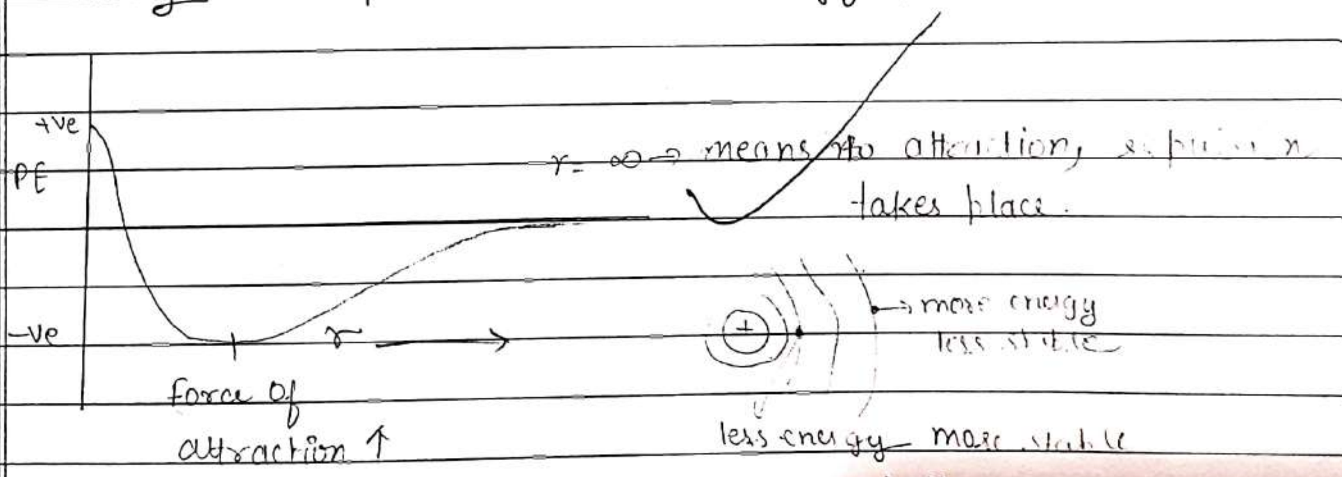
Chapter : 4
Chemical Bonding

Chemical Bond

- Strong Bond
  - → Ionic bond
  - → Covalent bond
  - → Metallic bond
  - → Coordination bond
- Inter molecular forces
  - → Vander waal forces
  - → Hydrogen bond

Cause of chemical bond formation –

- Tendency to acquire minimum energy



Force of attraction $\propto \frac{1}{\text{Energy}} \propto$ Stability

- Octate rule –
- It is given by Lewis and kossel
- all atoms have a tendancy to acquire octet ($s^2 p^6$) configuration in valence shell

- Octet may be complete in following manner

i) Comp. transfer of electron from one atom to another atom (ionic bond)

ii) Sharing of e^- b/w atoms (covalent bond)

iii) Sharing of e^- pair given by only one atom (species) (Ligan (coordination bond)

Limitations —

i) expansion of octet → It is due to presence of empty d-orbitals

e.g. PCl_5 SF_6 etc.

central e^- ~~atom~~ 10 12

ii) Contraction of octet

e.g. $BeCl_2$ $AlCl_3$

4 6

iii) Odd electron species

e.g. NO, NO_2

iv) Transition metal ions

e.g. Mn^{+2}: $3s^2\ 3p^6\ 3d^5$, Co^{+3} :

13 e^-

v) Pseudoinert configuration

Zn^{+2} $3s^2\ 3p^6\ 3d^{10}$

Cd^{+2} $4s^2\ 4p^6\ 4d^{10}$

Lewis – Dot Structure.

Rule :→ i) find out the total valence e^-

ii) Given atleast single bond between central atom and terminal atom.

iii) Find out the central atom. Those element which have lowest electronegativity act as central atom

e.g. in CO molecules C is act as central atom

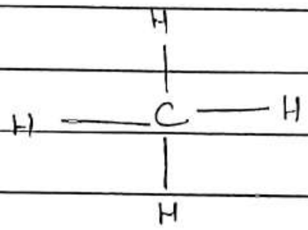
In generally central atom posses +ve formal charge

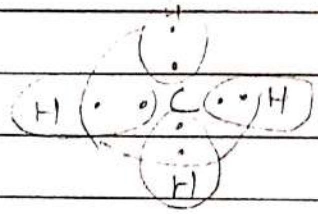
iv) Terminal atoms must octet complete in all conditions

CH_4

Valence $e^- = 8$

$(8-8(\text{bond } e^-)=0)$

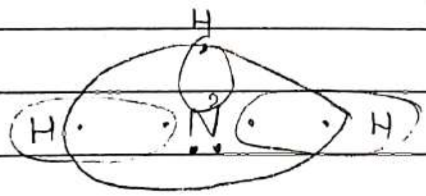




dot = Valence e^- − bond e^-

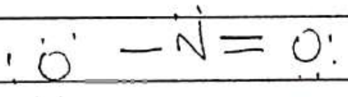
NH_3 *

Valence e^- = $5+3 = 8$



CO, O_3, NO_2^-, NO_3^-

NO_2^-

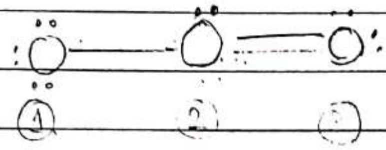


Central atom always have +1 charge

Formal charge = Valence e^- − lone pair e^- − bond line

Draw the Lewis dot st. and find out formal charge each oxygen atom in O_3 molecule

Valence e^- = $6 \times 3 = 18$
dot = $18 - 4 = 14$

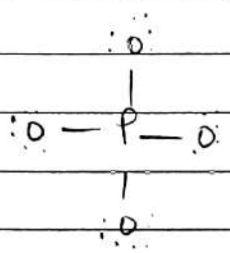


Formal charge 1 → $6-6-1 = -1$
2 → $6-2-3 = +1$
3 → $6-4-2 = 0$

SO_3 , NH_4^+ , CO_3

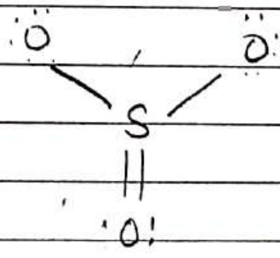
PO_4^{-3}

Valence e^- = 32
dot = $32 - 2 \times$ bond line = 24

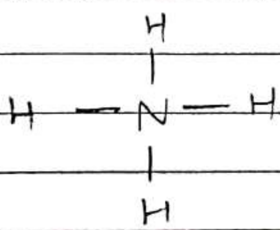


SO_3

total e^- = 24
dot = $24 - 6 = 18$

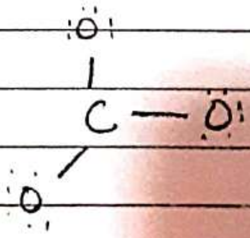


NH_4^+
total e^- = $5+4-1 = 8$



CO_3^{-2}

Valence e^- = 24
dot: $24 - 6 = 18$



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Valence Bond Theory :-

VBT =
- Overlapping theory (Heitler and London)
- Hybridisation (by Pauling)

Overlapping theory -

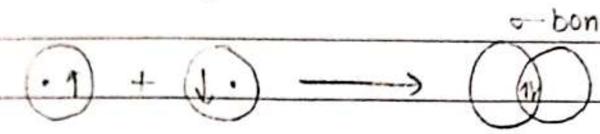
- To form a covalent bond overlapping carried out between half-filled valence shell orbitals
- for resulting bond acquired pair of e^- with opp. sign to get stability
- ?• Covalent bond is directional due to for max. overlapping orbitals come to close each other from indirection
- Extent of overlapping, higher the strength of covalent bond.
- Nature of overlapping -
  a) axial overlapping
  b) side to side overlapping

In axial overlapping extent is much more as compare to side to side overlapping

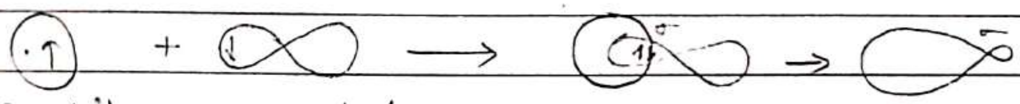
- Three types of bond is formed due to overlapping
  a) σ bond
  b) π bond
  c) δ bond (delta)

Types of Overlapping

a) S-S overlapping :- e.g (H_2)



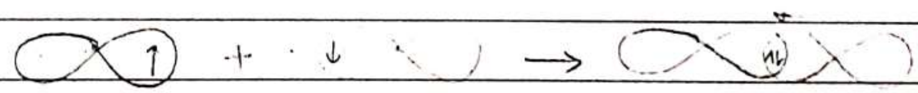
b) S-P overlapping :- e.g. (HCl)



s-orbital p-orbital S-p overlapping

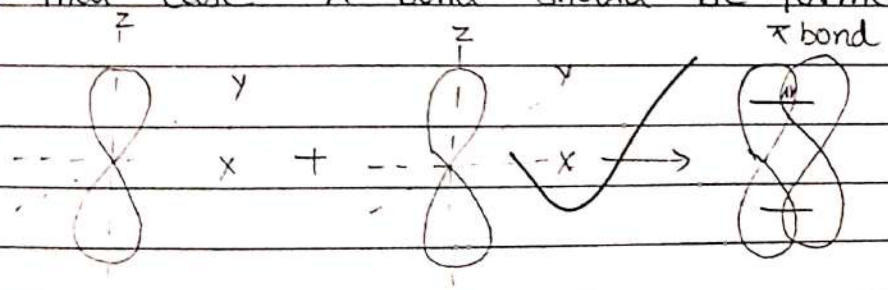
→ axis to axis overlapping
so σ bond is formed

c) P-P axial overlapping :- e.g. (Cl_2)



Px orbital Px orbital P-P overlapping

P-P side to side (bilateral) Overlapping :-
in that case π bond should be formed



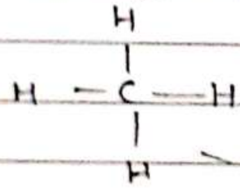
Pz-Orbital Pz-Orbital Pz-Pz Overlapping

Difference between σ bond and π bond

σ bond	π bond
• strong bond	As comparatively weak
• It is formed due to axial overlapping of orbital	It is formed due to side to side overlapping
• Free rotation exist around a σ bond	Free rotation do not exist
• Hybridise orbital or unhybridise ortals are involve in σ bond	Hybridise orbitals are never involved in π bond

Que. Find out the no. of σ and π bond in following –
(a) CH_4 (b) CO_2 (c) C_2H_4 (d) C_3H_4

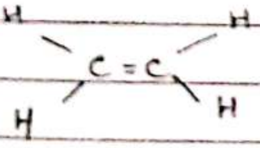
Sol. a)



= 4σ bond

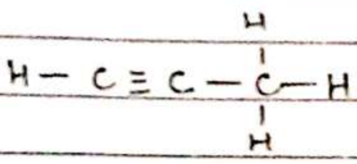
b) O = C = O = 2σ, 2π

c) $CH_2 = CH_2$



5σ and 1π

d)



6σ and 2π