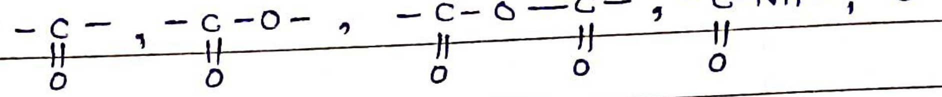
(Root word = change)

No. of branch → change.

b) Position and meta-merism :

Functional group (same f.g present in all possible isomerism)

- Mono-valent Functional group → Positional isomerism.
  - $-OH$, $-X$, $-CHO$, $-COOH$, $-NO_2$
- Bivalent Functional group → Metamerism



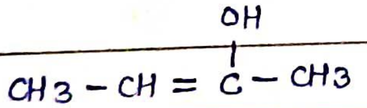
$-\overset{O}{\overset{\|}{C}}-$, $-\overset{O}{\overset{\|}{C}}-O-$, $-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-$, $-\overset{O}{\overset{\|}{C}}-NH-$, $-O-$

- 2 or more than 2 figure form by attachment of diff. Alkyl group in polyvalent Functional group.

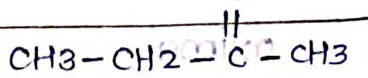
Different Alkyl group — Polyvalent Functional Group — Different Alkyl Group.

c) Functional Isomerism:

2 and more than 2 figure form by diff functional group present in all possible isomerism.



$CH_3-CH=\overset{OH}{\overset{|}{C}}-CH_3$ — (enol form)



$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$ — (Keto Form)

Note: If functional group change in migration of H^+ and double bond → Tautomerism (✓)

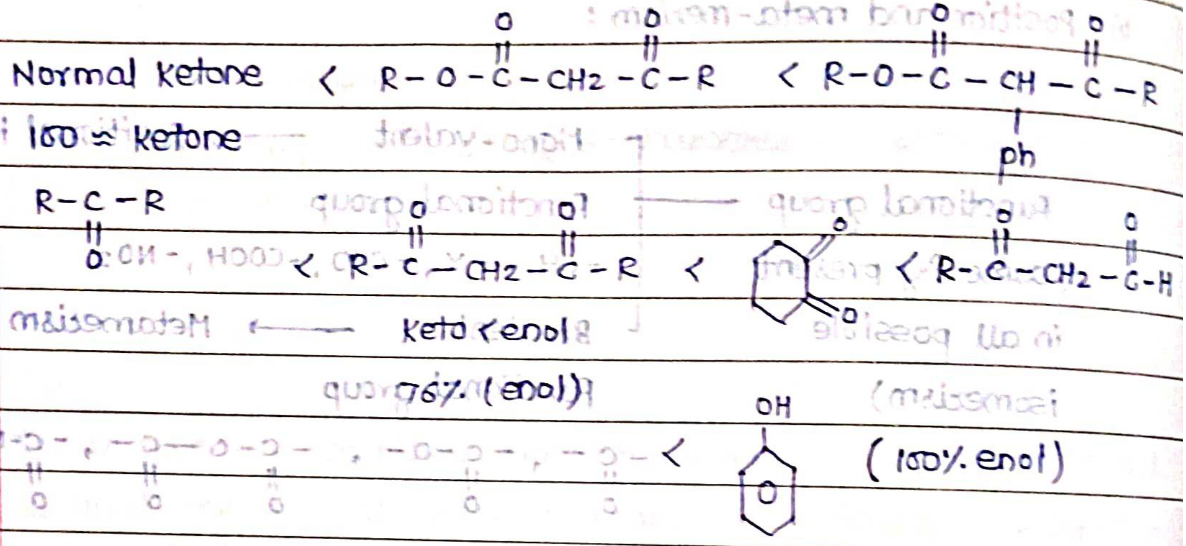
Ex: $H-C\equiv N \rightleftharpoons HNC$ (Tautomerism)

cyanide   Isocyanide

d) Tautomerism :

In presence of acidic med' / Basic med. migration of H⁺ between two molecules is known as Tautomerism phenomia

- Increasing order of enol content :



Normal Ketone $< R-O-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-R < R-O-\overset{O}{\overset{\|}{C}}-\underset{Ph}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-R$

100 ≃ ketone

$R-\underset{O}{\underset{\|}{C}}-R$

$< R-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-R <$ $<$ $R-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-H$

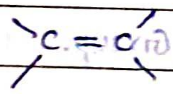
Keto < enol

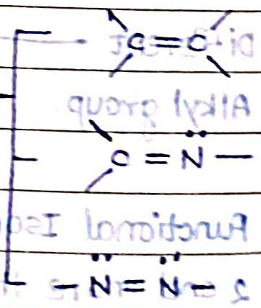
76% (enol)

< (100% enol)

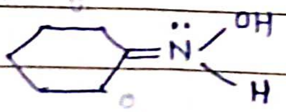
- Geometrical Isomerism :

- Single Bond Rotation —(X)→ G.I. occurs.

a)  Double Bond Formation



b) Ring Formation 

c) 

oxime

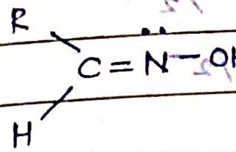
2 and more than 2 figure form by different arrangement of atom / group in 2D / 3D space

Bonding arrangement constant

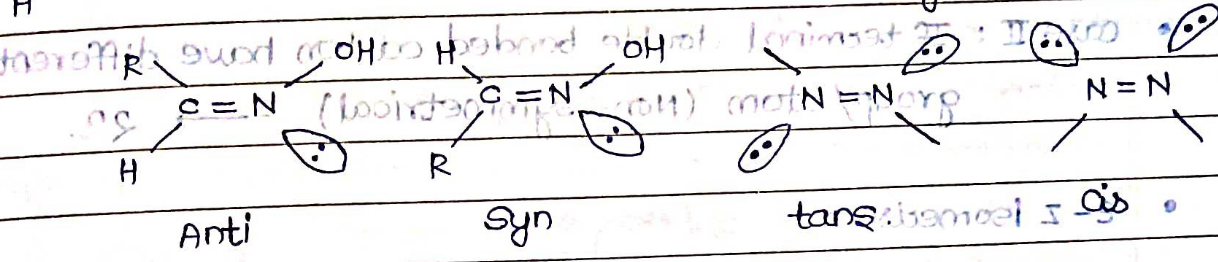
Cis – same side) Trans – opposite side

- Note : Terminal double bonded c-atom have Identical / same atom or group } → G.I ⊗

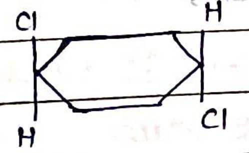
- Anti and Syn G.I :



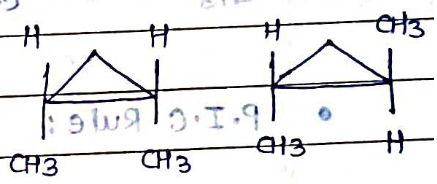
→ oxime group. (Two different atom or group hone chahiye)



- G.I about cyclic ring :



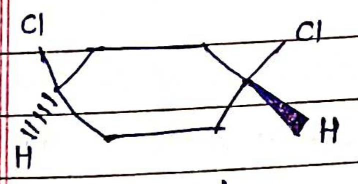
Fischer projection.

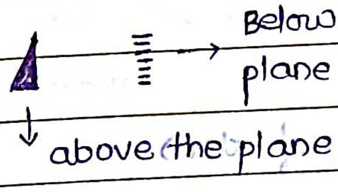


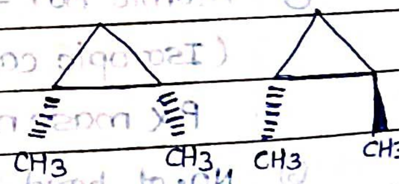
(tans)

(opposite

Fly-Wedge Projection

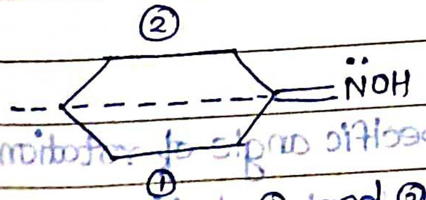


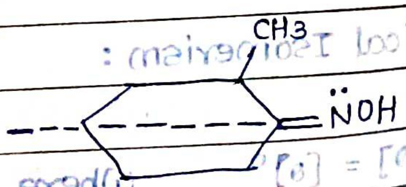




(Trans)

Q.





① and ② are same parts ⊃ G.I ⊗

① and ② are different parts G.I ✓

- Total No. of Geometrical isomers:

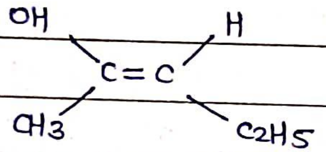
- Case I : If both terminal double bonded carbon have same atom / Ligand.

  a) Double bonds → odd → $2^{n-1} + 2^{n-1/2}$

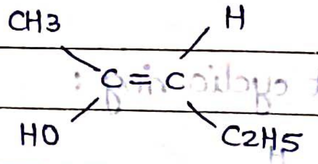
  b) Double bonds → even → $2^{n-1} + 2^{n/2-1}$

- Case II : If terminal double bonded carbon have different group/ atom (Non-symmetrical) $\longrightarrow 2^n$.

- E-Z isomerism:



E-form



Z-form

- P.I.C Rule:

① Periocity ∝ Atomic no. (If first atom same, compare next)

② Atomic no. → same.

(Isotopic case)

P ∝ mass no.

③ No. of bond = No of atom

- Optical Isomerism:

$[\theta] = \frac{[\theta]^\circ}{c \times l}$ Where, $[\theta]^\circ$ = specific angle of rotation $\begin{cases} c = 1gkm^3 \\ l = 1cm \end{cases}$

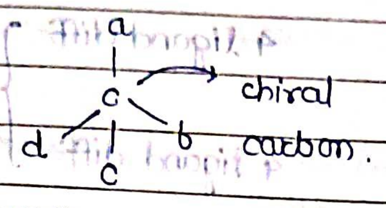
$[\theta]$ = Angle of Rotation

c = concn. of solution

l = length of tube.

Page No.
Date

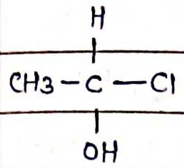
- Chiral carbon.



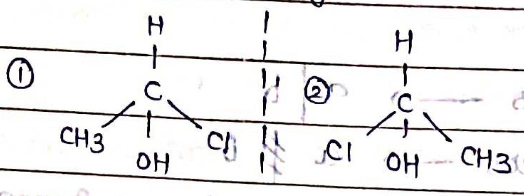
- Four different atom or ligand/group.

⊛ If molecule contains one chiral carbon → optically active.

Molecule have two figures

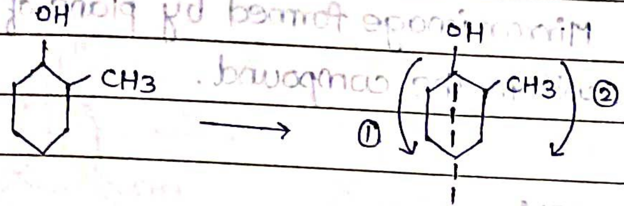


$$CH_3-\overset{H}{\underset{OH}{C}}-Cl$$



→ enantiomers pair.

Q.



- ① and ②
  - Same ↓ Same group
  - Different ↓ Different group

- Note: If 2 or more than 2 chiral carbons present in compound.

① R, S Nomenclature

<u>Check:</u> ① Use PIC Rule.

② Numbering.

③ 4th Number → Vertical line → ①-②-③
  - Clockwise Ⓡ
  - Anticlockwise Ⓢ

④ 4th Number Horizontal line → ①-②-③
  - Clockwise Ⓢ
  - Anticlockwise Ⓡ

- Concept: $n \geqslant 2$ → plane of symmetry, C.O.S
  - ✓ — optically Inactive
  - ⊗ — optically active.

  n ↓ no. of chiral carbon

- Note : Ⓡ | Ⓢ 4 ligand diff
  Ⓢ | Ⓡ 4 ligand diff } = same

(R, S) ⟶ (S, R) } all ligand ⟶ same.

① Enantiomers ⟶ a | b
② Diastereomers ⟶ a ∤ b
③ Meso compound ⟶ Mirror image formed by plane of symmetry within the compound.

- Total No. of optical isomers.

If terminal chiral carbon have different ligand (unsymmetrical)

$= 2^n$

Where n ⟶ No. of chiral carbon.

- Conformational Isomerism :

- 2 or more than two figures form in rotation of sigma bond.

- Projection ⟶ 3D-figure ⟶ project krta hain 2D-plane.
  ① Fly-wedge projection.
  ② Fischer projection.
  ③ Newmann projection.

(A) Fly-wedge projection :

 ⟶ below the plane (dotted line)

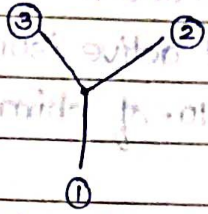
 — above the plane (wedge line)

 — on the plane (solid line)

③ Newmann projection :

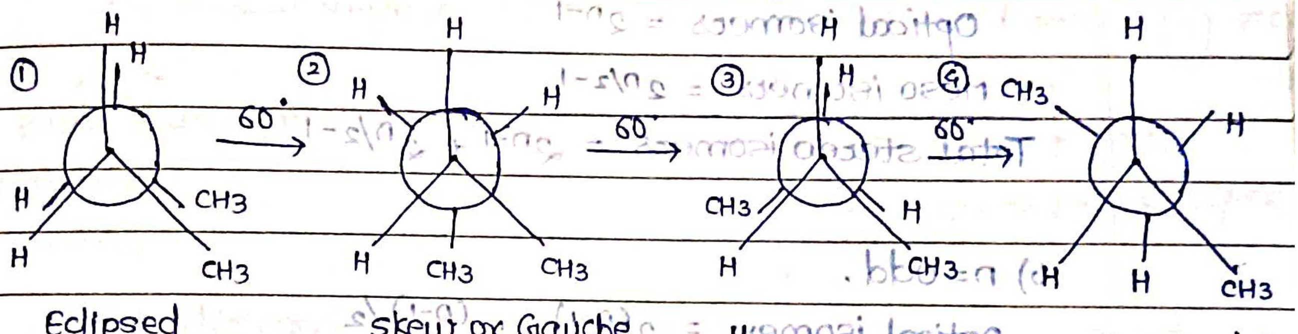
a) carbon → ○ or •

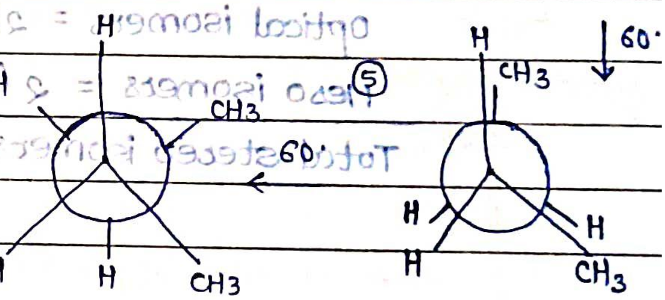
b) Valency of Carbon →



- Stability of Figure :

Check by steric Hindrance and H-bonding. (staggered





Stability →

④ ● > ② = ⑥ > ③ = ⑤ > ①

$$\text{Stability} \propto \frac{1}{\text{Potential energy}}$$

- Stability → skew > staggered > Eclipsed → (H-Bonding)
- Stability → staggered > skew > Eclipsed → (Regular)

- Baeyer strain Theory :

$$\text{stability} \propto \frac{1}{\text{angle strain}}$$

$$\text{Angle strain} = \frac{1}{2}(109.5 - d)$$

- Stereo-isomerism calculation.

a) Case - I : If terminal carbon chiral is unsymmetrical.

Total optical active isomers = 2^n

Where, n = No. of chiral carbons

b) Case - II : If terminal chiral carbon is symmetrical or molecule having POS.

a) n = even

Optical isomers = 2^{n-1}

Meso isomers = $2^{n/2-1}$

Total stereo isomers = $2^{n-1} + 2^{n/2-1}$

b) n = odd.

Optical isomers = $2^{(n-1)} - 2^{(n-1)/2}$

Meso isomers = $2^{(n-1)/2}$

Total stereo isomers = $2^{(n-1)}$