CHEMICAL BONDING MODEL

B.Sc.-II Chemistry(H/S)
Inorganic chemistry
Paper- III
Lecture-02

Estd.- 1962

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Chemical Bonding Model

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Sidwick and Powell Theory

- This theory was given by **Sidwick** and **Powell** in 1940
- But further redefined by Nyholm and Gillespie inn 1957
- Based on the repulsive interaction of the electronn pairs inn the valence shell of the atoms
- Assumes that lone pairs of electrons and bonding pairs were of equal importance
- Atoms are arranged symmetrically so as to minimise the repulsions
- The theory has made significant contributions in theory of valency and chemical bonding.

Chemical Bonding Model

<u>**Valence shell electron pair repulsion theory, or VSEPR theory**</u>

This theory was introduced to predict the shape of covalent molecule after failing of Lewis concept to explain the shape of a molecule

- To predict the geometry of individual molecules from the number of electron pairs surrounding their central atoms.
- Used to predict the shape of the molecules from the electron pairs that surround the central atoms of the molecule.
- Based on the assumption that the molecule will take a shape such that electronic repulsion in the valence shell of that atom is minimized.
- Repulsion between the pairs of <u>valence electrons</u> in all atoms, and the atoms will always tend to arrange themselves in a manner in which this electron pair repulsion is minimalized.
- The arrangement of the atom determines the geometry of the resulting molecule.

Postulates of VSEPR Theory:

- In polyatomic molecules , the central atom and all other atoms belonging to the molecule are linked.
- The total number of valence shell electron pairs decides the shape of the molecule.
- The electron pairs have a tendency to orient themselves in a way that minimizes the electron-electron repulsion between them and maximizes the distance between them.
- The electron pairs are localized in such a way that the distance between them is maximized.
- If the central atom of the molecule is surrounded by bond pairs of electrons, then, the asymmetrically shaped molecule can be expected.
- If the central atom is surrounded by both lone pairs and bond pairs of electrons, then the distorted shape can be expected
- The VSEPR theory can be applied to each resonance structure of a molecule.
- The strength of the repulsion is strongest in two lone pairs and weakest in two bond pairs.
- If electron pairs around the central atom are closer to each other, they will repel each other. Then the energy of the molecules will be high
- If the electron pairs lie far from each other, the repulsions between them will be less and

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Limitations of VSEPR Theory:

- This theory gives the geometry of the simple molecule but doesnot explain them theoretically
- This theory fails to explain isoelectronic species (i.e. elements having the same number of electrons). The species may vary in shapes despite having the same number of electrons.
- The VSEPR theory does not tell about the transition metals compounds.

VSEP Number

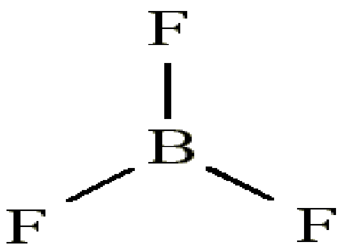
The VSEP number describes the shape of the molecule, as described below.

VSEP Number Shape of the Molecule

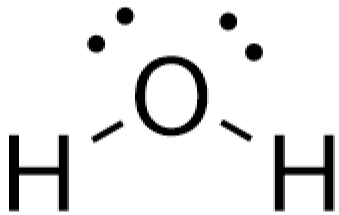
No of bonding pair	Molecular geometry	
i. 2	Linear	Eg: $BeCl_2$, $HgCl_2$
ii. 3	Trigonal Planar	Eg: BF_3
iii. 4	Tetrahedral	Eg: CH4,NH4+
iv. 5	Trigonal Bipyramidal	Eg: PCl_5
v. 6	Octahedral	Eg: SF6
vi. 7	Pentagonal Bipyramidal	Eg:IF7

Geometry/ Shape of molecules

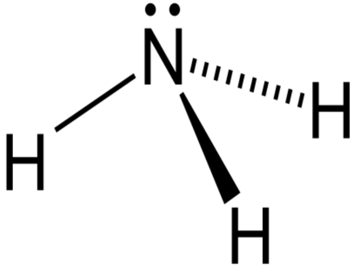
BF_3 Shape-Trigonal planer(no lone pair)



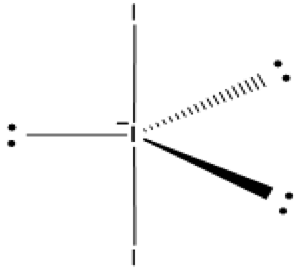
H_2O Shape-Bent (two lonepair)



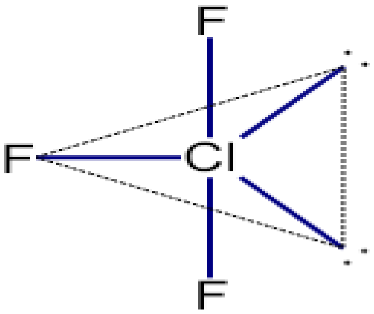
NH_3 Shape-Trigonal pyramidal(one lone pair)



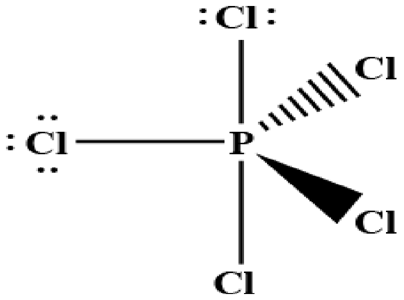
I_3^- Shape – linear (3paired lone pair)



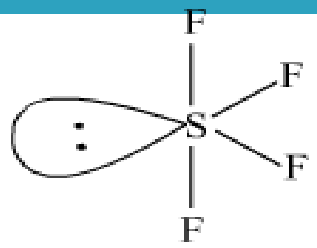
ClF_3 Shape- T-Shaped(2 paird Lone pair)



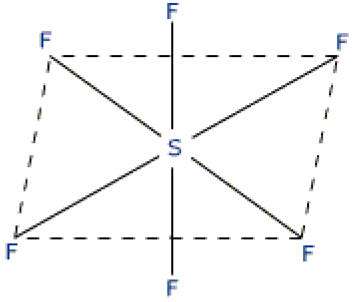
PCl_5 Shape-Trigonal bipyramidal



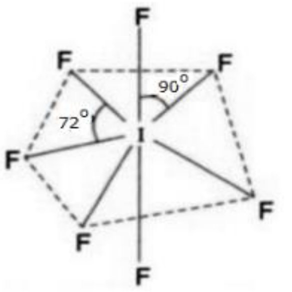
SF_4 Shape- See-Saw (one lone pair)



SF_6 Shape-Octahedral



IF_7 Shape- Pentagonal bipyramidal



Exercise:

Q: Predict the geometry/shape of different molecules

1. SO_2
2. O_3
3. $NH_4^{\ +}$
4. BrF_5
5. XeF_4