All Rights are reserved ©

CHEMICAL BONDING

Ionic Bond :-

Mutal + Non-metal
Cation + Anion Eg - NaCl

*Covalent Bond :- Mutual sharing of the e⁻
$H_2 \rightarrow H-H$, $O_2 \rightarrow O=O$

*Co-ordinate Bond :- Mutual sharing ✗
Eg :- $H_3N: + H^+ \rightarrow H_3N \rightarrow H^+$ (Dative Bond)

*Covalency :-
No° of Bonds formed by an atom.
NH_3 → 3 , NH_4^+ → 4

*Octet Rule :-
Every atom should have 8 e⁻ in outermost orbit • Except H ⇒ duplet !!

*Major Drawback :-
Oxyvalent :-
$e^- < 8$ $BeCl_2 = Cl-Be-Cl$, BF_3 , $BeCl_3$
Hypervalent :-
PCl_5 $e^- > 8$ 10e⁻ e⁻ Rich , PCl_5 , SF_6
Odd electron species :-
$NO_2 \rightarrow O=N-O$ 7e⁻

FAVOURABLE CONDITION IONIC BO

Metals + Non-metal
cation anion
Low IE High ΔegH

High lattice Energy → force of attraction between cation and anions.

LE ∝ Charge / Size
Dominating
Individual
Eg ⇒ Charge is the primary criteria.

LE = $Na^+Cl^- < Mg^{+2}Cl_2^- < Al^{+3}Cl_3^-$

*Covalent Bond :-

*Bond length = Distance b/w nucleus of Both atoms.
Eg :- C–C > C=C > C≡C

*Bond Order = No° of Bonds .
$H_2 \rightarrow H-H$ BO-1
$N_2 \rightarrow N \equiv N$ BO-3
O_3 → BO → 1.5 Resonance and M.O.T

*Bond angle
• Angle b/w 2 Bonds ;
Factors ;
(i) Bond angle ∝ 1 / lone pair on central atom
(ii) Bond angle ∝ EN of central atom.
(iii) Bond angle ∝ 1/EN of surrounding atom
Eg → CH_4 (0 lone pair) > NH_3 (1 lone pair) > H_2O: (2 lone pair)
Eg → NH_3 (1 LP, ENN) > PH_3 (1 LP, ENP)
Eg → H_2O < OCl_2

BOND STRENGTH :-

→ C–C > N–N > O–O > F–F
Bond dissociation Energy :-
$Cl_2 > Br_2 > F_2 > I_2$
↳ Small size
↳ e⁻ repulsion ↳ Strength ↓↓

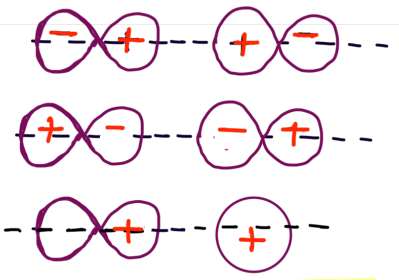
VALENCE BOND THEORY covalent Bond

*Orbital Overlap : Half filled and e⁻ opposite spin.
* More the extent of overlapping Stronger is the bond.

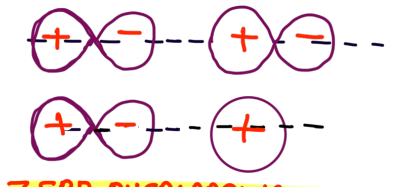
*Extent of overlapping :-
∝ closeness to Nucleus ∝ directional Nature
1s–1s > 2s–2s > 3s–3s
1–1 2–2 3–3

2s–2s < 2s–2p < 2p–2p
2–2 NO-NO 2–2 NO-D 2–2 D–D
S → non directional
P, d, f → directional

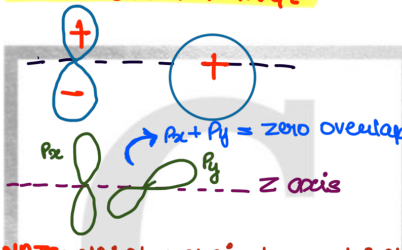
POSITIVE OVERLAPPING :-



NEGATIVE OVERLAPPING :-



ZERO OVERLAPPING :-

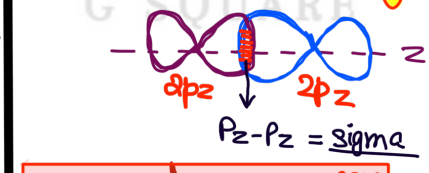


NOTE ; No° of unpaired e⁻ = No° of Bonds formed.

AXIAL / HEAD ON OVERLAPPING

→ Orbital overlap along inter nuclear Orbit.
→ σ Bond is formed.
→ s-orbital always = axial.

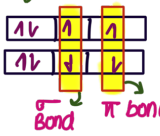
$F_2 \rightarrow$ F $1s^2\ 2s^2\ 2p^5$ (1↓ 1↓ 1 2p)
F $1s^2\ 2s^2\ 2p^5$ (1↑ 1↓ 1 2p)

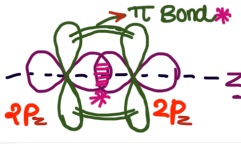


Pz–Pz = Sigma

PARALLEL / LATERAL OVERLAP

→ Orbitals overlap above and below inter-nuclear axis.
→ π bond is formed
→ p-orbital never for π bond.
→ 1st bond is always Sigma.
Eg ⇒ O $1s^2\ 2s^2\ 2p^4$
O_2 O $1s^2\ 2s^2\ 2p^4$





σ Bond	π Bond
• Formed by axial overlapping	• formed by parallel overlapping.
• Independent existence possible.	• No Independent existence
• Stronger → Strong overlapping	• weak → overlapping allowed. Px–Px, Py–Py, P–d
→ Overlapping allowed s–s, s–p, Pz–Pz	* Free Rotation not possible
→ Free Rotation possible	

HYBRIDISATION AND VSEPR :-

• Intermixing of pure atomic orbital ↳ s, p, d
• No° of hybrid orbital = No° of atomic orbital
• Orbitals used → nth shell, (n-1)th shell) empty, half filled, fully filled

*HOW TO CALCULATE HYBRIDISATION

Steric No° = $\frac{1}{2}(V + M - C + A)$

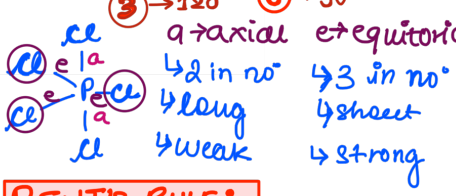
V = No° of valence e⁻
M = No° of mono-valent atom (H, F, Cl, Br, I)
C = cationic charge
A = anionic charge

SN ; 2 = sp 3 = sp^2 4 = sp^3 5 = sp^3d 6 = sp^3d^2 7 = sp^3d^3

SN = No° of BP + No° of LP
↳ only σ Bond, π bond play no role in hybridisation

NOTE ;
• If lone pair is zero. Geo = shape ↳ called as perfect case.
• Geometry ⇒ hybridisation
Shape = BP
• If lone pair present then bond angle gadbad.

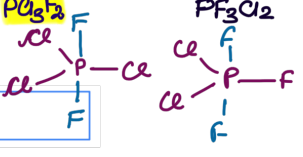
EXAMPLE	HYB	GEOMETRY	SHAPE	SPARTAN ARMY STRUCTURE
1) $BeCl_2$	SN = ½(2+2) = 2, sp, BP = 2, LP = 0	linear	linear	Cl–Be–Cl, θ = 180°
2) BF_3	SN = ½(3+3) = 3, sp^2, BP = 3, LP = 0	Trigonal Planer	Trigonal Planer	F, B, F, F, 3, 120°
3) SO_2	SN = ½(6+0) = 3, sp^2, BP = 2, LP = 1	Trigonal Planer	Bent / V shape or angular	O, S, O, θ < 120°, 2σ + 1LP = 3, sp^2
4) CH_4	SN = ½(4+4) = 4, sp^3, BP = 4, LP = 0	Tetrahedral	Tetrahedral	H, C, H, H, H, 6 → 109°28'
5) NH_3	SN = ½(5+3) = 4, sp^3, 3BP 1LP	Tetrahedral	Pyramidal	N, H, H, H, θ < 109°28'
6) H_2O	SN = ½(6+2) = 4, sp^3, 2BP 2LP	Tetrahedral	Bent or V shape or Angular	O, H, H, θ < 109°28'
7) PCl_5	SN = ½(5+5) = 5, sp^3d, 5BP 0LP	Trigonal Bipyramidal	Trigonal Bipyramidal	



BENT'S RULE :-

1. more EN atom goes to axial

PCl_3F_2 PF_3Cl_2



https://linktr.ee/G2garimagoel
garimagoel007_g2

All Rights are reserved ©

2. LP always on equitorial.

EXAMPLE	HYB	GEOMETRY	SHAPE	STRUCTURE
8) SF_4	SN = $\frac{1}{2}(6+4)$ = 5 sp^3d 4BP 1LP	Trigonal Bipyramidal	See Saw	
EXAMPLE	HYB	GEOMETRY	SHAPE	STRUCTURE
9) ClF_3	SN = $\frac{1}{2}(7+3)$ = 5 sp^3d 3BP 2LP	Trigonal Bipyramidal	T-shape	
10) XeF_2	SN = $\frac{1}{2}(8+2)$ = 5 sp^3d 2BP 3LP	Trigonal Bipyramidal	linear	
EXAMPLE	HYB	GEOMETRY	SHAPE	STRUCTURE
11) SF_6 No axial No equi.	SN = $\frac{1}{2}(6+6)$ = 6 sp^3d^2 6BP 0LP	Octahedral or Sq. Bipyramidal	Octahedral or Sq. Bipyramidal	(12) → 90° (3) → 180°
EXAMPLE	HYB	GEOMETRY	SHAPE	STRUCTURE
12) ClF_5	SN = $\frac{1}{2}(7+5)$ = 6 sp^3d^2 5BP 1LP	Octahedral or Sq. Bipyramidal	Square Pyramidal	
13) XeF_4	SN = $\frac{1}{2}(8+4)$ = 6 sp^3d^2 4BP 2LP	Octahedral or Sq. Bipyramidal	Square Planar	

DIPOLE MOMENT:-

→ $\oplus q \leftarrow d \rightarrow \ominus q$ $\quad \mu = q \times d$ $\quad \overset{\delta+}{H} \rightarrow \overset{\delta-}{Cl}$

→ vector quantity

→ more the EN more is the dipole movement.

μ:- H-F > H-Cl > H-Br > H-I

* Haalat Badal diye...

C-F C-Cl C-Br

μ:- C-Cl > C-F > C-Br } Reason; $\mu = q \times d$

here in Cl case distance dominate! here in Cl case distance dominate.

* Polar molecules; $\mu \neq 0$ $\quad \overset{\delta+}{H}-\overset{\delta-}{Cl}$

* Non-Polar molecules $\mu = 0$ $\quad Cl-Cl$

Eg; $BeCl_2$ $\quad Cl-Be-Cl$ $\quad \mu = 0$ Non Polar

BCl_3 $\quad \mu = 0$ Non-Polar

BCl_2F $\quad \mu \neq 0$ Polar

NCERT

NH_3 > NF_3

* Dipole moment always towards the lone pair.

* $\theta \uparrow = \cos\theta \downarrow = \mu_{net} \downarrow$

$\mu_{net} = \sqrt{\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2\cos\theta}$

Application of μ:-

→ To determine whether a molecule is polar or not. $\mu = 0 \Rightarrow$ Non-polar; $\mu \neq 0 \Rightarrow$ Polar

→ To find % ionic character in Covalent bond.

$$\% \text{ Ionic character} = \frac{\text{Given } \mu}{\text{Theoritical } \mu} \times 100$$

FORMAL CHARGE:-

FC = Valence e^- − [Non-Bonding e^-] − $\frac{1}{2}$ [Bonding e^-]

TRICK;

$O^1 = 6 - [2 + \frac{6}{2}] = +1$ (8 se doori)

$O^2 = 6 - [2 + 4] = 0$

$O^3 = 6 - [1 + 6] = -1$

DRAWBACK OF VBT:-

→ Could not explain paramagnetic behaviour of O_2.

→ Could not explain fractional Bond order.

→ Could not explain stability of molecules.

MOLECULAR ORBITAL THEORY

Molecular orbitals: σ π (Bonding molecular orbital BMO); σ^* π^* (Anti-Bonding molecular orbital ABMO)

→ No° of atomic orbital = No° of molecular orbital

2 atomic orbital → 2 molecular orbital (1 BMO, 1 ABMO.)

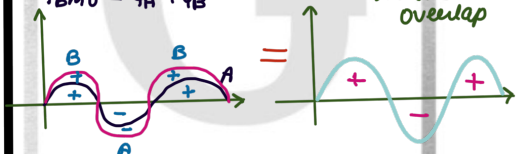
* Molecular orbital → 2 or more nuclei

* Electronic configuration
  - ↓ CAO (Linear Combination of atomic orbital)
    - ↳ Aufbau Rule
    - ↳ Hund's Rule
    - ↳ Pauli's exclusion

A and B $\quad \psi_{MO} = \psi_A \pm \psi_B$ $\quad \psi_A$ $\quad \psi_B$

BONDING MOLECULAR

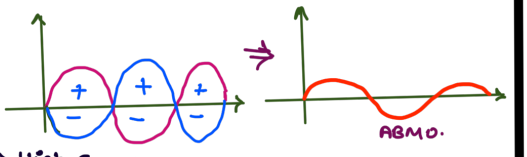
→ Formed by constructive interference. $\quad \psi_{BMO} = \psi_A + \psi_B$ (same overlap)



→ lower energy, more stability, electron density increase in the region b/w 2 nuclei.

ANTI BONDING MOLECULAR:-

* Formed by destructive interference. $\quad \psi_{ABMO} = \psi_A - \psi_B$



→ High Energy
→ lower Stability
→ e^- density decrease in region b/w two nuclei

CASE-I No° of electrons ≤ 14.

$\sigma 1s$ $\sigma^* 1s$ $\sigma 2s$ $\sigma^* 2s$ $(\pi 2px = \pi 2py)$ $\sigma 2pz$ $(\pi^* 2px = \pi^* 2py)$ $\sigma^* 2pz$

CASE-II No° of electrons > 14.

$\sigma 1s$ $\sigma^* 1s$ $\sigma 2s$ $\sigma^* 2p_z$ $(\pi 2px = \pi 2py)$ $\sigma 2pz$ $(\pi^* 2px = \pi^* 2py)$ $\sigma^* 2pz$

BOND ORDER

Bond order = $\frac{1}{2}(N_b - N_a)$

N_b = No° of e^- in BMO
N_a = No° of e^- in ABMO.

BO > 0 ⇒ more exist
BO ≤ 0 ⇒ molecule doesn't exist.

Stability of molecules;

* more BO ⇒ more stability
* If BO is same, then lesser e^- in ABMO more stability.

Eg:- $H_2 \Rightarrow 2e^- \rightarrow \sigma 1s^2$ (BMO) $\quad Nb = 2$ $\quad Na = 0$

$BO = \frac{1}{2}(2-0) = 1$

$H_2^+ \rightarrow 1e$ $\quad \sigma 1s^1 = Nb = 1$ $\quad Na = 0$

$\frac{1}{2}(1-0) = 0.5$

Stability:- $H_2 > H_2^+ > H_2^-$

★ Haalat Badal diye;

$B_2 \rightarrow 10e^-$

$\sigma 1s^2$ $\sigma^* 1s^2$ $\sigma 2s^2$ $\sigma^* 2s^2$ $\pi 2px^1 = \pi 2py^1$

$Nb = 6$ $\quad Na = 4$

$BO = \frac{1}{2}(6-4) = 1$ → π bond

★ $C_2 \rightarrow 12e^-$

$\sigma 1s^2$ $\sigma^* 1s^2$ $\sigma 2s^2$ $\sigma^* 2s^2$ $\pi 2px^2 = \pi 2py^2$

$Nb = 8$ $\quad Na = 4$ $\quad BO = \frac{1}{2}(8-4) = 2$

2 π bond both first bonds Possible in the case of MOT.

★ Case-2

$O_2 = 16e^-$

$\sigma 1s^2$ $\sigma^* 1s^2$ $\sigma 2s^2$ $\sigma^* 2s^2$ $\sigma 2p_z^2$ $(\pi 2px^2 = \pi 2py^2)$

$\pi^* 2px^1 = \pi^* 2py^1$

↑ ↑

2 unpaired e^- Paramag

TRICK;

No° of e^-	BO
$1e^-$	1
$11e^-$	1.5
$12e^-$	2
$13e^-$	2.5
$14e^-$	3
$15e^-$	2.5
$16e^-$	2
$17e^-$	1.5
$18e^-$	1

exception for the trick;

$CO^+ = 6+8-1 = 13$ → 3.5

Q: $O_2 \Rightarrow 16e^- = 2$

$O_2^+ \Rightarrow 15e^- = 2.5$

$BO \propto \frac{1}{BL} \propto BE$

https://linktr.ee/G2garimagoel
garimagoel007_g2