

Quantum No. Quantum No. gives the complete information about an electron in all atom.

It is used to locate the position of electron in an atom in size & shape of the orbital as well as orientation of an electron.

Types of Quantum Number - It is denoted by symbol n it tells about the position of an e^- in the shell.

The principal Quantum no. cannot be zero it has values of 1, 2, 3, 4. it also tells us about the distance of an e^- from the nucleus.

NO. of shell	Name (shell)
$n = 1$	K
$n = 2$	L
$n = 3$	M
$n = 4$	N

2) Azimuthal Quantum No. it is also called as angular Quantum No. It is denoted by the symbol l .

The value of l depends on n .
The value of l at particular value of n . l can have integer value ranging from 0 to $(n-1)$.
value of n value of l

$n = 1$	0, 1
$n = 2$	0, 1
$n = 3$	0, 1, 2
$n = 4$	0, 1, 2, 3

Name of subshell	No. of subshell
1s	1
2s, 2p	2
3s, 3p, 3d	3
4s, 4p, 4d, 4f	4

Magnetic Quantum No. It determines about the orientation of the cloud and also tells the no. of orbital. The value of m varies $-l \dots +0 \dots +l$.
 $m = (2l+1)$

value of l	value of m	Name of orbital
$l=0$	0	s
$l=1$	$+1, 0, -1$	p
$l=2$	$-2, +1, 0, +1, +2, -1$	d
$l=3$	$-3, -2, -1, 0, +1, +2, +3$	f

Spin Quantum No. It is denoted by s . It indicates about the orientation of spin of an electron. It can have two values +half & -half. The arrow pointing upwards denotes +half and the arrow pointing downward denotes -half.

Q1) Define Quantum Number.

Q2) discuss about all four types of Quantum No. what are their significance

Q3) write all the Quantum No. of following electrons.

$4s^2, 4s^1, 3p^2, 3d^3$

n	$n=3$
l	$l=f=3$
m	$m=-3, -2, -1, 0, 1, 2, 3$
s	$s=\pm\frac{1}{2}$

iv) $3d^9 \quad n=3, \quad l=2, \quad m=+1, \quad s=-\frac{1}{2}$

v) $3p^5 \quad n=3, \quad l=1, \quad m=0, \quad s=-\frac{1}{2}$

vi) $4f^1 \quad n=4, \quad l=3, \quad m=3, \quad s=\pm\frac{1}{2}$

4) An atomic orbital has $n=3$ what are the possible values of m

$n=3$	l	m
	0	0
	1	$-1, 0, +1$
	2	$-2, -1, 0, +1, +2$

5) Using s, p, d, f notations describe the orbitals with the following quantum number.

1) $n=1, \quad l=0; \quad 1s$

2) $n=2, \quad l=0; \quad 2s$

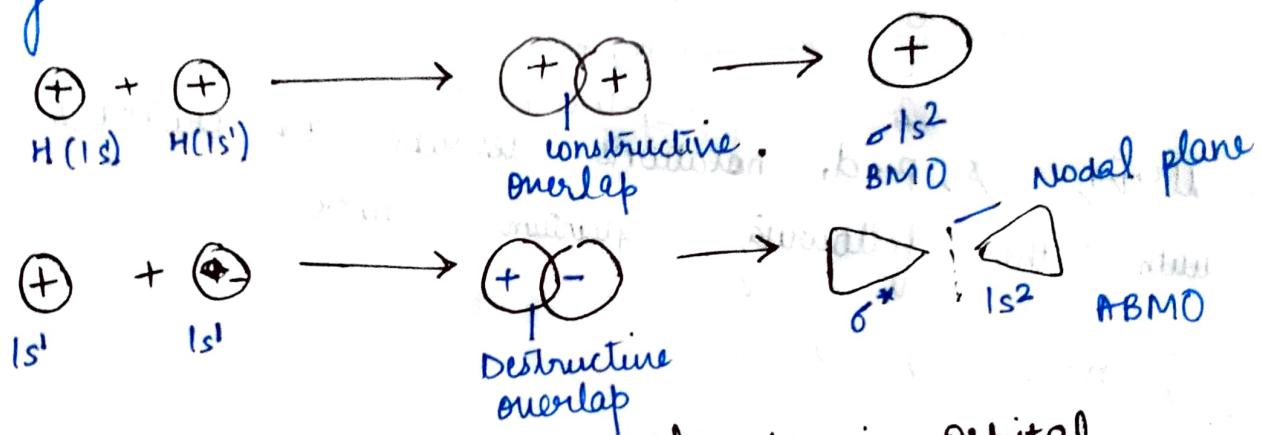
3) $n=3, \quad l=1; \quad 3p$

Molecular Orbital Theory

1) MOT was proposed by Hund & Mulliken in 1932

(CONCEPTS)

- Molecular orbital was formed by the addition of two atomic orbitals and these are called as ^{AO}_{Bonding M.O.}
- Bonding Orbital was formed by the subtraction of two atomic orbital are called as anti bonding molecular Bonding



- Conditions for the combination of atomic orbital
 - The energy of the atomic orbital should be comparable
 - Orbitals must overlap to max. for the combination of atomic orbital
 - Atomic orbital should have the same symmetry about the inter nuclear axis.
 - The number of molecular orbital formed is equal to the no. of atomic orbital that are combined.
 - Electrons are filled in increasing order of energy in the molecular orbital (Hfaw Principle).
 - The max. no. of electron that can exist in the given molecular orbital and its spin must be (polys explosion Principle)

Hund's Rule.

Electron enter in the molecular orbital of identical energy singly before they one paired up. molecular nb > na - No. of e⁻ in anti bonding molecular orbital.

No. of electron in bonding molecular orbital.

Na=Nb (molecule doesn't exist).

The stability of molecule is expressed in bond order. the greater the bond order the greater will be the stability of molecule.

B.O. of stability

$$B.O. \propto \frac{1}{\text{Bond length}}$$

B.O. of Bond dissociation

→ Bond Order is expressed as $\frac{Nb-Na}{2}$.

- If the Bond order is 0 the molecule will not exist.
- If all the electron in molecule are paired then it is diamagnetic.
- There are unpaired e⁻ in a molecule or ion the molecule will be paramagnetic in nature.

(Q) Discuss about the concept of molecular orbital theory. & bonding & anti bonding.

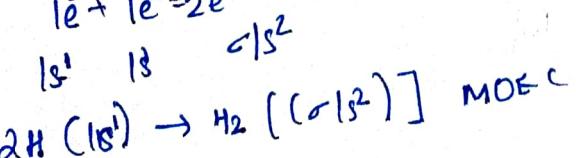
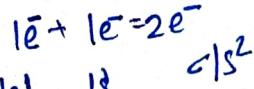
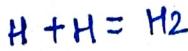
(Q) Diff between bonding molecular orbital & anti bonding.

for molecule which contain e⁻ upto fourteen i.e. upto Nitrogen.

for eg. molecules like B₂, N₂, C₂. the order of filling of

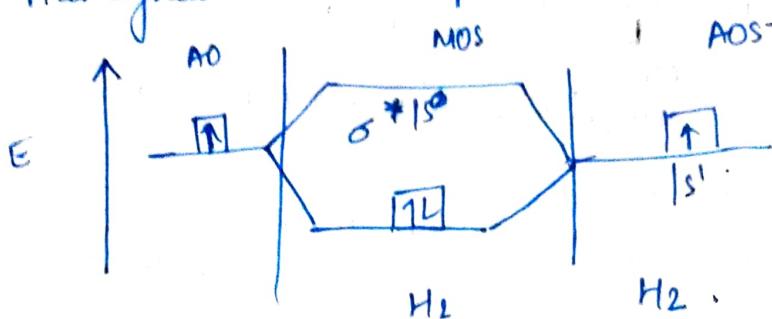
Molecular orbital is as follows:

$\Rightarrow \sigma 1s, \sigma^* 1s, \sigma 2p, \sigma^* 2s [\pi^* 2py = \pi^* 2pz], - 2px, [\pi^* 2py = \pi^* 2pz]$



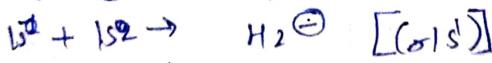
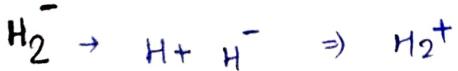
$$B.O \Rightarrow \frac{Nb - Na}{2} = \frac{2-0}{2} = 1$$

M.p. \Rightarrow paramagnetic all e^- are paired



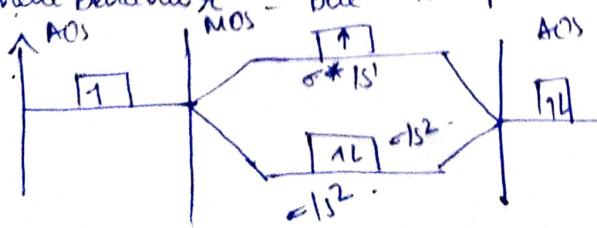
Ans 1) The M.O.T states that every atom tends to combine in order to form molecular orbital and it is the method for describing the electronic structures using Quantum Mechanics.

Ans 2) The main difference between bonding and anti-bonding molecular orbital is that representing bonding molecular orbitals represent the shape of a molecule whereas anti-bonding molecule orbital do not contribute to the determination of the shape of a molecule.



$$B.O = \frac{Nb - Na}{2} = \frac{0-1}{2} = \frac{1}{2}$$

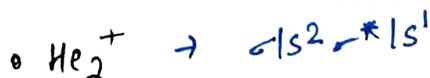
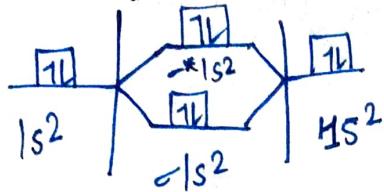
Magnetic behavior - Due to presence of unpaired electron.





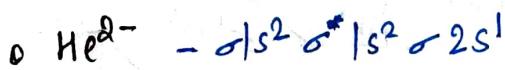
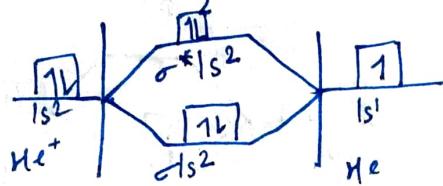
$$\Rightarrow \text{B.O.} = \frac{2-2}{2} = 0$$

Magnetic Behaviour - diamagnetic

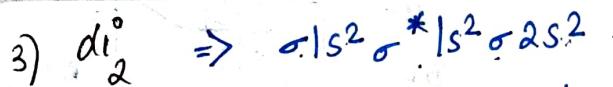


$$3e^- \text{ B.O.} \Rightarrow \frac{2-1}{2} = \frac{1}{2}$$

Magnetic Behaviour = paramagnetic
(due to presence of unpaired e⁻)

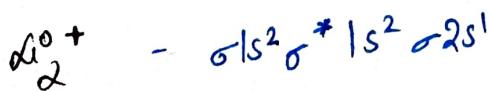
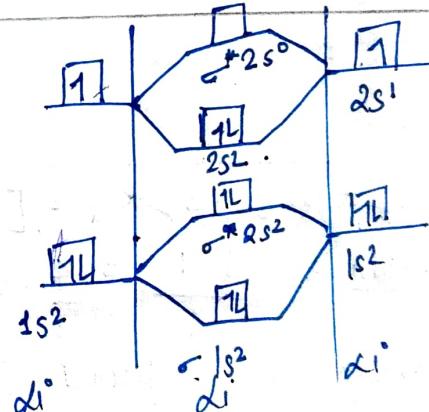


$$5e^- \quad \text{B.O.} = \frac{5-2}{2} = \frac{1}{2} \quad (\text{paramagnetic})$$



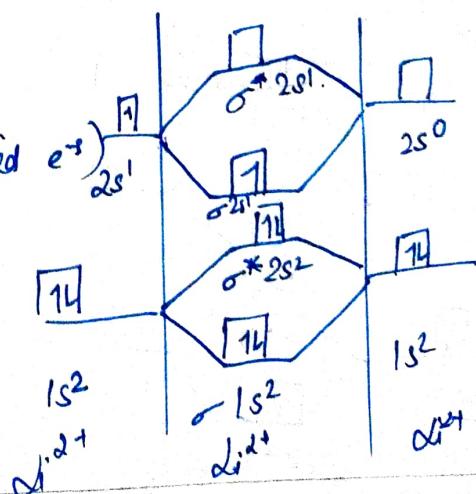
$$6e^- \quad \text{B.O.} \Rightarrow \frac{4-2}{2} = 1$$

M.B. \Rightarrow Diamagnetic (paired e⁻)



$$5e^- \Rightarrow \text{B.O.} \frac{3-2}{2} = 0.5$$

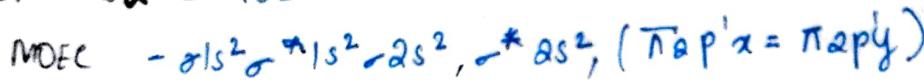
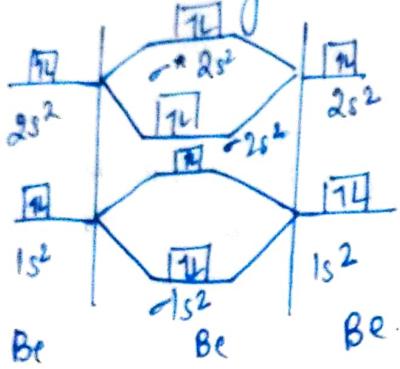
M.B. \rightarrow paramagnetic (unpaired e⁻)





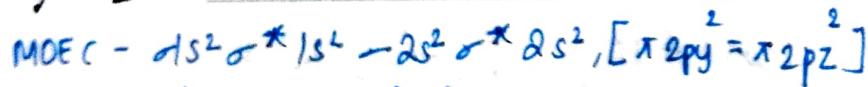
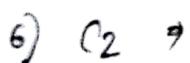
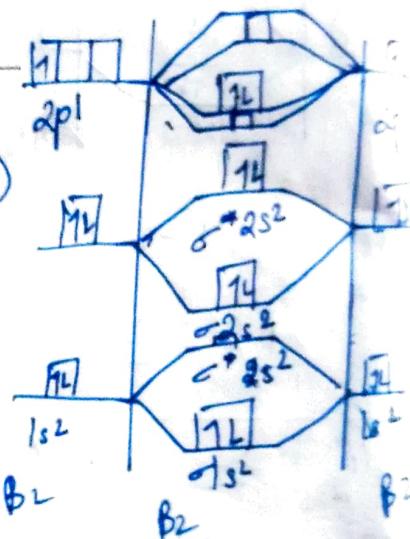
$$\text{B.O.} \Rightarrow \frac{4-4}{2} = 0$$

M.B. = g_t will not exist. if it would have been existed M.P.
 ⇒ Diamagnetic



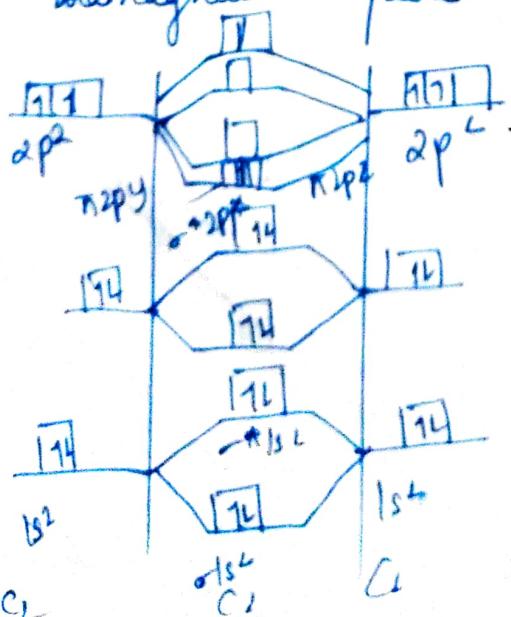
$$\text{B.O.} = \frac{\text{Nb}-\text{Na}}{2} = \frac{6-4}{2} = 1$$

M.B. Paramagnetic



$$\text{B.O.} = \frac{\text{Nb}-\text{Na}}{2} = \frac{8-4}{2} = \frac{4}{2} = 2$$

M.B. diamagnetic = paired.

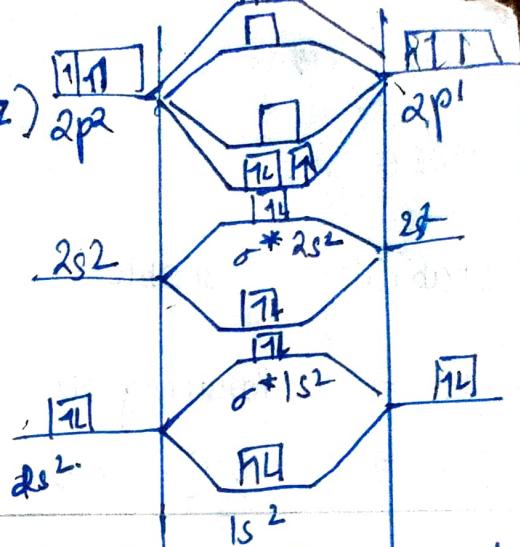


$$E_g^+ = 11e^-$$

$$MOEC = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 (\pi 2p_y^2 = \pi 2p_z^2) 2p_2$$

$$B.O. = \frac{N_B - N_A}{2} = \frac{4-4}{2} = 1.5$$

M.B. Paramagnetic

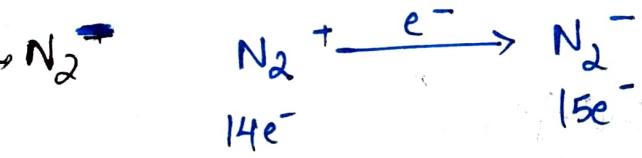
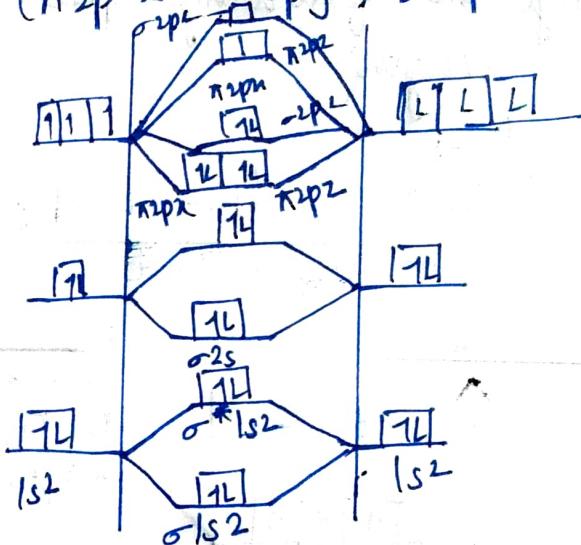


$$N_2 = 14e^-$$

$$MOEC = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 (\pi 2p_x^2 = \pi 2p_y^2) -2p_z^2 \sigma^* 2p_z^2$$

$$B.O. = \frac{B.O.}{2} = \frac{3.5}{2} = 3.5$$

M.B. Diamagnetic



Bond Order

$$\Rightarrow NB - NA$$

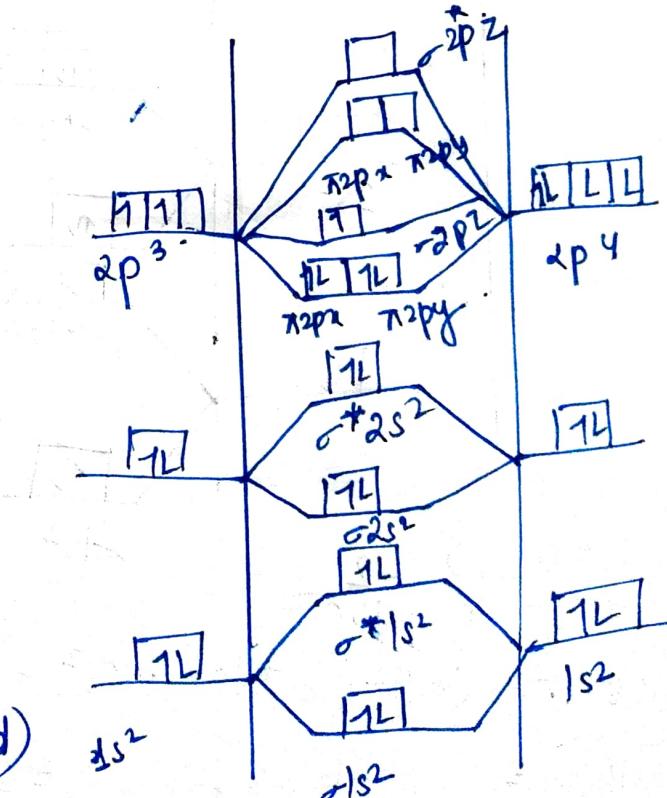
$$\Rightarrow \frac{5-0}{2}$$

$$\Rightarrow 2.5$$

\Rightarrow stable

Magnetic Property

\Rightarrow Paramagnetic Property (unpaired)



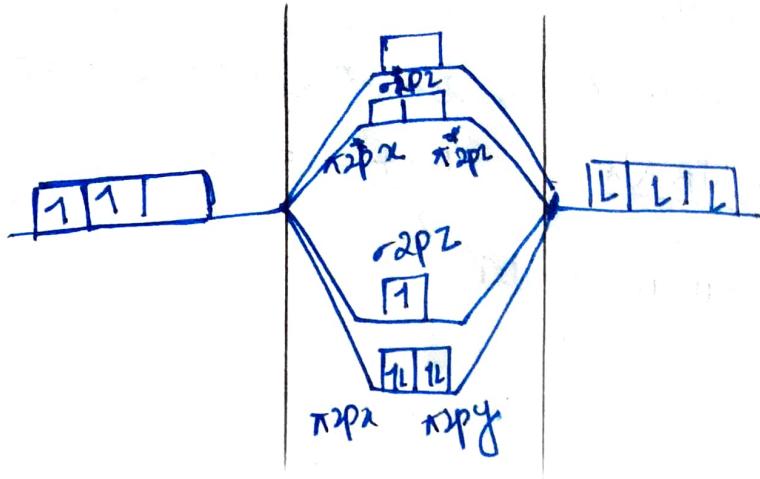


MOEC

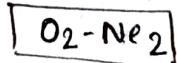
Stability - stable

M.P \rightarrow paramagnetic

$$B.O. \cdot \Rightarrow \frac{5-0}{2} = 2.5$$

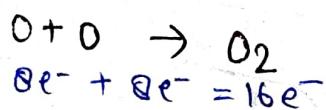
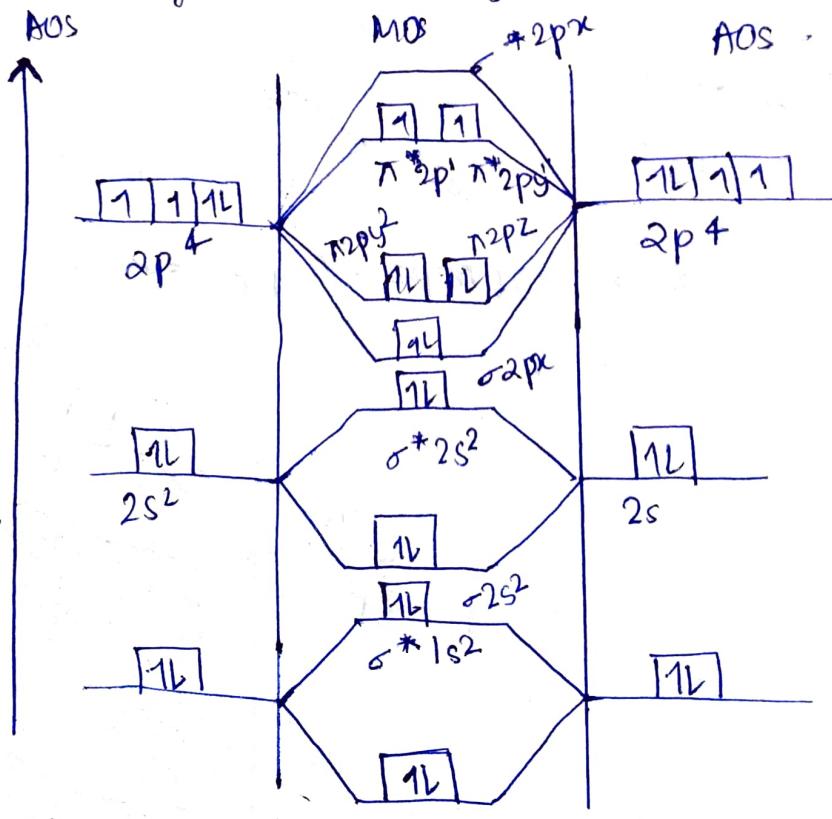
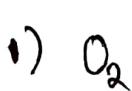


Q) Arrange the following species in increasing order of bond length



$\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2p_x, [\pi 2p_y = \pi 2p_z], [\pi^* 2p_y = \pi^* 2p_z], \sigma^* 2p_x$

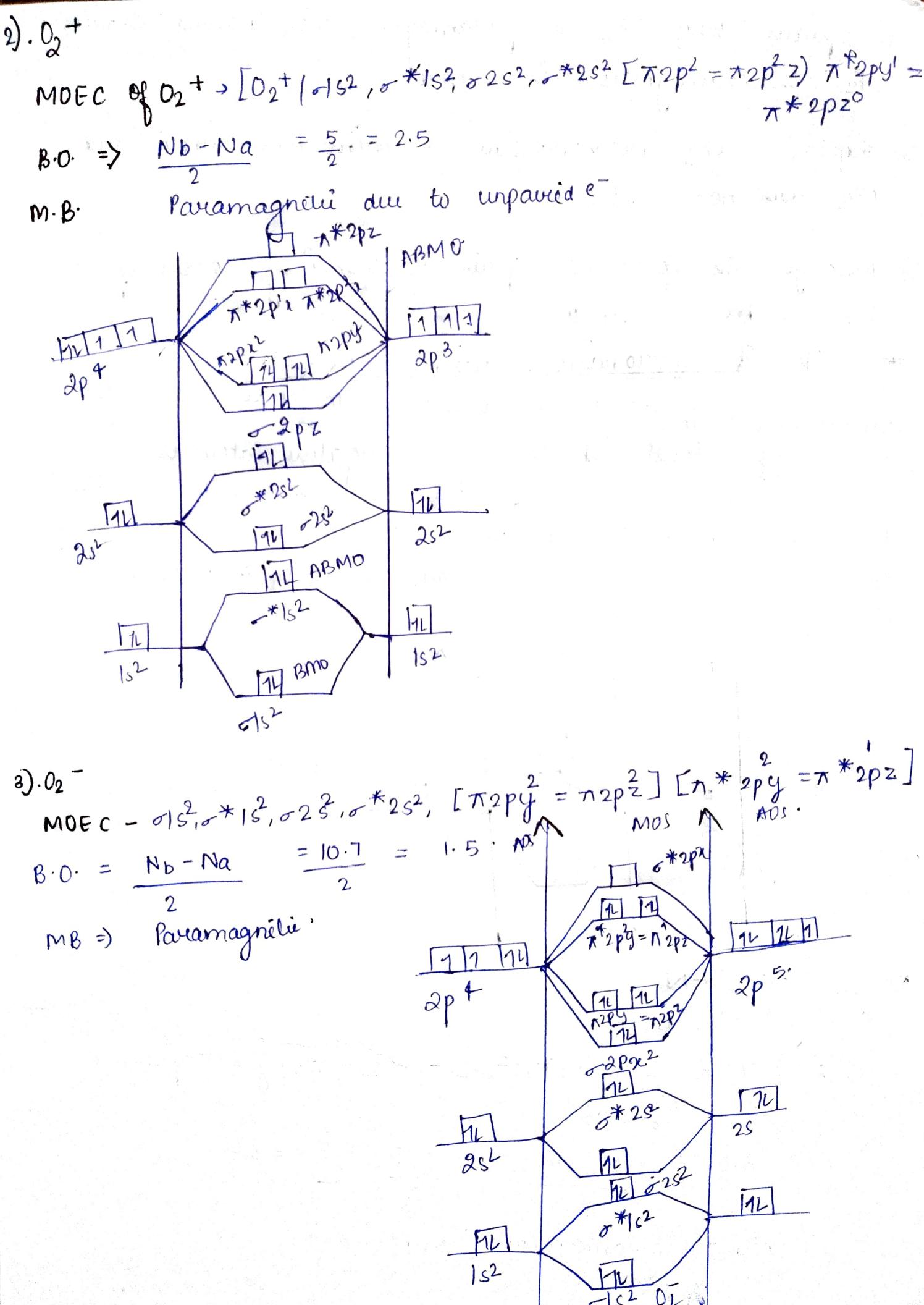
increasing order of energy.



MOEC $\rightarrow (\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_z^2, \pi^* 2p_y^2 = \pi^* 2p_z^2)$

$$B.O. \cdot = \frac{10-6}{2} = 4/2 = 2$$

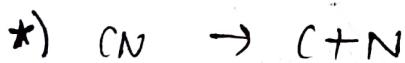
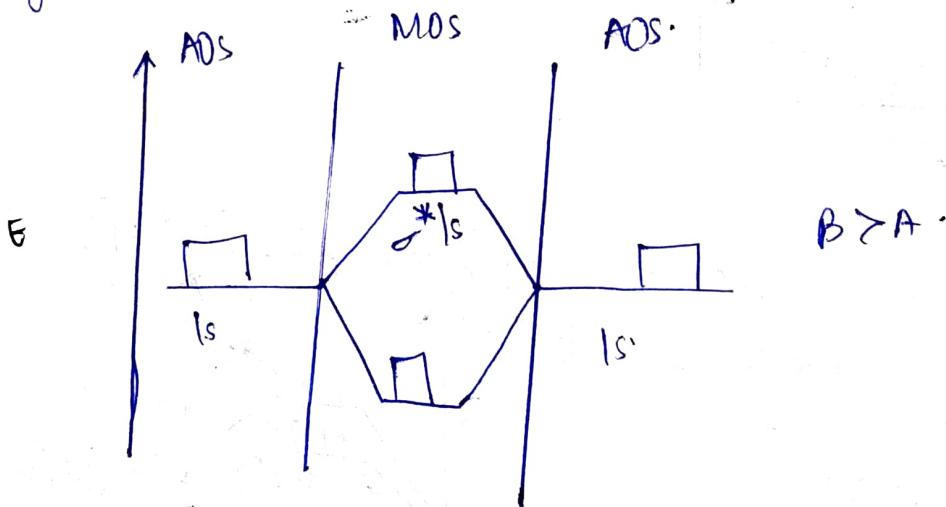
M.B - Paramagnetic - due to unpaired e^-



- B) Explain why O_2 is paramagnetic in nature whereas F_2 is diamagnetic in nature.
- B) Explain why Neon molecule remains monoatomic and Ne_2 does not exist.
- B) Arrange the following species in increasing order of their bond length.

* MOE of heteronuclear diatomic molecule.

The MOT of heteronuclear diatomic molecule is not symmetrical then the, the energy level of more electronegative atom is slightly lower than that of the less electronegative atom for e.g. In A, B molecule the B is more electronegative than A than the energy level of A will be slightly lower than A .

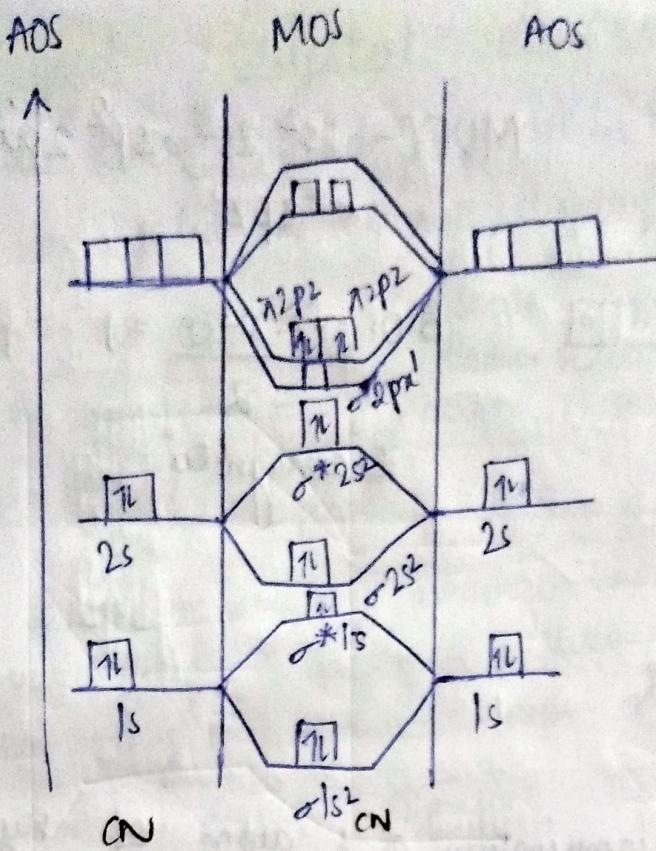


$$6e^-s + 4e^-s = 13e^-s.$$

$$\text{MOEs of } CN \Rightarrow -1s^2 \sigma 1*1s^2 - 2s^2 \sigma *2s^2 \pi 2p_y^2 = \pi 2p_z^2, \\ -2p_x^1$$

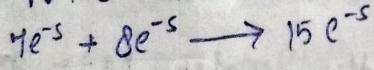
$$\text{B.O.} \Rightarrow \frac{\text{Nb-Na}}{2} \Rightarrow \frac{9-4}{2} = \frac{5}{2} = 2.5.$$

M.B \Rightarrow Paramagnetic (unpaired).



b) NO

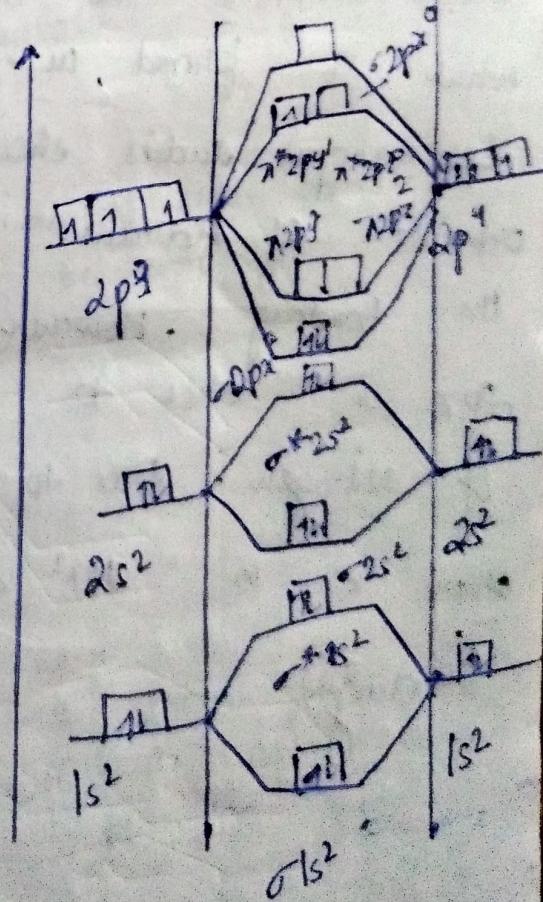
$N + O$



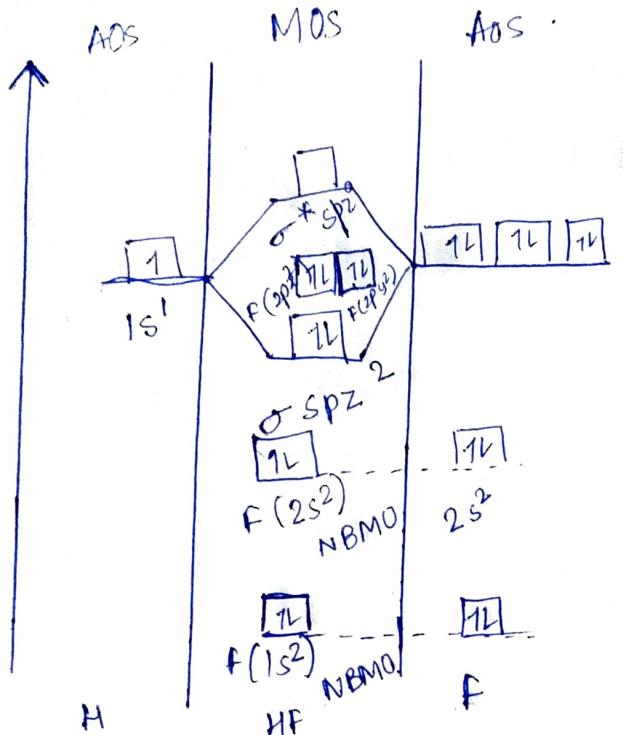
MOEC $\Rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \pi^* 2p_z^2, \pi^* 2p_y^1 = \pi^* 2p_z^0, \sigma^* 2p_x^0$

$$B.O. \Rightarrow \frac{Nb - Na}{2} = \frac{10 - 5}{2} = 2.5$$

M.B. Paramagnétic



HF



Mg²⁺ - $1s^2$ $2s^2$ σ sp^2 $2p^2$ σ^* sp^2

$$B \cdot O \cdot \Rightarrow \frac{2 - 10}{2} = 0$$

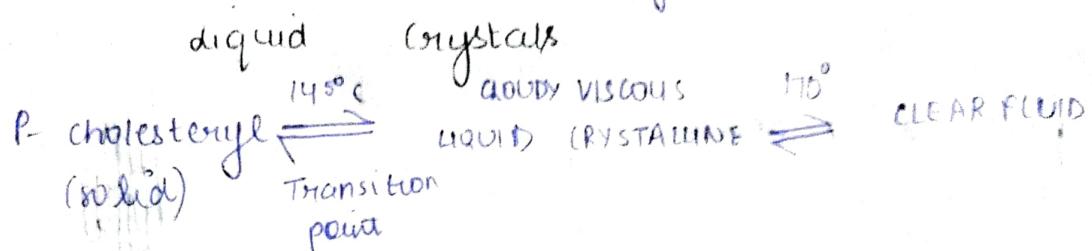
Diamagnete

HF is formed by the combination of 1 atom of Hydrogen with another atom of Fluorine. The 1s orbital of H and 2p⁵ orbital of Fluorine combine to produce the M.O. of HF molecule. The Bonding sp² is the only M.O. which is formed in the HF molecule.

Spectroscopic studies show that energy of 1s or 2s orbitals of fluorine & therefore do not take part in the bonding. However (2p) orbital of fluorine sp² is able to combine with 1s orbital of Nitrogen. Due to energy & symmetry of Nitrogen, the other e⁻ in 2p³, 2p⁴ do not take part in the bonding.

Liquid Crystal Display

Friedel shows that liquid crystalline is the intermediate between the solid & liquid display



certain solids on heating undergo two changes one after they first give cloudy & viscous liquid or after heating but when they are heated ~~at~~ at higher temp. they give clear liquid. Therefore the intermediate phase between the solid & clear state

These are substances which flow like liquid but have some arrangement of their molecule. liquid crystals can be broadly divided into two main type thermotropic liquid crystals. lyotropic

liquid crystal

Thermotropic - Phase material it shows the is changed.

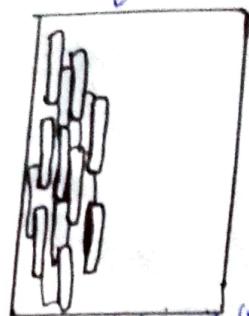
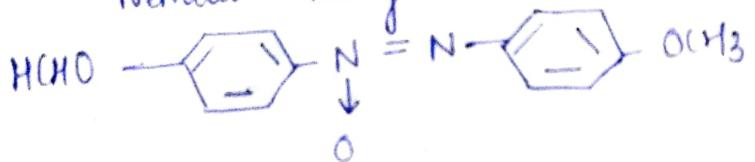
- i) Nematic
- ii) Smectic
- iii) cholesteric
- iv) Discotic / columnar

is a function of the temp of the mesomorphic behaviour as the temp

Nematic liquid crystal. Nematic is derived from greek word Nematic - "thread like" these molecule appear to have thread like structure when observed from polarised

when the molecules have parallel to one another they flow readily & have low viscosity they move up & down along their length the example of this type of liquid crystal is para azoxy anisole.

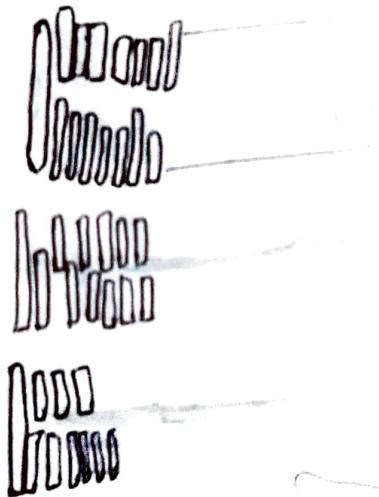
Nematic Range - 118 - 136 °C



Nematic liquid crystal

Semimic liquid crystal

Semimic word is derived from greek word greek therefore they are soapy in nature they are more ordered than N.L.C. they do not flow as normal liquid but they flow as layers over one another because of weak of attraction



Cholesteric liquid crystal

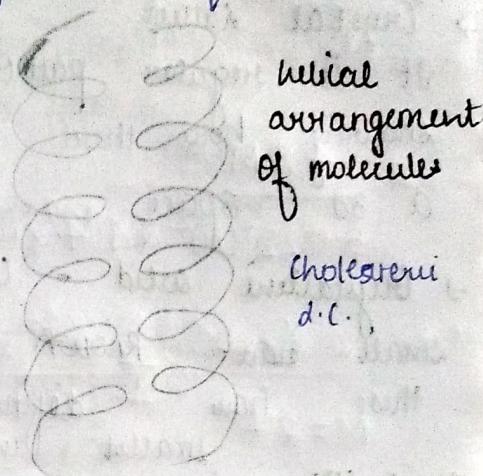
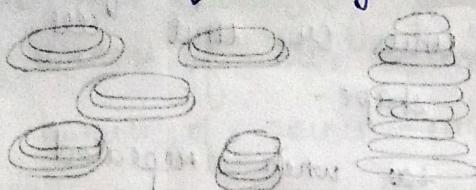
They are also known as chiral because they have large molecules containing cholesterol they are formed of compound active) compound naming chiral and by optically active) arrangement of molecule form netix - The helical arrangement of molecule

is either left handed or right handed these molecule show optical property of reflecting light of diff colours at diff temp.

Discotic liquid crystal -

they are also known as

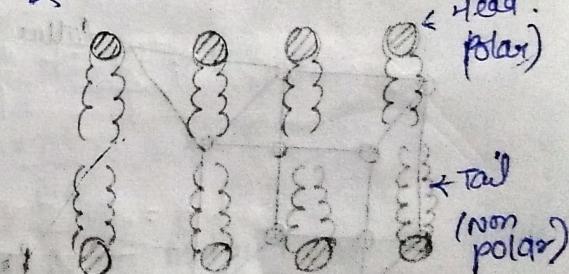
columnar liquid crystal.



These liquid crystal are formed from the molecule having disc like or plate like structure.

dyotropic

These substances show liquid crystal behaviour when they react with water or specific solvent. Many biological structure brain, muscle, blood contain dyotropic double property i.e. one end of these compound have polar & other end is non polar.



Applications of liquid crystal

- liquid crystal has display many application in traffic & industrial control system
- They are also used as Petrol pump indicator & automobile dash board they are used in TV & computer screen.
- Used in wrist watches & pocket calculators
- Used in laptop & mobile phone etc.
- They are used in measuring temp. & therefore in measuring temp.

→ They are used for detecting tumor by thermography

→ Crystal lattice

It is regular pattern of units [atoms, ions, molecules] showing how they are arranged in a crystal in a 3d space.

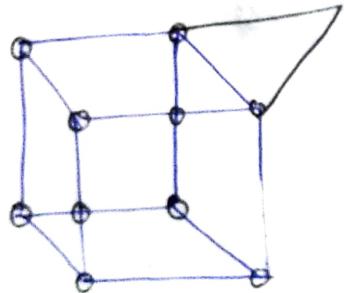
→ Crystalline solid - Crystalline solid is made up of many small unit known as repeating units or unit cell. These have definite geometrical shape.

Unit cell - it is smallest unit in space lattice which when repeated over & over again results in a crystal of a given substance

1) Primitive cell / simple cubic cell

2) Body centred cell

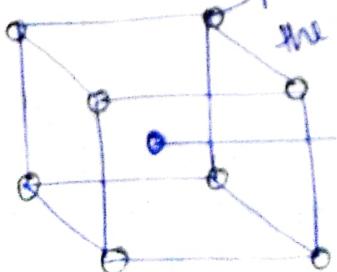
3) Face centred cell,



Lattice points (Atoms / Ions / Molecules).

Primitive cell

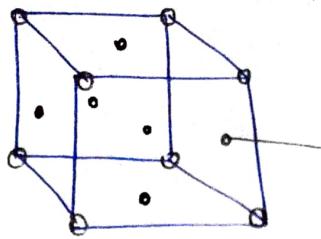
2) BCC



Atoms are present at
the corner

Atoms present inside
the unit cell

b) FCC \rightarrow



Lattice points
(Atoms | Ions | Molecules).

Points are present at the centre of each face.

Number of atoms in the unit cell $\Rightarrow \frac{n_c}{8} + \frac{n_f}{2} + \frac{n_i}{1}$
where n_c = number of points at all the corners of the unit.

n_f = number of points at the centre of each face.

n_i = Number of points present inside the unit cell.

UNIT CELL

$$\text{for SCC} = 8/8 + 0 + 0 = 1$$

$$\text{BCC} = 8/8 + 0 + 1/1 + 1/1 = 1 + 1 = 2$$

$$\text{FCC} = 8/8 + 6/2 + 0 = 1 + 3 = 4$$

\Rightarrow radius

\Rightarrow area (edge length).

$$\text{SCC} = r_1 = a/2$$

$$\text{BCC} = r = \frac{\sqrt{3}}{4} a$$

$$\text{FCC} = r = \frac{\sqrt{2}}{4} a$$

$$1 \text{ picometer} = 10^{-10} \text{ cm}$$

$$1 \text{ Å} = 10^{-8} \text{ cm.}$$

Density of the unit cell.

$$d = \frac{M}{V}$$

$$d = \frac{\text{Mass of the unit cell}}{\text{volume of the unit cell}}$$

Mass of the unit cell \Rightarrow

Number of atoms in the cell \times Mass of each atom

$$m = \frac{M}{N_A} = Z \times m$$

where M is Atom mass or molar mass of the species

N_A = Avagadro's No.

mass of the unit cell.

$$= \frac{Z \times M}{N_A}$$

$$d = \frac{M}{V} = \frac{Z \times M}{N_A \times a^3} \text{ g cm}^{-3}$$

Q) A Metal has a FCC crystal structure, what is the density of the metal if the molar mass of the metal atom is 42 g cm^{-3} .

$$is 42 \text{ g cm}^{-3}$$

$$\Rightarrow \frac{ZX M}{N_a \times a^3} g \text{ cm}^{-3}$$

$$Q12 \quad \frac{4 \times M}{6.022 \times 10^{23} \times 404 \times 10^{-10}} g \text{ cm}^{-3}$$

$$M \Rightarrow \frac{2.42 \times 6.022 \times 10^{23} \times (404 \times 10^{-10})}{4}$$

$$M = 27$$

=) Rb atomic Mass = 85.5
 crystallises in the BCC lattice with a density of 1.5 gm^{-3}
 if the radius is 248 pm. Calculate Avagadro No.

$$\Rightarrow Rb = 85.5$$

$$\text{Density} = 1.5 \text{ gm}^{-3}$$

$$a^3 = 248 \times 10^{-10}$$

$$\text{Avagadro's No.} \rightarrow 6.022 \times 10^{23}$$

$$\text{Density} = \frac{Z \times M}{N_a \times a^3}$$

$$1.5 = \frac{85.5 \times 2}{1.5 \left(\frac{4}{\sqrt{3}} \times 2.48 \times 10^{-8} \right)^3}$$

$$\Rightarrow \frac{171}{1.5 \left(\frac{4}{\sqrt{3}} \times 2.48 \times 10^{-8} \right)^3}$$

$$6.022 \times 10^{23}$$

Q. An element atomic mass is 60 having FCC structure has a density of 6.023 gm per cc. what is the edge length?

$$\text{atomic mass of element} = 60$$

$$\text{FCC} = 4$$

$$\text{density of the element} = 6.023 \text{ g/cm}^3 \\ = \frac{6.023}{10^{23}} \text{ g/cm}^3$$

$$\text{Density} = \frac{N \times M}{N_A \times a^3} = a^3 = \frac{ZM}{d \times N_A} = \frac{60 \times 4 \times 10^{30}}{6.023 \times 6.02 \times 10^{23}}$$

$$a \Rightarrow 400 \text{ pm}$$

Q) Chromium (52) metal crystallizes with a BCC lattice the length of the unit cell edge is found 204 pm. what is the density of Chromium.

Ans. 2
M = 52

$$\text{BCC} = 2$$

$$d = 5.96 \text{ g/cc}$$

$$d \Rightarrow \frac{ZM}{a^3 \times N_A}$$

$$5.96 = \frac{2 \times 52}{a^3 \times 6.023 \times 10^{23}}$$

$$0.3 \times 6.023 \times 10^{23}$$

$$a^3 = \frac{2 \times 52}{5.96 \times 6.023 \times 10^{23}}$$

$$a^3 = 2.78 \times 10^{-23}$$

Q) A metal atom $M=50$ has a BCC structure. The density of the metal is 5.96 g per cm^3 . Find the volume of the unit cell (cm^3).

$$\text{Ans 1)} M = N\bar{V}a = 4\bar{V}a$$

$$\bar{V} = \frac{\sqrt{3}}{4} a^3$$

$$\bar{V} = \frac{\sqrt{3}}{4} \times 287 \text{ pm} = \bar{V} = \frac{1.732}{4} \times 287$$

$$\bar{V} = 124.4 \text{ pm}$$

$$d = \frac{2M}{N\bar{V}a^3}$$

$$\Rightarrow \frac{2 \times 52}{6.022 \times 10^{23} \times 124.4 \times 10^{-30}}$$

$$\Rightarrow 7.3 \text{ g/dm}^3$$

Any deviation from a Completely

Imperfection / Defects in SOLID.

Point defect - When a crystal is missing from its usual position is called Point defect

stoichiometric defect - No change in stoichiometry takes place i.e. the ratio of no. of the ion does not change

1) Vacancy defect

2) Interstitial "

3) Frenkel "

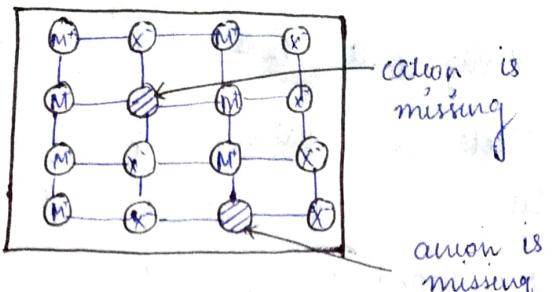
4) Schottky "

1) Vacancy Defect - When some of the lattice sites are vacant. The defects are known as Vacancy Defect $d = \frac{M}{V}$

2) Interstitial defect - When some constituents atoms are occupied the interstitial sites in the lattice is called Interstitial Defect.

This increases the density of the substance.

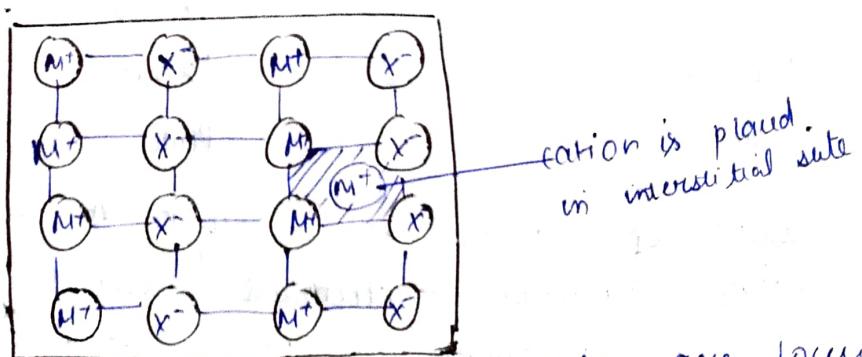
3) Schottky defect :-



In this defect equal No. of cation & Anion are missing from a crystal lattice leaving behind pair. These defect are formed from compound having Number. The Density of the substance is decreased in this type of defect.

4) Frenkel defect

Frenkel defect is created when a cation leaves the normal lattice site & occupies the interstitial site these defect are found in ionic compound with low coordination NO.
Eg. AgBr , AgCl .



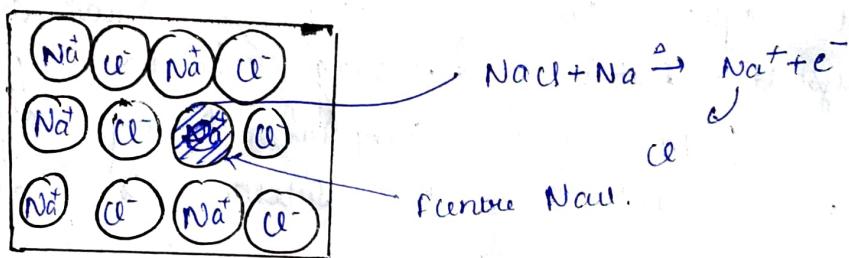
In this density of the crystal remains the same & does not change.

5) Non stoichiometric defect :- In this type of compound there is a change in the stoichiometry of the chemical formula. These are also called as Berthollard defect.

Ex. $\text{FeO} \cdot 9\text{H}_2\text{O}$ transition ion found in

These defect are produced due to presence of excess metal ion & Non Excess metal ion.

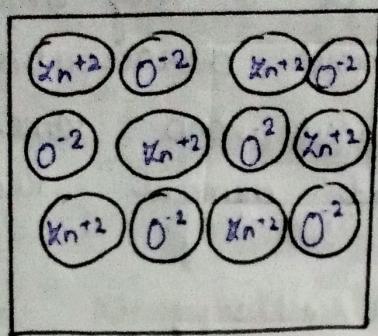
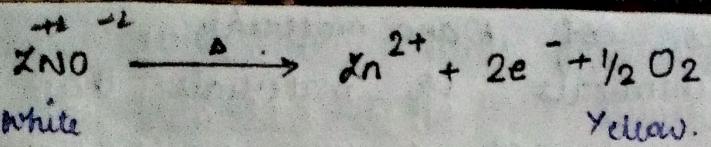
Metal Excess Defect - These defects arise when a compound has excess metal ion because a negative ion is absent from a lattice site. This leaves a hole which is occupied by e^- to maintain electrical neutrality. These crystal upto hole occupy by e^- are called as F centres) Farbe Unters Farbe \rightarrow Greek word \rightarrow colour centres



IONIC SOLID	EXCESS METAL	COLOUR
NaCl	Na	Yellow
KCl	K	Pink
CsCl	Cs	Pink

The effect of metal excess defect it imparts colour to the crystal
① It increases electrical conductivity
② It increases paramagnetic behaviour of the crystal
Before defect

③ Metal Excess Defect due to Interstitial cation - This defect arises if an extra ion is present in an interstitial site. Electrical Neutrality is maintained by the presence of an e^- in the adjacent interstitial site.



Before effect

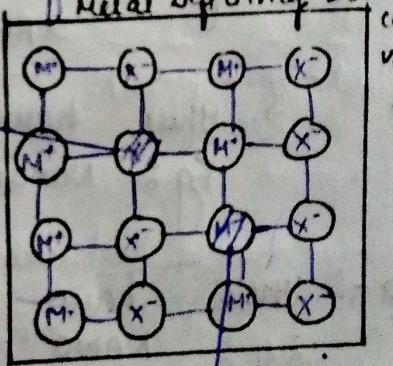
Zn : O
6 6

After defect
 Zn^+O
7:6

Effect \Rightarrow the presence of these defect imparts the colour to the crystal.

- ① Paramagnetic character Increases
 - ② Electrical Conductivity Increases
 - ③ Metal Deficiency after due

③ Metal Deficiency defect due to Cation Vacancy:..
 These defect arise when a compound has metal deficiency due to the absence of a metal ion from its lattice site.
 The charge is balanced by an adjacent ion having higher valency. These type of defect - are found in transition metal deficiency due to cation
 compound. Eg 3-
Impurity defects
Doping ... is defined as the addition of small amount specific substitutional impurity to pure crystal lattice. The addition of dopant increases the conductivity of intrinsic semiconductor by 10¹² times.



agent conductivity of intrinsic semiconductor by 10^4 times. Generally one part of the dopant is added to 10^6 part of parent element.
e.g.: Germanium & Silicon etc.

Nanomaterials & types of Nano material

Nanomaterials are the chemicals or materials that are manufactured that are used at a very small scale. These are developed to show novel characteristics compare to the same material without nano same feature. These material have increased chemical reactivity & conductivity.

Types of Nanomaterial

One dimensional (Nanometer) Two dimensional (N.M) Three dimensional (N.M)

1D - A nanomaterial is a small particle that ranges between 1 to 100 nm.

→ These have one dimensional in nanometer.
Eg :- MICRO CHIPS, THIN FILMS, COMPUTER CHIPS SURFACE COATINGS etc.

2D - → These have 2D in nanoscale.
Eg :- Nanowires & Nanotubes etc

3D - These have 3D in Nanoscale
Eg :- NANO PARTICLE, NANO PRECIPITATE, COLLOIDS & QUANTUM DOTS.

Quantum Dots - These are man made nanoscale crystal that can transform e^- . These artificial semi conductor have found application in SOLAR CELL.

CLASSIFICATION BASED ON ORIGIN OR SOURCE

- 1) Natural
- 2) Artificial or man made.

Natural Nano material :- These natural material exist in Biological system - present in the bone matrix, viruses etc. It is found in viruses, these are also present volcanic ash, spray & fine sand etc.

Artificial or Man made Nanomaterial - These are fabricated by different experiment & are subdivided into four types

⇒ Carbon Based Nanomaterials - These are Nanomaterials are mostly composed of carbon and take the form of HOLLOW SPHERE, ELLIPOIDS OR TUBES. Carbon Nanomaterials are called as fullerenes while carbon Nanomaterials that are cylindrical are (NT) carbon Nanotubes

⇒ Metal Based - These material include quantum dots Nano gold, Nano silver, Titanium dioxide (TiO_2)

⇒ DENDRIMERS - It is derived from Greek word Dendro "Tree like" and Meros "Parts". These are highly branched polymer with control composition and

Nanospace -
Eg :- POLYAMIDOAMINE (PANAM) - These are radially symmetric molecules and have typically symmetric core, outer shell. These are suitable for medical sized & biotechnology application. The surface of Dendrimers have numerous chain ends which can be tailored to perform specific chemical function. This property is used in making catalyst.

