CHAPTER-8
CHEMICAL BONDING

Lewis symbols (or) Lewis dot structures:

- The valence electrons in the atom of an element is depicted in a short form by Lewis symbol or electron dot structure.
- We represent the nucleus and inner shell electrons of the atom by the symbol of the element and electrons in the outer shell by dots or cross marks.

Examples: $:\ddot{\underset{\cdot\cdot}{Ar}}:$ Na^{x}

Formation of ionic bond

The electrostatic attractive force that keeps cation and anion (which are formed from metal atoms and non-metal atoms due to transfer of electrons) together to form a new electrically neutral compounds is called 'ionic bond'.

Formation of sodium chloride (NaCl):

NaCl is formed from the elements Na and Cl

Cation formation: When Sodium atom loses one electron to get octet electron configuration

$$Na \longrightarrow Na^{+} + e^{-}$$
$$(2,8,1) \quad (2,8)$$

Anion formation: Chlorine atom to gain one electron from the sodium atom and get the octet electron configuration.

$$Cl + e^{-} \longrightarrow Cl^{-}$$
$$(2,8,7) \quad (2,8,8)$$

Formation of NaCl: These oppositely charged ions get attracted towards each other due to electrostatic forces and form the NaCl compound.

$$Na^{+} + Cl^{-} \longrightarrow NaCl$$

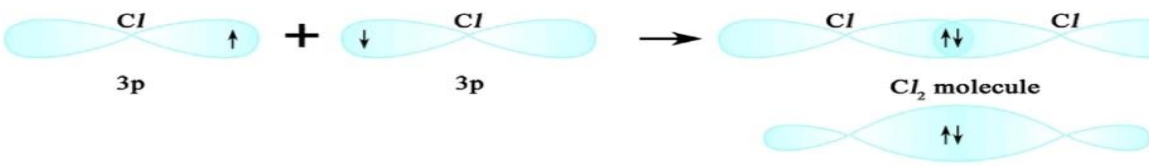
Valence bond theory

Formation of H_2 molecule (Single Bond):

- H(z=1) Electronic configuration - $1s^1$
- In the formation of H_2 molecule, the 1s orbital of one 'H' atom containing an unpaired electron overlaps the '1s' orbital of the other 'H' atom containing unpaired electron of opposite spin giving H-H bond and H_2 molecule.

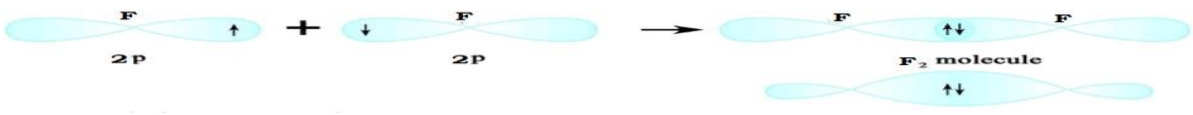
Formation of Cl-Cl molecule (Single Bond)

- Cl (z=17) Electronic configuration - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3px^2\ 3py^2\ 3pz^1$
- In the formation of Cl_2 molecule, the $3p_z$ orbital of one chlorine atom containing an unpaired electron overlaps the $3p_z$ orbital of other chlorine atom that contains unpaired electron of opposite spin.



Formation of F-F molecule (Single Bond)

- F(z=1) Electronic configuration - $1s^2\ 2s^2 2px^2\ 2py^2\ 2pz^1$
- In the formation of F_2 molecule, the $2p_z$ orbital of one Florine atom containing an unpaired electron overlaps the $2p_z$ orbital of other Florine atom that contains unpaired electron of opposite spin.

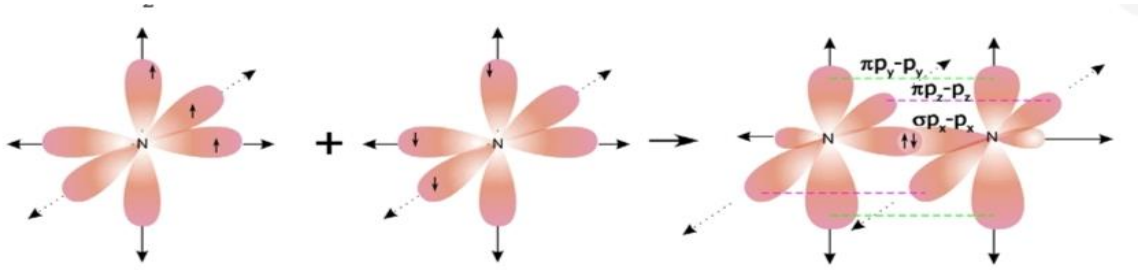


Formation of O_2 molecule (Double Bond)

1. $_8O$ has electronic configuration $1s^2\ 2s^2\ 2px^2\ 2py^1\ 2pz^1$.
2. The 'p_y' orbital of one 'O' atom overlaps the 'p_y' orbital of other 'O' atom along the Internuclear axis, a sigma p_y- p_y bond (σp_y- p_y) is formed.
3. p_z orbital of one 'O'atom overlaps the p_z orbital of other 'O' atom laterally, perpendicular to the inter-nuclear axis giving a πp_z- p_z bond.
4. O_2 molecule has a double bond between two oxygen atoms.

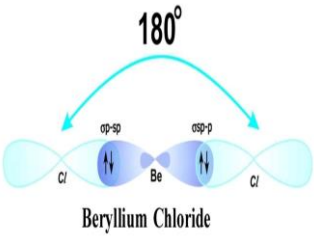
Formation of N_2 molecule (Triple Bond)

1. $_7N$ has electronic configuration $1s^2\ 2s^2\ 2px^1\ 2py^1\ 2pz^1$.
2. The p_x orbital of one 'N' atom overlaps the 'p_x' orbital of the other 'N' atom giving $\sigma\ p_x - p_x$ bond along the inter-nuclear axis.
3. The p_y and p_z orbitals of one 'N'atom overlap the p_y and p_z orbital of other 'N' atom laterally, respectively perpendicular to inter-nuclear axis giving πp_y-p_y and πp_z-p_z bonds.
4. Therefore, N_2 molecule has a triple bond between two nitrogen atoms.



Hybridisation:- Hybridisation is a phenomenon of intermixing of atomic orbitals of almost equal energy which are present in the outer shells of the atom and their reshuffling or redistribution into the same number of orbitals but with equal properties like energy and shape.

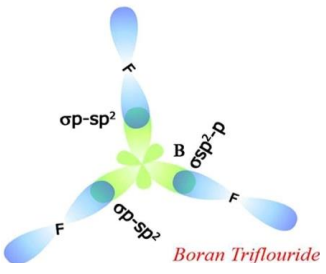
Formation of $BeCl_2$:-



Beryllium Chloride

a) Be(z=4) has electronic configuration $1s^2 2s^2$
b) It has no unpaired electrons
c) It is suggested that excited Be atom in which an electron from 2s shifts to $2p_x$ level.
d) The excited electronic configuration of Be is $1s^2\ 2s^1\ 2p^1{}_x$
e) Electronic configuration of Cl(z=17) is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2{}_x\ 3p^2{}_y\ 3p^1{}_z$
f) If Be forms two covalent bonds with two Chlorine atoms, one bond should be σ2s-3p due to the overlap of 2s orbital of Be, the $3p_z$ orbital of one Chlorine atom.
g) The other bond should be σ2s-3p due to the overlap of $2p_x$ orbital of Be atom the 3p orbital of the other Chlorine atom and bond angle is 180^0

Formation of BF_3:-



Boran Triflouride

a) B(z=5) has electronic configuration $1s^2\ 2s^2\ 2p^1{}_x$
b) The excited electronic configuration of B is $1s^2\ 2s^1\ 2p^1{}_x 2p^1{}_y$
c) As it forms three identical B-F bonds in BF_3
d) It is suggested that excited B atom undergoes hybridization.
e) There is an intermixing of 2s, $2p_x$, $2p_y$ orbitals and their redistribution into three identical orbitals called sp^2 hybrid orbitals
f) For three sp^2 orbitals to get separated to have minimum repulsion the angle between any two orbitals is 120^0 at the central atom.
g) Now three fluorine atoms overlap their $2p_z$ orbitals containing unpaired electrons. [F (z=9) $1s^2 2s^2 2p^2{}_x 2p^2{}_y 2p^1{}_z$] the three sp^2 orbitals of B that contain unpaired electrons to form three σsp^2-p bonds.

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