

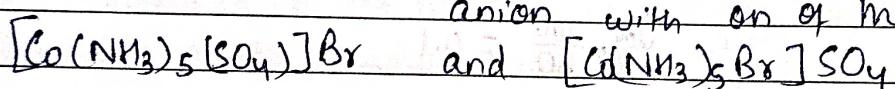
i) Which Spectroscopic technique is most powerful to identify the presence / known impurity in a drug subst? NMR.

ii) Van der waal's forces are directly proportional to Molecular weight / Surface area.

iii) Ex. of State function. Entropy, Enthalpy, etc.

iv) Soft acid ex. - Cu^+ , Ag^+ , Au^+ , etc.

v) Ionisation isomerism - Occurs by exchange of counter anion with one of the ligand.



vi) Reactivity order of alkyl halide in S_{N}^2 mechanism:-

S_{N}^2 rxns. are sensitive to steric factors.

∴ they are greatly retarded by steric hindrance at the site of rxn.

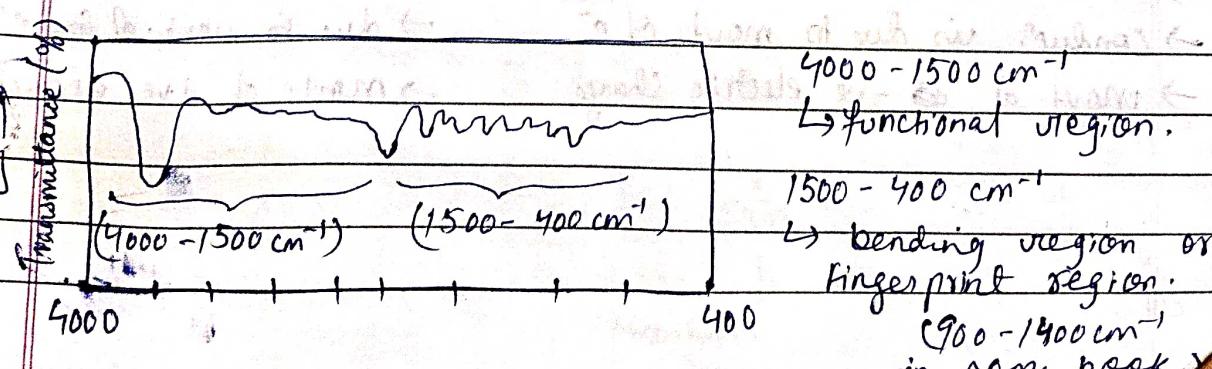
So, Order of reactivity of alkyl halides in S_{N}^2 rxns.

:- methyl $>$ $1^\circ > 2^\circ > 3^\circ$.

\downarrow
 3° alkyl halide are so crowded that they don't generally react by S_{N}^2 mech.

vii) Fingerprint region range in IR spectra?

Representation of Spectrum:-



viii) formula of critical vol., critical temp., critical press.

for VDW gas:-

$$\rightarrow V_c = 3b$$

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

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

ix) State one applin' of 1st law of T.D. of substances

→ Heat engine refrigerator.

x) Shielding constant value for is orbital e⁻? 0.30

xi) What will be the absorbance if % of Transmittance=80?

$$\rightarrow \text{Absorbance}, A = \log_{10} \frac{1}{T}$$

$$A = \log_{10} \frac{100}{80} = 0.1$$

~~Group-B :-~~ Group B elements are which are

i) Why does Ge act as n-type SC? What is the diff. b/w

→ n-type & p-type SC?

→ Ge is neither trivalent nor pentavalent; it has 4e⁻ in its

outermost orbit. The Ge element is not doped with any impurities. Hence, it is a n-type SC.

N-type SC

p-type SC

→ doping Si or Ge with pentavalent impurity (eg. P, As) → doping Si or Ge with trivalent impurity (eg. B, Al, Ga)

→ excess of e⁻

→ excess of holes.

→ conduct. is due to movt. of e⁻

→ due to movt. of free e⁻ holes

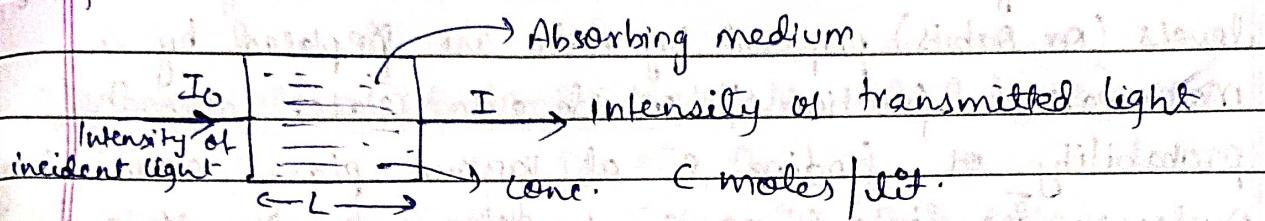
→ movt. of -ve electric charge

→ movt. of +ve elec. charge

Q) Intensity of Spectral line depends on which factor? What is Lambert - Beer law?

Ans: Brightness / Intensity of spectral line depends on no. of photons of same λ or \sim absorbed or emitted.

Law of absorption of light: - follows Lambert - Beer's law:



Lambert law: When a beam of monochromatic light is allowed to pass through an absorbing medium, the rate of \downarrow of intensity with the thickness of the medium is directly proportional to the intensity of the medium radiation.

$$\frac{-dI}{dl} \propto I$$

Beer's law: When a beam of monochromatic light is allowed to pass through an absorbing medium, the rate of \downarrow of intensity with the thickness of the medium is directly proportional to the conc. of the medium.

$$\frac{-dI}{dl} \propto c$$

Combining Lambert - Beer Law:

$$\frac{-dI}{dl} \propto Ic \Rightarrow \frac{-dI}{dl} = k Ic \quad K = \text{proportionality const.}$$

$$\therefore \int_{I_0}^I \frac{dI}{I} = k \int_0^l dl$$

$$\therefore -\ln \frac{I}{I_0} = kcl$$

$$\therefore \ln \frac{I_0}{I} = kcl$$

$$\therefore \log \frac{I_0}{I} = \frac{k}{2.303} cl \quad \begin{matrix} \text{molar extinction} \\ \text{coeff. or molar absorp.} \end{matrix}$$

$$\therefore A = cl \quad A = \log \frac{I_0}{I}, \quad E = \frac{k}{2.303}$$

Absorbancy / Optical density

3) P.T. $(V - \frac{h^2}{8\pi^2 m} \nabla^2) \Psi = E\Psi$.

The Schrodinger's wave equation:-

e^- behave as a wave, so, there must be a wave eqn. to describe their behaviour. Schrodinger derived an eqn. to describe the wave behaviour of e^- in atoms.

In Schrodinger wave model of an atom, the discrete energy levels (or orbits) proposed by Bohr are replaced by a mathematical function Ψ which is related with the probability of finding e^- at various places around the nucleus. The state of an e^- is defined by the state func. or wave func. Ψ , which is a func. of coordinates x, y, z .

$$\therefore \Psi = f(x, y, z)$$

Schrodinger's wave eqn. for an e^- wave propagating in 3-D in space is written as:-

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

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

$$\Rightarrow \left[-\frac{h^2}{8\pi^2 m} \nabla^2 + V \right] \Psi = E\Psi$$

$$\Rightarrow \boxed{H\Psi = E\Psi}$$

Energy eigen value eqn.

where, ∇^2 = Laplacian operator.

$$E = T.E.$$

V = P.E. of the system.

- 4) What kind of molecules shows IR Spectra? "IR Spectra is often characterized as molecular 'finger prints' Justify.

Criteria of Vibrational Transition of Molecules :-

Only those molecules execute vibrational transition whose dipole moment (M_D) changes due to vibration. That is the molecules must be an oscillating dipole for IR-active. Thus, all molecules can't absorb IR-radiation and so, don't give IR-spectra.

a) Homonuclear diatomic molecules (A-A type)

IR-inactive. e.g. H_2 , N_2 , O_2 .

b) Heteronuclear diatomic molecules (A-B type)

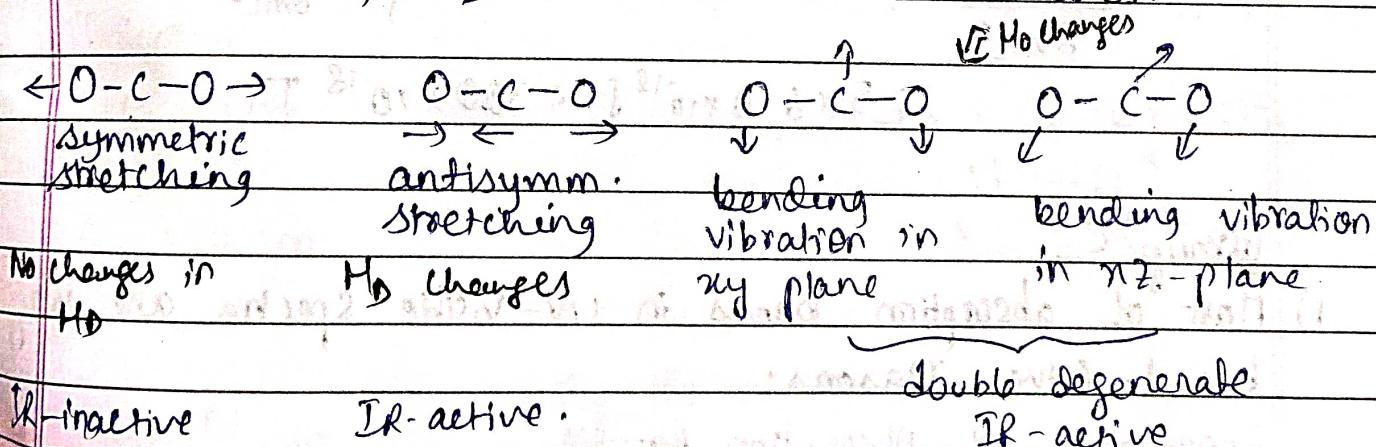
Always IR-active \rightarrow can give IR-spectra.

e.g. $H-Cl$, HBr , CO , NO , etc. (Vibrational transition always occurs).

c) Non-polar molecules like CO_2

Show Vibrational transition (IR-spectra) in some modes of vibrations in which these produce dipole moment.

CO_2 is a linear molecule, so, no. of modes of vibration is $(3n-5)$; where n is the no. of atoms in the molecule. So, CO_2 can vibrate in 4 modes:-



Region b/w 400cm^{-1} and 1500cm^{-1} in an IR Spectrum is known as fingerprint region. Usually contains large no. of peaks, making it difficult to identify individual peaks. However, fingerprint region of a given comp. is unique.

and \therefore can be used to distinguish b/w compounds. Each molecules has unique singe pattern in this region.

5) An e^- is confined in 1-D box of length $10^{-10} m$ with P.E. equal to 0 inside ($V=0$) and $V=\infty$ outside the box.

Calculate the ground state energy & separation b/w the levels with quantum no. 2 & 3. [mass of $e^- = 9.11 \times 10^{-31} kg$, Planck's constant $= 6.627 \times 10^{-34} Js$]

$$\Rightarrow \text{Energy of } e^- \text{ in 1-D box, } E_n = \frac{n^2 h^2}{8mL^2} \quad \text{When } n=1, \\ \text{we will get G.S. energy.}$$

$$\text{So, G.S. energy, } E_1 = \frac{1^2 h^2}{8mL^2} = \frac{h^2}{8mL^2} = \frac{(6.627 \times 10^{-34} Js)^2}{8(9.11 \times 10^{-31} kg) \times (10^{-10} m)^2} \\ = 6.0 \times 10^{-18} J \quad (J = kg \cdot m^2 s^{-2})$$

Separation b/w levels with quantum no. 2 and 3 $= 5E_1$

The general formula for energy separation b/w n and $n+1$ states,

$$\Delta E = \frac{(2n+1)h^2}{8mL^2} = (2 \times 2 + 1)E_1 = 5E_1, \quad \left\{ E_1 = \frac{h^2}{8mL^2}, \text{ G.S. Energy} \right\}$$

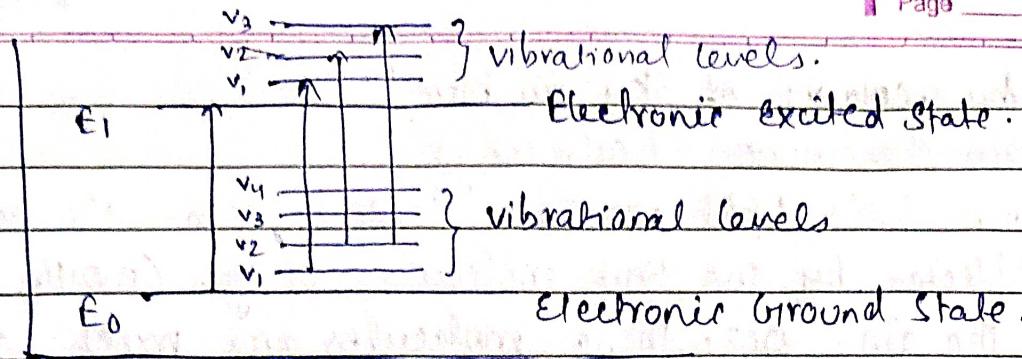
$$= 5 \times 6.0 \times 10^{-18} J = 30.0 \times 10^{-18} J$$

Group - C

- Most of absorption bands in UV-Visible Spectra are very broad. Give reasons.

Appearance of Absorption Band

All the wavelength in the UV-radiation (200nm-800nm) are not absorbed by the molecules. The energy of the absorption is quantized i.e., a particular radiation is absorbed for a single e^- transition.

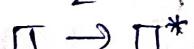


Thus, a discrete line is obtained for each type of electronic transition. However, instead of a discrete line a band of absorption (peak) is obtained ∵ the absorpt. is superimposed on rotational & vibrational energy levels.

The origin of bands can be

∵ the energy diff. b/w no. Vibrational & rotational levels for a particular electronic level are very small, many possible changes in energy b/w vibrational & rotat. levels of 2 electronic levels overlap, creating broad absorpt. bands in UV region for polyatomic molecules.

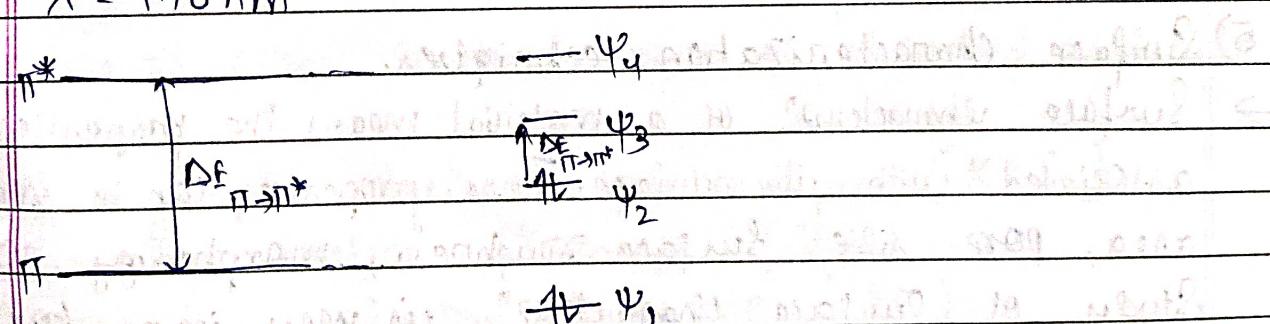
- 2) Why does 1,3-butadiene possess higher λ_{\max} value than that of ethene?
- UV-VIS spectra is more meaningful for conjugated 1T-system.



$$\lambda = 170 \text{ nm}$$



$$\lambda = 215 \text{ nm}$$



So, with increasing conjugation, $\Delta E \downarrow$ and $\lambda \uparrow$.

3) Why colour of sky is blue?

Main phenomenon - [Scattering]

When Sun's light reaches Earth's atm. it's scattered, or reflected by the tiny molecules of gas (mostly N and O) in the air. Bcz. these molecules are much smaller than the λ of visible light, the amnt. of scattering depends on the wavelength. This effect is called Rayleigh scattering

Shorter λ (violet & blue) are scattered the most strongly, so more of blue light is scattered towards our eyes than the other colours.

\therefore there isn't as much violet in sunlight to start w/, and our eyes are much more sensitive to blue.

The blue light gives sky its colour, as sufficiently bright to make all the stars that we see at night disappear \because the light they emit is much dimmer.

4) Predict the proton NMR spectra of CH_4 .

\rightarrow NMR spectrum of methane (CH_4) shows just a single peak bcz. all the 4 H are chemically equivalent. The chemical shift value for CH_4 protons will appear at 0.23 ppm.

5) Surface characterization techniques.

\rightarrow Surface characteriz' of a material means the properties associated with its surface. These properties can be surface area, pore size, surface roughness, morphology, etc. Study of surface characteriz' is very imp. for reactant research with catalyst, material sciences, and also biological research.

i) Langmuir's Surface area - Surface area of an adsorbent is calculated based on the formⁿ of mono layer by the adsorbate. The Langmuir eqⁿ. is -

$$\text{Surface area (m}^2\text{/g}) = \frac{X_m \times N_A \times S}{M}$$

where, X_m = max. amnt. of adsorbate adsorbed per gm. of adsorbent for monolayer formⁿ. in mg/g.

N_A = Avagadro no.

S = contact S.A. by each molecule (m^2)

M = a molecular wt. of the adsorbate.

ii) BET Surface Area:- (for multilayer adsorption)
Brunauer, Emmett and Teller (BET) eqⁿ. is

$$\frac{Z}{(1-Z)V} = \frac{(C-1)Z}{C V_{\text{mono}}} + 1$$

where, V = vol. of gas adsorbed at press. P

V_{mono} = vol. of gas needed for mono layer formⁿ.

$Z = \frac{P}{P_0}$, P = press. of gas

P_0 = saturation press.

C = a const.

$$\text{BET S.A.} = \frac{V_{\text{mono}} \times N_A \times A_{\text{cs}}}{\text{wt. of adsorbate.}}$$

A_{cs} = cross sectional area of absorbed molecule.

iii) X-ray photoelectron Spectroscopy (XPS)

iv) Scanning Electron Microscope (SEM)

v) Transmission Electron Microscope (TEM)

vi) High Resolution Transmission Electron Microscopy (HR-TEM)

vii) Atomic force Microscope (AFM)

These techniques are used to get high quality magnified images of the surface of a materials.

6) Discuss types & conditions of H-bonding.

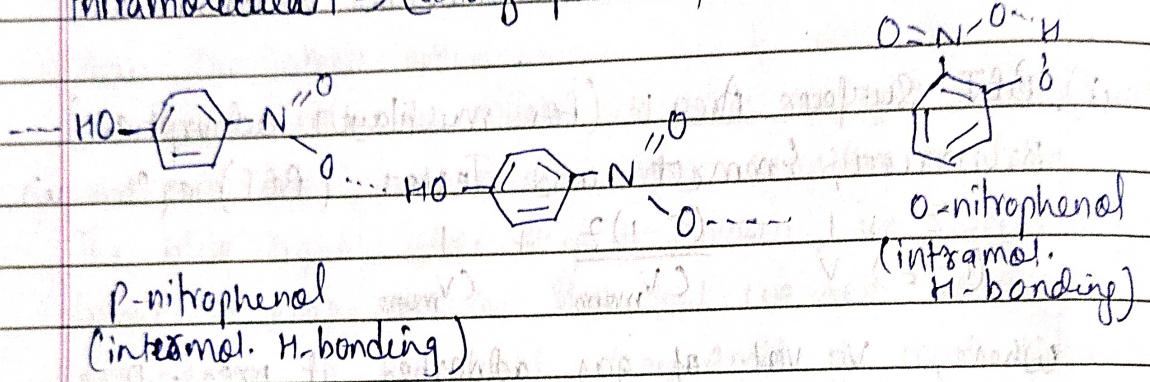
Conditions :-

- Presence of highly EN atom: molecule having H-bond should have a highly EN atom like N, F, O directly linked to H-atom by a covalent bond.
- Presence of atom with small size.

Types :-

Intermolecular → (b/w separate molecules)

Intramolecular → (among parts of same molecule)



7) Write eqn. of state for real gas. Mention Significance of a and b .

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

eqn. of State for n mole real gas.
 P is gas press.
 v is vol. of n mole gas

R = Universal gas const.

T = temp. (Kelvin Scale)

a, b = VDW constants.

Significance of a and b

(i) ' a ' term originates from intermol. attrac. & press. corrct.

$(P_a = \frac{an^2}{v^2})$. Thus, ' a ' is measure of int. press. of gas.

i.e., attractive forces b/w molecules.

higher the value of ' a ', greater is intermolecular attrac. & more easily gas could be liquified.

Thus, $a_{\text{O}_2} = 3.95$ while $a_{\text{H}_2} = 0.22$

$$\text{Unit: } - P_0 = \frac{\text{cm}^2}{\text{m}^2} \Rightarrow a = \frac{P_0 V^2}{n^2} = \text{atm L}^2 \text{ mol}^{-2}$$

ii) 'b' measures molecular size & also a measure of repulsive forces. Values of 'b' can be utilized to calculate molecular diameter. Greater the value of 'b', larger is size of gas molecules. Thus,

$$b_{H_2} = 0.02 \text{ L mol}^{-1} \text{ but } b_{CO_2} = 0.04 \text{ L mol}^{-1}$$

$$\text{Unit: } nb = V \Rightarrow b = \frac{V}{n} = (\text{L mol}^{-1})$$

(8) Discuss critical phenomenon of real gas.

Saathi

Date _____ / _____ / _____

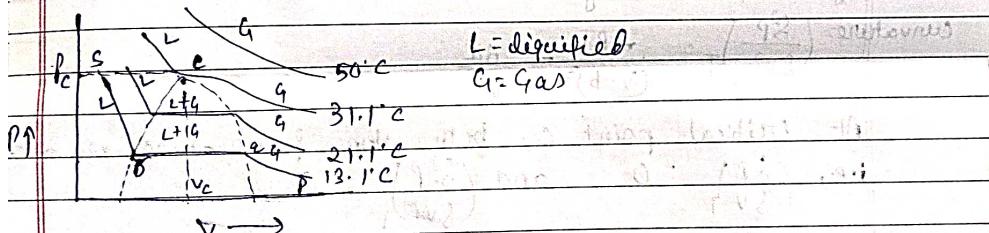
Critical phenomena - Andrew's curves:-

A gas can be liquified by lowering of temp. & ↑ press. But influence of temp. is more imp. Most gases are liquified at ordinary press. by suitably lowering the temp. But a gas can't be liquified unless its temp. is below a certain value depending on nature of gas whatever high the press. may be applied to. This temp. of gas is Critical T (T_c). A gas can only be liquified when temp. is kept below T_c of the gas.

The press. req. to liquify the gas at its critical temp. is called critical press. (P_c) & the vol. occupied by 1 mol of gas at T_c & P_c is called critical vol. (V_c).

Andrew's curve - P vs V at diff. temp.

1 mol CO_2 collected data of P & V at various temp.



Isotherm at $13.1^\circ C$ $P \propto S$.

Point p represents \rightarrow gaseous CO_2 at low press.

As P is \uparrow , V is correspondingly \downarrow acc. to Boyle's law.

At q, gaseous CO_2 begins to liquify.

As V is \downarrow , more of the gaseous CO_2 transforms into liq. CO_2 but P remains unchanged.

This isothermal conversion continues upto & when all the gaseous CO_2 is converted into liq. CO_2 .

Curve is very steep as the liq. is highly incompressible.

When temp. of $21.1^\circ C$ is taken for study, similar curve is obtained except the liquid begins to form at high press.

At $31.1^\circ C$: gaseous CO_2 becomes indistinguishable at point c

This point is called critical point of temp. $31.1^\circ C$ is T_c of CO_2 . P corres. to c is P_c & vol. of 1 mol gas, corres to c is V_c .

Date _____ / _____ / _____
 Above 31.1°C (T_c), Gas is not liquified & isotherm at 50°C follows rectangular hyperbola obeying Boyle's law

Dotted line encloses dome-shaped area within which liquid and gas are co-existent. The highest point C of the area indicates the critical point. On the right side of air gas alone exists & at the left liquid.

Expression of P_c, V_c, T_c with VDW const. (a, b):-

$$\text{For 1 mol of gas: } \left(P + \frac{an}{v^2} \right) (v - b) = RT$$

$$\text{or } P = \frac{RT}{v-b} - \frac{a}{v^2}$$

differentiating w.r.t. v at const. T :-

$$\text{Slope} = \left(\frac{\delta P}{\delta v} \right)_T = \frac{-RT}{(v-b)^2} + \frac{2a}{v^3}$$

again differentiating:-

$$\text{Curvature} = \left(\frac{\delta^2 P}{\delta v^2} \right)_T = \frac{2RT}{(v-b)^3} - \frac{6a}{v^4}$$

At critical point C , both slope & curvature are zero
 i.e., $\left(\frac{\delta P}{\delta v} \right)_T = 0$ and $\left(\frac{\delta^2 P}{\delta v^2} \right)_T = 0$

$$\Rightarrow \frac{RT_c}{(V_c-b)^2} = \frac{2a}{V_c^3} \quad \text{(i)} \quad \text{&} \quad \frac{2RT_c}{(V_c-b)^3} = \frac{6a}{V_c^4} \quad \text{(ii)}$$

$$\text{(i)} \div \text{(ii)} : - \quad \frac{V_c-b}{2} = \frac{V_c}{3} \quad \Rightarrow \quad V_c = 3b$$

Putting value $V_c = 3b$ in (i), we get,

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

Putting V_c & T_c in VDEq., we get,

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

9) Calculate Boyle temp. for a gas whose VDW const.

$$a = 7.18 \text{ L}^2\text{atm}\text{mol}^{-2}, b = 0.854 \text{ L}\text{mol}^{-1} \text{ & } R = 0.082 \text{ Latm mol}^{-1}\text{K}^{-1}$$

\Rightarrow Boyle temp. for a gas,

$$T_b = \frac{a}{Rb} = \frac{7.18 \text{ L}^2\text{atm}\text{mol}^{-2}}{(0.082 \text{ Latm}\text{mol}^{-1}\text{K}^{-1})(0.854 \text{ L}\text{mol}^{-1})}$$

$$= \frac{7.18}{0.070028} \text{ K} = 102.53 \text{ K}$$

10) Write Nernst eqⁿ. for the cell rxn. in Daniel cell.
How will the E_{cell} effected when conc. of Zn^{2+} is increased?

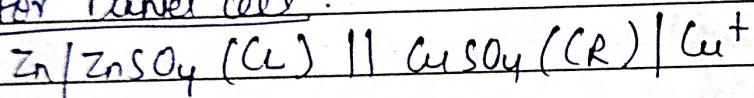
\Rightarrow Nernst Equation :- of cell potential at 25°C is

$$E_{cell} = E_{cell}^\circ - \frac{0.059}{n} \log \frac{[P]}{[R]} \quad n = \text{no. of moles of e- transfer}$$

$$E_{cell}^\circ = \text{std. cell potential}$$

(when all reacting components of cell are at unit conc.)

for Daniel cell :-



cell rxn. is :-



$$E_{cell} = E_{cell}^\circ - \frac{0.059}{2} \log \frac{[\text{Zn}^{2+}][\text{Cu(s)}]}{[\text{Zn(s)}][\text{Cu}^{2+}]}$$

$$E_{cell} = E_{cell}^\circ - \frac{0.059}{2} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} ; [\text{Cu(s)}] = 1 ; [\text{Zn(s)}] = 1$$

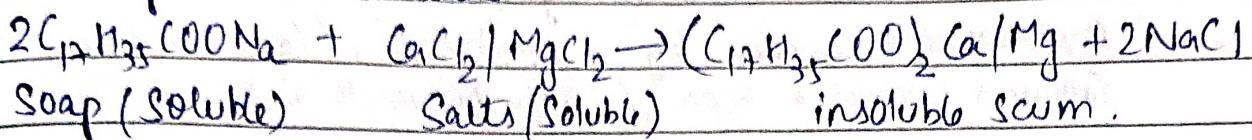
When conc. of $Zn^{2+} \uparrow$

$$E_{cell} \downarrow$$

11) Define hardness of water? Explain how hard water fails to form lather with soap? What is alkalinity of water?

\rightarrow Hardness of water \rightarrow which prevent lathering of soap. This is due to presence of certain salts like Ca^{2+} , Mg^{2+} & other heavy metals dissolved in water.

fails to form lather with soap: Water which doesn't give lather with soap is hard water.



Here, Ca/Mg chloride in hard water reacts with sodium stearate giving a precipitate of Ca/Mg stearate.

Instead of lather, a precipitate is formed.

Alkalinity of water

Alkaline nature of water is developed due to presence of carbonate, bi-carbonate & hydroxide salts.

(2) Define corrosion: What are diff. types of corrosion?

→ Corrosion is the deterioration of metals & alloys in the presence of an envir. by chemical or electrochemical means. In simple terminology, corrosion processes involve rxn. of metals with environmental species.

Types :-

i) Galvanic corrosion:

- Electrochemical corrosion.
- When 2 dissimilar metals are in contact & jointly exposed to corrosive environment.
- Metal with highly +ve electrode potential act as anode & undergoes corrosion.

e.g. Zn and Fe, Zn & Cu, Zn & Ag, Fe & Cu.

Avoided by → i) coupling of metals very close in emf series.
ii) providing an insulating material b/w 2 metals.

ii) Concentration cell corrosion:

- Electrochemical corrosion
- When metal is partially dipped in sol. & partially exposed to air.
- Anode - less aerated part
- Cathode - more aerated part.

iii) Pitting corrosion:- localized attack result in form of hole around which metal is relatively unattacked

Anode \rightarrow area covered by drop of water (less O₂ conc.) suffers corrosion
 Cathode \rightarrow uncovered area (freely exposed to air)

iv) Water line corrosion

- due to storage of water in metal containers

- Cathode - highly oxygenated area (above water line)

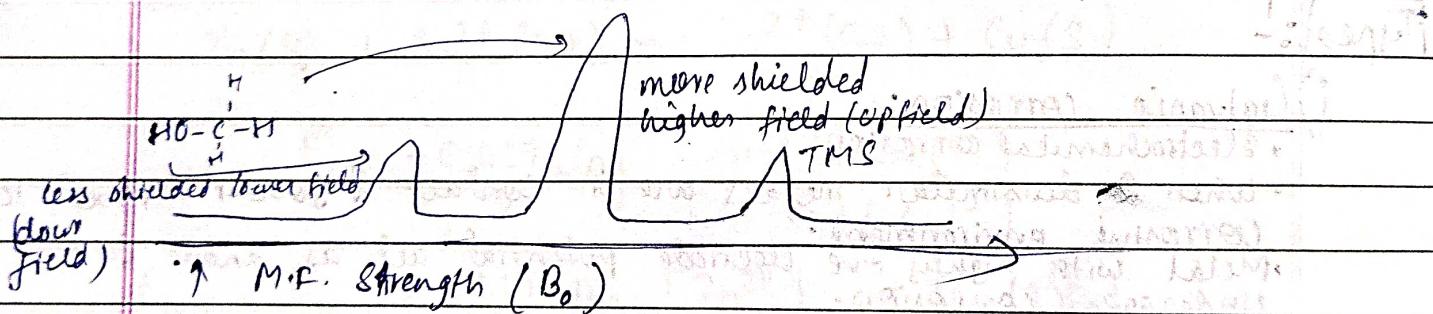
- Anode - highly poorly oxygenated area (beneath water line)

(13) Shielding & deshielding effects involved in NMR Spectroscopy

\rightarrow Shielding:- When e⁻ density around the nucleus is high in NMR, the M.F. due to e⁻ opposes the ext. field i.e. likewise ↑, providing significant shielding.

Deshielding:- Occurs when nucleus's sur. e⁻ density is low, the M.F. that opposes it weakens, and the nucleus that experiences a strong ext. M.F.

NMR Graph :-



(14) Given that spacing of lines in microwave spectrum of ²⁷Al¹H is constant at 12.604 cm⁻¹. Calculate no. M.O.I & B.L. of molecule. (²⁷Al = 26.981 amu).

\rightarrow The separation (spacing) of lines of rotational spectra is equal to $2B$.

B is rotational const. of the molecule

$$B = \frac{h}{8\pi^2 I}$$

$$I = \text{M.O.I.}$$

$$\boxed{J = \frac{\mu}{8\pi^2 c B}}$$

$$\omega = \text{cm}^{-1}$$

we have to incorporate vol. of agar (ρ)

$$J = \frac{\mu}{8\pi^2 c B} = \frac{6.6 \times 10^{-34}}{8\pi^2 c (3 \times 10^8) \times 6.302 \times 10^2} = 4.439 \times 10^{47} \text{ kg/m}^2$$

Q:

$$\begin{aligned} \mu &= \frac{m_A \times m_H}{m_A + m_H} = \frac{26.9 \times 1.008}{26.9 + 1.008} = 0.9716 \text{ atomic} \\ &= 0.9716 \times 1.6 \times 10^{-27} \text{ kg} = 1.6 \times 10^{-27} \text{ kg.} \end{aligned}$$

$$J = \mu r^2 \Rightarrow r^2 = \frac{1}{\mu} \Rightarrow r = \sqrt{\frac{1}{\mu}} = 165.8 \times 10^{-12} \text{ m}$$

(15) ^{13}C is NMR active while ^{12}C is not. Explain.

→ for $^{13}\text{C}_6$, mass no. is odd & at.no. is even,
so, J value is $\frac{1}{2}$, i.e., $J \neq 0 \Rightarrow {^{13}\text{C}_6}$ is NMR active.
But for $^{12}\text{C}_6$, both mass no. & at.no. are even,
so, J value is 0. $^{12}\text{C}_6$ is NMR inactive.

(16) Predict the kind of electronic transition in

a) Cl_2 b) carbonyl group. Also give their intensity.

⇒ a) for Cl_2 , two transitions are possible

$$\sigma \rightarrow \sigma^* \text{ and } n \rightarrow \sigma^*$$

intensity of $\sigma \rightarrow \sigma^*$ transition is larger than $n \rightarrow \sigma^*$
which is forbidden transition.

b) carbonyl group, will show 2. transitions: $\pi \rightarrow \pi^*$ and
 $n \rightarrow \pi^*$

: O :

Intensity of $\pi \rightarrow \pi^*$ transition is larger than
 $n \rightarrow \pi^*$ which is forbidden transition.

(17) "Complexes of 1st transition series are mainly high spin while those of 3d & 3rd transition series are of low spin." Explain. 1st I.E. of 5d elements are higher than 3d & 4d elements. Give reason.
→ 1st part → due to high Δ_o value (CFS energy) of 3rd & 2nd transition series.

- Order of Δ_o value of 1st, 2nd & 3rd transition series elements is $[5d > 4d > 3d]$
- hence, 1st t.s. have low Δ_o value & high pairing energy & hence, form high spin complexes. ($\Delta_o < P$).
- Again, 2nd & 3rd t.s. have a high Δ_o value & low pairing energy, so it forms low spin complexes ($\Delta_o > P$)

2nd part → due to greater eff. nuclear charge acting on outer valence e⁻ bcz. of the weak shielding of the nucleus by 4f - e⁻.

$S > p > d > f$ (magnitude of shielding eff. on valence e⁻ for same n).

(18) 2nd I.E. for Cr & Cu are enormously high? Why?

Iron is a transition element but Na is not. Explain.

→ Configuration of Cr is $4s^1 3d^5$

Configuration of Cu is $4s^2 3d^{10}$.

So, Removal of 1e⁻ from 4s orbital of Cr or Cu is relatively easy to form outer e.c. of Cr⁺ is $3d^5$ (half-filled) and that of Cu⁺ is $3d^{10}$ (completely filled).

The 2nd I.E. of Cr means removal of 1e⁻ from highly stable $3d^5$ core and $3d^{10}$ core, so, very high energy is required.

$\text{Fe} \rightarrow [\text{Ar}] 3\text{d}^6 4\text{s}^2$, i.e., has partially filled d-orb. So, it is a transition metal.

$\text{Na} \rightarrow 1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^1$ i.e., has no d-orb. e⁻ of the last p-enter into 3s orbital. So, it belongs to s-block elem.

Q) 1st I.E. of Cu is higher than those of alkali metals while 2nd & 3rd energies are lower. Explain. Why are lanthanides & actinides placed in separate rows at the bottom of the periodic table?

→ Due to smaller size & due to poor shielding effect of 3d orbital, Cu has higher 1st I.E.

If we put lanthanides & actinides into the periodic table like transition metals, the table will become too wide & there will be the loss of the compactness.

SAMPLE PAPERS - ②

Date _____
Page _____

Regd.

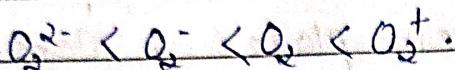
Group - A.

(1) Eqn of Schrodinger wave eqn?

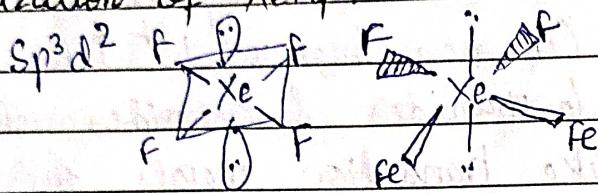
$$\nabla^2 \Psi + \left(\frac{8\pi^2 m}{h^2} \right) (E - V) \Psi = 0$$

(2) All living system is an ex. of Open System.

(3) correct order of bond dissociation energy is -
with ↑ B.O. bond dissociation energy ↑.



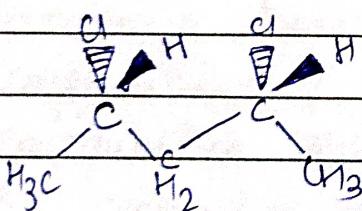
(4) Hybridization of XeF_6 ?



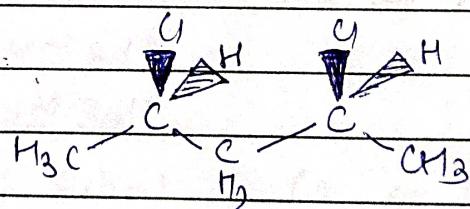
(5) $S_2R,4S^2$ - 2,4-dichloropentane & $(2S,4R)$ -2,4-dichloropentane are identical

2,4-dichloropentane → has 2 Cl-atoms at C-2 and C-4.

Hence, we can number it from both sides & hence even if the configuration is changed from $2R,4S$ to $2S,4R$, it will not make any change. Hence, 2 molecules are identical.



2S,4R 2,4-Dichloropentane



2R,4S 2,4-Dichloropentane

(6) In electrochem. corrosion:- Oxidation occurs at anode.

(7) Exhibits fluorescence? BaF_2 .

(8) Unit of ω is \rightarrow hertz

(9) Part of Polarimeter?

NICOL

Simple tube

Analyser.

not part of Polarimeter

\rightarrow Diffraction grating

(10) The nucleus which will not show any peak in NMR spectrum is ^{16}O (both mass no. (16) & at. no. (8) are even, so, $I = 0$).
Hence, ^{16}O is NMR inactive).

(11) Galvanic cell:- Chem. energy \rightarrow Electrical energy.

(12) Van der Waals type of bond is formed by:-

weak electrostatic PDI among fluctuating dipoles.

(13) Si doped with Ga forms:- p-type SC.

Group-B

(1) Explain chemical potential. Free energy per mole of a subst. G/n = chemical potential.

G = Gibbs free energy & n = mole no.

(2) Relation of EMF of cell with ΔG & ΔH .

\because rxn. in cell occurs spontaneously, the free energy (G) of the rxn. decreases & this decrease in free energy is transformed into electrical energy. Thus, the imp. reln. b/w chemical energy (ΔG) & electrical energy (nFE_{cell}) is given by.

$$\frac{-\Delta G}{T, P} = nFE_{\text{cell}}$$

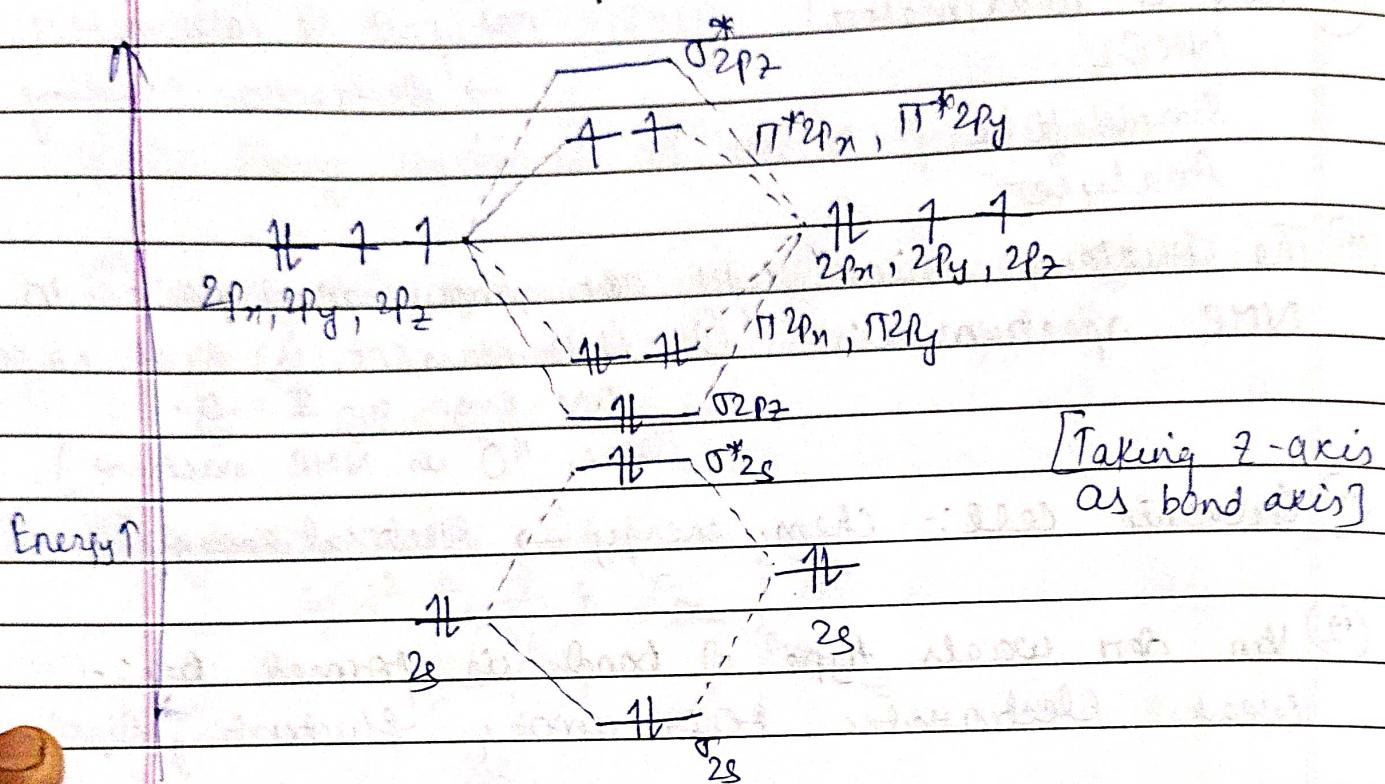
F = Faraday = 96.500 coul.

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

(Putting value of S)

$$-\Delta H + T\Delta S = -nFE_{\text{cell}} + TnF \left(\frac{\Delta S_{\text{cell}}}{ST} \right)_P$$

③ a) Draw M.O. Diagram for O_2 .



$$\text{Bond Order} = \frac{8-4}{2} = 2 \quad (O=O)$$

There are 2 unpaired e^- in $\pi_{2p_x}^4$ & $\pi_{2p_y}^4$ MO.

So O_2 molecule shows paramagnetism.

VBT was unable to explain paramagnetic nature of oxygen molecule. So, MOT was adopted.

$$(4) P.T. \left(\frac{V - h^2}{8\pi^2 m \nabla^2} \right) \Psi = E \Psi$$

$\rightarrow e^-$ behave as a wave, so, there must be a wave eq. to describe their behaviour. Schrodinger derived an eq. to describe the wave behaviour of e^- in atoms.

In Schrodinger wave model of an atom, the discrete energy levels (or orbitals) proposed by Bohr are replaced by mathematical func. Ψ which is related with probability of finding e^- at various places.

around the nucleus. The state of an e^- is defined by "state func." / wave func. Ψ , which is a function of coordinates x, y, z .

$$\therefore \Psi = \Psi(x, y, z)$$

Schr. wave eqn for an e^- wave propagating in 3-D in space, is written as:-

$$\frac{\nabla^2 \Psi}{m^2} + \frac{\nabla^2 \Psi}{\delta x^2} + \frac{\nabla^2 \Psi}{\delta y^2} + \frac{\nabla^2 \Psi}{\delta z^2} + \frac{8\pi^2 m}{h^2} (E - V) \Psi = 0$$

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

$$\Rightarrow \left[\frac{-h^2}{8\pi^2 m} \nabla^2 + V \right] \Psi = E \Psi$$

$$\Rightarrow [H \Psi] = E \Psi$$

where, ∇^2 = Laplacian operator

$$E = TE$$

V = P.E. of the system.

(S) Show mean entropy of mixing of ideal gases $\Delta S_{\text{mix.}} > 0$.

b) What is phys. sig. of free energy change (ΔG_f)?

$$\rightarrow a) \Delta S_{\text{mix.}} = -nR \sum x_i \ln x_i$$

$\therefore x_i$ = mole fraction < 1 , so, $\ln x_i = (-)\text{ve}$

$$\text{Hence, } \Delta S_{\text{mix.}} = (+)\text{ve}, \text{ i.e., } > 0$$

That means spontaneous mixing of ideal gcs leads to increase of entropy.

b) Decrease in Gibb's energy at constant temp. & press. in a rev. process gives a measure of max. non-PV work (useful work) which can be obtained from system.

Ex. of non-PV work is electrical work by chemical battery.

(6) a) Define specific rotation for an optically active molecule.

→ Specific Rotation: $[\alpha]_D^T$

Specific Rotation $[\alpha]$:

$$[\alpha]_D^T = \frac{\alpha}{l \times c}$$

α : obs. rotation

l = sample path length (dm)

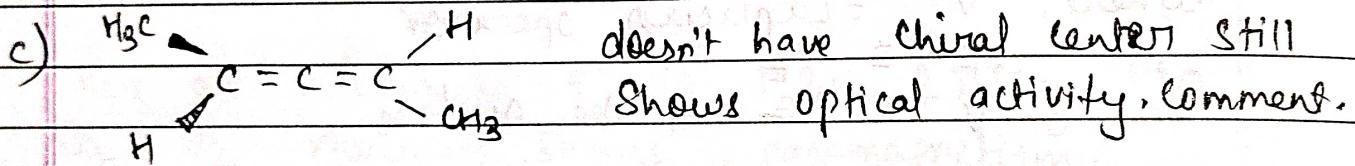
c = Sample conc. (g/mL)

$$[\alpha]_D^T = \frac{\text{obs. rotation, } \alpha}{\text{path length, } l \text{ (dm)} \times \text{conc. of sample, } c \text{ (g/mL)}} = \frac{\alpha}{l \times c}$$

Specific rotation depends on the temp. & wavelength of light that is employed.

b) What is the necessary & sufficient condition for a molecule to be optically active?

→ Molecular dissymmetry \Rightarrow molecules must not possess the symm. elements σ , i and s_n but it may have C_n axis.



This type of molecule is called alkene.

When the 2 ends of alkene are substituted by diff. grps. Then it becomes a chiral comp. & show Optical activity. This type of chirality is called axially chiral.

Group-C

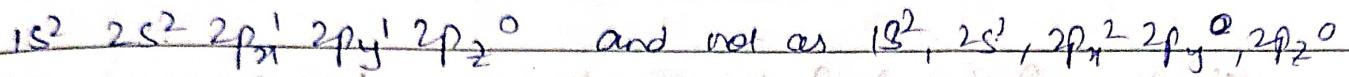
① State Hund's rule of spin multiplicity & Pauli Exclusion principle. Write down e.r. of Fe. ($Z=26$).

→ Hund's rule of max. multiplicity:-

In the L.R.S. e.r. of an atom, e^- pairing in orbitals of the same energy will not take place unless all such available orbital of a given subshell contain one e^- each with parallel spin. e.g.

We know that there are 3 p-orbitals (p_x, p_y, p_z) of the p sub-shell. Acc. to Hund's rule, each of the 3 orbitals must get one e⁻ each of parallel spin before any one of them gets the 2nd e⁻ of opp. spin. (Spin pairing)

Ex- 6 e⁻ in carbon distribution:-



→ Pauli Exclusion principle:- No 2 e⁻ in one atom can have all 4 quantum no. No same. An orbital can contain a max. of 2 e⁻ and these 2 e⁻ must be of opp. spin.

→ e.c. of Fe (z=26) :- $1s^2 \ 2s^2 \ 2p^6 \ 3s^2 \ 3p^6 \ 4s^2 \ 3d^6$.

(2) Calculate effective nuclear charge of 4s e⁻ of Fe(z=26) with the help of Slater's rule.

e.c. acc. to Slater's rule:- $(1s)^2 (2s, 2p)^8 (3s, 3p)^8 (3d)^6 (4s)^2$

$$\sigma = 2 \times 1.0 + 8 \times 1.0 + 8 \times 0.85 + 1 \times 0.35$$

We have to consider only 1e⁻ in 4s, as we are calculating σ for the last e⁻.

$$\sigma = 22.25$$

$$Z_{\text{eff.}} = Z - \sigma = 26 - 22.25 = (3.75).$$

(3) Define Pauli's scale of EN.

→ Most widely used scale is based on bond dissociation energy data. Acc. to Pauling, the diff. in EN of 2 atoms A & B is given by:-

$$X_A - X_B = 0.208 \Delta + \alpha \quad \Delta = D_{A-B} - \frac{D_{A-A} \cdot D_{B-B}}{D_{A-A} + D_{B-B}}$$

D_{A-B} , D_{A-A} , D_{B-B} \Rightarrow B.D. energy of bond A-B, A-A, B-B.
 α is the arbitrary constant.

(Q4) e⁻ affinity of Cl is greater than F. explain.

→ F is the most EN element but still its e⁻ affinity is less than that of Cl, Bc¹. of the small size of F. The other e⁻ in the atom repels the incoming e⁻ significantly, thus nullifies the effect of higher EN of F over Cl.
So, [Cl > F > Br > I] e⁻ affinity order.

(Q5) B/w BeCl₂ & BaCl₂, which one has more mp & why?

→ M.P. BeCl₂ 405°C
BaCl₂ 960°C

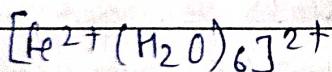
covalent

ionic. Due to stronger coulombic attrac?
B/w ions in ionic comp., BaCl₂, the mp is larger?

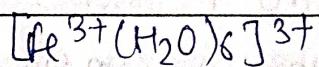
Acc. to Fajan's rule \Rightarrow Cationic size smaller \rightarrow Polarizing power more
covalent bond

(Q6) Show the hybridizⁿ & calculate CFSE of [Fe²⁺(H₂O)₆]²⁺
and [Fe³⁺(H₂O)₆]³⁺.

→ Both are octahedral \Rightarrow hybridizⁿ: 8p³d²



fe²⁺ :- d⁶



fe³⁺ :- d⁵

+ + eg

+ + eg

1 t_{2g}

- - 1 1 1 t_{2g}

$$\text{CFSE} : - 4D_{2g} \times 4 + 6D_{2g} \times 2$$

$$= -4D_{2g}$$

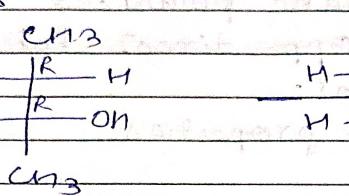
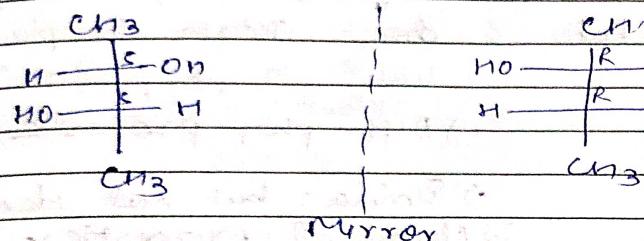
$$\text{CFSE} = -4D_{2g} \times 3 + 6D_{2g} \times 2 \\ = 0.$$

(7) Draw all possible stereoisomers for butane-2,3-diol. Are all of them optically active?

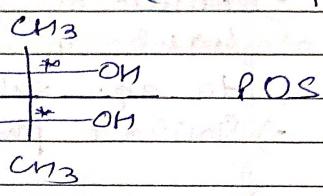
→ 3 stereoisomers :-

2 Optically active isomers :-

Enantiomers



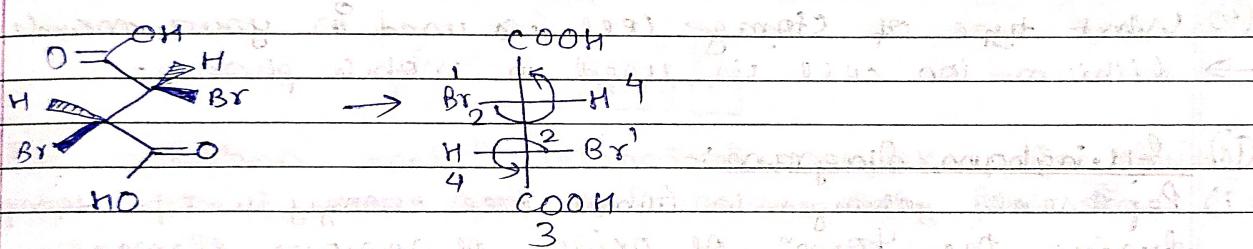
1 Optically inactive isomer :- (meso compound)



(* chiral centre)

(8) Fisher projection formula of :-

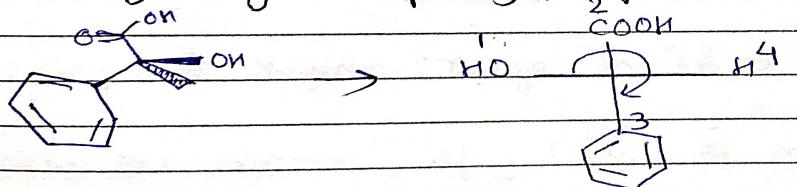
i) (2R,3R)-2,3-dibromobutanedioic acid.



(2R,3R)-2,3-dibromobutanedioic acid

1 → 2 → 3, anticlockwise
SO, R-configuration.

ii) S-2-Hydroxy-2-phenylpropanoic acid-1B



S-2-hydroxy-2-phenylpropanoic acid.

G₃-4 is on horizontal posn :- 1 → 2 → 3 rotation
is clockwise SO, S-configuration.

(9) Enantiomers

- Non-
Diastereoisomers
- Non-superimposable mirror images. (Stereoisomers related to each other)
 - Rotate no plane polarized light in opp. direc. but to eq. extent.
 - Similar phys. properties
 - have identical chemical properties except towards optically active reagents.
 - Mirror images & non-superimposable (Stereoisomers are not related to each other)
 - if optically active, they don't rotate the plane polarized light in opp. direc. to eq. extent.
 - diff. phys. properties
 - Similar but not identical chemical properties.

(10) What type of storage cell is used in your mobile cell?

→ Lithium-ion cell is used in mobile phones.

(ii) Ellingham diagram:-

- i) Represents changes in Gibbs free energy w.r.t. temperature during the "form" of oxides of various elements.
- ii) Helpful in predicting the feasibility of thermal reduc. of an ore / best reducing agent.

Features of Ellingham diagram:-

i) Energy req. to remove an e^- from outermost shell of an isolated gaseous atom is ionization energy.

ii) At inversion temp. Joule-Thomson coeff. is zero.

iii) Uncertainty in pos. & momentum are equal, the uncertainty in velocity is?

Heisenberg Uncertainty Principle:

$$\Delta x \cdot \Delta p = \frac{\hbar}{4\pi}$$

$$\Delta x \cdot \Delta mv = \frac{\hbar}{4\pi}$$

Now, $\Delta A\theta$, $\Delta x = \Delta mv$

$$\therefore (\Delta mv)^2 = \frac{\hbar}{4\pi} \Rightarrow \Delta v^2 = \frac{1}{m^2} \frac{\hbar^2}{4\pi}$$

$$\boxed{\Delta v = \frac{1}{2m} \sqrt{\frac{\hbar}{\pi}}}$$

iv) for transition metal octahedral complexes, the choice b/w high spin & low spin e.c. arises only for: - d^4 to d^7 complex.

v) form. of bonding molecular orbital from at. orbitals having wave functions Ψ_a and Ψ_b : $\Psi_a + \Psi_b$.

vi) IR Spectra detects functional group.

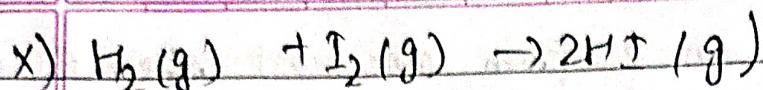
vii) Fingerprint region range in $IR \rightarrow 1600 - 400 \text{ cm}^{-1}$

viii) During the motion of COG of molecule changes, the molecule possesses:- Translational energy.

ix) Strength of van der Waals forces depends upon size of molecule

by molecular str.

x) no. of e^- present in the molecule



no. of moles of gaseous product -
no. of moles of gaseous reactants.

$$[\Delta H = \Delta U + \Delta n g RT]$$

$$\Delta n_g = 2 - (1+1) = 0$$

Hence, $\Delta H = \Delta U$

xii) water at $4^\circ C$, under press. of 1 atm, ($C_p - C_V$) is > 0 .
water has highest density at $4^\circ C$. When water is at $4^\circ C$,
vol. of liquid \downarrow . So, $C_p - C_V = -ve$.

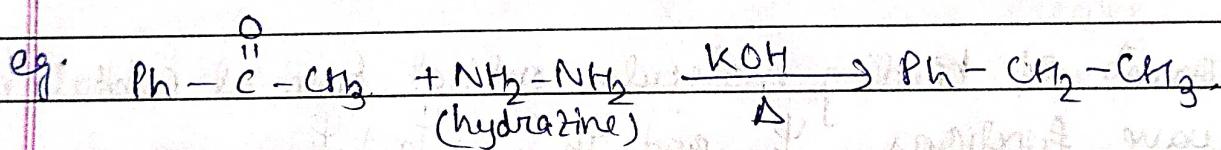
xiii) Conversion of $CO_2(g)$ into dry ice.

In randomness, ΔS , entropy decreases.

Group-B

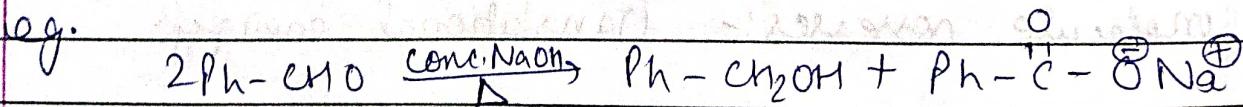
i) Wolf-Kishner Reduction:-

When an ald. or a ket. is Δ with hydrazine in the presence of strong base (KOH), the carbonyl grp. is reduced to a methylene grp. (-CH₂-). This rxn. is known as Wolf-Kishner reduction.



Cannizzaro reaction:-

When aldehydes which have no α -hydrogen atom are heated with conc. KOH or NaOH, they undergo self oxidation-reduction to give the corresponding primary alcohol and the salt of the carboxylic acid. This rxn. is known as Cannizzaro rxn.

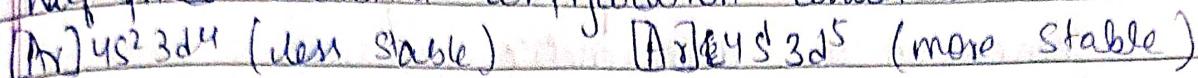


benzaldehyde

benzyl alcohol & sodium benzoate.

② Presence of only 1e⁻ in 4s subshell of chromium.

One of the 4s e⁻ is moved to 3d orbital to attain the half-filled d orbital configuration which is more stable.



③ Which has larger size and Why?

- i) Mg²⁺ ii) N³⁻

Both of them are isoelectronic species that is they contain same no. of e⁻ (10 e⁻). So, the one with the

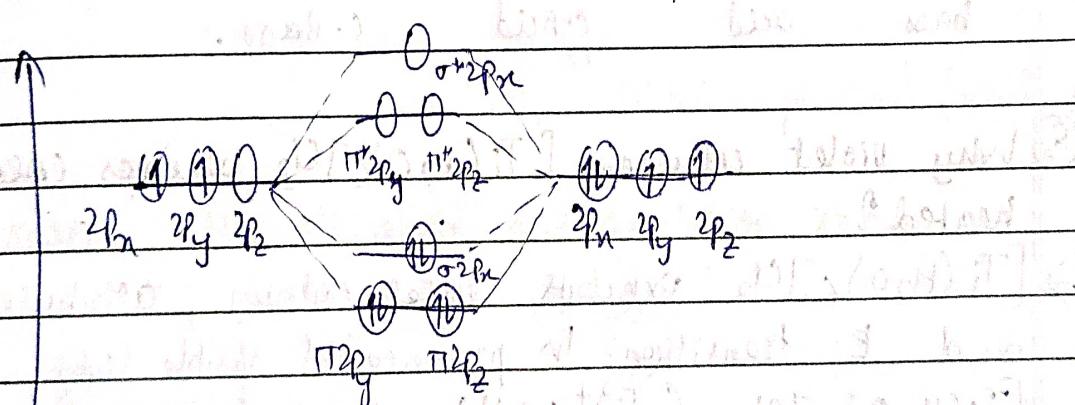
charge (Mg²⁺) is smaller bcz. bcz. of greater eff. nuclear charge & one with -ve charge (N³⁻) has larger size bcz. of lesser eff. nuclear charge.

N can't control 3 extra-e⁻ by the nucleus.

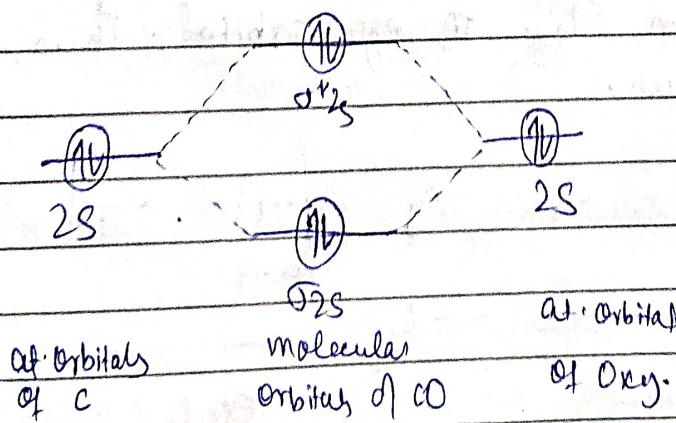
④ MO of CO.

→ e.c. of C-atom: - 1s² 2s² 2p²

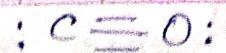
e.c. of O-atom: - 1s² 2s² 2p⁴



energy



$$\text{B.O.} = \frac{\text{No. of valence electrons}}{2} - \frac{\text{No. of lone pairs}}{2} = \frac{8-2}{2} = 3$$



Molecule has no unpaired e⁻, i.e., all the e⁻ are paired hence it is diamagnetic.

- (6) For a rxn. ΔH and ΔS both are +ve. Under what conditions will the rxn. be spontaneous?

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

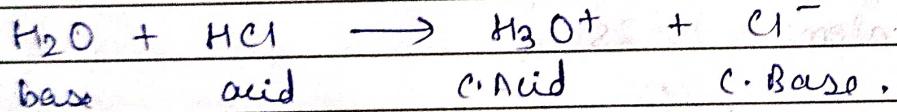
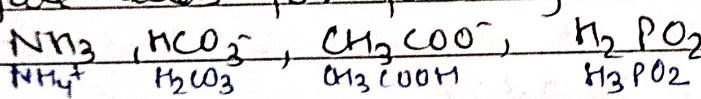
for spont. rxn. $\Delta G < 0$

$$\Delta H - T\Delta S < 0$$

$$\Delta H < T\Delta S$$

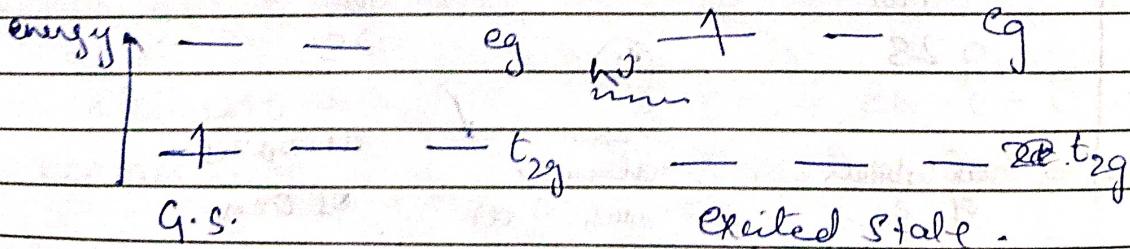
$$\Delta S > \frac{\Delta H}{T}, \text{ this is the condition.}$$

- (7) Conjugate acids for following Bronsted bases:-



- (8) Why violet coloured $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ becomes colorless when heated?

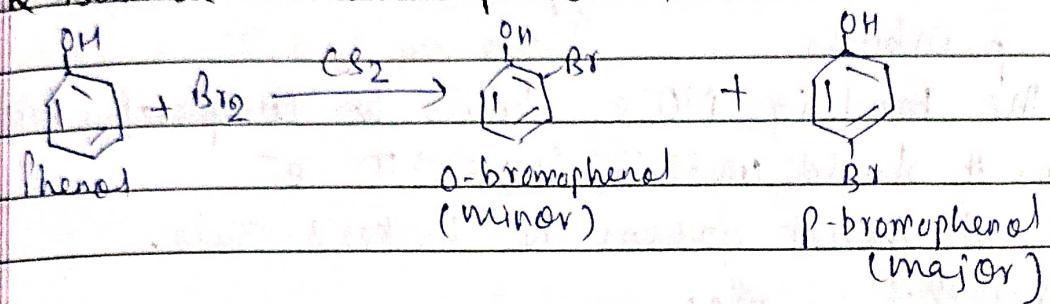
$[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ exhibits violet colour, attributed to d-d e⁻ transition. In presence of visible light, the complex $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ ($\text{Ti}^{3+}; 3d^1$) absorbs photon that excites the e⁻ from t_{2g} to eg orbital. Thus, complex shows violet colour.



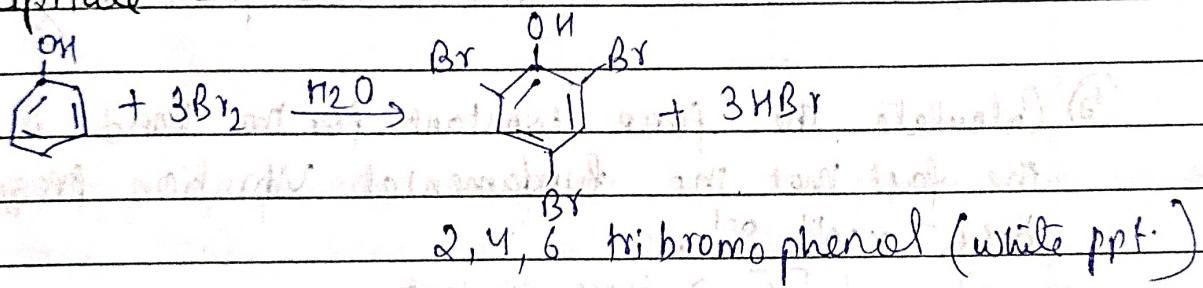
On Δ , H_2O ligands are gone out from coordination sphere of forms $TiCl_3$. In absence of ligand, CFS doesn't occur, hence, no π -transition occurs & the subst. becomes colourless.

Group - C

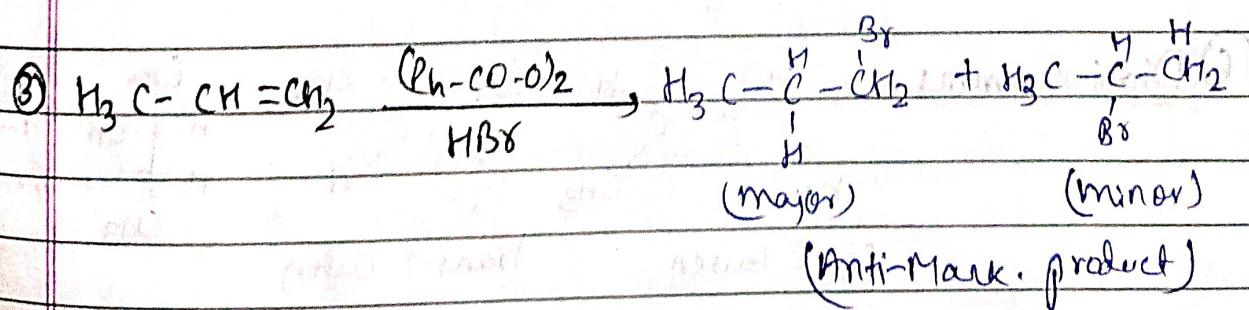
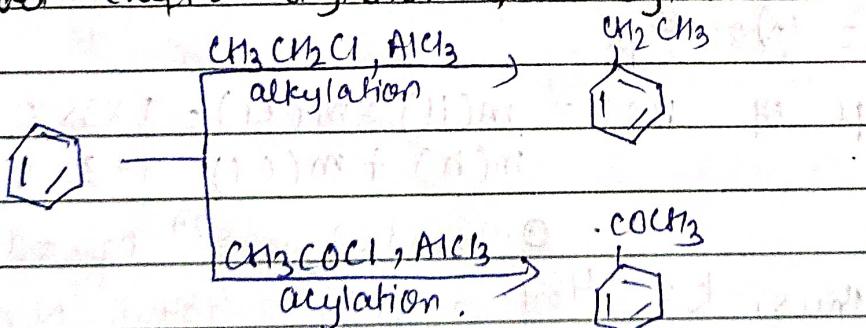
- ① Phenol on treatment with Br_2 in CS_2 at low temp. gives 2 isomeric monobromophenols X and Y.

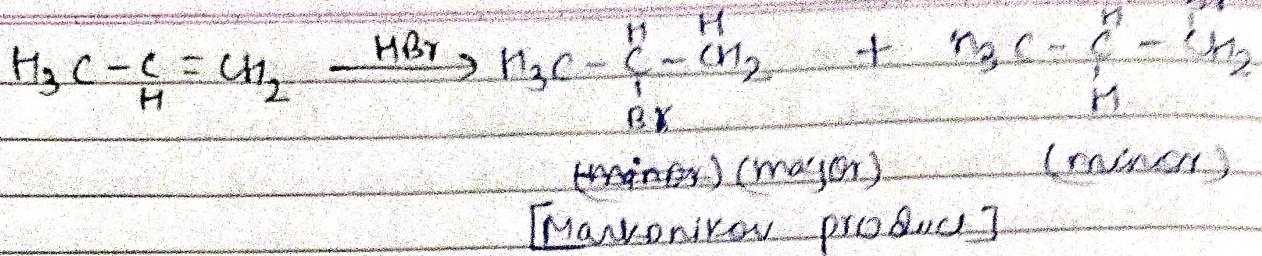


Phenol on treatment with Br_2 in water gives a white precipitate Z.



- ② Friedel-Craft's alkylation and acylation rxn.





④ Criteria for aromaticity.

~~The requirement -~~

- i) molecule should be flat / planar to allow maximum overlap of p orbitals.
- ii) All the bonding MO's should be completely filled. That means it should contain $(4n+2)\pi e^-$
i.e., it should follow the Hückel's Rule.

$$n=1, 2, \dots \text{etc.}$$

for Benzene, $n=1$, and it is planar
so, benzene is aromatic compound.

⑤ Calculate the force constant for the bond in HCl from the fact that the fundamental vibration frequency is $8.667 \times 10^{13} \text{ s}^{-1}$.

$$\Rightarrow \nu = \frac{1}{2\pi} \sqrt{\frac{k}{\mu}} \rightarrow \text{force constant}$$

$$\rightarrow \nu = \frac{1}{2\pi} \sqrt{\frac{k}{M}} \rightarrow \text{reduced mass.}$$

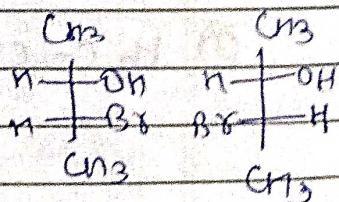
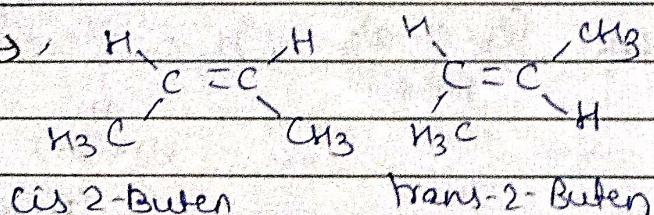
$$\text{So, } k = (\nu^2 2\pi)^2 \mu$$

$$\text{Now, } \mu \text{ of HCl} = \frac{m(\text{H}) \times m(\text{Cl})}{m(\text{H}) + m(\text{Cl})} = \frac{1 \times 35.5}{1 + 35.5} = 0.98 \text{ amu}$$

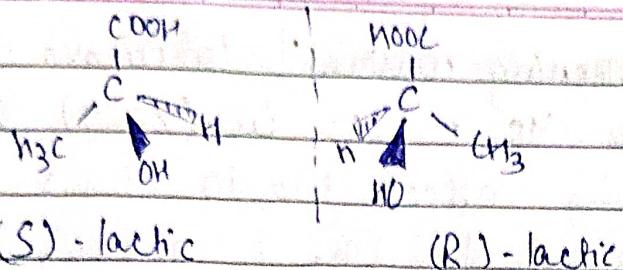
$$= 0.98 \times 1.67 \times 10^{-27} \text{ kg} = 1.637 \times 10^{-27} \text{ kg}$$

$$\text{thus, } k = 484.6 \text{ kg s}^{-2} = 484.6 \text{ N m}^{-1}.$$

⑥ Diastereomers \rightarrow



Enantiomers :-



Q) Calculate the energy of one photon of light of wavelength 2450 Å. Will it be able to dissociate a bond in diatomic molecule which absorbs this photon & has a bond energy equal to 95 kcal per mole?

$$\begin{aligned} \text{Energy of 1 photon} &= h\nu \quad (h\nu = \frac{hc}{\lambda}) \\ &= \frac{(6.6 \times 10^{-23})(3 \times 10^8)}{2450 \times 10^{-8}} \text{ ergs} \\ &= \frac{8.11 \times 10^{-12}}{4.184 \times 10^{-7}} \text{ cal} = 1.938 \times 10^{19} \text{ cal} \end{aligned}$$

Energy req. for dissociation of one bond:-

$$\frac{9500}{6.02 \times 10^{23}} \text{ cal} = 1.578 \times 10^{-19} \text{ cal}$$

This energy of photon is greater than energy req. to break the bond. Hence, bond will be dissociated.

Q) All adiabatic reversible expansions lead to a fall of temp.
→ from 1st law of T.D.

for adiabatic process, $q = 0$

$$\therefore 0 = dU + PdV \Rightarrow -dU = PdV$$

We know, $dU = n\bar{C}_V dT$

$$\therefore -n\bar{C}_V dT = PdV$$

$$-n\bar{C}_V(T_2 - T_1) = P(V_2 - V_1)$$

$$P(V_2 - V_1) = n\bar{C}_V(T_1 - T_2)$$

Thus, in adiabatic expansion of gas $V_2 > V_1$ & to balance the above eq? $T_1 > T_2$, i.e., adiabatic expansion of an ideal gas cause a fall in temp.

9) What is screening constant? Calculate eff. nuclear charge (Z_{eff}) of one $4s^-$:- Cu ($Z=29$) \rightarrow K ($Z=19$).

\rightarrow The screening effect due to other e^- is expressed as a constant called Shielding / screening constant, σ eff. nuclear charge (Z_{eff}), as seen by a particular e^- is obtained by subtracting screening const. (σ) from actual nuclear charge (Z).

$$\text{Thus, } Z_{eff} = Z - \sigma$$

e^- -distribution of Cu acc. to Slater:-

$$(1s)^2 (2s, 2p)^8 (3s, 3p)^8 (3d)^10 (4s)^1$$

$$\sigma = 2 \times 1.0 + 8 \times 1.0 + 8 \times 0.85 + 10 \times 0.85 = 25.3$$

$$Z_{eff} = Z - \sigma = 29 - 25.3 = 3.7$$

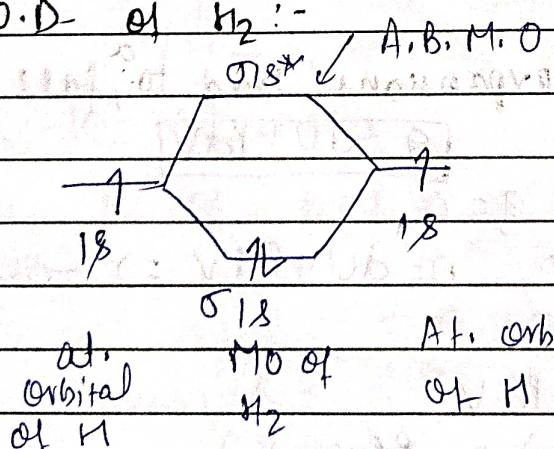
e^- -distribution of K acc. to Slater:-

$$(1s)^2 (2s, 2p)^8 (3s, 3p)^8 (4s)^1$$

$$\sigma = 2 \times 1.0 + 8 \times 1.0 + 8 \times 0.85 = 16.8$$

$$Z_{eff.} = Z - \sigma = 19 - 16.8 = 2.2$$

10) M.O.D. of H_2 :-



$$\text{B.O. of } H_2 = \frac{2-0}{2} = 1 \quad (\text{Max.B.O.})$$

$$H_2^+ = \frac{1-0}{2} = \frac{1}{2}$$

$$H_2^- = \frac{2-1}{2} = \frac{1}{2}$$

B.O. (no. of bonds)

No. of e^- in B.M.O.

Nb-Na

2

M.O.D. of O_2 :- already drawn. O_2^{2+} has max. B.O.

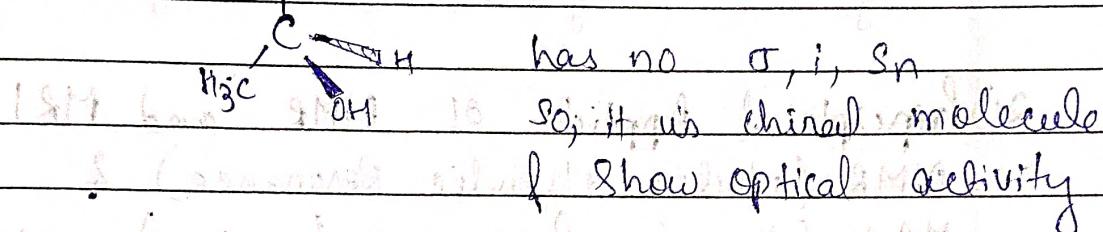
$$\text{B.O. of } O_2 = \frac{8-4}{2} = 2$$

So, it has strongest bond.

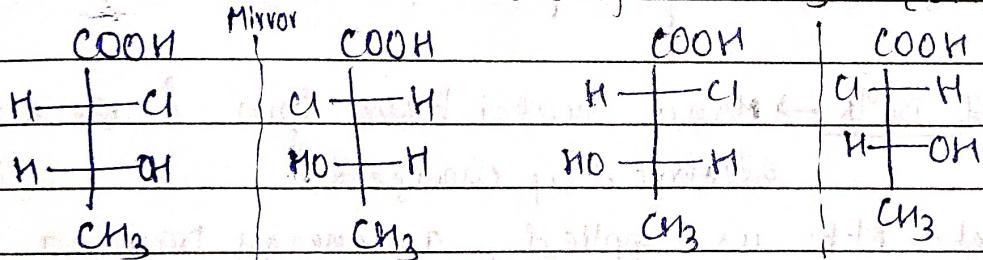
$$O_2^{2+} = \frac{8-2}{2} = 3$$

$$O_2^{2-} = \frac{8-6}{2} = 1$$

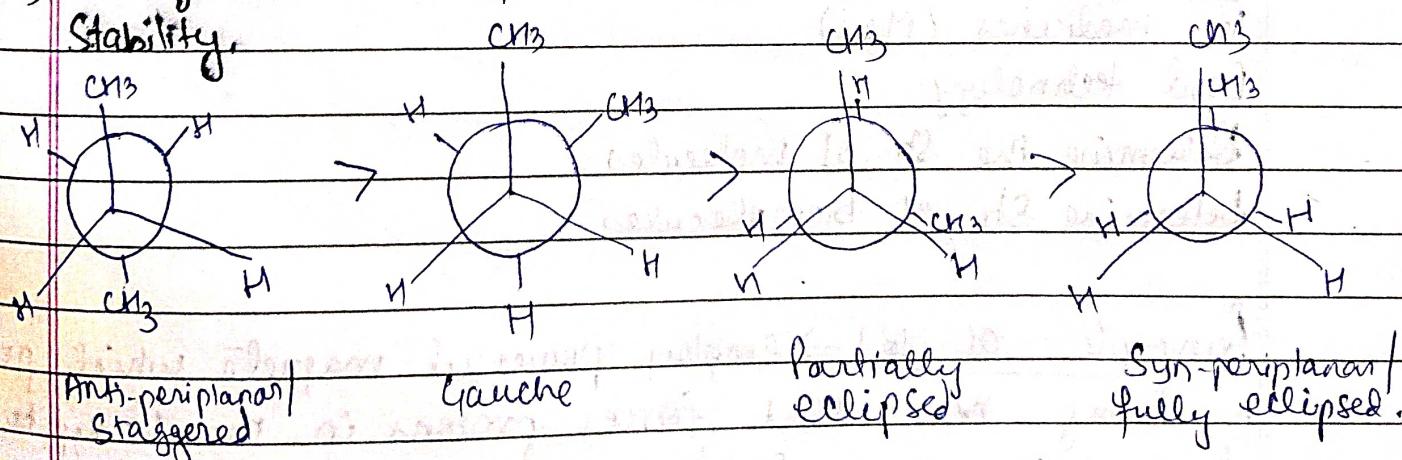
Q) Necessary & sufficient condition to exhibit optical activity.
molecular dissymmetry \Rightarrow the molecule must not possess
the symm. elements, σ , i , S_n but it may have
 C_n axis



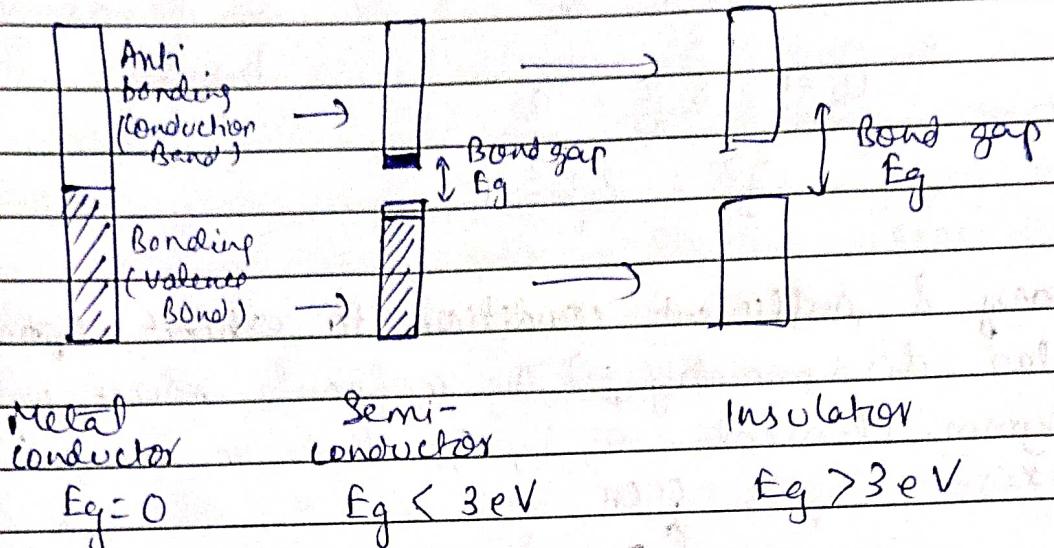
B) Draw all stereo-isomers for: $CH_3CH(OH)-CH(Cl)COONa$



14) Arrange diff. conformation of 2-butane in terms of their stability.



20) Energy level diagram of conductor, semi-conductor, insulator.



21) Principle & Appli. of NMR and MRI.

NMR (Nuclear Magnetic Resonance) &

MRI (Magnetic Resonance Imaging) are related techniques that rely on the principles of nuclear magnetic resonance.

Principle of NMR → Many nuclei have spin & all nuclei are electrically charged.

If an ext. M.F. is applied, an energy transfer is possible b/w the base energy to a higher energy level &.

Application of NMR :-

In medicines (MRI)

Food technology

Determine the str. of molecules

Determine str. of biomolecules.

Principle of MRI → employ powerful magnets which produce a strong M.F. that forces protons in the body to align with mag field.

Appli. of MRI → most frequently used imaging test of the brain & spinal cord.

→ Help diagnose:- Aneurysms of cerebral vessels

Deformities of eye & inner ear.