Use of Free Energy in Chemical Equilibria

1. Prove that For an adiabatic process, PV^{γ} = constant

(or)

For an adiabatic Reversible process, derive an relation btwn pressure & volume For 1 mole of an ideal gas.

(or)

Deduce a relationship btwn P Vs. V For Adiabatic process. What will be the relation For Isothermal process.

Sol:- We know that,

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\left(\frac{V_1}{V_2}\right)^{\gamma-1} = \frac{T_2}{T_1} \quad \text{——— (1)}$$

For an Ideal gas we know,

$$P_1 V_1 = RT_1 \quad \& \quad P_2 V_2 = RT_2$$

$$\Rightarrow \frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2} \quad (\text{or}) \quad \frac{T_2}{T_1} = \frac{P_2 V_2}{P_1 V_1}$$

Putting the value of $\frac{T_2}{T_1}$ in eq(1).

$$\text{eq}(1) \Rightarrow \frac{V_1^{\gamma-1}}{V_2^{\gamma-1}} = \frac{P_2 V_2}{P_1 V_1}$$

$$\Rightarrow P_1 V_1 V_1^{\gamma-1} = P_2 V_2 V_2^{\gamma-2}$$

$$\Rightarrow P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

So we can write,

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma} = P_3 V_3^{\gamma} = \cdots = \text{constant}$$

Hence, $\boxed{PV^{\gamma} = \text{Constant}}$

For Isothermal Process, The relation between P & V is

$\boxed{PV = K}$ (Constant)

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1. Show that for an Ideal gas, $C_p - C_v = R$

Let U be a state function.

i.e is, $U = f(T, V)$

Differentiating partially.

$$dU = \left(\frac{\partial U}{\partial T}\right)_V dT + \left(\frac{\partial U}{\partial V}\right)_T dV \quad \text{——} \quad (1)$$

From 1st Law,

$$dq = dU + pdV$$

$$dU = dq - pdV$$

ptv of 'dU' in eq(1),

$$eq(1) \Rightarrow dq - pdV = C_v dT + \left(\frac{\partial U}{\partial V}\right)_T dV$$

Dividing Each term by 'dT' at Constant P.

$$\left(\frac{dq}{dT}\right)_P - P\left(\frac{dV}{dT}\right)_P = C_v + \left(\frac{\partial U}{\partial V}\right)_T \left(\frac{dV}{dT}\right)_P$$

$$C_p - P\left(\frac{dV}{dT}\right)_P = C_v + \left(\frac{\partial U}{\partial V}\right)_T \left(\frac{dV}{dT}\right)_P \quad \left[\because \left(\frac{dq}{dT}\right)_P = C_p\right]$$

$$C_p - C_v = P\left(\frac{dV}{dT}\right)_P + \left(\frac{\partial U}{\partial V}\right)_T \left(\frac{dV}{dT}\right)_P$$

$$C_p - C_v = \left(\frac{dV}{dT}\right)_P \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]$$

For Ideal gas, $\left(\frac{\partial U}{\partial V}\right)_T = 0$

$$C_p - C_v = P\left(\frac{dV}{dT}\right)_P$$

$$\boxed{C_p - C_v = R} \quad \left[\because P\left(\frac{dV}{dT}\right)_P = R\right]$$

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3. For adiabatic process, PT^{γ}, $TV^{\gamma-1}$ = constant.

Sol:- For adiabatic Reversible change,

$$q = 0.$$

From 1st Law of Thermodynamics,

$$\Delta U = -w$$

$$dU = -dw$$

$$nC_v dT = -p dv$$

$$nC_v dT = -\frac{nRT}{V} dv \quad \text{--- (1)} \quad \left[\because PV = nRT, \; P = \frac{nRT}{V}\right]$$

Now, Integrating Left hand side from T_1 to T_2 & Right hand side from Volume V_1 to V_2.

$$\int_{T_1}^{T_2} nC_v dT = \int_{V_1}^{V_2} -\frac{nRT}{V} dv$$

$$\cancel{n}C_v \int_{T_1}^{T_2} dT = -\cancel{n}RT \int_{V_1}^{V_2} \frac{dv}{V}$$

$$C_v \int_{T_1}^{T_2} \frac{dT}{T} = -R \int_{V_1}^{V_2} \frac{dv}{V}$$

$$C_v \ln \frac{T_2}{T_1} = -R \ln \frac{V_2}{V_1}$$

$$\ln \frac{T_2}{T_1} = -\frac{R}{C_v} \ln \frac{V_2}{V_1}$$

$$\ln \frac{T_2}{T_1} = \frac{R}{C_v} \ln \frac{V_1}{V_2}$$

$$\ln \frac{T_2}{T_1} = (\gamma - 1) \ln \frac{V_1}{V_2} \quad \left[\because \frac{R}{C_v} = \gamma - 1\right]$$

$$\ln \frac{T_2}{T_1} = \ln \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\frac{T_2}{T_1} = \frac{V_1^{\gamma-1}}{V_2^{\gamma-1}}$$

$$\Rightarrow T_1 V^{\gamma-1} = T_2 V_2^{\gamma-1}$$

So we can write,

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} = T_3 V_3^{\gamma-1} = \dots = \text{Constant}$$

Hence, $\boxed{TV^{\gamma-1} = \text{constant}}$

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Q. Derive an Expression For Workdone by the System during reversible isothermal Expansion of Ideal gas.

Sol:-

$$dW = -PdV$$

$$\therefore dW = -\frac{nRT}{V}dV \qquad \left[\because PV = nRT,\ P = \frac{nRT}{V}\right]$$

Integrating, ~~from~~ ~~from~~ ~~V_1 to V_2~~

$$\int dW = -nRT\int_{V_1}^{V_2}\frac{dV}{V}$$

$$W = -nRT\,[\ln V_2 - \ln V_1]$$

$$W = -nRT\log\frac{V_2}{V_1}$$

$$\boxed{W = -2.303\,nRT\log\frac{V_2}{V_1}}$$

Since, $P_1V_1 = P_2V_2 \Rightarrow \frac{V_2}{V_1} = \frac{P_1}{P_2}$

$$\therefore \boxed{W = -2.303\,nRT\log\frac{P_1}{P_2}}$$

For 1 mole of Ideal gas, $n = 1$.

Hence, $\boxed{W = -2.303\,RT\log\frac{V_2}{V_1}}$

$$\boxed{W = -2.303\,RT\log\frac{P_1}{P_2}}$$

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5. Prove that $\left(\frac{\partial V}{\partial S}\right)_P = \frac{RT}{P.C_p}$ For one mole of ideal gas.

Sol :—

We know,

Enthalphy, $H = U + PV$

$$dH = \underline{dU + P.dV} + V.dP$$

$$dH = dq + VdP \quad —(1) \quad [\because dU + PdV = dq]$$

Now,

For 1 mole of Ideal gas,

$$dH = C_p dT$$

$$eq(1) \Rightarrow C_p dT = dq + VdP$$

$$dq = C_p dT - VdP$$

Assume there is no heat transfer & no Entropy change

$$\therefore dS = 0 \quad dq = 0$$

$$0 = C_p dT - VdP$$

$$C_p dT = VdP$$

$$\frac{dT}{dP} = \frac{V}{C_p}$$

From Maxewell relation,

$$\left(\frac{\partial V}{\partial S}\right)_P = \left(\frac{\partial T}{\partial P}\right)_S$$

$$\Rightarrow \left(\frac{\partial V}{\partial S}\right)_P = \frac{V}{C_p}$$

$$\boxed{\left(\frac{\partial V}{\partial S}\right)_P = \frac{RT}{PC_p}}$$

$$\left[\because PV = RT, \quad V = \frac{RT}{P}\right]$$

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7:- Define Gibb's Free Energy and Derive Gibbs-Helmholtz equation showing change in Gibbs' Free Energy (ΔG).

Sol:- The ~~total~~ maximum amount of Energy available for the system to perform some useful work is known as Gibb's Free Energy.

It is Denoted by 'G'.

$$\therefore \boxed{G = H - TS}$$

Where H → Enthalphy
S - Entropy of system
T - Temperature

The Change in Gibb's Energy is given as;

$$\Delta G = \Delta H - \Delta(TS)$$

$$\Delta G = \Delta H - T\Delta S - S\Delta T$$

At Constant Temperature $\boxed{\Delta T = 0}$,

$$\therefore \boxed{\Delta G = \Delta H - T\Delta S}$$

Note:-
$\Delta G < 0 \rightarrow$ Spontaneous
$\Delta G = 0 \rightarrow$ Equilibrium
$\Delta G > 0 \rightarrow$ non-spontaneous

This is Gibb's-Helmholtz Equation.

If Change occurs at Constant Temperature,

$$(\Delta G)_T = \Delta H - T\Delta S$$

$$(\Delta G)_T = \Delta H - T(S_f - S_i)$$

where, S_f → final Entropy
S_i → Initial Entropy

$$(\Delta G)_T = \Delta H - T\left[-\left(\frac{\partial G_f}{\partial T}\right)_P - \left\{-\left(\frac{\partial G_i}{\partial T}\right)_P\right\}\right]$$

$$(\Delta G)_T = \Delta H + T\left[\left(\frac{\partial}{\partial T}\right)\left\{(G_f)_P - (G_i)_P\right\}\right]$$

$$\boxed{(\Delta G)_T = \Delta H + T\left[\frac{\partial}{\partial T}(\Delta G)_P\right]}$$

Deduce Gibbs-Helmholtz Equation in standard Form, write this same answer

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8. State the Significance of Gibbs Free Energy....

(or)

Show that decrease in Gibbs Free Energy at constant temp and pressure is equal to total work and is above the mechanical work.

Sol:-

Significance of Gibb's Free Energy is to Find the total work done at constant temp & pressure.

We know,

$$G = H - TS$$

At constant temp & pressure,

$$(\Delta G)_{T,P} = (\Delta H)_{T,P} - T\Delta S \longrightarrow (1)$$

We also know, $H = U + PV$

$\therefore$ at constant temp & pressure,

$$(\Delta H)_{T,P} = \Delta U + P\Delta V$$

$\therefore$ eq(1) $\Rightarrow$ $(\Delta G)_{T,P} = \Delta U + P\Delta V - T\Delta S$

$$(\Delta G)_{T,P} = \Delta U + P\Delta V - q_{rev} \quad [\because T\Delta S = q_{rev}]$$

$$(\Delta G)_{T,P} = \Delta U - q_{rev} + P\Delta V$$

$$(\Delta G)_{T,P} = -W + P\Delta V \quad [\because \Delta U - q_{rev} = -W]$$

(or)

$$-(\Delta G)_{T,P} = W_{Total} - W_{mechanical}$$

$= W_{non\text{-}mechanical}$ → work received for an external use

[where $P\Delta V$ is mechanical work.]

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Bond order

$$B.O = \frac{1}{2}\left[N_b - N_a\right]$$

1. N_2

$$M.O \text{ of } N_2 = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \pi_{2px}^2 = \pi_{2py}^2\ \sigma_{2pz}^2$$

$\therefore N_b = 10$ & $N_a = 4$

$$\frac{1}{2}[10-4]$$

$$= \frac{6}{2}$$

$$= 3 \text{ (Diamagnetic)}$$

2. N_2^+ → mtlb last orbit se ek e^- nikal gya.

$$M.O \text{ of } N_2^+ = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \pi_{2px}^2 = \pi_{2py}^2\ \sigma_{2pz}^1$$

$N_b = 9$ & $N_a = 4$

$$= \frac{1}{2}[9-4]$$

$$= \frac{5}{2}$$

$$= 2.5$$

3. N_2^- — Nyaa orbit add hua haa (π^*_{2px}) having $1e^-$

$$M.O \text{ of } N_2^- = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \pi_{2px}^2 = \pi_{2py}^2\ \sigma_{2pz}^2\ \pi^{*1}_{2px}$$

$N_b = 10$ $N_a = 5$

$$= \frac{1}{2}\left[10-5\right]$$

$$= 2.5$$

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σ_{2pz} aage aa gya (+) $\pi^*_{2px} = \pi^*_{2py}$ add hua last m having 1e each

4. O_2

M.O of $O_2 = \sigma_{1s}^2 \sigma^*_{1s}{}^2 \sigma_{2s}^2 \sigma^*_{2s}{}^2 \sigma_{2pz}^2 \pi_{2px}^2 = \pi_{2py}^2 \pi^{*1}_{2px} = \pi^{*1}_{2py}$

$B.O = \frac{1}{2}[N_b - N_a]$

$= \frac{10-6}{2}$

$= 2.$ [paramagnetic]

O_2^+ → last wale m 'o' e^- ho jaye 2nd last m $1e^-$ rhega

M.O of $O_2^+ = \sigma_{1s}^2 \sigma^*_{1s}{}^2 \sigma_{2s}^2 \sigma^*_{2s}{}^2 \sigma_{2pz}^2 \pi_{2px}^2 = \pi_{2py}^2 \pi^{*1}_{2px} = \pi^{*0}_{2py}$

$B.O = \frac{10-5}{2}$

$= 2.5$

$O_2^- = \sigma_{1s}^2 \sigma^*_{1s}{}^2 \sigma_{2s}^2 \sigma^*_{2s}{}^2 \sigma_{2pz}^2 \pi_{2px}^2 = \pi_{2py}^2$
$\pi^{*2}_{2px} = \pi^{*1}_{2py}$

$O_2^{2-} = B.O = \frac{10-8}{2}$

$= \frac{2}{2}$

$= 1$ → Diamagnetic.

$B.O = \frac{10-7}{2}$

$= 1.7$

CO → Isme Nitrogen wale configuration rhega aur sirf σ_{2pz} will exchange position with σ^*_{2s}.

M.O of CO $= \sigma_{1s}^2 \sigma^*_{1s}{}^2 \sigma_{2s}^2 \sigma_{2pz}^2 \pi_{2px}^2 = \pi_{2py}^2 \sigma^{*2}_{2s}$.

$B.O = \frac{10-4}{2}$

$= \frac{6}{2}$

$= 3.$

CO^+ → last wale m ek e^- rhega

$CO^+ = \sigma_{1s}^2 \sigma^*_{1s}{}^2 \sigma_{2s}^2 \sigma_{2pz}^2 \pi_{2px}^2 = \pi_{2py}^2 \sigma^{*1}_{2s}$.

$\frac{10-3}{2}$

$= 3.5$

$CN = \sigma_{1s} \sigma^*_{1s} \sigma_{2s} \sigma_{2pz} \pi_{2px} = \pi_{2py} \sigma^*_{2s}$

$B.O = \frac{10-4}{2}$

$= 3.$

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Q. Derive an Equation For Ideal gas? / Eqn For state.

Ans. Boyles Law, Charles Law & Avogadro Law combined in a single equation Forms Ideal gas Equation.

According to Boyles' Law, $V \propto \frac{1}{P}$ [At constant Temp] — (I)

According to charles Law, $V \propto T$ [At constant pressure] — (II)

According to Avogadro Law, $V \propto n$ [At Constant pressure] — (III)

Combining (I), (II) & (III)

$$V \propto \frac{1}{P} \times T \times n$$

$$V = R \times \frac{Tn}{P}$$

$$PV = RTn$$

$$\boxed{PV = nRT}$$ Where, R = universal gas constant.

~~When n = 1 mole~~ For 1 mole of Ideal gas, $n = 1$

$$\boxed{PV = RT}$$

Q. What is the value For Molar gas constant (R). ?

Ans. From Ideal gas Eqn,

$$PV = nRT$$

$$R = \frac{PV}{nT}$$

$$= \frac{10^5 \times 22.71 \times 10^{-3}}{1 \times 273.15}$$

$$= 8.314 \ J K^{-1} mol^{-1}$$

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Q. Ideal gas	Real gas
• obeys gas Law under all conditions of Temp & pressure	• Obeys gas Laws at high Temp & Low pressure.
• No gas is Ideal	• All gases are real.
• Volume occupied by a molecule is negligible compared to whole volume of the gas.	• Volume occupied by a molecule is not negligible compared to whole volume of the gas.
• The Force of attraction between the molecule of the gas is negligible. Hence Can be neglected.	• The Force of attraction between molecule of the gas Cannot be neglected.
• obeys Equation, $PV=nRT$	• obeys Van der Waals Eqn. $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$

Q. What is Compressibility Factor?

Ans. The Extent to which Real gas deviates from its Ideal behaviour Can be determined by a Factor Called Compressibility Factor.

$$\boxed{Z=\frac{PV}{nRT}}$$

For Ideal gas, $PV=nRT$

So $Z=1$

For Real gas, $PV\neq nRT$

So, $Z\neq 1$

(i) When $Z<1$, gas is More Compressible

(ii) When $Z>1$, gas is Less Compressible.

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Q. What is Boyles Temp (or) Boyle point?

Ans. The Temperature at which Real gas behaves like Ideal gas over an appreciable pressure range called Boyle's Temperature (or) Boyle's point

$$T_b = \frac{a}{Rb}$$

where
a → co-efficient of attraction
R → universal gas constant
b → Excluded volume

Q. Write van-der waals ~~constan~~ Equation & Explain significance of Vanderwaals constants 'a' & 'b'?

Ans. Vander Waals Eqn is given as,

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Where P - pressure, V - Volume
a, b → constant
n - number of moles
R → universal gas constant.
T → Absolute Temperature.

Vanderwaal's constant 'a'

- Measure magnitude of attractive Forces among the molecule of the gas.
- Larger the value of 'a', greater is intermolecular Force of attraction.

$$P = \frac{an^2}{V^2}$$

$$a = \frac{PV^2}{n^2}$$

Unit = atmosphere lit²/mol²

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Vanderwaal constant 'b'.

- Measure effective size of gas molecule.
- Also called exclude volume
- Value is equal to 4 times the ~~actual~~ actual volume of gas molecule

$$V = nb$$

$$b = \frac{V}{n}$$

unit = lit/mol.

Q. Vanderwaals Equation for different conditions of Temperature & pressure.

Sol:-

For n-moles, $\boxed{\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT}$

For n = 1 mole, $\boxed{\left(P + \frac{a}{V^2}\right)(V - b) = RT}$

At Low pressure,

- When pressure is Low, Volume is Large.
- Term $\frac{a}{V^2}$ is Small. Hence neglected
- ~~Sim~~ Also 'b' is neglected.

So, $\boxed{PV = RT}$

- Thus at Low pressure, Real gas behaves as Ideal gas.

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At moderate pressure.

- When pressure is moderate, volume decrease.
- So $\frac{a}{V^2}$ increases.
- b is neglected.

$$\left(P+\frac{a}{V^2}\right)V = RT$$

$$PV + \frac{aV}{V^2} = RT$$

$$PV + \frac{a}{V} = RT$$

$$PV = RT - \frac{a}{V}$$

Divide both side by RT,

$$\frac{PV}{RT} = \frac{RT}{RT} - \frac{a}{RTV}$$

$$\frac{PV}{RT} = 1 - \frac{a}{RTV}$$

$$\boxed{Z = 1 - \frac{a}{RTV}}$$

$\because \frac{PV}{RT} = Z$

At High pressure,

- When pressure is high, Volume is small
- $\frac{a}{V^2}$ is neglected.

~~b is also neglected~~.

$$P(V-b) = RT$$

$$PV - Pb = RT$$

$$PV = RT + Pb$$

Divide b.s by RT.

$$\frac{PV}{RT} = \frac{RT}{RT} + \frac{Pb}{RT}$$

$$\boxed{Z = 1 + \frac{Pb}{RT}}$$

- At High pressure, Z is greater than 1 $(Z>1)$.
- Thus, when pressure increases $\frac{Pb}{RT}$ increases.

- At moderate pressure, 'Z' is less than 1 $(Z<1)$

- Thus when pressure increases, $\frac{a}{RTV}$ increases.

At High Temp

- When Temp is High, Volume is very Large
- $\frac{a}{V^2}$ & 'b' is neglected

$\therefore \boxed{PV = RT}$

Thus at High Temp, real gas behaves as Ideal gas.

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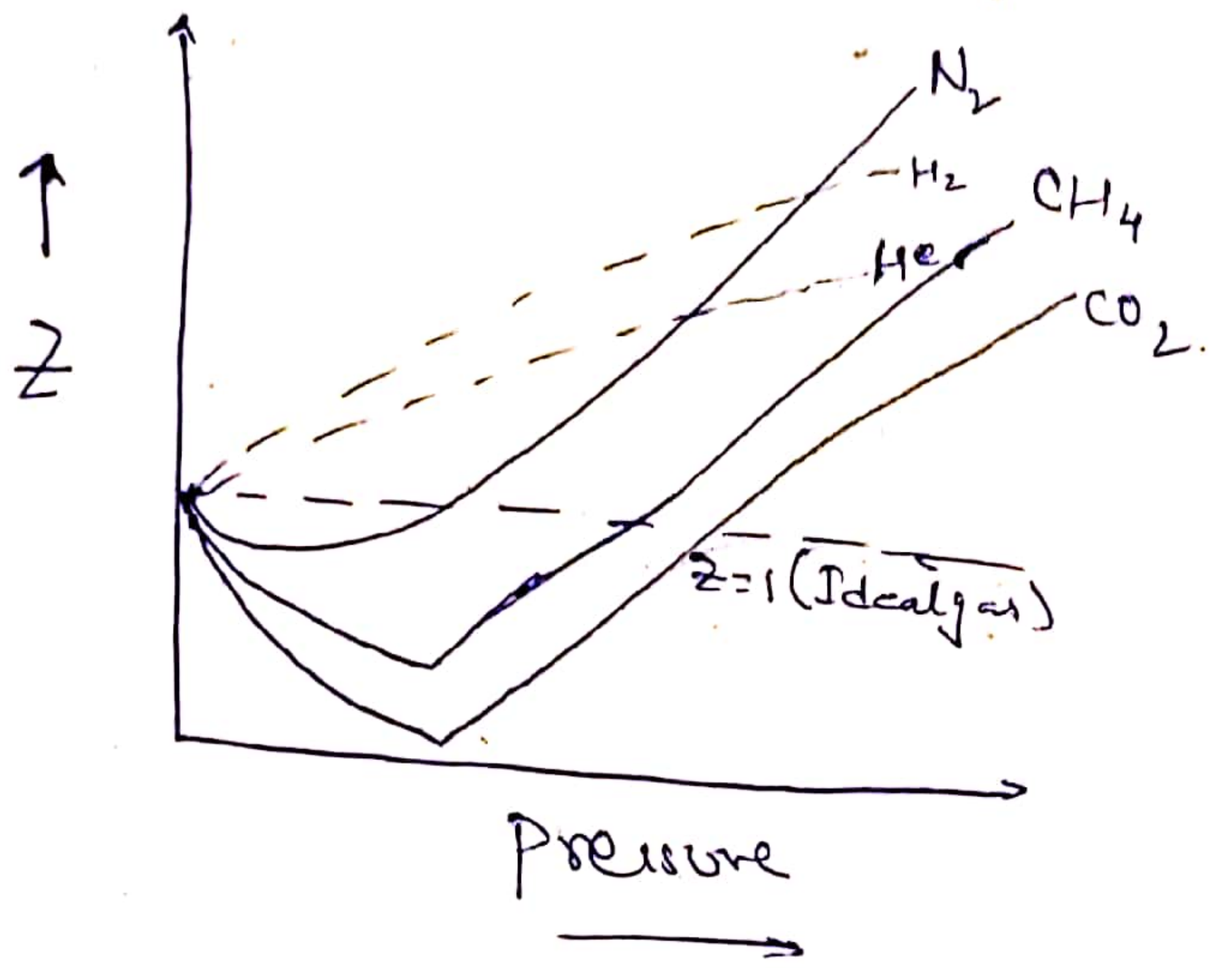
Q Explain the behaviour of Hydrogen & Helium using Vanderwaals Equation

Ans:-



- As pressure increases, the 'Z' increases.
- For H_2 & He, Z is greater than 1 (Z>1)
- Becoz of small size of H_2 & He, intermolecular force of attraction is negligible.
- Therefore $\frac{a}{V^2}$ can be neglected.

i.e is $P(V-b) = RT$

$PV - Pb = RT$

$PV = RT + Pb$

Divide both side by RT

$$\frac{PV}{RT} = \frac{RT}{RT} + \frac{Pb}{RT}$$

$$\boxed{Z = 1 + \frac{Pb}{RT}}$$

Q Why do Real gas deviate From Ideal behaviour.

Ans: At Low Pressure & High Temp, Real gas behaves as an Ideal gas.

- But at High pressure, & Low Temperature, it deviates from the Ideal behaviour because,

(i) The Volume of the molecule is not negligible as compared to whole Volume of the gas.

(ii) The Force of attraction between the molecule is not negligible.

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Critical Temperature

The Temperature above which gas cannot be Liquified ~~only~~ using only High pressure.

$$T_c = \frac{8a}{27Rb}$$

Critical Volume

The volume occupied by one mole of a gas at critical Temperature & critical ~~volume~~ pressure is critical volume.

$$V_c = 3b$$

Critical pressure

The pressure required to liquify the gas at critical Temp is called critical pressure.

$$P_c = \frac{a}{27b^2}$$

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Spectroscopic Techniques & Applications :-

Spectroscopy

Branch of science which deals with the interaction between matter and EM radiations (light)

Intrument used to measure spectroscopy is called spectrophotometer.

Atomic spectroscopy

Deals with interaction of Electromagnetic radiation with atoms.

i.e $\boxed{\Delta E = h\nu}$

where ΔE = Energy difference of quantized energy levels.

$h \rightarrow$ plancks constant.

$\nu \rightarrow$ Frequency of photon.

Molecular spectroscopy

Deals with interaction of EM radiation with molecules.

Visible & UV spectroscopy

When ~~Fortheir~~ the EM radiation in UV region (Source - Discharged hydrogen lamp) & visible region is made to pass through a compound (source → ~~Fro~~ Discharged Tungsten lamp) having multiple bonds, then a part of incident radiation is absorbed which involves transition of valence electrons.

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Use of UV spectroscopy

(1) Helps to determine str. of several Vitamins.

(2) Helps to determine dissociation constant of acids & bases.

Failure

- Cannot detect individual Functional group.

Infrared spectroscopy

Gives information about the structure of a compound.

It helps to determine the str. of both organic & inorganic compounds.

In IR spectroscopy, the source of EM radiation is Electrically heated rod of rare-Earth oxides...

The most important requirement for a substance to absorb in infrared region is that the vibration in the molecules must give rise to a unsymmetrical charge distribution. Thus it is not necessary for a molecule to possess a permanent dipole moment.

Uses of IR spectroscopy

1. Gives Information about the presence of various Functional group.
2. ——— ——— about the Hydrogen bonding (Inter or Intra molecular)

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3. Identification of cis-trans isomers.

4. conformational orientation in aromatic compounds

Nuclear Magnetic Resonance (NMR) spectroscopy

Here, The source is powerful magnet of stable field strength.

- NMR spectroscopy is generally carried out on liquids or solutions.

- The best solvents are those which donot contain protons.

- A nucleus consisting of odd no. of protons (or) odd no. of neutrons (or) both has the property of Nuclear spin. A spinning proton generates a circulating Electric current which in turn produces a magnetic field. & thus spinning proton behaves like a magnet.

- Now, when a proton is placed in magnetic field it aligns itself in one of two possible orientations.

(i) Low Energy Alignment

Here the, magnetic field of Nucleus & applied Magnetic Field are in same direction.

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(ii) High Energy Alignment

The magnetic field of Nucleus & applied magnetic field are in opposite direction.

NMR Uses.

Tells us how many protons are present in a Molecule and also their Environment.

Mass Spectroscopy

In this, the molecules are bombarded with a beam of Energetic electrons & Further Converted to highly Energetic positively charged ions which may break up into smaller ions.

- The different Volatilized Fragements are Further seperated by deflection into Variable magnetic Field according to their (mass / charge) ratio
- They also generate a current at the Collector in proportion to their relative abundance.

Uses of Mass Spectroscopy

1. To measure the molecular wt. & molecular formula of a Compound.
   - Helps in Establishing new Compounds.
2. To identify unknown compound by comparing their mass spectra with that of known Compounds.

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Questions

1. What are the different Electronic transitions ~~by~~ of organic molecules by UV Transitions.

Ans. A molecule contains three types of Electron.

(i) σ Electron.

(ii) π electron.

(iii) non - bonded electrons (n)

Now, By absorption of UV radiation, these e^- will move to high energy ~~[illegible]~~ anti-bonding orbital and possible

Transitions are :-

$\sigma - \sigma^*$, $\pi - \pi^*$, $n - \pi^*$, $n - \sigma^*$, $\pi - \sigma^*$ etc...

Q.

Absorption spectrum	Emmission spectrum
• It is obtained when EM radiations are transmitted through a substance.	• It is obtained when EM radiations are emmitted by a substance.
• It is produced when atoms absorbs Energy.	• It is produced when atoms releases energy.
• Shows dark lines (or) gaps.	• It shows coloured lines.
• In absorption spectrum, atoms obtains higher Energy level.	• In Emmission spectrum, atom obtains low Energy level.
• It accounts for wavelength absorbed by a substance	• It accounts for wavelength emmitted by a substance.

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Atomic spectroscopy	Molecular spectroscopy
• It is study of EM radiation absorbed (or) ~~commit~~ emitted by atoms.	• It is the study of EM radiation absorbed (or) emitted by molecules.
• It helps to determine the type of atoms present in a given sample.	• It helps to determine the Str of molecule present in a given sample.
• Here, an atoms moves to an Exicted state From ground state.	• Here, ~~an~~ a molecule move to an Exicted state From ground state.
• It is a discontinuous spectra	• It is a Continuous spectra.

UV-Visible Spectroscopy

Refr previous (+)

Q.(1) +

uske baad likhna,

An isolated covalently bond group which shows a characteristic ~~change~~ absorption in UV or visible region is called chromophore.

Chromophore even are of two types:-

(1) Chromophore which contain π-electrons.

Such as alkenes (or) alkynes, C=C, ~~[illegible]~~ which undergoes π-π* transition. which shows absorption above 190 nm.

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② chromophores which contains 'π' & 'n' electrons both.

Such as $>C=O$, $R-NO_2$ which undergoes $n-\pi^*$ transition.

- The greater the number of double bonds in a compound, the longer is its wavelength to absorb UV-radiation.
- Compounds containing carbon-oxygen double bond can absorb light in UV-region.

  Ex- Acetone, which has broad absorption peak at 280nm.

Visible-UV spectrometer:-

Here a beam of light, is splitted into two halves.

- One half of the beam (sample beam) is directed towards a transparent cell containing the solution of the compound being analyzed.
- The other half of the beam (reference beam) is directed towards the identical cell containing the solvent.
- The Intensity of sample beam (I) will be less than the intensity of reference beam (I_0)

Hence, $A = \left(\frac{I_0}{I}\right)$ where, A = Absorbance.

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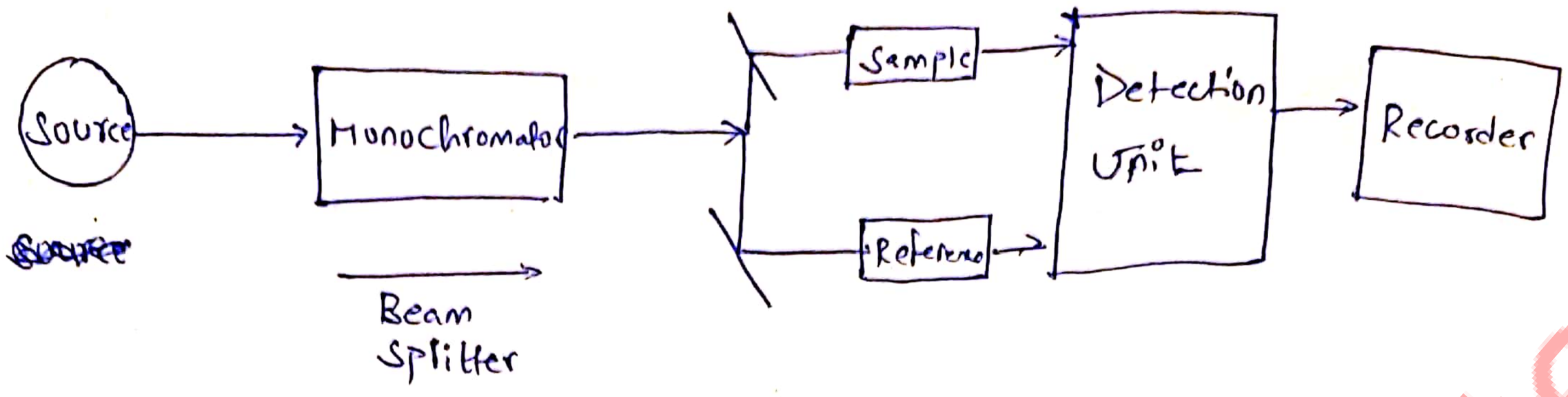

Visible-UV spectrometer

Some Applications of UV spectroscopy

previous refr (+).

- To Know the relation between different group, especially wrt to conjugation existing between,
  - (i) C-C multiple bond.
  - (ii) C-C & C-O double bond.
  - (iii) C-C doublebond and aromatic benzene ring.
- To determine Steric hindrance.

Infrared Spectroscopy

Previous (+)

- Absorbtion in IR region is due to changes in vibrational & rotational levels. Hence these spectra also called vibrational - rotational spectra.
- The ordinary IR region extends From 2.5μ to 15 μ, in which molecular vibrations can be detected.
- The region From 0.7μ to 2.5μ called Near IR

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- The region from 15μ to 200μ called Far IR region.

- Band position in IR ~~region~~ spectrum is expressed as :-

$$\bar{\nu} = \frac{1}{\lambda}$$

where $\bar{\nu} \rightarrow$ wave no.
$\lambda \rightarrow$ wavelength.

- Band Intensity in IR spectrum expressed as

$$A = \log_{10}\left(\frac{1}{T}\right)$$

where
$A \rightarrow$ Absorbance
$T \rightarrow$ Transmittance.

- Fingerprint Region.

The Region from $1500 cm^{-1}$ to $600 cm^{-1}$ is ~~called Fi~~ rich in Absorption band & Shoulders. This Region is called Fingerprint region.

- Every molecules spectra differ in Fingerprint region which indicates that their main structural unit is different.

- Fingerprint Region subdivided into three regions.

(i) 1500 – 1350 cm^{-1}

(ii) 1350 – 1000 cm^{-1}

(iii) Below 1000 cm^{-1}

- The Region 1350 – 1000 cm^{-1} Contains alcohols, esters, etc..

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Applications of IR spectroscopy

1. To Identify the unknown Compound by Fingerprint Technique by Comparing the IR spectrum of unknown compound with the known compound.

2. To detect impurities in a sample. The IR spectra of impure sample shows more absorption band.

3. It gives information about molecule symmetry, bond length, bond strength & dipole moment.

Sample preparation method in IR spectroscopy

- The great diffuctly in IR spectroscopy is to Form thin Samples.

- The most common methods are :-

(i) Compressing, moulding and dissolving the sample in a solvent. Here the solvent is Carbon di sulphide (or) tetra chloro ethylene whose spectrum is Free from intense absorption bands.

(ii) By preparing a thin Film by Casting a solution.

(iii) Can also be prepared by pressing a finely grinded mixture of sample with KBr to Form a disc.

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Application of NMR studies :—

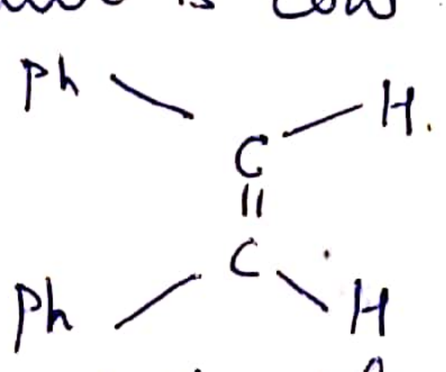
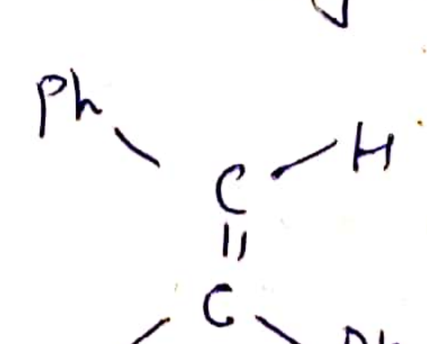
- Tells us how many protons are present in a molecule. ~~because~~ As area under the peak gives the measure of no. of protons involved.
- Gives information about the environment of a particular Hydrogen. Ex- CH_3OH has three protons, (CH_3) of one type and (OH) of another type.

Q. Different btwn $n-\pi^*$ and $\pi-\pi^*$ transition based on absorptivity Value. (ε)

$n-\pi^*$	$\pi-\pi^*$
• It is a Symmetry Forbidden Transition.	• It is a Symmetry allowed Transition.
• 'ε' Value is Low (100)	• 'ε' Value is high ($\simeq$ 10,000)

Q. Can UV differentiate Cis-stilbene and Trans-stilbene.

Ans. It can differentiate between cis & trans isomers but ~~not~~ Cannot differentiate between enaitiomers

Cis isomer	Trans isomer
• Here, both λ_{max} & ε_{max} Value is Low	• Here, both λ_{max} & ε_{max} Value is high
 cis-stilbene	 Trans-stilbene
λ_{max} 280nm (7,500)	λ_{max} 295nm (35,000)

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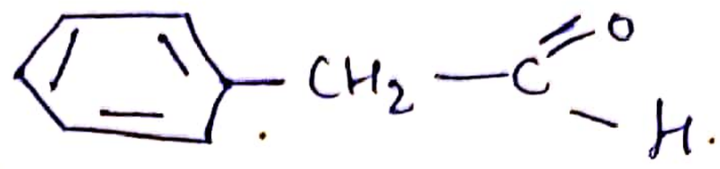
Q. Which one of the following compound will have greater λ_{max} ?

a.

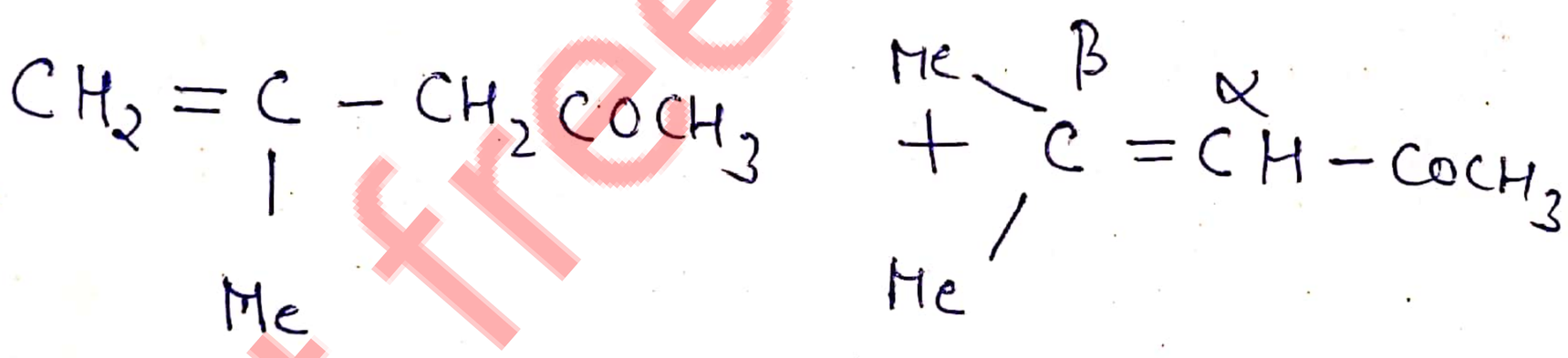
b. 

In case (a), both π-electrons and 'n' (non bonded e⁻) are in conjugation hence it will absorb higher UV radiation. Hence λ_{max} value will be high.

Q. $CH_3-\underset{\underset{O}{\|}}{C}-CH_3$ on condensation, followed by dehydration gives two products. Name them also differentiate them using UV spectrum.

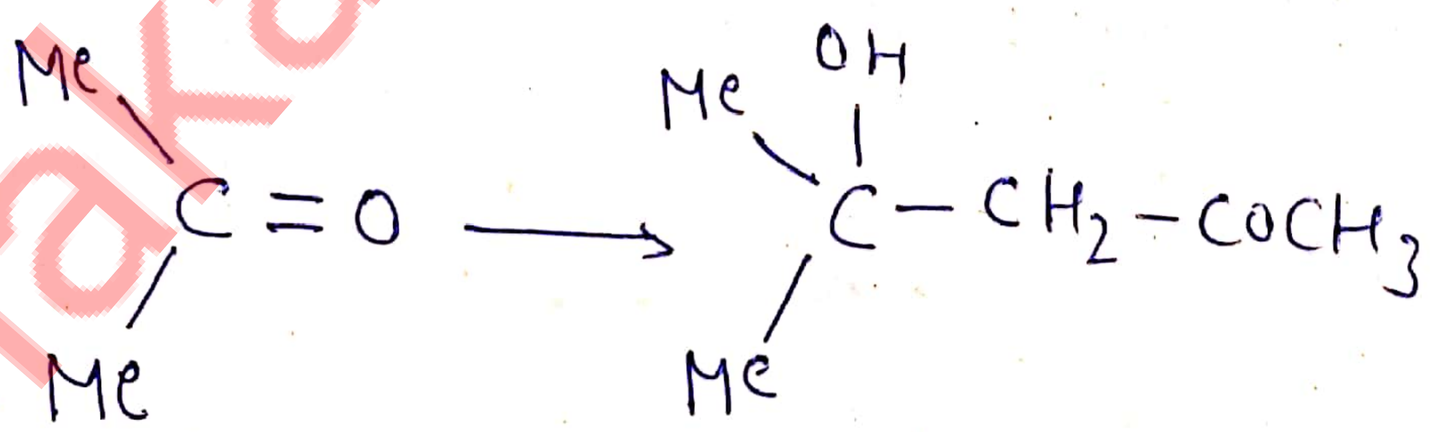
(condensat + Dehy)

Sol:-



Isomesityl oxide

Mesityl oxide



The Mesityl oxide is a α-β saturated carbonyl compound. Hence forms a conjugated system and will absorb UV radiation at higher wavelength

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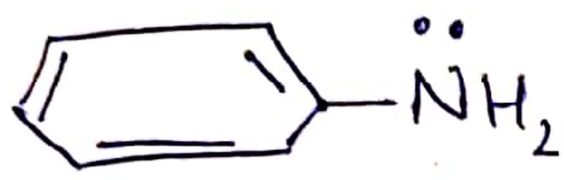
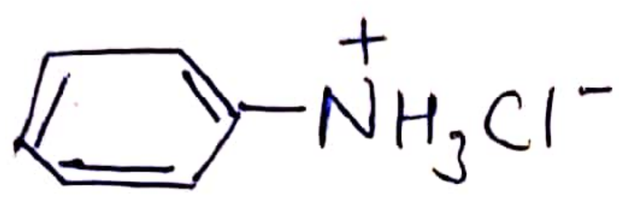
compared to non-conjugated isomesityl oxide.

Q. Between Aniline & Aniline hydrochloride which will have greater λ_{max} value?

Sol:-



Aniline



Aniline hydrochloride.

Aniline have lone pair of e^- on Nitrogen. Hence it is in conjugation with benzene ring. Hence it will absorb UV radiation at higher λ_{max} value.

Wheras in Aniline hydrochloride, such conjugation is absent due ~~due~~ to absence of lone pair of e^- on Nitrogen atom. Hence will absorb UV radiation at lower λ_{max} value.

Q. The extinction co-efficient of $Coen_2Br_2^+$ is 40 $M\,cm^{-1}$ at 650 nm. Calculate percent transmission for 5cm cell filled with 0.01M solution. Neglect solvent.

Sol:-

~~We know~~ Here, $\varepsilon = 40\ M\,cm^{-1}$, $C = 0.01\ M$, $l = 5cm$

We know, optical density $= \log \frac{I_0}{I} = \varepsilon C l$

$$\Rightarrow \log \frac{I_0}{I} = 40 \times 0.01 \times 5 = 2.$$

$$\frac{I_0}{I} = \log^{-1}(2)$$

$$\frac{I_0}{I} = 100 \Rightarrow \frac{I}{I_0} = 0.01$$

$\therefore$ % Transmission $= 0.01 \times 100 = 1\%$.

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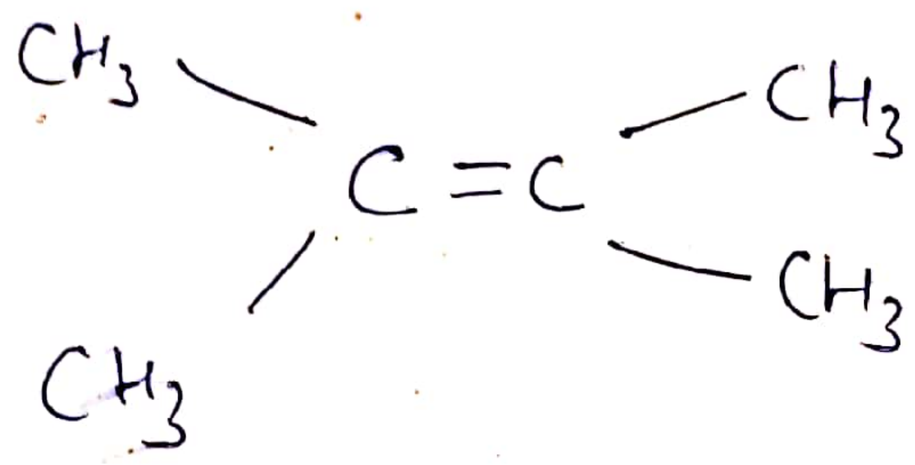
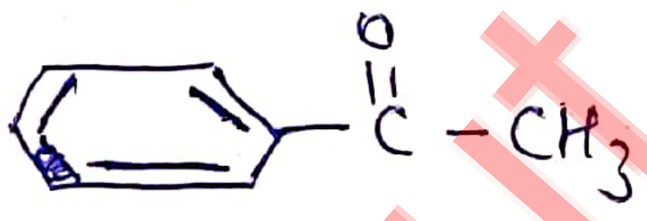
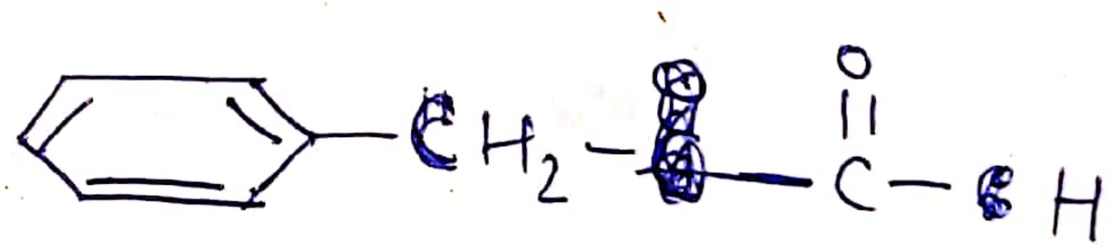
Q. $CH_3-CH=CH_3$ it gives IR absorption For C=C stretching For 1640 cm^{-1} but 2,3 dimethyl 2 butene does not give any peak in that region for C=C streching Why?

Sol:-



It is a centrosymmetric molecule. Hence it is Transparent to IR. Hence does not give any absorption band at 1640 cm^{-1}

Q. Diff btwn Acetophenone & phenyl acetaldehyde.

Acetophenone	phenyl acetaldehyde
	
• Here, C=O is weak because of '+M' effect and is conjugated with benzene ring. Hence resonance is Possible	• Here, C=O is strong and it is not conjugated with benzene ring Hence resonance is not possibe.

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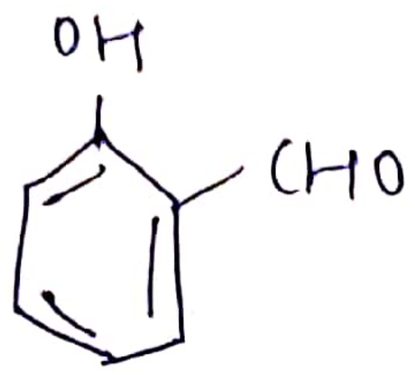
Q: How can you diff O-hydroxybenzaldehyde & P-hydroxy benzaldehyde by IR spectroscopy.

Sol:-



O-hydroxy benzaldehyde.

Para-hydroxybenzaldehyde.

→ Ortho will give intra-molecular hydrogen bonding.

→ para will give inter-molecular Hydrogen bonding.

→ By Compairing their IR absorption intensities we Can differentiate these compounds.

Q. Define Shielding & Deshielding Effect in NMR Spectroscopy.

Shielding Effect.

A Nucleus whose chemical shift has been decreased due to addition of Electron density, magnetic induction (or) other effect.

Deshielding Effect.

A Nucleus whose chemical shift has been increased due to addition of Electron density, magnetic Induction (or) other effect.

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Adding (2 more points) to Fingerprint Region

- The region below 1500 cm^{-1} is rich in many absorptions due to bending & streching vibrations of C-C, C-O, C-N bonds.

- Usually there are more bending vibrations compared to streching vibrations.

- Some molecules show similar absorption above 1500 cm^{-1}. Since they have same Functional group; but their spectra differ in Fingerprint region.

Absorption Law

1. Lamber'ts Law :-

When a beam of monochromatic radiation is passed through the absorbing medium, then the decrease in the intensity of radiation will be directly proportional to the thickness (pathlength) of the solution.

i.e is, $A = \log_{10}\left(\frac{I_0}{I}\right) \propto l$

$A \propto l$

$$\boxed{A = \varepsilon l}$$

Where $\varepsilon \rightarrow$ Molar Extinction cofficient.

$l \rightarrow$ path length.

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Beer's Law

When a beam of Monochromatic radiation is passed through the absorbing medium, then the decrease in the intensity of the radiation is directly proportional to the Conc. of the solution.

$$A = \log_{10}\left(\frac{I_0}{I}\right) \propto C$$

$$\Rightarrow A \propto C$$

$$\Rightarrow \boxed{A = \varepsilon C}$$

where $\varepsilon \rightarrow$ Molar Extinction Cofficient

$C \rightarrow$ Conc. of the solution.

Lambert - Beer's Law

When a beam of Monochromatic radiation is passed through the absorbing medium, then the decrease in the intensity of the radiation is directly proportional to the thickness (path length) as well as Conc. of the Solution.

$$A = \log_{10}\left(\frac{I_0}{I}\right) \propto l \cdot C$$

$$A \propto l \cdot C$$

$$\boxed{A = \varepsilon \cdot l \cdot C}$$

ε - Molar Extinction coefficient

$l \rightarrow$ path length.

$C \rightarrow$ Conc. of Solution..

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Isomerism

Two (or) more compounds having chemical Formula but differ in arrangement of Atom and ~~physical~~ also differ in physical & chemical properties are called Isomers & phenomenon is called Isomerism.

Types :- (i) Stereo → Geometrical, optical
(ii) structural → Linkage, Ionisation, Co-ordination, Solvate/Hydrate

Stereo isomerism

Two (or) more compounds having same chemical Formula & chemical bond but differ in Spatial arrangement of atom

Types :-

1. Geometrical

These are isomers which differ in ~~Spatial arrangement~~ relative position of like groups around central metal atom.

- If like groups are present adJacent to each other then they are called cis-isomers.
- If like groups are present opposite to each other then they are called trans-isomers.

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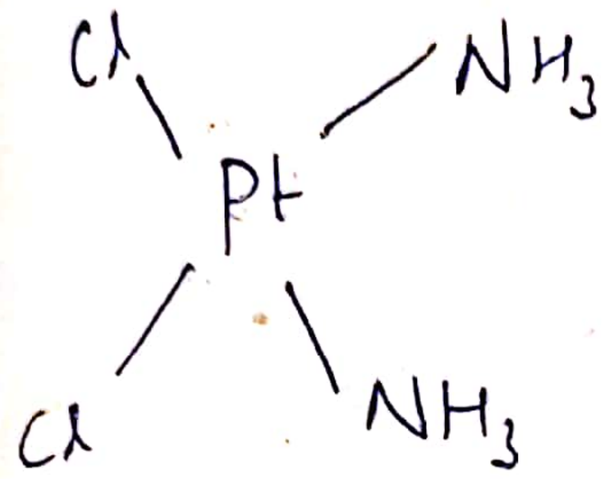
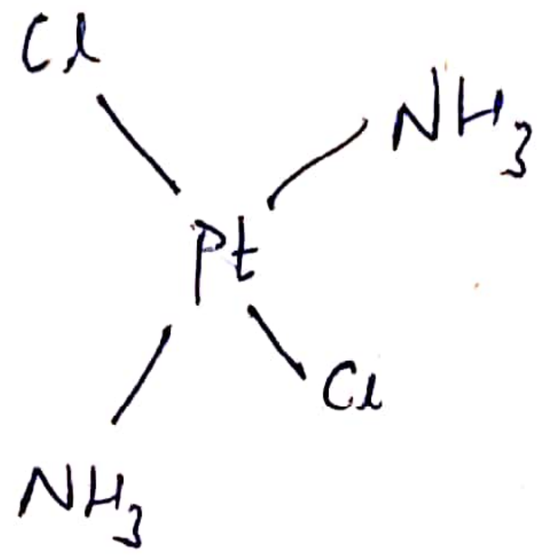
Example $[PtCl_2(NH_3)_2]$



Cis.



Trans.

2. Optical.

These are Isomers which have same physical & chemical properties but differ in the direction of rotation of plane polarized light.

The isomers which are mirror images to each other and are non-super imposible are called enantiomers.

The molecules and ions which are non-superimposible are called chiral.

Optical Isomers 2 types :-

(i) Dextro-rotatory (d)

Rotates plane polarised light towards right

(ii) Laevo-rotatory (l)

Rotates plane polarised light towards left.

Exam

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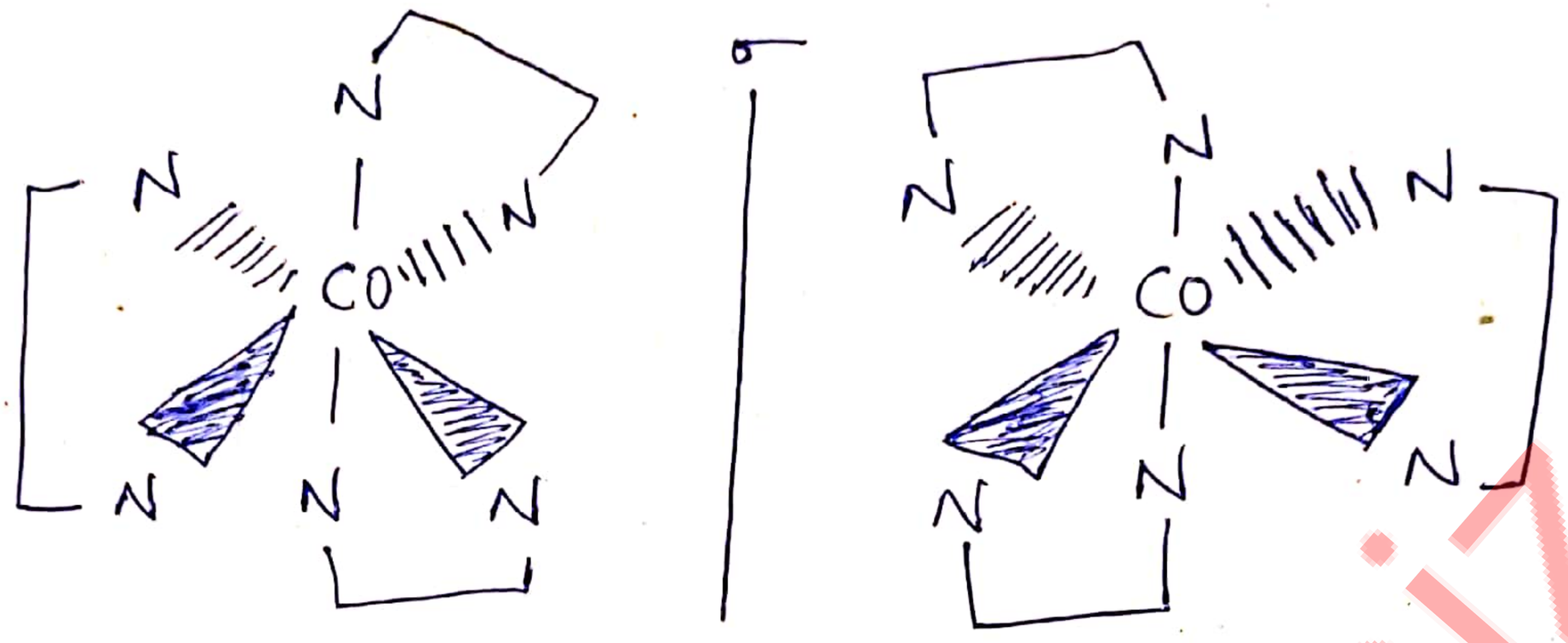
Example – $[Co(en)_3]^{3+}$



Structural Isomer

Same Molecular Formula but differ in Spatial arrangement of atoms (or) group of atoms around central metal atom.

1. Linkage

Same MF but differ in attachment of monodentate ligand to central metal atom.

Ex – $[Co(NH_3)_5(ONO)]Cl_2$

$[Co(NH_3)_5NO_2]Cl_2$.

2. Co-ordination

These isomers contain both complex cation & complex anion and exchange of Ligands occurs btwn the complex cation & complex anion.

$[Co(NH_3)_6][Cr(CN)_6]$

$[Cr(NH_3)_6][Co(CN)_6]$

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3. Ionisation Isomer

These are produced by interchange of position of Ligands inside the Complex zones and anions outside the Complex zone.

Ex- $[PtCl_2(NH_3)_4]Br_2$

$[PtBr_2(NH_3)_4]Cl_2$

4. Solvate / Hydrate.

These have same Molecular Formula but differ in number of Water molecule as Ligand.

Ex- $[Cr(H_2O)_6]Cl_3$

$[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

$[Cr(H_2O)_4Cl_2]Cl \cdot (H_2O)_2$.

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Stereochemistry

1. Chain Isomerism

When two (or) more compounds have same Molecular Formula but differ in the arrangement of C-atom in the main chain. ~~Phenomena~~ such compounds called Chain Isomers & Phenomenon is called Chain Isomerism

Ex-

$CH_3-CH_2-CH_2-CH_3$ n-butane

$CH_3-CH(CH_3)-CH_3$ 2-Methyl propane.

2. Position Isomerism

When two (or) more compounds have same Molecular Formula but differ in position of double & Triple bond ~~and~~ (or) Functional group. (Baki same pehle ke Taran)

Ex-

$CH_2=CH-CH_2-CH_3$ but-1-ene

$CH_3-CH=CH-CH_3$ but-2-ene.

3. Functional Isomerism

When two (or) more compounds have same Molecular Formula but differ in the Functional groups.

Ex-

CH_3-CH_2-OH (Alcohol group) Ethanol

CH_3-O-CH_3 (Ether group) methoxy methane.

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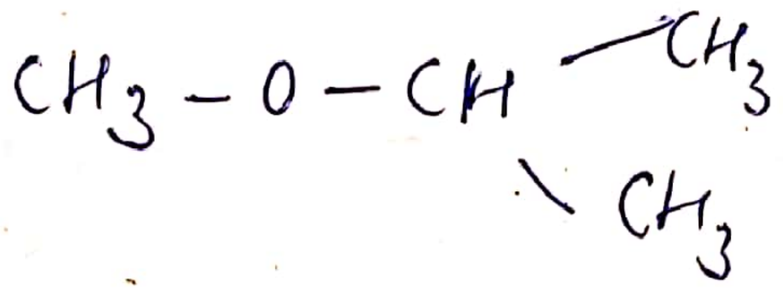
4. Metamerism

When two (or) more Compounds have same Molecular Formula & same Functional group but possess different type of alkane group on both side of Functional group.

Ex - $CH_3-O-CH_2CH_2CH_3$

1- methoxy propane.



2-Methoxy propane

$CH_3CH_2-O-CH_2CH_3$

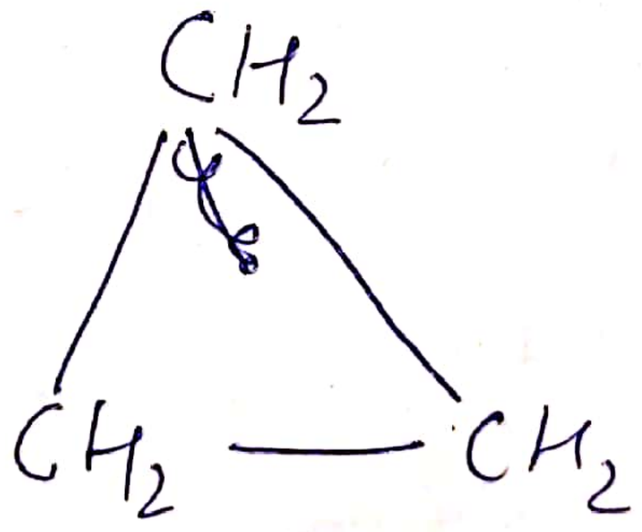
Ethoxy ethane.

5. ~~Pattern~~ Ring Chain

When two (or) more Compounds having same Molecular Formula but differ in linking of C-atom & have both open chain as well as closed chain str.

$CH_3-CH=CH_2$

Propene



Cyclopropane

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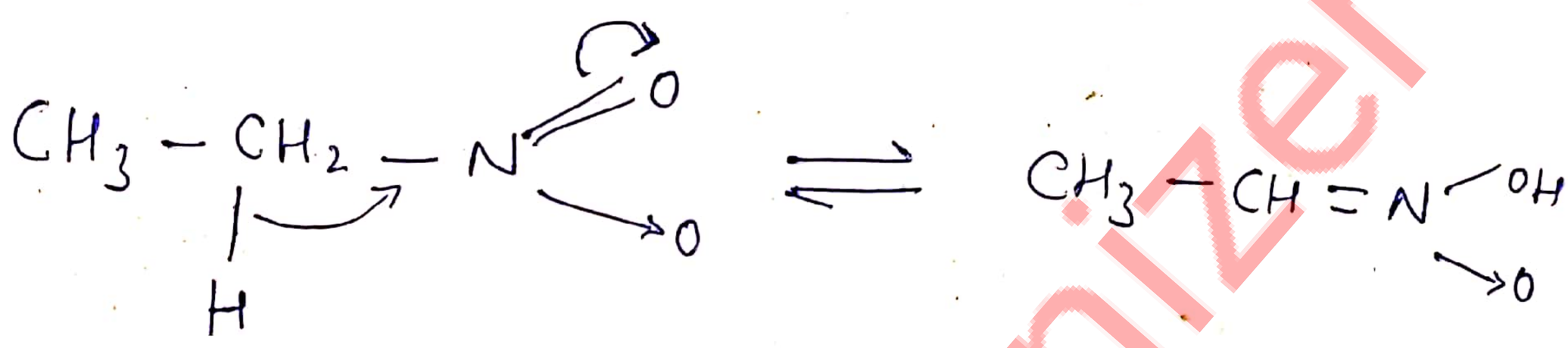
Tautomerism

Phenomenon in which a single compound exist in two readily interconvertible form which differ ~~markedly~~ in relative position of atleast one atomic Nucleus which is Hydrogen



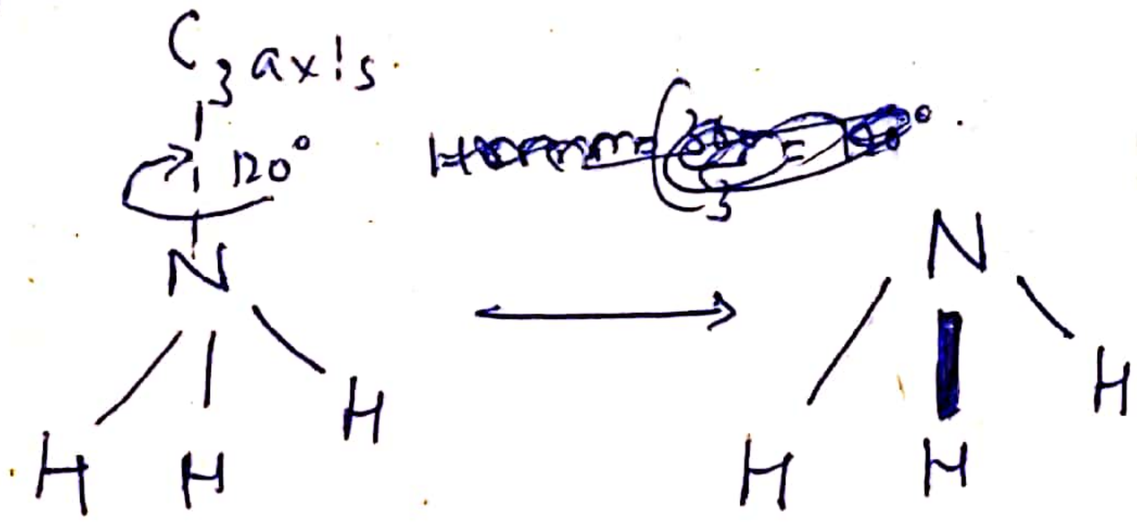
Nitroethane Isonitroethane.

Rotational axis of symmetry (or) proper axis of symmetry (C_n)

Rotational axis of ~~symm~~ a molecule is an imaginary axis passing through the molecule, such that if the molecule rotates about the axis through an angle of $\frac{360^\circ}{n}$, than the resulting equivalent str will be superimposible with the original one.

- It is denoted by C_n, where 'n' denotes order of ~~rotation~~ rotation which is obtained by dividing 360° by the smallest angle through which the molecule has rotated about the axis.

Ex – NH_3



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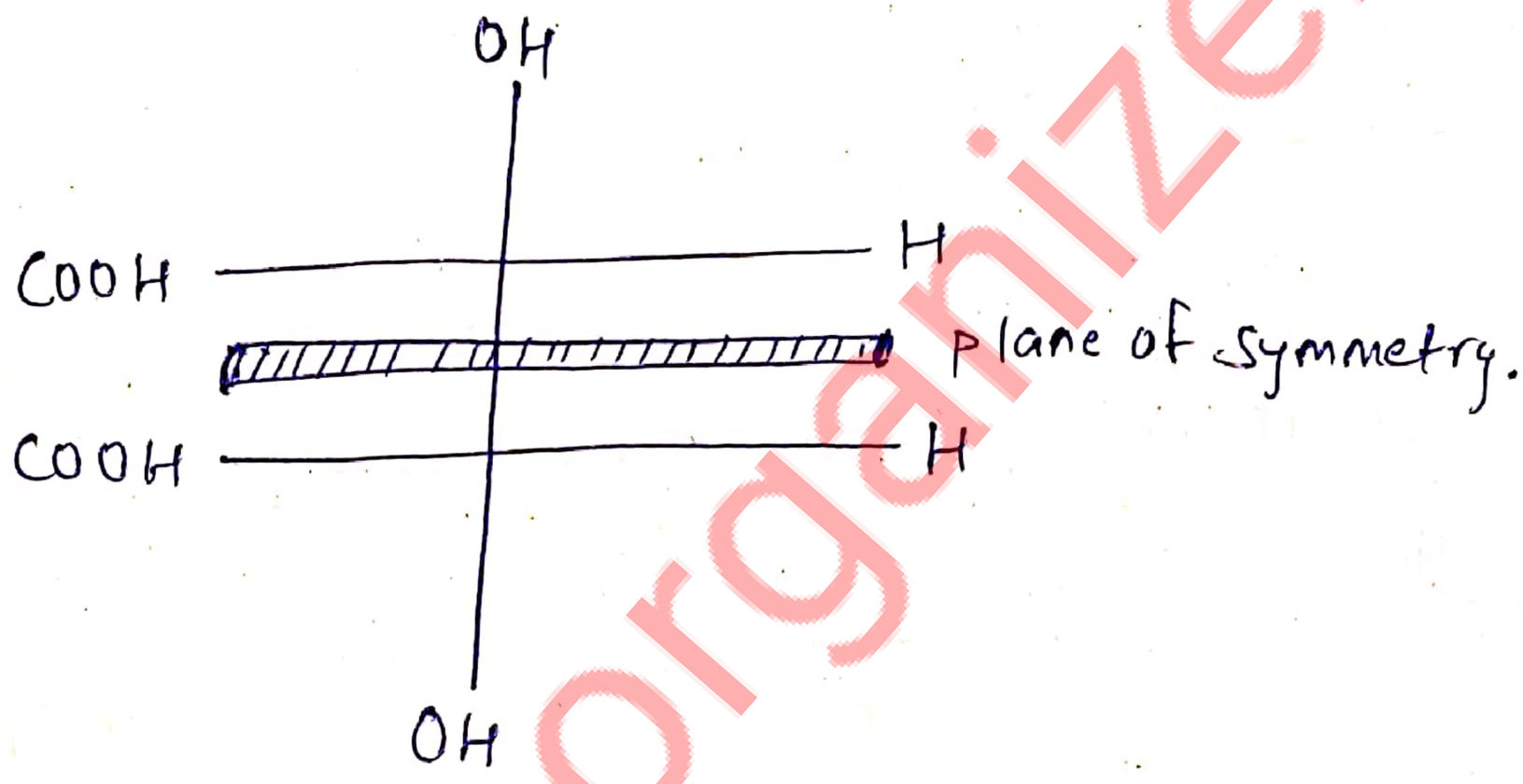
Plane OF Symmetry

A molecule is said to have plane of symmetry, if an imaginary plane divides it into two halves. ~~Each being~~ Each half being mirror image to the other. ~~Symbottical~~

, symbolically represent as sigma (σ).

~~Ex- Mesotartaric~~

Ex- Mesotartaric acid has plane of symmetry.



Centre of Symmetry / Centre of Inversion

A molecule is said to have centre of symmetry if,

- There is a point (centre) ~~within~~ within the molecule such that if a line is drawn through that point it will meet an atom at a certain distance.
- From the point it will meet another similar atom on the other side of the point at the identical distance.
- Also known as centre of Inversion.
- Symbolically represented as 'c'.

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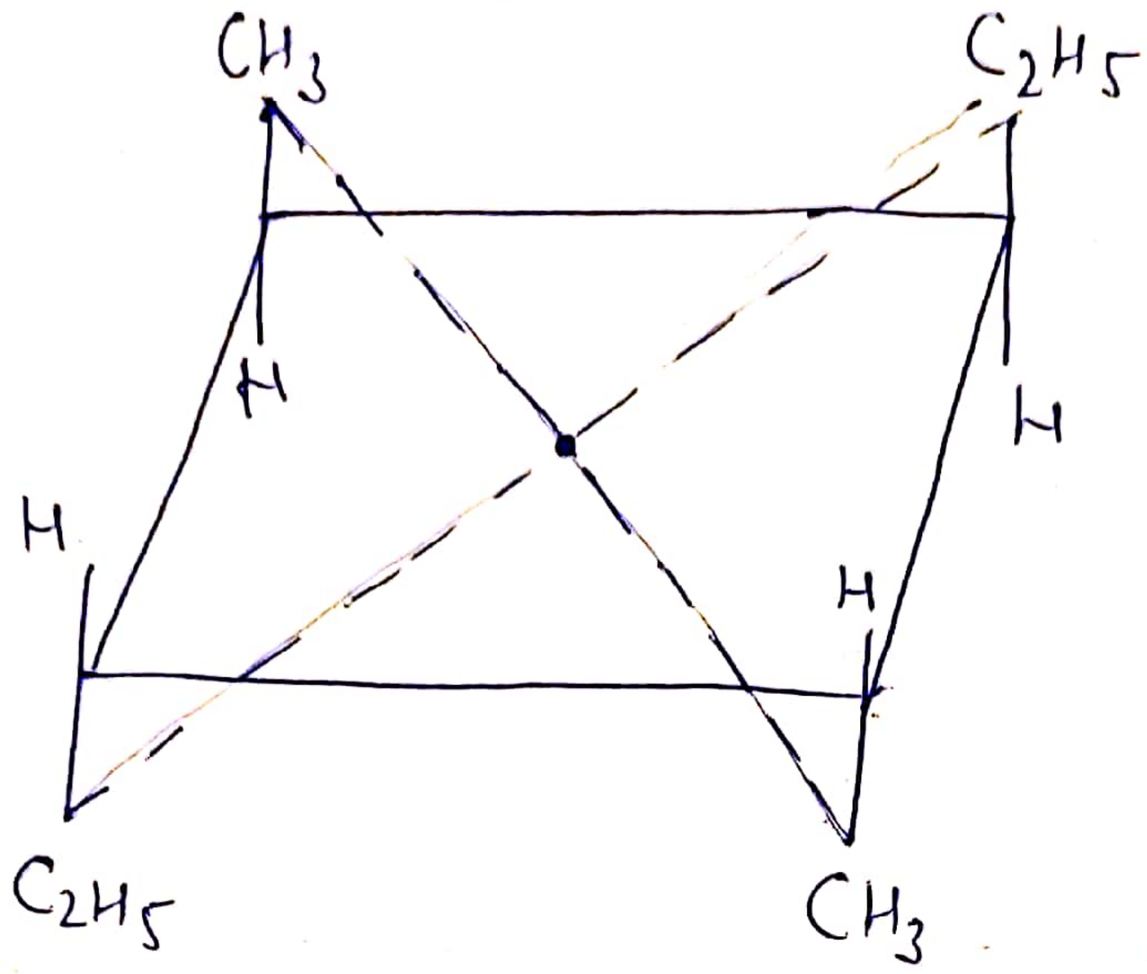
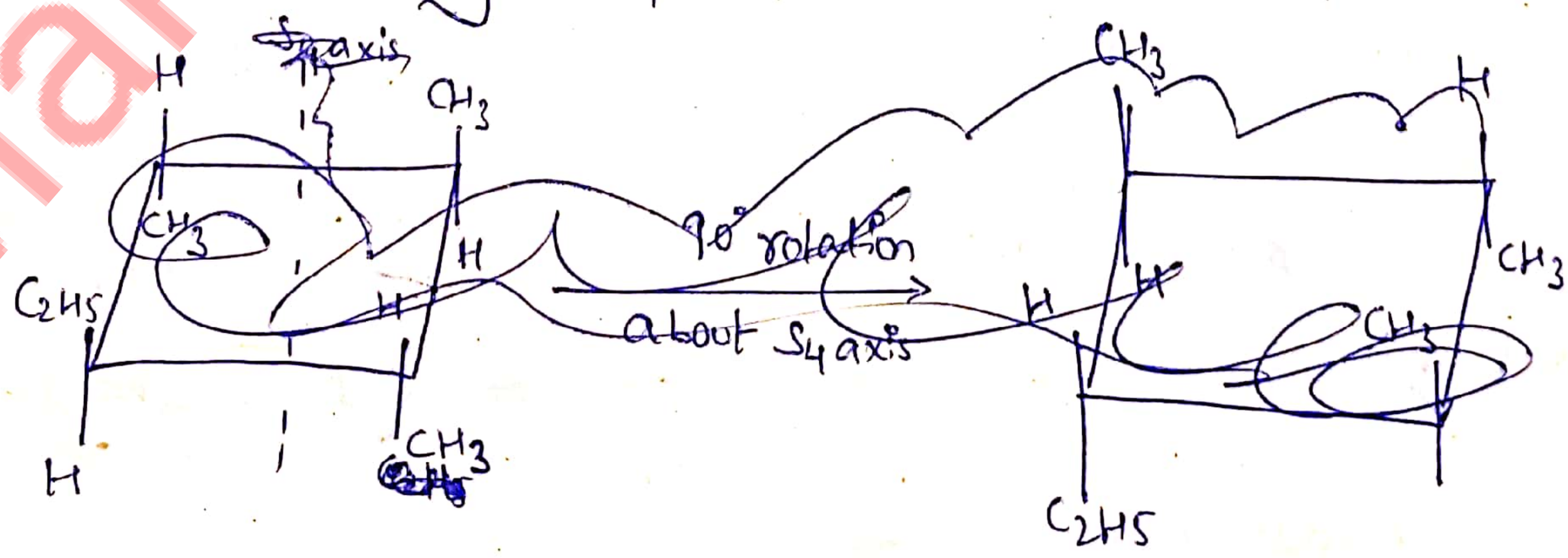


Centre of symmetry

Alternating axis of Symmetry / Rotation Reflection Symmetry

A molecule is said to have an alternate axis of symmetry, when the molecule rotates about the axis by $\frac{360^\circ}{n}$ followed by reflection of the plane perpendicular to the axis, produces an indistinguishable molecule from the original.

- Also known as Rotation Reflection Symmetry.
- Symbolically represented as S_n.



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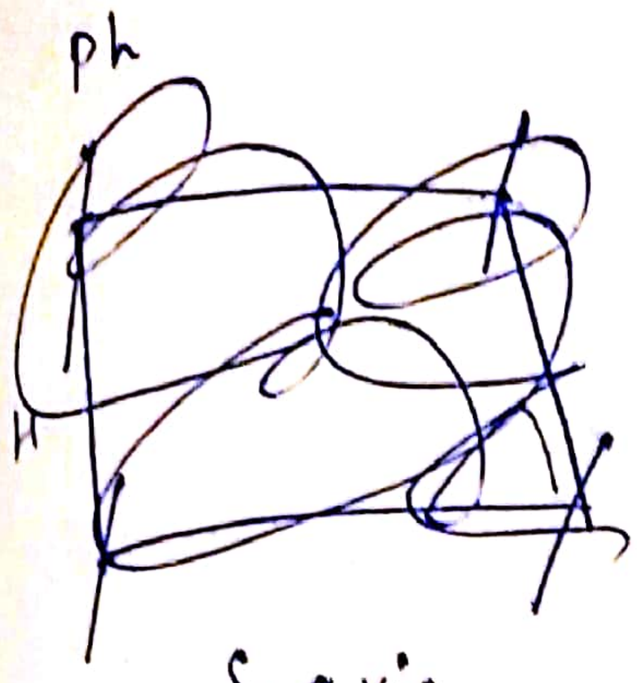

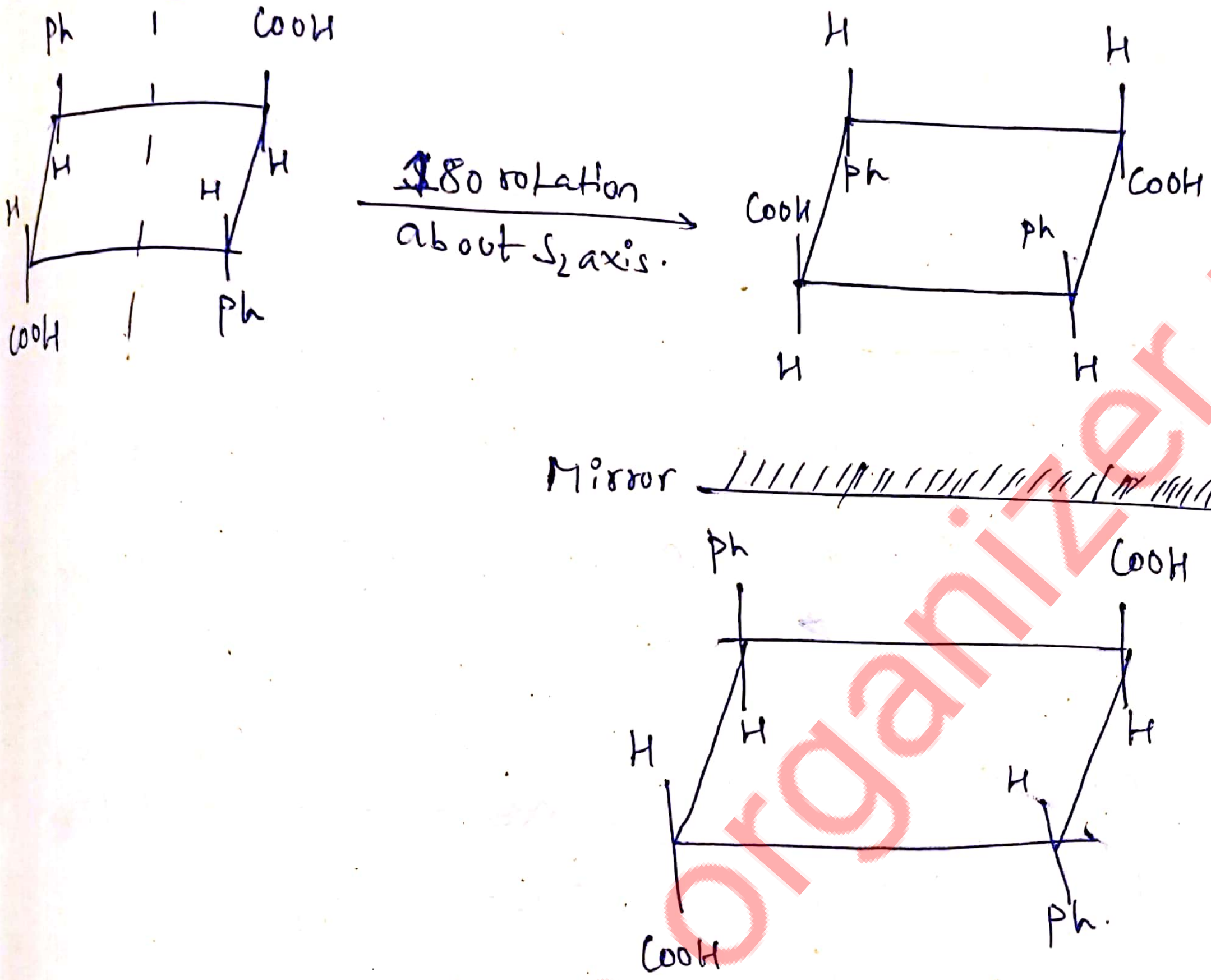

α – Truxillic acid.

Newman projection

In this, the molecule is viewed along the bond ~~joing~~ joining the carbon atoms.

- These atoms are represented as superimposed circle.
- The front C-atom is represent by centre of the circle.
- The back C-atom represented by the circumference.
- The remaining bonds are shown by small straight lines at angle of 120° which are joined to centre & the circumference.

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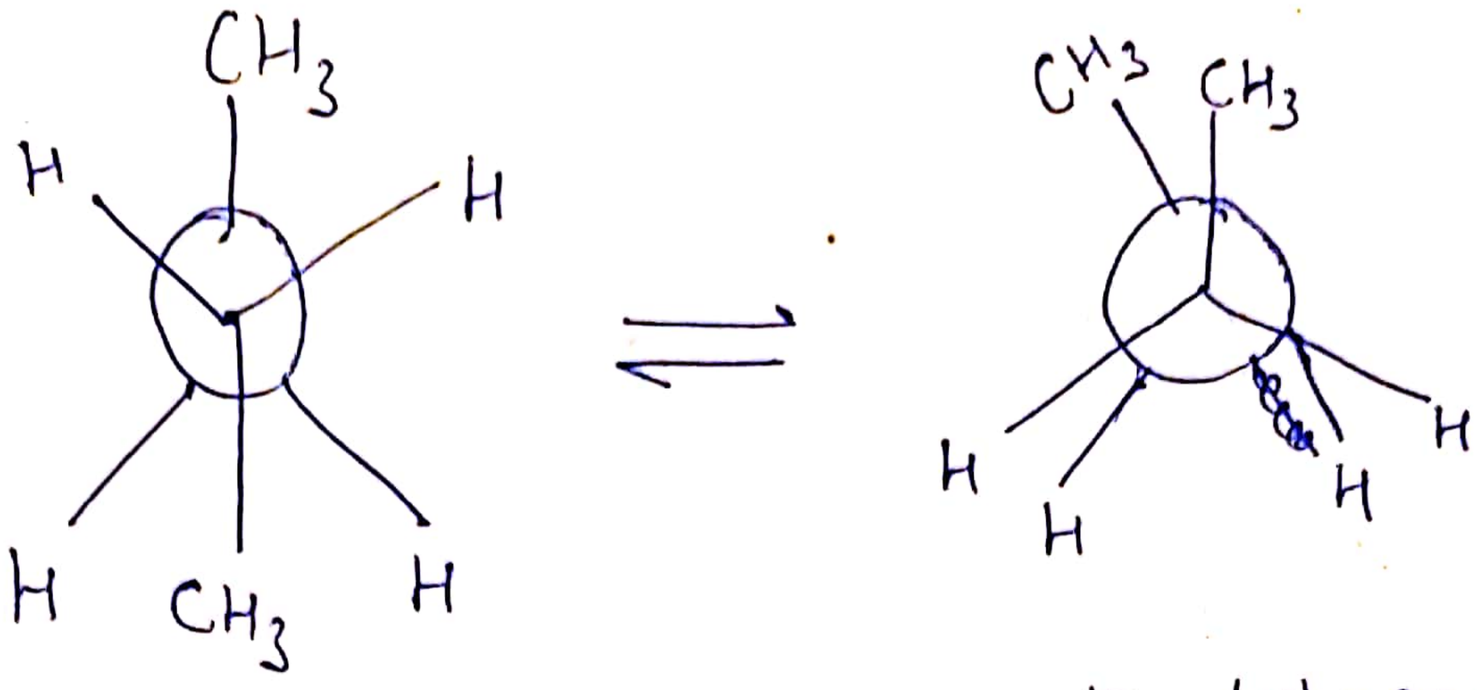
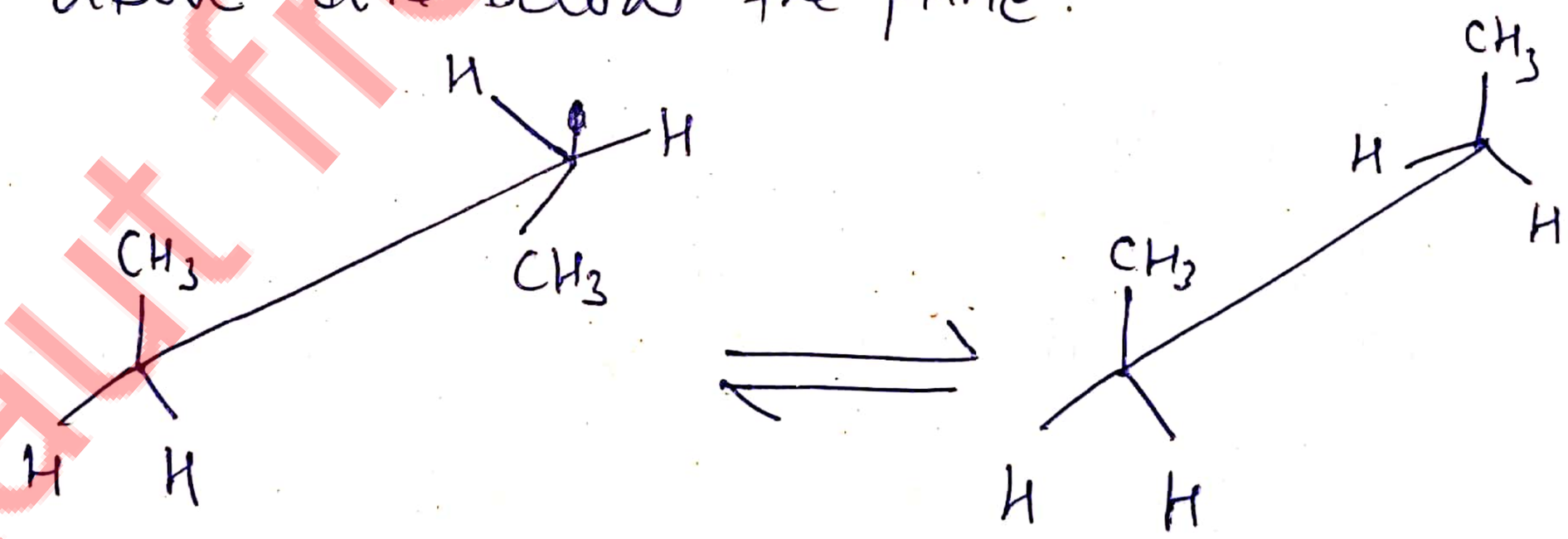


n-butane (staggered) n-butane (Eclipsed).

Saw horse projection.

- It is necessary to know the spatial relationship btwn the substituents attached to two adjacent carbon atom.
- Two key carbon atoms are joined by a diagonal line which is taken as the plane of the paper.
- Remaining bonds are shown by small line projected above and below the plane.



n-butene (staggered) n-butane (eclipsed).

Note :- ~~eclipsed~~ staggered conformation is more stable than eclipsed because in eclipse the positioning of atom forces them close together hence increasing steric hinderance in molecule.

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Fajans' rule

- The power of an ion to distort the other ion is called its polarising power.

- The Tendency of an ion to get polarised or ~~distort~~ get distorted is called its polarised ability.

Fajan bought up a number of Emperical rule ~~called~~ known as Fajan's rule.

According to this rule "The increased polarisation of a ionic compound", is favoured by small positive ion, large negative ion, & high charge on the ion.

Fajan's rule also depends on :-

1. E.C of cation.

The molecule having cation with $18e^-$ shell configuration are more covalent compared to those having $8e^-$ shell configuration, because 'd' e^- of the $18e^-$ shell shield the Nuclear charge less effectively than s & p e^- of ~~8e electron~~ ~~8 shell~~ $8e^-$ shell.

- Hence $18e^-$ shell has larger effective Nuclear charge compared to the ~~8e~~ cation having $8e^-$ in outermost shell.

Ex- ~~In~~ AgCl is more covalent & stable compared to NaCl.

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Hard base	Soft base
• It contains non-polarisable donar atoms. such as (N, O, F)	• It contains polarisable donar atoms such as (P, S, Cl).
Ex - NH_3, H_2O, F^-, Cl^-	Ex - H^-, CN^-, I^-, CO.

Hard acid	Soft acid
• Metal ions which have high affinity for hard bases are called hard acid.	• Metal ions which have high affinity for soft bases are called soft acid.
• They are cation of high electropositive metal.	• They are cation of less electropositive metal.
Ex - H^+, Li^+, Na^+, K^+	Ex - Ag^+, Cu^+, Pd^+, Pt^+.

Ligand

It is a molecule (or) an ion bound to the central metal atom and is capable of donating one (or) more pair of e^- to the central metal atom.

Ex - Cl^-, H_2O, NH_3.

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1. Monodentate Ligand

Ligands which have only one donar atom and is co-ordinated with central metal atom.

Ex - NH_3, NO, CO.

2. polydentate Ligand.

Ligands which many donar atoms and is coordinated to central metal atom.

~~Ex~~ Ex - EDTA.

3. Bidentate Ligand

Which have 2 donar atoms & Co-ordinates to central metal atom from two positions.

Ex - $NH_2 - CH_2 - CH_2 - NH_2$.

Ethane - 1,2 diamine.

4. Tridentate Ligand

Which have 3 donar atom & Co-ordinates to central atom from three positions.

Ex - $NH_2 - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH_2$

Diethylene triamine.

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Ambidentate Ligand.

Which has more than one donar side but Co-ordinates with central metal atom using one of side at a time.

Ex - $[S-C\equiv N]^-$ (or) NO_2^-

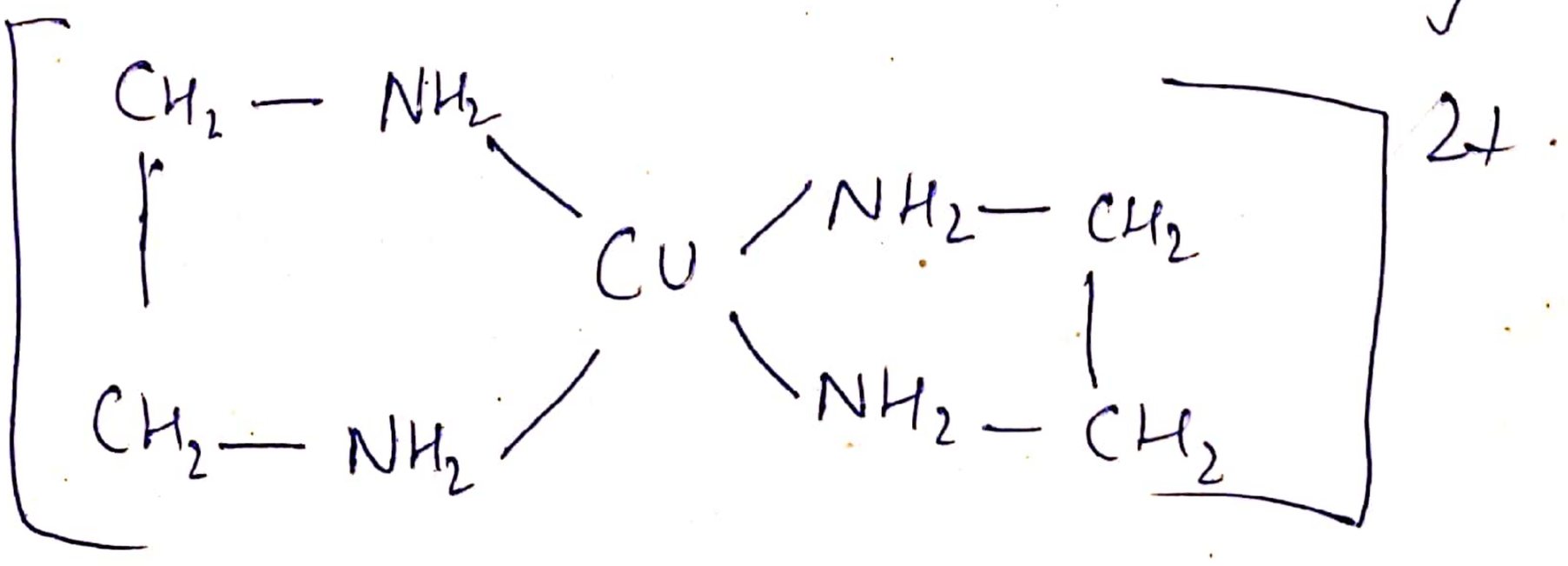
~~Bsoeg~~

Isothiocyanate.

~~Chelati~~. Chelating Ligand

It is a bidentate (or) polydentate Ligand which attaches to central metal ~~to~~ atom with two (or) more donar atoms forming a ring str.

Ex- Ethane - 1,2 diamine acts as chelating Ligand ∴ attaches to Cu^{2+} to form ring str.



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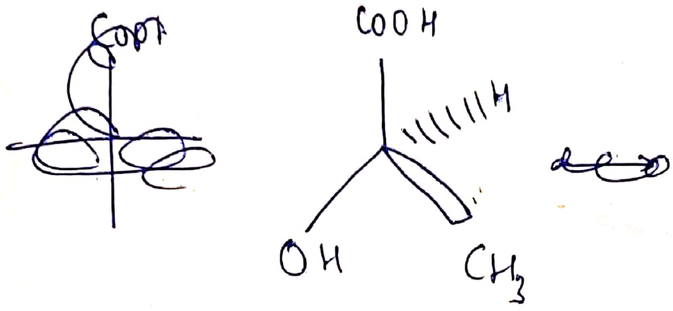
Assign R & S configuration

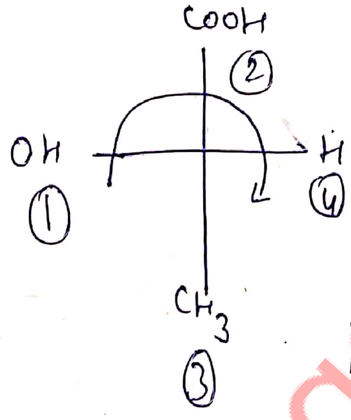
Note R → Clockwise

S → Anticlockwise

1.



Sol:-



R-configuration.

Note :- I > Cl > Br > F

atm no. Jyada Hai

1st prefference to this group

(2) Ph, COOH

1st preference.

(3) Ph, CH_3

1st.

(4) H, CH_3

1st.

(5) Ph, OH

1st

$\equiv \rightarrow sp$

$= \rightarrow sp^2$

$- \rightarrow sp^3$

sp d f

sp < 4s < 3d < 4p

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Lewis acid

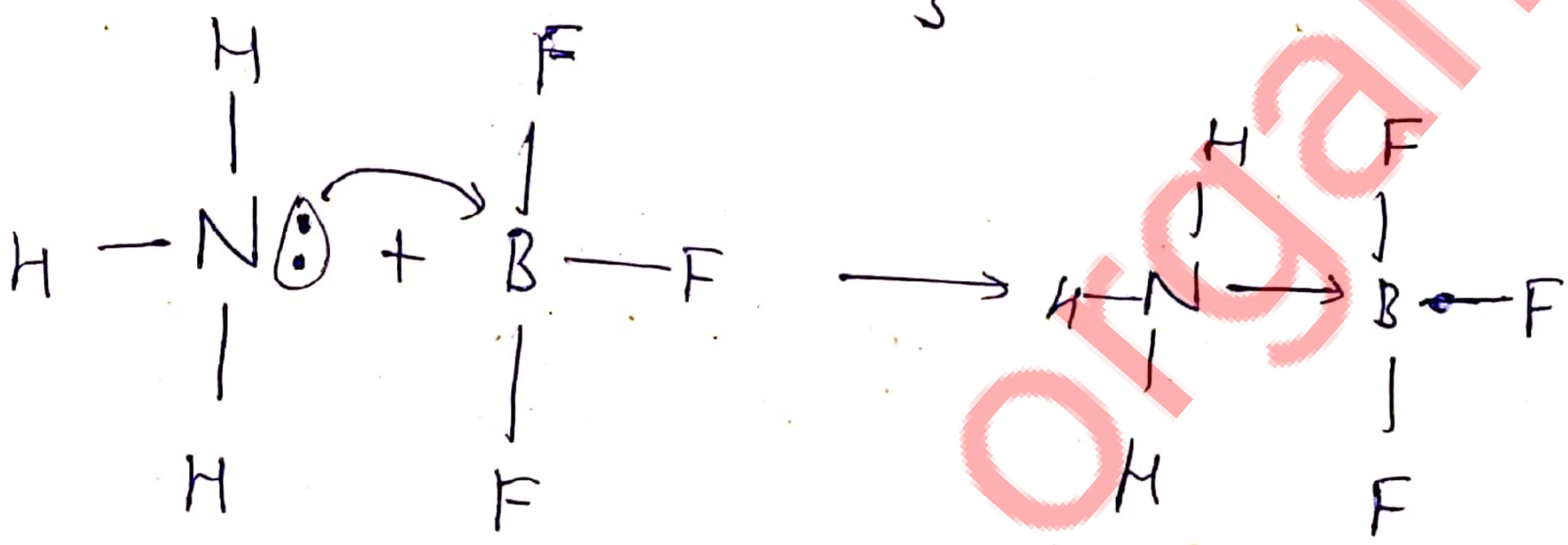
Compound having incomplete octet in Central atom acts as Lewis acid.

Ex- BF_3.

Lewis Base

Compound having ~~an~~ one (or) more unshared paired of e^- acts as Lewis Base

Ex- $\ddot{N}H_3$



Lewis Base — Lewis acid.

Adding Few more points to Fajans rule :-

1. Small Positive Ion

Small +ve Ion has high polarising power.

Ex- Li^+ has more polarising power than Na^+ & K^+.

2. Large Negative Ion

Large ~~Neg~~ -ve Ion get polarised Easily

Ex- I^- get polarised easily than Cl^-

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3. High Charge

- If there is high charge on cation, ~~at~~ greater its tendency to polarize the anion.

- High charge on anion, greater its tendency to get polarised.

Ex- Mg^{2+} has greater polarising power than Na^{+}.

De-Broglie Eqn

According to Broglie,

$$E = h\nu \quad \text{—— (I)}$$

According to Einstein,

$$E = mc^2 \quad \text{—— (II)}$$

$$h\nu = mc^2$$

$$h \times \frac{c}{\lambda} = mc^2 \qquad \left[\because \nu = \frac{c}{\lambda}\right]$$

$$\frac{h}{\lambda} = mc$$

$$\boxed{\lambda = \frac{h}{mc}}$$

Heisenberg uncertainly principle

For an e^-, it is impossible to determine both the position & momentum at any instant

$$\Delta p \times \Delta x \geq \frac{h}{4\pi m}$$

Schrondinger wave Eqn

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi^2 m}{h}(E - V)\psi = 0.$$

(or)

$$\nabla^2 \psi + \frac{8\pi^2 m}{h}(E - V)\psi = 0.$$

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n-type Semiconductors	P-Type Semiconductors.
1. Such Semiconductors are Formed by doping Si (or) Ge with Pentavalent impurity (Ex - P, As)	1. Such Semiconductors are Formed by doping Si (or) Ge by Trivalent impurity (Ex - B, Al, Ga)
2. Such Semiconductors Have Excess of e⁻.	2. Such Semiductors Have Excess of Electron holes.
3. Conduction is due to movement of Free e⁻	3. Conduction is due to movement of electron holes.
4. Conduction is due to movement of negative electric Charge	4. Conduction due to movement of +ve electric charge

Q. What is CFSE?

Ans. Octahedral Crystal Field.

- E.C is $e^p_{2g}\, e^q_g$

$$CFSE = -4PDq + 6qDq + mp$$

Tetrahedral Crystal Field

- E.C is $e^{2p}\, t_2^q$

$$CFSE = -6PDq + 4qDq + mp$$

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Adipic acid hexamethylene diamine

1. $nCOOH-(CH_2)_4-COOH + nNH_2-(CH_2)_6-NH_2$

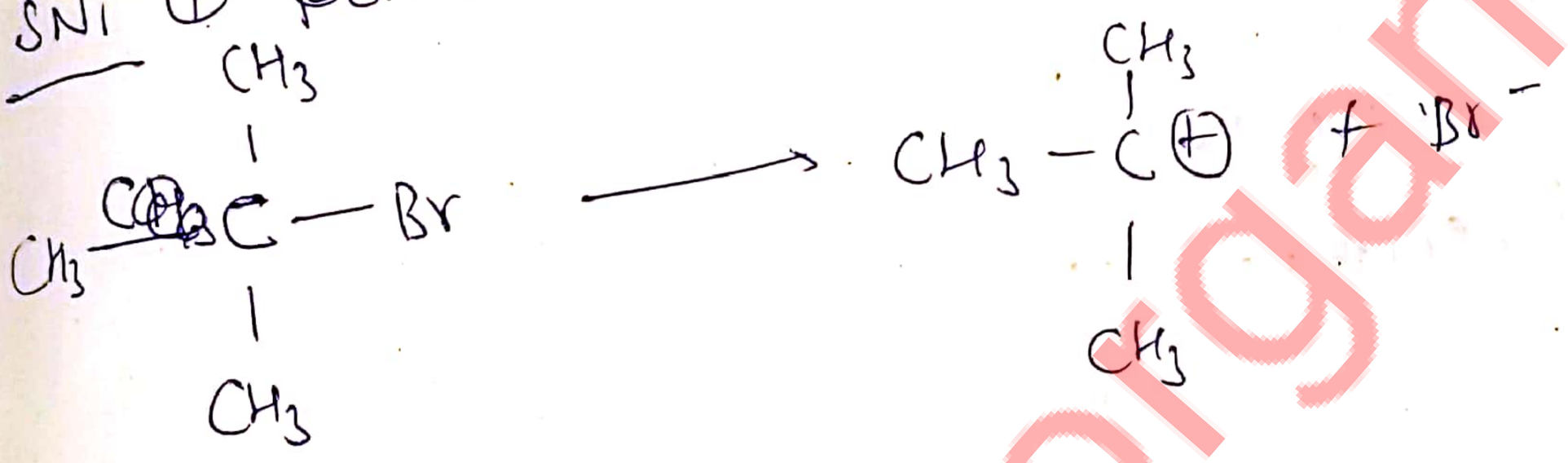
$$\longrightarrow \left(-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_6-NH- \right) + nH_2O$$

Nylon 6,6.

2. $n\,CF_2=CF_2 \xrightarrow{\text{persulphate}} (CF_2-CF_2)_n$

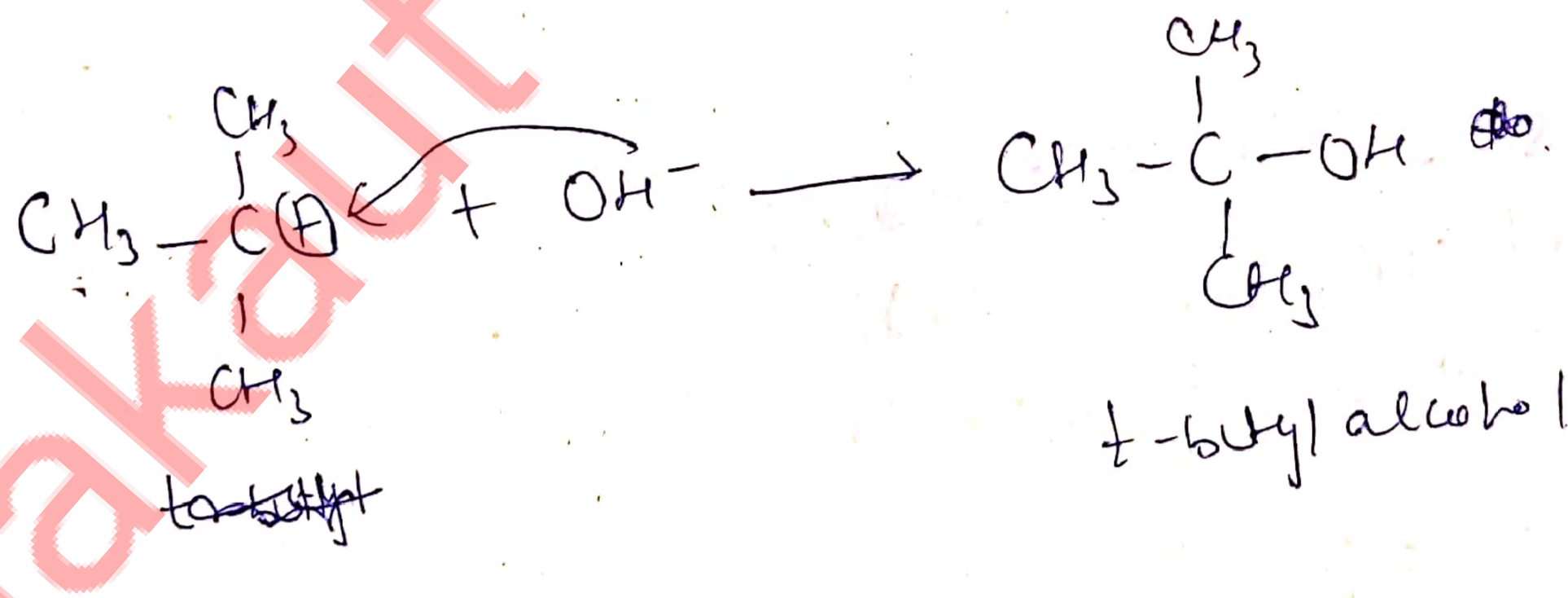
tetraFluoroethene Teflon

SN1 ① Formation of carbocation



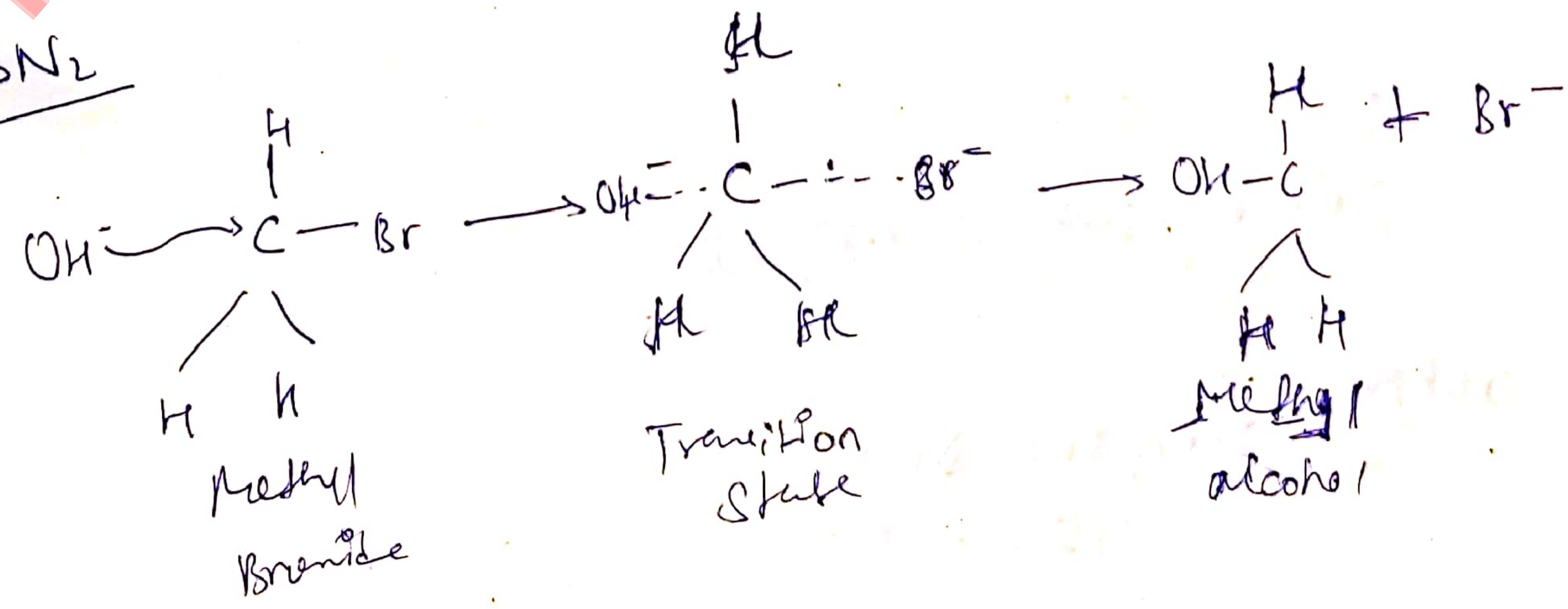
② Attack of Nucleophile on carbocation.

$KOH \longrightarrow K^+ + OH^-$



t-butyl alcohol

SN2



Methyl Bromide Transition State Methyl alcohol

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