

Structure and Bonding models

Planck's Quantum theory :- [It is proposed in 1901]

Introduction :-

A & B are the two persons, A used continuous pumping of water, B used throwing of small stones. 'A' is James Clark Maxwell conforms matter is in continuous manner. 'B' is Max Planck conforms matter is discontinuous manner.

Postulates :-

* Black body radiation :- The substance which acts as perfect emitter

(or) perfect absorber is known as black body radiation.

Example :- carbon black powder [95%]



Note:- There is no perfect body but we used carbon black powder as a black body radiation [95% only]

* Electromagnetic radiation is not emitted or absorbed continuously but it's possible due to releasing of small energy packets is known as 'quantum' is singular, 'quanta' in plural

* The Energy of electromagnetic radiation is directly proportional to frequency of the radiation.

$$E \propto \nu$$

$$E = h\nu$$

Where, h = Planck's constant

$$\therefore h = 6.625 \times 10^{-34} \text{ J/sec}$$

E = Energy of the radiation $h = 6.625 \times 10^{-34} \text{ erg/sec}$

ν = frequency of radiation

* The Energy of radiation is equal to integral multiple of Quantum of radiation

$$E = nh\nu$$

From physics;

speed of light (c) = frequency (ν) \times wavelength (λ)

$$c = \nu \cdot \lambda$$

$$\nu = \frac{c}{\lambda}$$

Therefore,

$$E = \frac{nhc}{\lambda}$$

Where, E = Energy of radiation

n = photons [light packets]

c = speed of light

$\Rightarrow 'n'$ is introduced by 'Albert Einstein'.

Applications & significance :- [6M] Q²EL

1. Quantum computing:

Which is used to calculate of difficult problems related to quantum mechanics.

2. Quantum cryptography:- [used in cyber security]
Which is used to calculate research related quantum concepts.

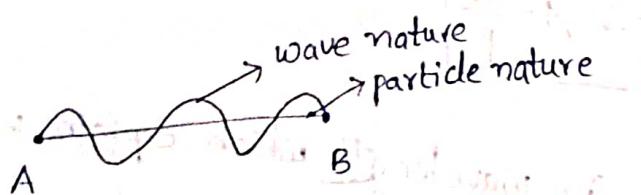
3. Electrical appliances:- Electrical components.

4. Laser:- [light Amplification by stimulated Emission of radiation]

(wave nature of electron)

Dual nature of Matter (DT) De-Broglie's Equation:- [4M] Hypothesis

When ever material is in Movement manner, direct displacement gives particle nature, disturbance displacement gives wave nature.



Derivation:-

According to Einstein mass energy relation

$$E = mc^2 \rightarrow ①$$

$$E = hv$$

we know that,

$$c = v \cdot \lambda$$

$$\Rightarrow v = \frac{c}{\lambda}$$

Therefore $E = \frac{hc}{\lambda}$ — (2)

once we observe (1) and (2), equation Energy of the radiation is same so, we equal (1) and (2) equation then,

$$mc^2 = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda = \frac{hc}{mc^2}$$

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

from the above equation 'c' is speed of light which explains only light property but matter having energy property so, we replace 'c' term with velocity of the matter(v) then,

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

We know that, mass of the matter (m) and velocity of the matter (v) is nothing but momentum of the matter (P)

$$\boxed{\therefore \lambda = \frac{h}{P}}$$

Where,

λ = wavelength which explains wave nature.

h = planck's constant

P = momentum of matter which explains particle nature.

Applications of EMSA in MALES

1. Electron Microscope

to calculate the size of the minute objects like micro-organisms.

2. calculate the size of solid substances

3. To study of crystalline structures of solid substances

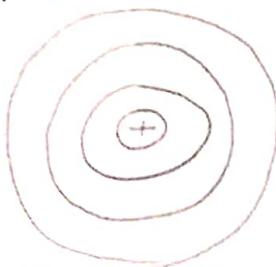
4. It is used to calculate least molecular weight, large molecular

Weight substances by using $\lambda = \frac{h}{mv}$ formula

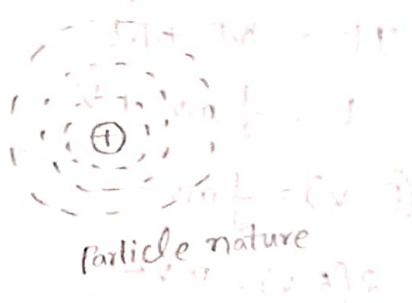
5. It is used to calculate angular momentum of the electron in Bohr's atomic theory.

Schrodinger Wave Equation :- [10M] - 1st question

When ever electron rotated around the nucleus in continuous manner which shows wave nature, electron rotated in discontinuous manner which shows particle nature.



Wave nature



Particle nature

derivation:- [1911]

According to classical wave-function equation (1) we

$$\psi = A \sin \frac{2\pi x}{\lambda} \rightarrow \text{Eq(1)}$$

partial differentiate with respect to x

$$\frac{\partial \psi}{\partial x} = A \cos \frac{2\pi x}{\lambda} \cdot \frac{2\pi}{\lambda}$$

Again, partial differentiate with respect to x

$$\frac{\partial^2 \psi}{\partial x^2} = -A \sin \frac{2\pi x}{\lambda} \cdot \frac{2\pi}{\lambda} \cdot \frac{2\pi}{\lambda}$$

$$\frac{\partial^2 \psi}{\partial x^2} = -A \sin \frac{2\pi x}{\lambda} \cdot \frac{4\pi^2}{\lambda^2}$$

from Eq (1) ψ value is $A \sin \frac{2\pi x}{\lambda}$

$$\frac{\partial^2 \psi}{\partial x^2} = -\psi \frac{4\pi^2}{\lambda^2}$$

$$\frac{\partial^2 \psi}{\partial x^2} + \psi \cdot \frac{4\pi^2}{\lambda^2} = 0 \rightarrow (2)$$

According to de-Broglie's equation (and assumption) $\lambda = \frac{h}{mv}$

$$\Rightarrow \lambda^2 = \frac{h^2}{m^2 v^2} \rightarrow \text{Eq (3)}$$

Substitute Eq (3) value in Eq (2)

$$\frac{\partial^2 \psi}{\partial x^2} + \psi \cdot \frac{4\pi^2}{h^2/mv^2} = 0$$

$$\frac{\partial^2 \psi}{\partial x^2} + \psi \cdot \frac{4\pi^2 m^2 v^2}{h^2} = 0 \rightarrow \text{Eq (4)}$$

The sum of the kinetic energy and potential energy is equal to total energy. (and Assumption)

$$T.E = K.E + P.E$$

$$E = \frac{1}{2}mv^2 + V$$

$$(E-V) = \frac{1}{2}mv^2$$

$$2(E-V) = mv^2$$

The above equation is multiplied with 'm' on both sides

$$2m(E-V) = m^2 v^2 \rightarrow \text{Eq (5)}$$

Substitute Eq (5) value in Eq (4)

$$\frac{\partial^2 \psi}{\partial x^2} + \psi \cdot \frac{4\pi^2 2m(E-V)}{h^2} = 0$$

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

It is one dimensional Schrodinger wave equation but we have three imaginary axis so, we include 'y' and 'z' axis $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi^2 m(E-V)}{h^2} = 0$

We know that,

Laplacian operation

$$(\text{dell}^2) \quad \nabla^2 = \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2}$$

$$\nabla^2 \psi + \frac{8\pi^2 m}{h^2} (\epsilon - V) \psi = 0 \quad [\text{Time Independent}]$$

where ∇^2 = laplacian operator

ψ = wave function (ii)

$$\pi = 22/7$$

h = planck's constant

m = mass of electron

V = potential energy

E = total energy.

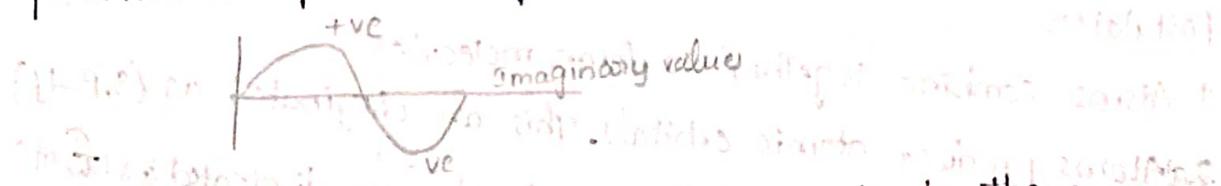
Significance of ψ : - (or) wave function:- [2M]

1. ψ is wave function (or) Amplitude of wave (Amplitude-vibration)

2. ψ must be posses single value.

3. ψ has no physical significance.

4. ψ values are positive, negative and Imaginary values.



5. The wave consisting of different displacements in there positions which gives different values is known as Eigen values.

Significance of ψ^2 (or) probability function. [2M]

1. ψ^2 is probability function (or) find of electrons (e^-) in orbitals.

2. ψ^2 value is zero and the probability of finding of electrons is zero.

3. ψ^2 value is high which indicates probability of finding of electrons is Maximum.

4. ψ^2 value is low which indicates probability of finding of electrons is Minimum.

5. The probability function is used to find out the electrons present in infinite manner.

$$\int_{-\infty}^{+\infty} \psi^2 dx dy dz = 1$$

Molecular orbital theory (MO) & Band Theory (VBT)

Drawbacks of valency bond theory

1. It could not explain the magnetic nature of oxygen molecule.

2. It could not explain the formation of Ionic crystals.

3. It could not explain the formation of Anti Bonding Molecular orbitals.

Postulates:-

Assumption of NMOT:-

To over come the Drawbacks of valency bond theory "Hund" & "Mulliken" proposed molecular orbital theory. later, modified by "Jones" & "Colusen"

Postulates:-

1. Atoms combine together to form molecules

2.a) Atoms produce atomic orbitals. This are designated as (s,p,d,f)

2.b) Molecules produce Molecular orbitals. This are designated as (σ , π)

3. The total no. of atomic orbitals, is always equals to the total no. of molecular orbitals.

4. a) Ψ_1, Ψ_2 are two atomic orbitals which are connected in constructive interface to form bonding Molecular orbitals.

These are lower energetic and stable orbitals.

b) Ψ_1, Ψ_2 are two molecular orbitals which are connected in destructive interface to form Anti Bonding molecular orbital

These are higher energetic and unstable orbitals.

$$5. \text{Bond order} = \frac{N_B - N_A}{2}$$

where, N_B = No. of electrons present in Bonding molecular orbitals

N_A = No. of electrons present in Anti Bonding molecular orbitals.

6. (LCAO)- linear combination of atomic orbitals stated three conditions i.e., same energy, similar energy, same shape.

7. To full fill the electron's in bonding molecular orbitals and antibonding molecular orbitals. we should follow three rules.

- a) Aufbau's principle
- b) Hund's rule
- c) Pauli's exclusion principle.

a) Aufbau's principle:- The electron's entering into lower energetic orbitals before entering into higher energetic orbital by using $(n+l)$ value. not all are of same energy

b) Hund's rule:- whenever degenerate orbitals are available for electrons, the pairing of electrons takes place after all orbitals are filled with one electron each.

c) Pauli exclusion principle:- No two electrons can have same set of four quantum numbers.

Diatomic molecules:-
The combination of two elements to form diatomic molecules.

Example:- H_2 , HCl , CO , etc.,

Homonuclear diatomic Molecules:-
the combination of two same elements having same energy. to form Homonuclear diatomic molecules

Example:- H_2 , O_2 , N_2 etc.,

Heteronuclear diatomic Molecules:-
The combination of two different elements having similar energy to form heteronuclear diatomic molecules.

Example:- CO

Energy level order of diatomic molecules upto nitrogen:-

upto nitrogen:-

$$\sigma_{1s} < \sigma_{1s}^* < \sigma_{2s} < \sigma_{2s}^* < \pi_{2p_x} = \pi_{2p_y} < \sigma_{2p_z} < \pi_{2p_x} = \pi_{2p_y} < \sigma_{2p_z}^*$$

Energy level order of diatomic molecules (upto) After nitrogen

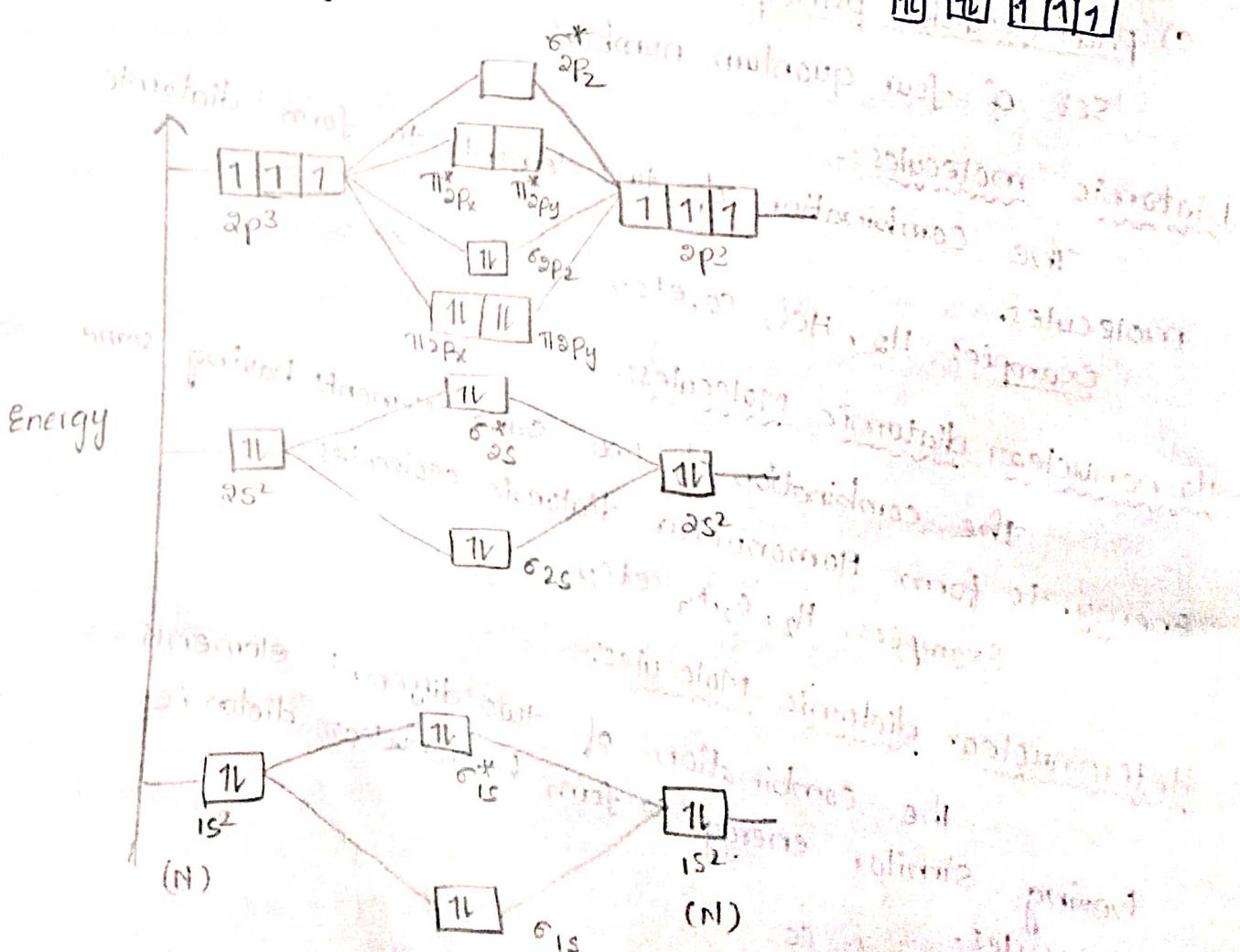
$$\sigma_{1s} < \sigma_{1s}^* < \sigma_{2s} < \sigma_{2s}^* < \sigma_{2p_z} < \pi_{2p_x} = \pi_{2p_y} < \pi_{2p_x}^* = \pi_{2p_y}^* < \sigma_{2p_z}^*$$

Energy level diagram of N₂ molecule:- [12 marks]

The Nitrogen molecule is an example of homo-nuclear diatomic molecules because of two nitrogen element having same energy to form nitrogen molecule.

Atomic number (z) is 7

The electronic configuration of Nitrogen element is $1s^2 2s^2 2p_3$



Bond order :-

$$\text{Bond Order (B.O)} = \frac{N_B - N_A}{2}$$

where,
 N_B = No. of electrons present in Bonding molecular orbital

N_A = No. of electrons present in Anti-Bonding molecular orbital.

$$\Rightarrow \text{B.O} = \frac{10 - 4}{2} = \frac{6}{2} = 3$$

It represents $\boxed{\text{N} \equiv \text{N}}$

Magnetic Nature :-

case-(i) :-

In case of no lone pairs of electrons present in Bonding molecular orbitals and Anti-Bonding orbital that molecule exhibits "dia magnetic" nature.

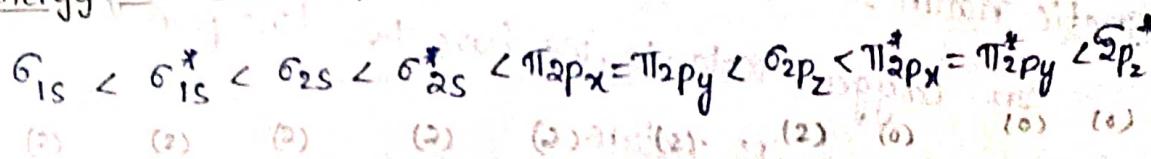
case-(ii) :-

In case of any lone pair of electrons present in Bonding molecular and Anti-Bonding molecular orbital that molecule exhibits "Para magnetic" nature.

Therefore,

In nitrogen molecule we don't have any lone pair of electrons that's why Nitrogen molecule exhibits Diamagnetic nature.

Energy level order of N_2 molecule :-

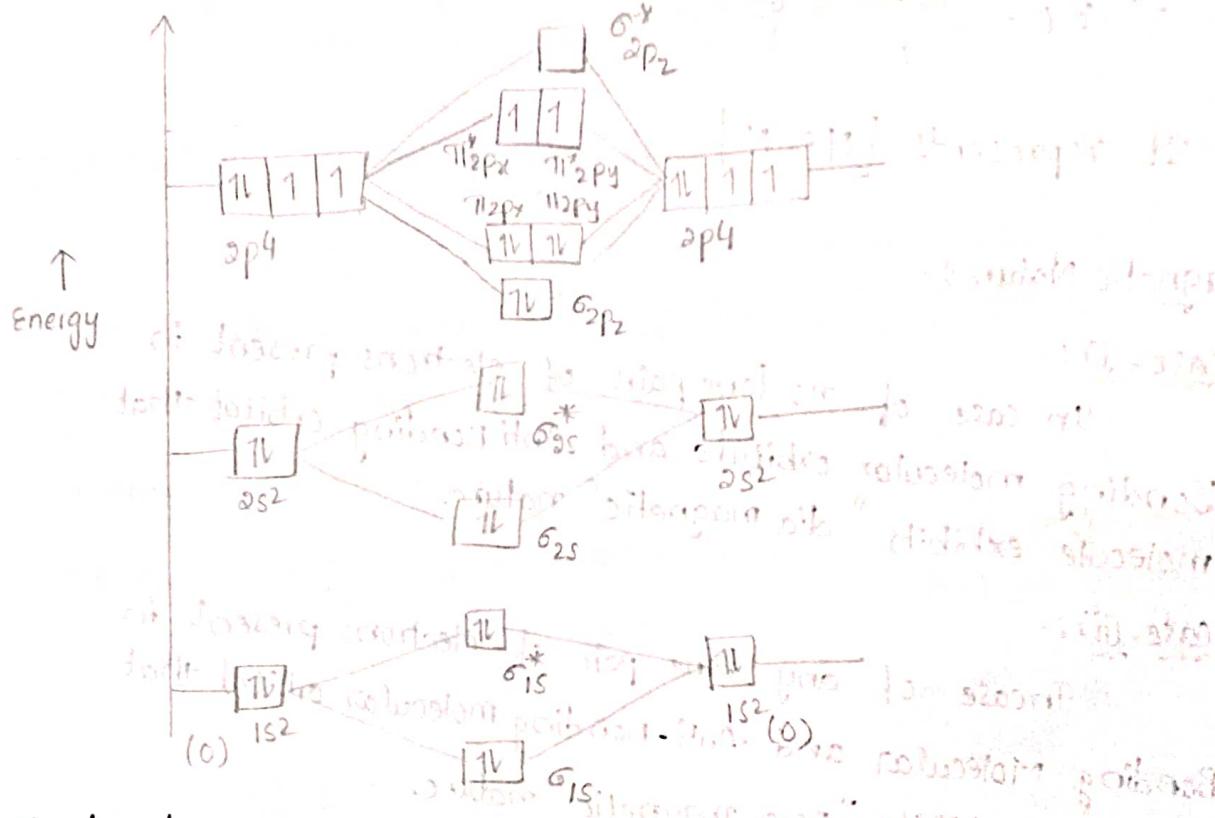


Bond order :- The no. of covalent bonds present in between the two atoms of a covalent molecule is called its Bond order.

~~QMP~~ Energy level diagram of O_2 molecule:- [12 marks] and question

The oxygen molecule is an example of homo nuclear diatomic molecule because of two oxygen element having same energy to form nitrogen molecule.

Atomic number (z) of oxygen is 8. The electronic configuration of oxygen is $1s^2 2s^2 2p^4$. [12/21]



Bond order:-

$$BO = \frac{NB - NA}{2}$$

$$= \frac{10 - 6}{2} = \frac{4}{2} = 2$$

It represents $[O=O]$

Magnetic nature:-

In oxygen Molecule, we have two lone pairs it shows paramagnetic nature.

Energy level order of O_2 molecule:-

$$\sigma_{1s} < \sigma_{1s}^* < \sigma_{2s} < \sigma_{2s}^* < \sigma_{2p_z} < \pi_{2p_x} = \pi_{2p_y} < \pi_{2p_z}^*$$

Energy level of H₂ molecule [2marks]

H₂ is Hetero nuclear diatomic molecule

atomic number of H is 1

electronic configuration of H is 1s¹



Bond order:-

$$B.O = \frac{N_B - N_A}{2} = \frac{2-0}{2} = 1$$

Magnetic nature:- Diamagnetic nature.

Energy level :-

$$6_{1s} < 6^*_{1s}$$

Energy level diagram of CO molecule :-

The CO molecule is an example for heteronuclear diatomic molecule. Because of two different elements having similar energy to form carbon monoxide molecule.

Atomic number (z) of carbon atom is 6

The electronic configuration of carbon is 1s²2s²2p²

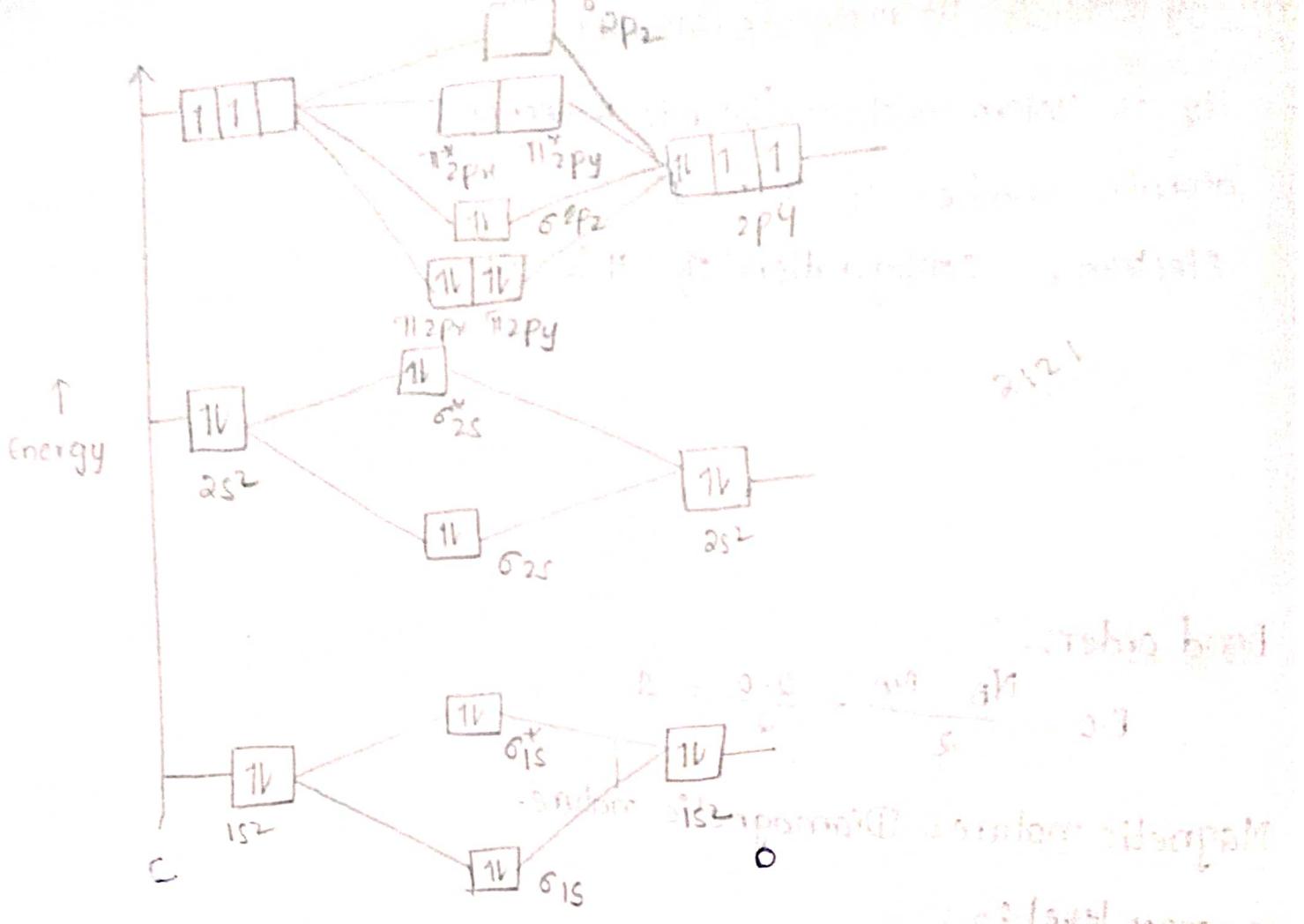
Atomic number (z) of oxygen atom is 8

The electronic configuration of oxygen is 1s²2s²2p⁴

In the above molecule we have two rules which explains the energy of 2s orbital and 2p orbital

$$E_{2s}(C) > E_{2s}(O)$$

$$E_{2p}(C) > E_{2p}(O)$$



Bond order :-

$$\text{Bond order} = \frac{N_B - N_A}{2} = \frac{10 - 4}{2} = \frac{6}{2} = 3$$

N_B = No. of e⁻ present in Bonding molecular orbital of co molecule

N_A = No. of e⁻ present in Antibonding molecular orbital of co molecule.

Magnetic nature :-
In co molecule. There is no lone pairs of electrons in Bonding molecular and Anti Bonding molecular orbital. So co molecule exhibits diamagnetic nature.

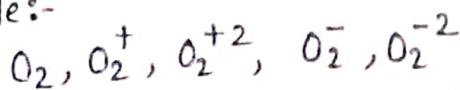
Energy level order of co molecule :-

$$\sigma_{1s} < \sigma_{1s}^* < \sigma_{2s} < \sigma_{2s}^* < \pi_{2p_x} = \pi_{2p_y} < \sigma_{2p_z} < \pi_{2p_x}^* = \pi_{2p_y}^* < \sigma_{2p_z}^*$$

Calculation of Bond order for molecular species :-

The molecule is associated with positive (+) charge (or) negative (-) charge is known as molecular species.

Example:-



$$\text{O}_2 \Rightarrow \text{B.O} = \frac{\text{NB} - \text{NA}}{2} = \frac{10-6}{2} = \frac{4}{2} = 2$$

$$\text{O}_2^+ \Rightarrow \text{B.O} = \frac{\text{NB} - \text{NA}}{2} = \frac{10-5}{2} = \frac{5}{2} = 2.5$$

$$\text{O}_2^{+2} \Rightarrow \text{B.O} = \frac{\text{NB} - \text{NA}}{2} = \frac{10-4}{2} = \frac{6}{2} = 3$$

$$\text{O}_2^- \Rightarrow \text{B.O} = \frac{\text{NB} - \text{NA}}{2} = \frac{10-7}{2} = \frac{3}{2} = 1.5$$

$$\text{O}_2^{-2} \Rightarrow \text{B.O} = \frac{\text{NB} - \text{NA}}{2} = \frac{10-8}{2} = \frac{2}{2} = 1$$

π - Molecular orbitals of 1,3 Butadiene. 3rd question

The atomic number (z) of carbon element is 6

The Electronic configuration in ground state $1s^2 2s^2 2p^2$

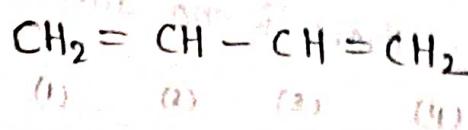
The Electronic configuration in excited state is $1s^2 2s^1 2p^3$

In 1,3 butadiene, 4 carbon's are attached with two alternative double bonds i.e alkene compound

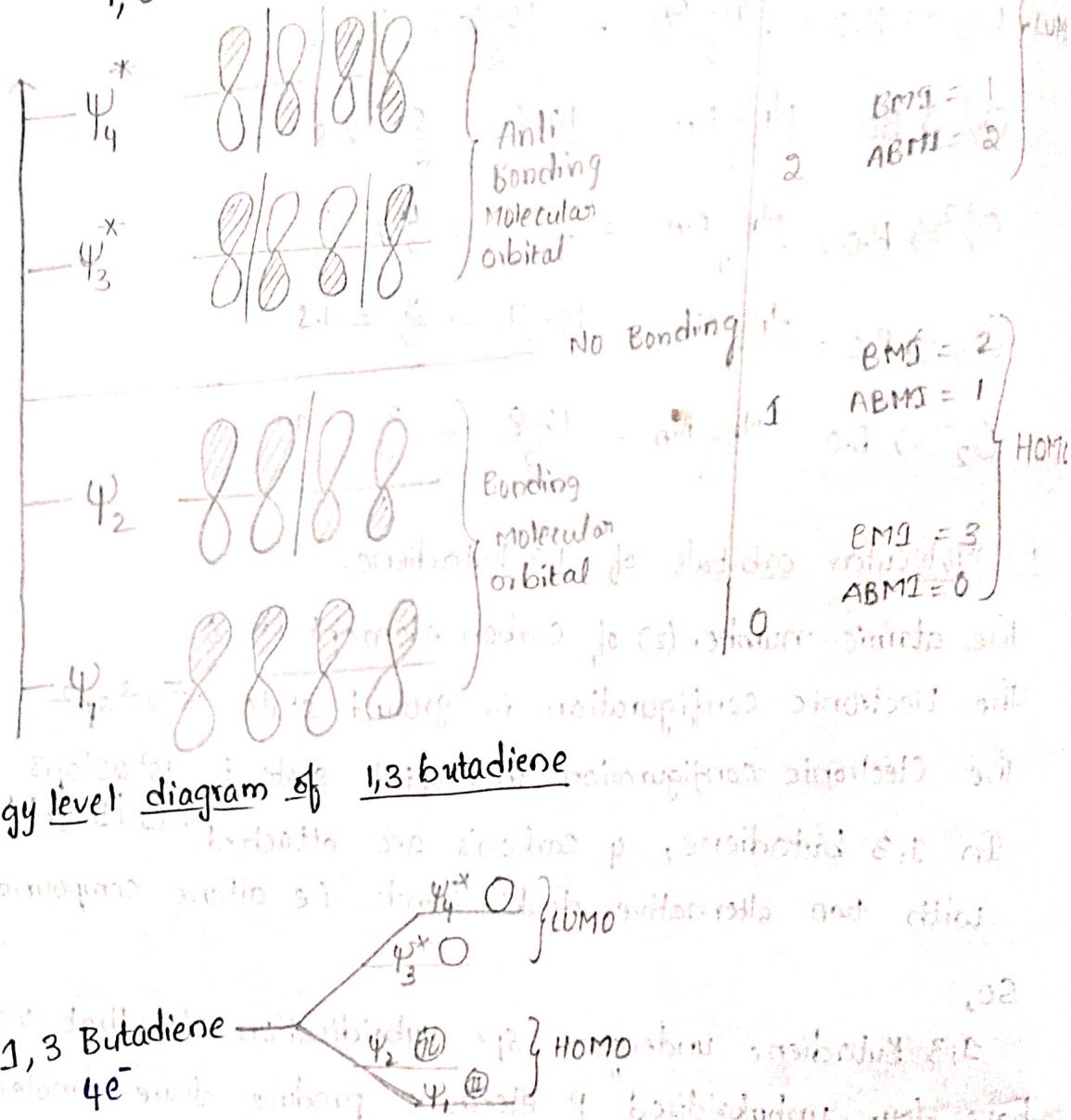
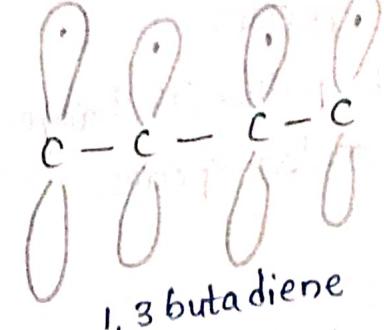
So,

1,3 Butadiene undergoes sp^2 hybridisation after that we have four unhybridised P electrons produce four 'π' molecular orbitals.

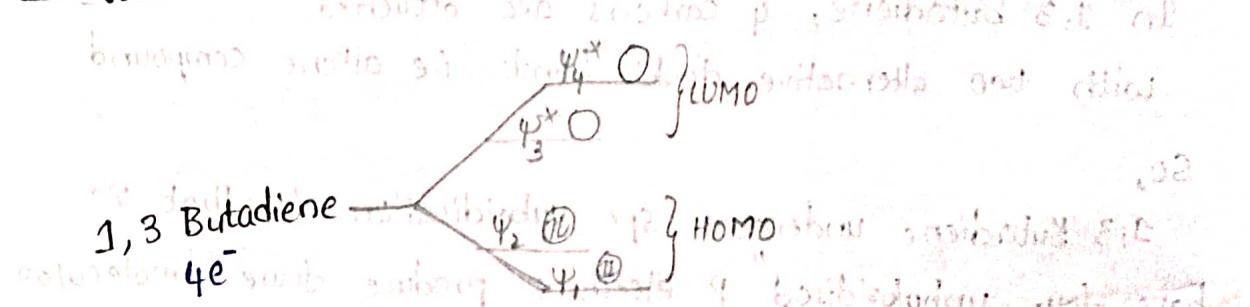
In this four 'π' molecular orbitals two are formed in constructive interface i.e., Ψ_1, Ψ_2 [BMO's], the another two are formed in destructive interface i.e., Ψ_3^*, Ψ_4^* [ABMO's].



Magnetic nature:- 1,3 butadiene exhibits Diatomic nature due there is no lone pair present in it.



Energy level diagram of 1,3-butadiene

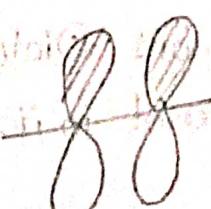


Note:-

Inphase :- In 1,3-butadiene, the positive lobes are arranged such that on the same side of the plane, the positive lobes (or) negative lobes are arranged in same side of the plane is known as Inphase manner.

In Inphase manner if there is no attraction forces,

no nodes

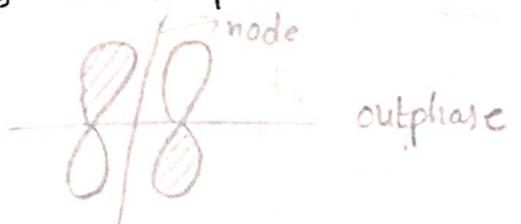


Inphase

outphase :-

The positive lobes are arranged in opposite side of the plane is known as outphase manner.

In these we have attraction forces between oppositely charged lobes which produce nodes.



HOMO → Highest occupied Molecular orbital [B.M.O]

LUMO → Lowest unoccupied Molecular orbital [A.B.M.O]

π-molecular orbitals of benzene :-

The atomic number of carbon is '6'

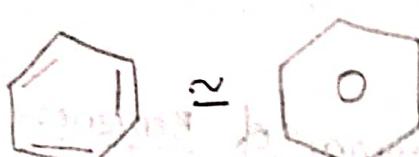
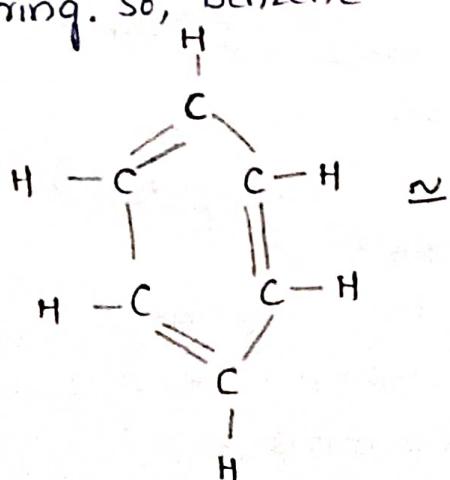
The electronic configuration in ground state is $1s^2 2s^2 2p^2$

The electronic configuration in excited state is $1s^2 2s^1 2p^3$



The formula of benzene is C_6H_6 , 6 carbons are attached with 6 hydrogen elements having three alternative double bonds.

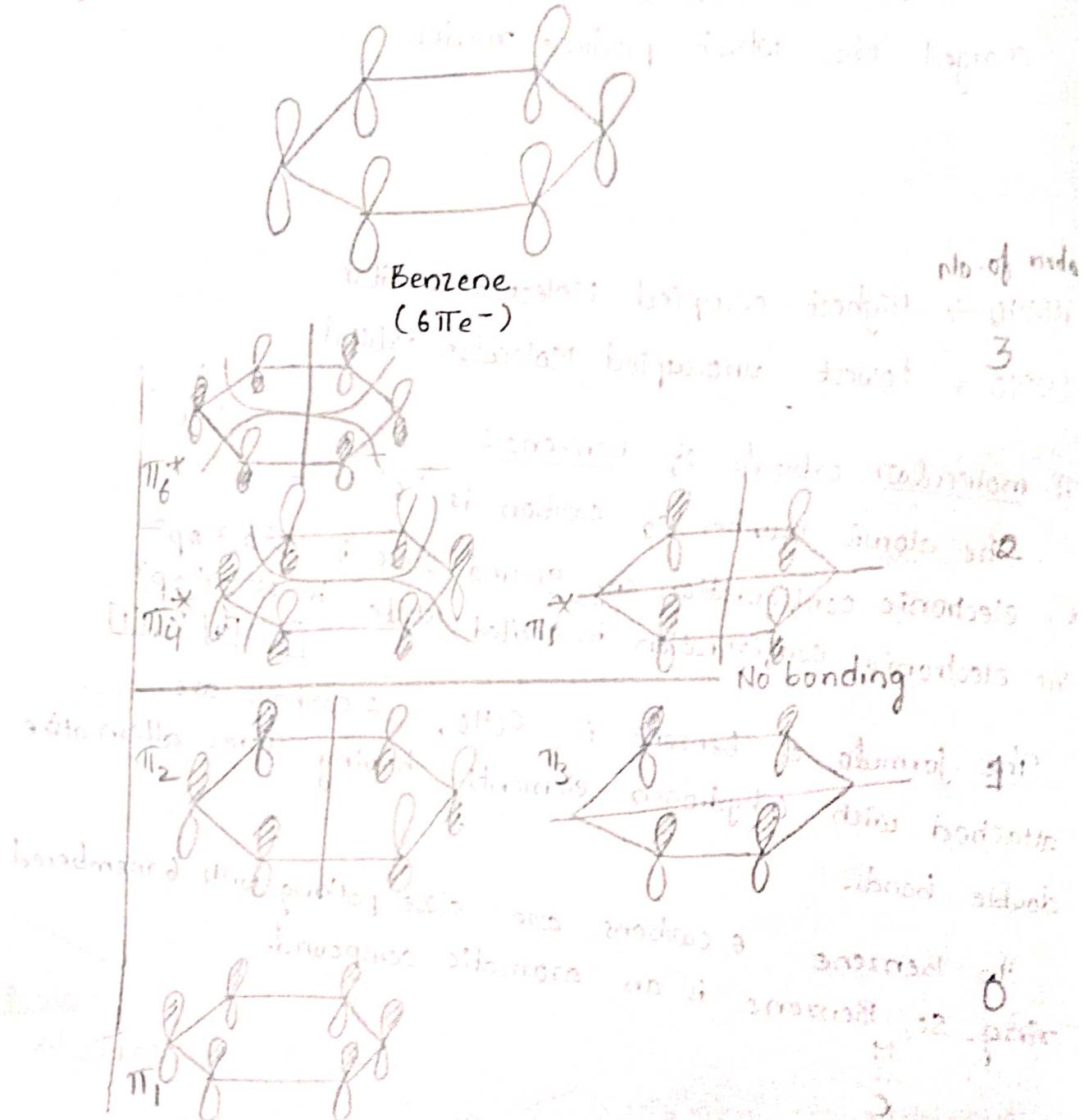
In benzene 6 carbons are close packing with 6 membered ring. So, Benzene is an aromatic compound.



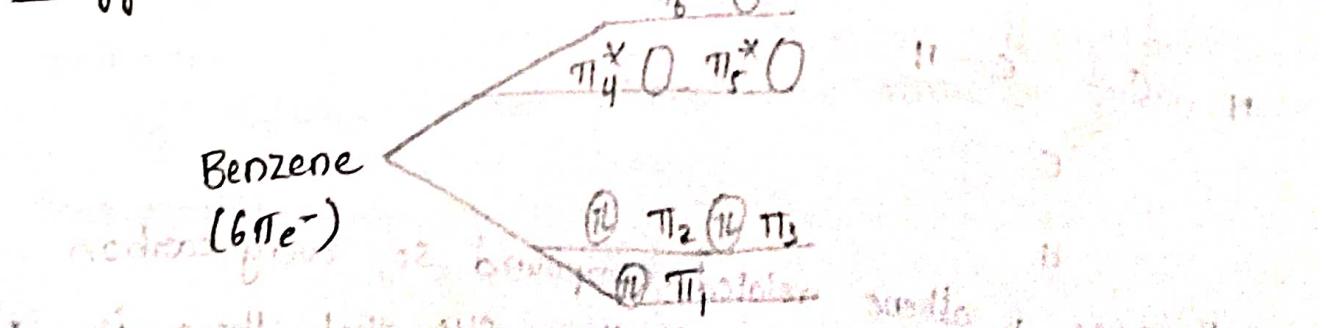
Benzene is alkene related compound so, every carbon element undergoes sp^2 Hybridisation. After that there is one Unhybridised electron present in orbital to form

π -molecular orbital.

So, Benzene produce six π -molecular orbitals. In this π_1, π_2, π_3 as Bonding molecular orbital (HOMO) another three $\pi_4^*, \pi_5^*, \pi_6^*$ as Anti molecular orbital (LUMO).



Energy-level diagram of Benzene:-



Annotations in red provide additional details:

- "It results in high stability and low reactivity" is written near the bottom left.
- "Effect of tetrahedral is to form resonance hybrid" is written near the bottom right.

Bond order :-
The total no. of double bonds = $\frac{N_B - N_A}{2}$
 $= \frac{6 - 0}{2} = \frac{6}{2} = 3$

There are three double bonds.

Magnetic nature :-

It is diamagnetic nature.

Crystal field theory :-

"Brethe" and "vanvleck" proposed crystal field theory in 1952 to explain formation of co-ordinate covalent compounds.

The combination of Lewis acids and Lewis bases means form co-ordinate covalent compounds. Here Lewis acids means electron pair acceptors; Lewis bases means electron pair donors.

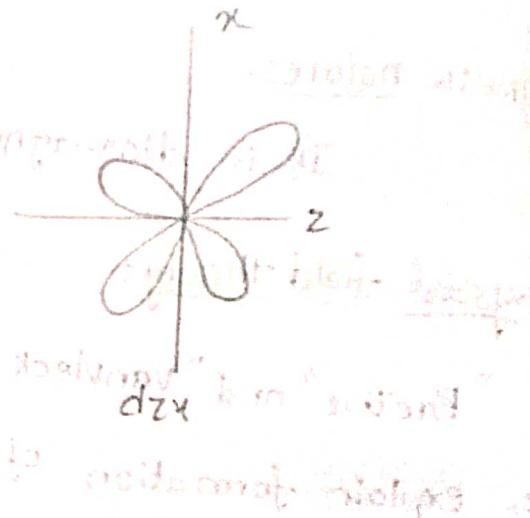
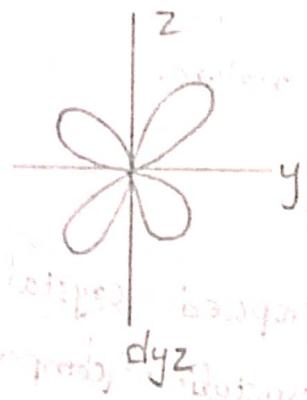
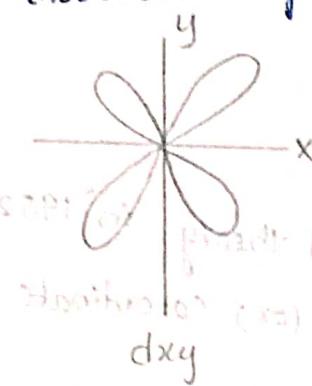
Postulates :- (salient features)

1. Transition metals are taken as Lewis acids, Ligands taken as Lewis bases.
2. Transition metal possess always '+ve' charge, ligand possess sometimes negative charge and sometimes neutral charge.
3. a) Attractions :-
The transition metals having '+ve' charge, ligands having '-ve' charge to produce attraction forces.
- b) Repulsions :-
The transition metals having '+ve' charge, ligands having neutral charge to produce repulsion forces.
4. All the transition metals have 'five' degeneracy d-orbitals [same energy orbitals] i.e., d_{xy} , d_{yz} , d_{zx} , $d_{z^2-y^2}$, d_{x^2}

5. When ever ligand approaches to the central metal atom - the 's' degeneracy d-orbitals destroyed that means splitting into two sets. Those are "tag" set and "eg" set

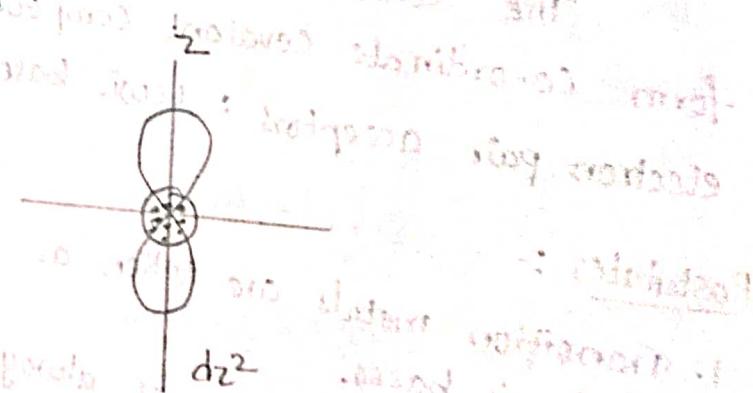
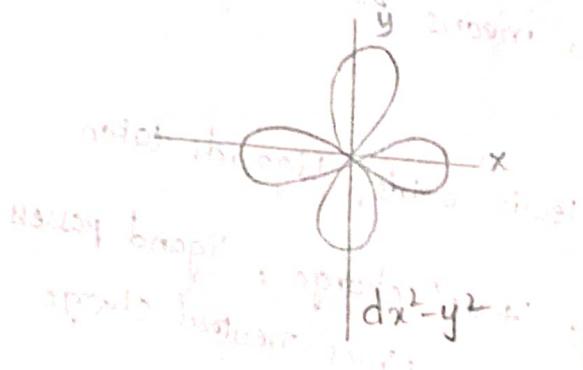
tag set:-

Three d-orbitals are drawn between the axis those are tag set of orbitals



Eg set:-

Two d-orbitals are drawn along the axis those are eg set of orbitals.

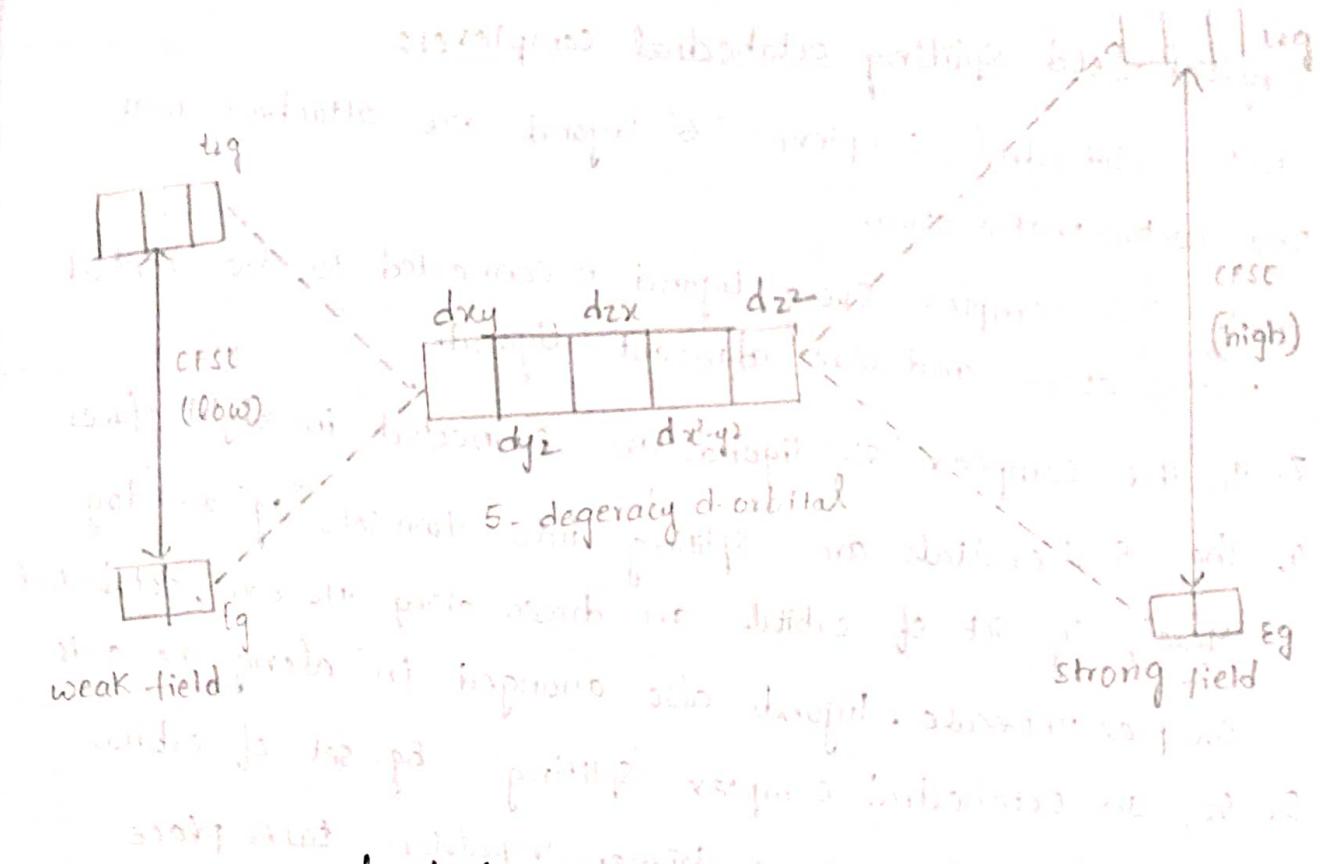


6. Crystal field Spiling Energy or crystal field stabilization Energy:-

The distance between tag set of orbital and Eg set of orbital is known as CFSE (Crystal field splitting Energy)

Case-i:- If the CSFE value is low which indicates the ligand character is weak field.

Case-ii:- If the CSFE value is high which indicates the ligand character is strong field.



7. Spectrochemical series:- A series of ligands are arranged in increasing order of energy is known as spectrochemical series.

I brought some checkbooks
 $I^- < Br^- < SCN^- < Cl^- < SO_4^{2-} <$

for his old wallet
 $F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < EDTA <$

and earned new currency coins
 $NH_3 < en < NO_2 < CN^- < CO$

NCS^-

8. Nature of ligands:-

a) Weak field ligands:-

The ligands consisting of electron pair donor atoms like Halogens, sulphur, oxygen is known as weak field ligands.

b) Strong field ligands:-

The ligands consisting of electron pair donor atoms like carbon, nitrogen, phosphorus is known as strong field ligands.

Octahedral comp.
Octahedral comp.
spectral

Crystal field splitting octahedral complexes:- (12 M) 4th question

1. In octahedral complexes '6' ligands are attached with the central metal atom.

2. In this complex every ligand is connected to the central metal atom and also adjacent ligand.

3. In this complex 'six' ligands are connected in eight faces.

4. The s-d orbitals are splitting into two sets "eq" and "tag". Here, eq set of orbitals are drawn along the axis, octahedral complex molecule. ligands also arranged in along the axis.

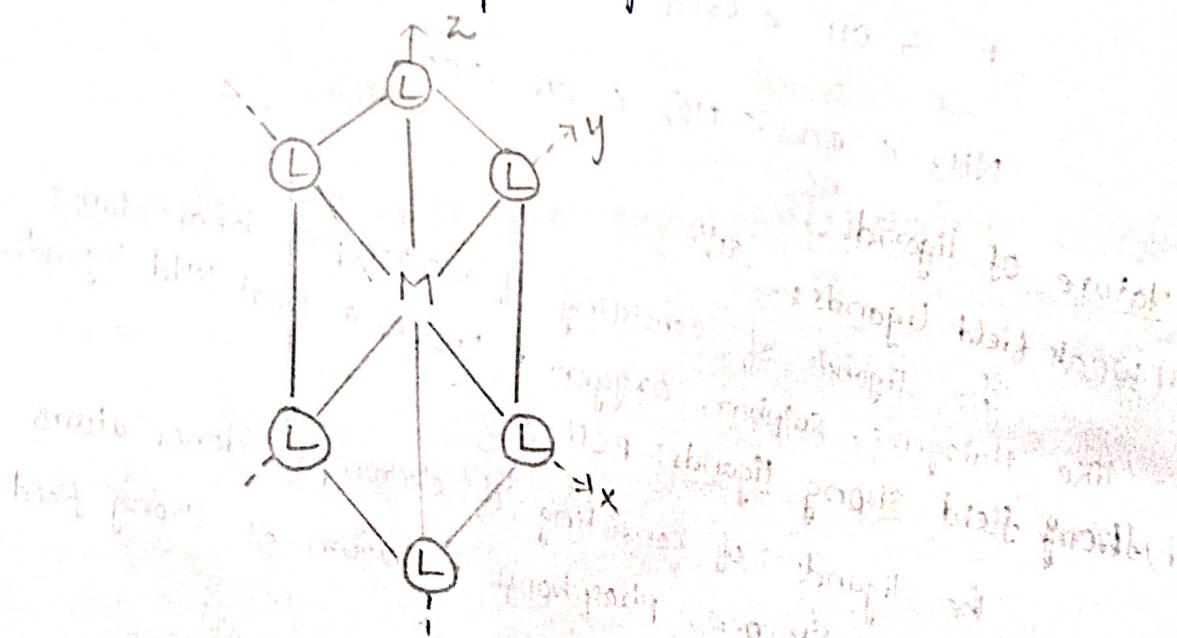
5. So, In octahedral complex splitting eq set of orbital get excited because of higher repulsion takes place when compare to tag set of orbitals.

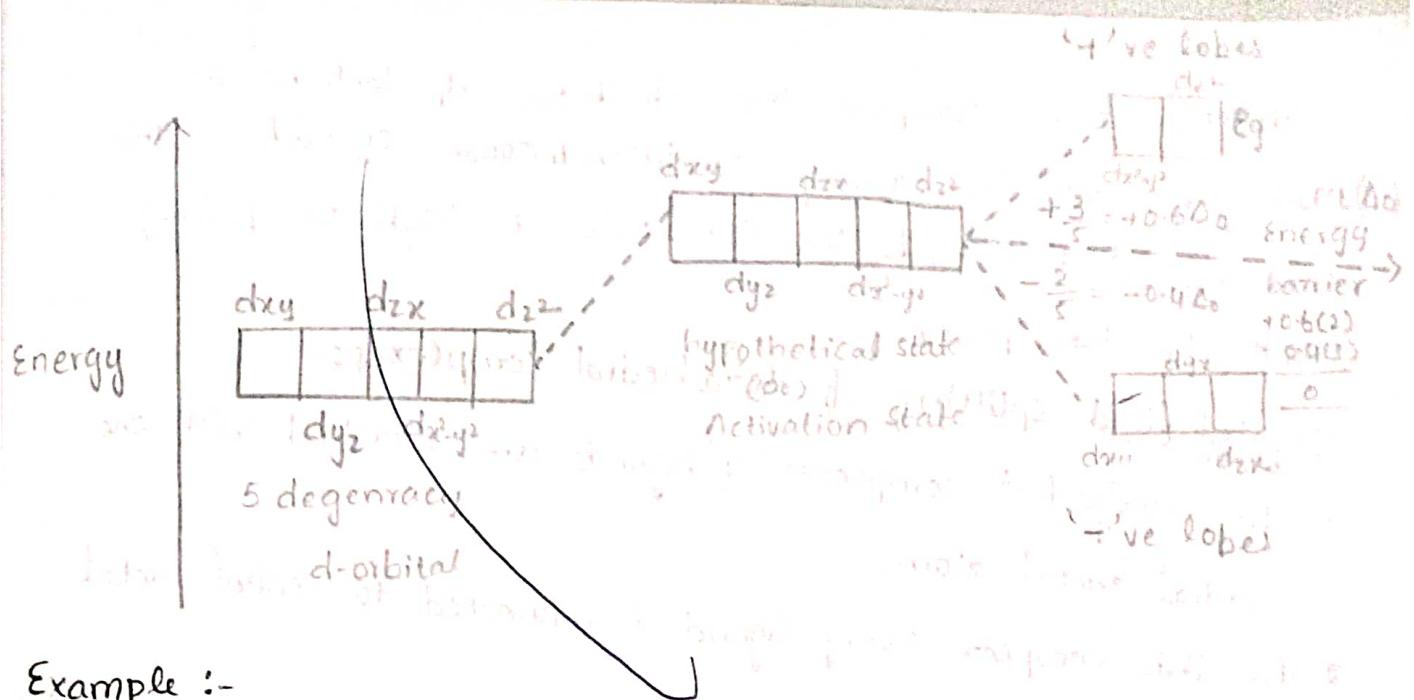
6. The formula of octahedral complexes is $[ML_6]^n$

Where M = Central metal atom

L = Ligands

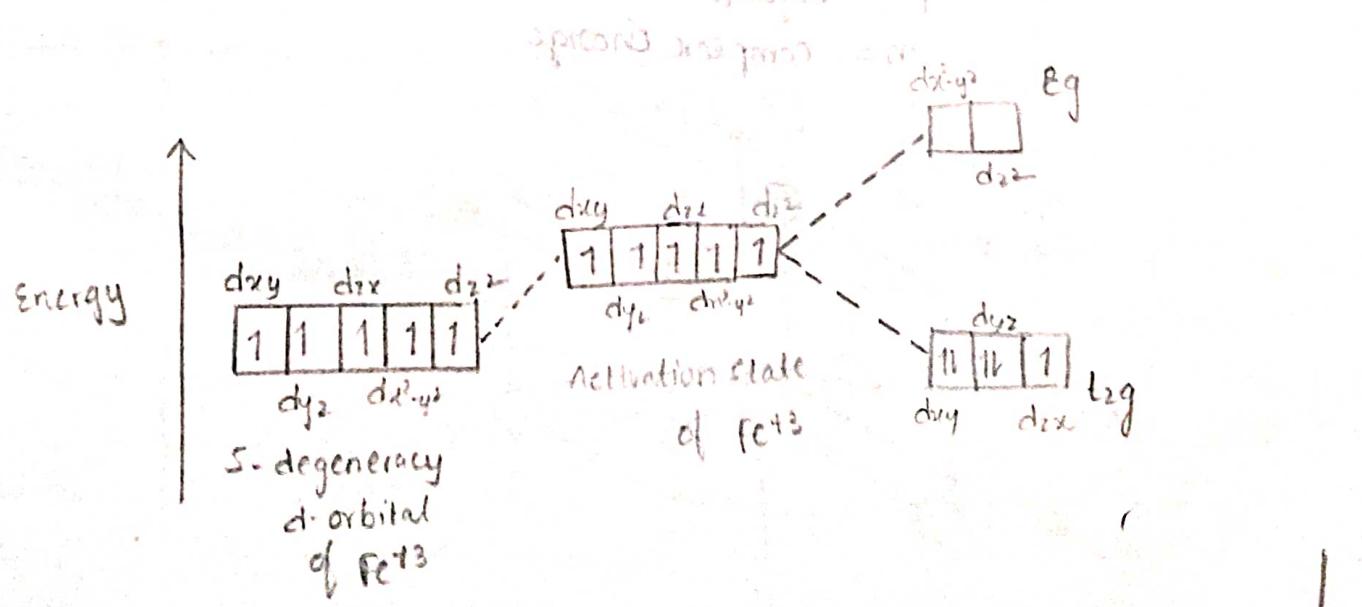
n = complex charge.





Example :-

- $[\text{Fe}(\text{CN})_6]^{3-}$ is formed in $\text{d}^6 \text{t}_{2g}^4 \text{e}_g^2$ state.
1. The name of complex is Hexacyanoferrate(III) ion
 2. In this complex Iron metal surrounded by six cyanide ligands to form octahedral complex.
 3. Atomic weight of Iron [Fe] is 26
 4. The electronic configuration $1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^2 3\text{p}^6 4\text{s}^2 3\text{d}^6$
 5. In complex formation Iron metal [Fe] loses three electrons to form ferric Ion $[\text{Fe}^{+3}]$.
The E.C of $\text{Fe}^{+3} = 23 \Rightarrow 1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^2 3\text{p}^6 4\text{s}^0 3\text{d}^5$



In the above complex the distribution of electrons in d-orbital will be pairing condition because cyanide is the strong field ligand. The CFSE value is high so pairing will be take place.

Crystal field splitting of Tetrahedral complexes:-

1. In tetrahedral complexes '4' ligands are attached with one central metal atom.

2. In this complex every ligand is connected to central metal atom.

3. In this complex, 'four' ligands are connected in four faces.

4. The 5-d orbitals are splitting into two sets 'e' and 't₂' set orbitals.

Here, 't₂' set of orbitals are drawn between the axis. In tetrahedral molecule ligands are arranged in between the axes.

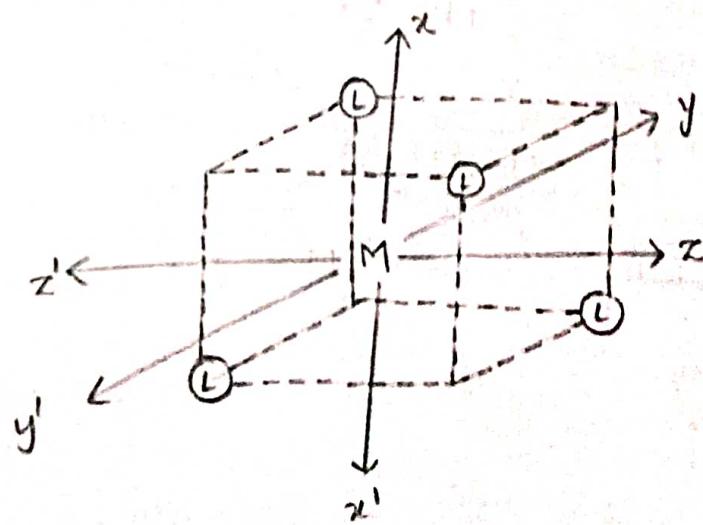
5. So, In tetrahedral complex splitting of 't₂' set of orbital get excited because of higher repulsion takes place when compared to 'e' set of orbital.

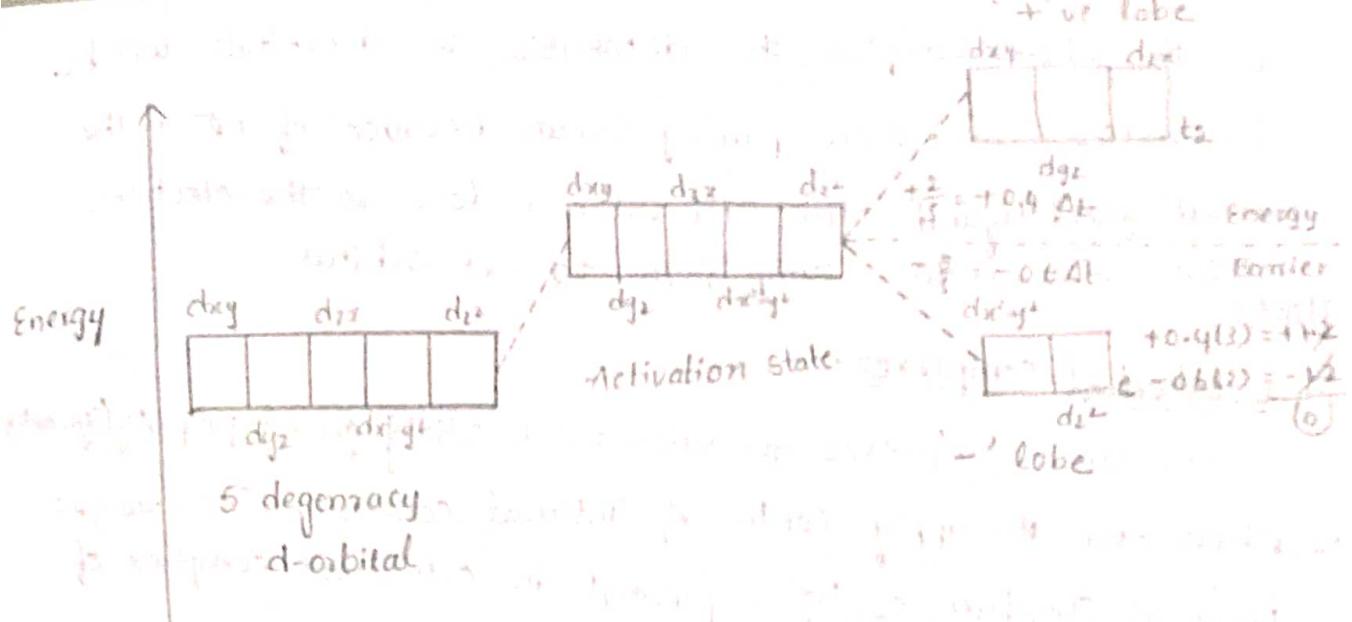
6. The formula for tetrahedral complexes is $[ML_4]^n$.

where, M = central metal atom

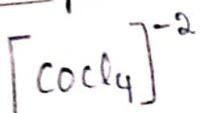
L = Ligand

n = complex charge

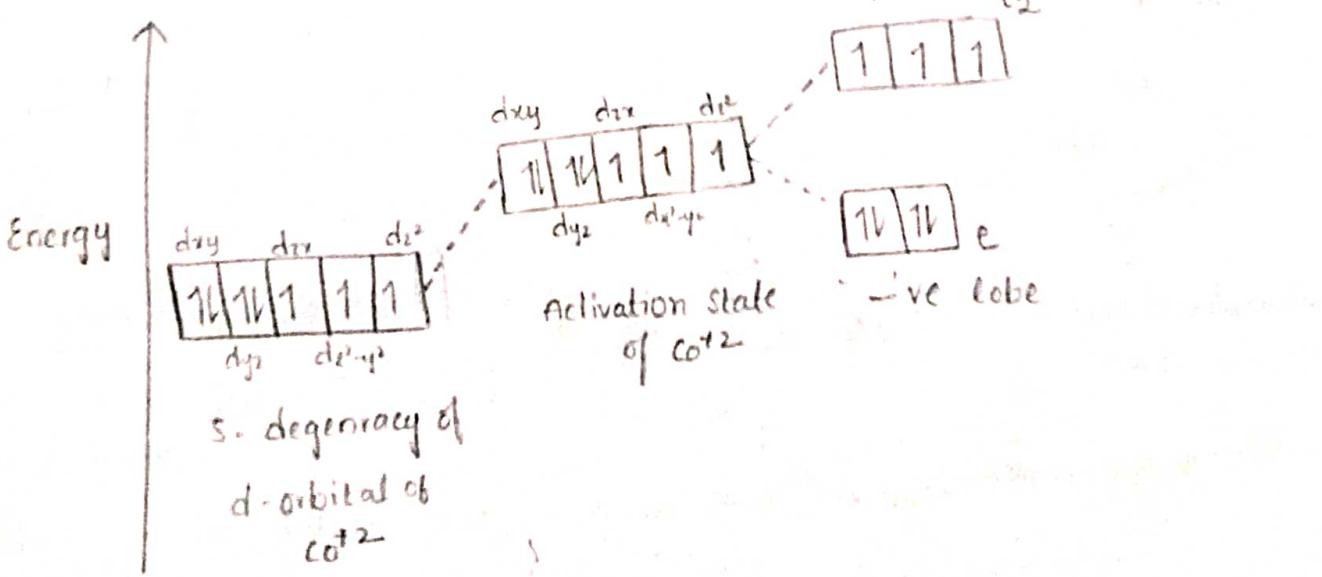




Example:-



1. The name of complex is Tetra chloridocobaltate (II) ion
2. In this complex cobalt (Co) metal surrounded by 4 chloride ligands to form tetrahedral complex
3. Atomic number of (Co) is 27
4. The E.C. of (Co) is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$
5. If 'Co' losses two electrons to form Co^{+2} . Then the electronic configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^7$

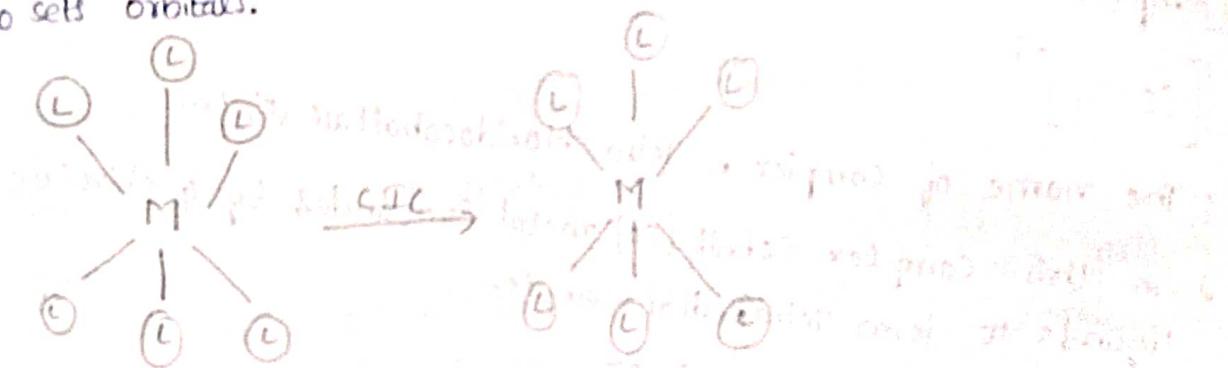


In the above complex the distribution in d-orbitals will be in existing and then pairing occurs. because of Cf is the weak field ligand - the CFSE value is low so the electrons have chance to jump into t_2 set orbital

Note:-

In Octahedral complexes :-

In this complexes formation which satisfy gerand property (symmetry), when ever we apply centre of Internal conversion (CIC) we get identical structure, so 'g' is present in octahedral complex of two sets orbitals.



Tetrahedral complexes :-

In this complex formation which doesn't satisfy the gerand property (symmetry) i.e, when ever we apply centre of Internal conversion (CIC) we get inverse or opposite structure so, 'g' is absent in Tetrahedra complexs of two orbitals.

