V.S.E.R Theory

Valence shell Electron Pair's Repulsion Theory.

The idea of a Correlation between molecular geometry and number of valence (shell) electron pairs (Both B.P & LP) was originally proposed in 1939 by R. Tsuchinda (Japan) In 1940, it was first presented by Sidgwick and Powell in University of Oxford.

In 1957 Ronald Gillespie and Ronald. S. Nyholm of University College London refined this Concept into a more detailed theory

Valence shell electron pair repulsion theory is a model used to predict the Geometry of individual molecule in three dimensional space on the basis of numbers of electron pairs surrounding Central atom.

The Premise of V.S.E.P.R Theory is that the valence electron pair surrounding an atom to repel each other and will, therefore adopt an arrangement that minimise this repulsion, SO, it decreases the energy of a molecule and increases the stability of molecules.

or in other words it explains the shape of Simple molecules and ions on the basis of repulsions among the electron pair present in the valence shell of their Central atoms

This theory may be pointed as follows,

(1) Valence electrons of the Central atom of molecules or ions form pair with antiparallel Spins.
Each electron pair occupies a reasonably well defined region in the space and other electron pairs are effectively excluded from this space.

(2) The electrons already present in valence (outermost) shell and the additional electrons acquired by the central atom as a result of bonding with others are called valence electrons or valence shell electrons.

(3) These electron pairs stay as far apart from one another in space as possible to minimise the mutual repulsions to form stable geometrical shape or arrangement.

4. The most stable geometrical arrangement of, two, three, four five & six (2, 3, 4, 5, & 6) electron pairs is linear, trigonal plane tetrahydral, trigonal bi-pyramid and Octahedral respectively.

5. Some or all electron pairs may be involved in boudings called Bond Pairs (B.P.) while others are called lone pairs (L.P) or non-bondings.

6. If the Central atom in molecule is surrounded by only Bond pairs then the molecule has regular or symmetrical geometry but in Case of BPs and LPs, the molecule does not have regular geometrical shape eg in CH_4, the four sp^3 hybridised orbitals have bond pairs resulting in a symmetrical tetrahyd shape.

As in Case of NH_3, H_2O & HF have One, two and three lone pairs on the Central atoms, hence they have Pyramidal, Angular and Linear shape respectively, but not the tetrahydral shape, though they have the same Sp^3 hybridisation and tetrahydral Structure.

7. A lone pair occupies more space on the surface of the Central atom than a bond pair because a bond pair is attached by two nuclei and the lone pair is attached by only one nuclei.

Hence bond order of decreasing repulsion is:-

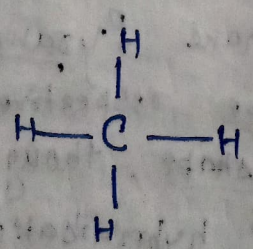
$$LP - LP > LP - BP > BP - BP$$

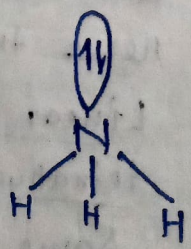
or Electrostatic repulsion between L.P & B.P in the following order.

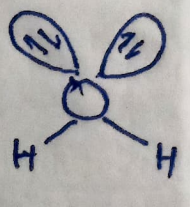
Lone pair – Lone pair > Lone pair – Bond Pair > Bond Pair – Bond Pair

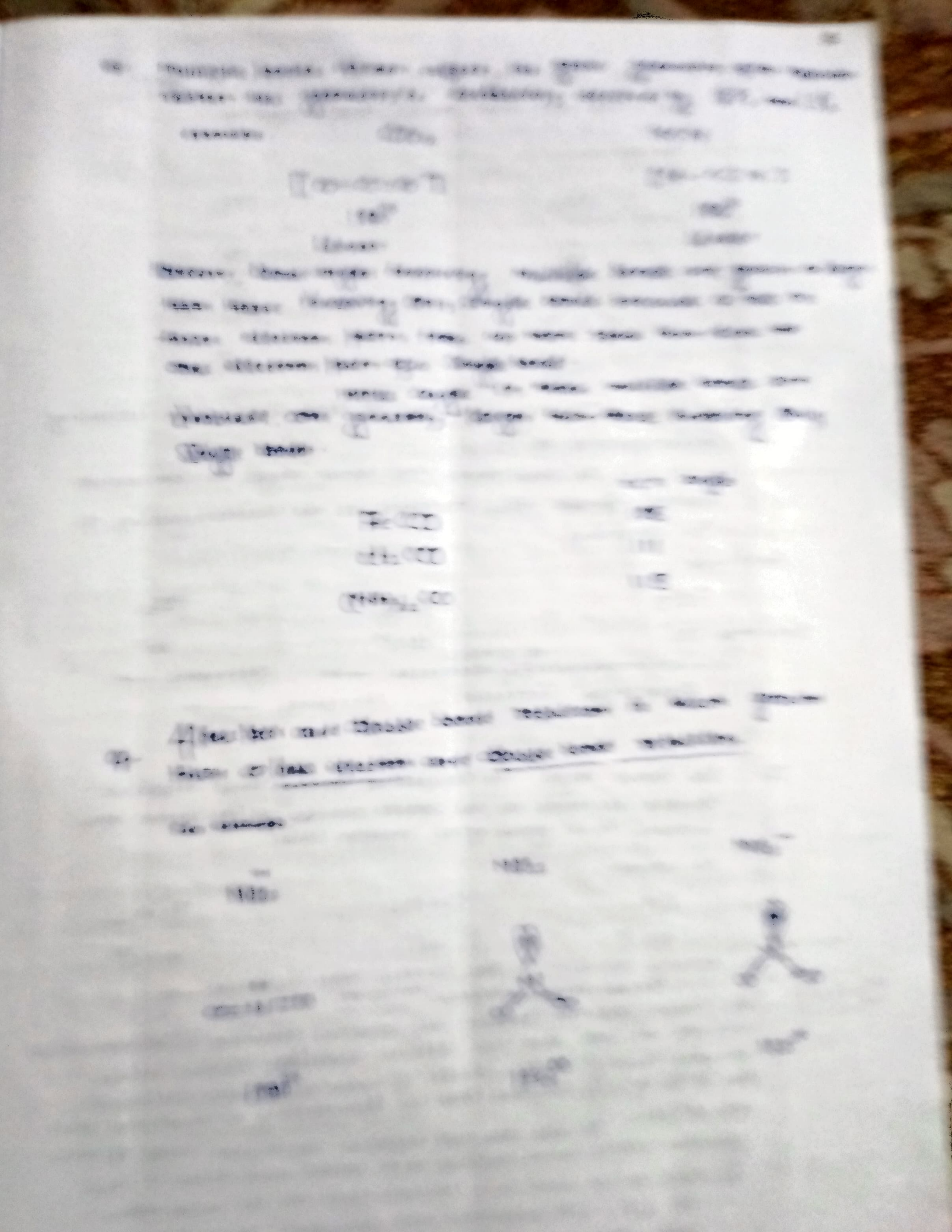
Now the increasing repulsion decreases the bond angle.

Molecule:-	CH_4	NH_3	H_2O
Hybridisation:-	sp^3	sp^3	sp^3
Structure:-	Tetrahedral	Tetrahedral	Tetrahedral
No. of B.Ps	4	3	2
No. of L.Ps	0	1	2
Repulsion between electron Pairs	→ Increases		→ Increases
Bond angle	109.5^0	107.3^0	104.5^0
	→	Decreases	→ Decreases



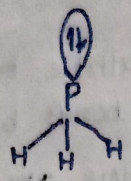




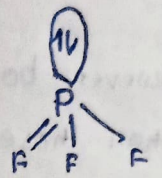


10. A lone pair and single bond repulsion is larger than a lone pair and double bond repulsion.

For example.

PH_3 

99.3°

PF_3 

104°

11. The Size of Bonding Pair on A decreases with increasing electronegativity of B.

In other words the bond angle in compounds having formula AB_n increases as the electronegativity of B decreases.

For example:-

	PCl_3	PBr_3	PI_3
Bond angle:-	100°	101.5°	102°

i.e → electronegativity of X = Cl, Br, I decreases → decreases →

Bond angle increases :- increases →

12. The bond angle in compounds having same empirical formula decreases as the atomic number of the central atom increases in a group of the periodic table.

For example:-

SH_2	SeH_2	TeH_2
92.5°	91°	89.5°

Atomic number of the central atom increases →

Bond angle decreases →

Defect :- This theory does not predict the detailed structure of Unsymmetrical molecules or ions and the species involving Central atoms formally having valence shells of more than twelve electrons, thus it is of only limited help in interpreting a complicated state of affairs.

It also does not explains the angular shape of some gaseous alkine earth halides and Alkali metal oxide i.e Li_2O as they do not have any electron pair on the metal atom.

If LP - LP repulsions are strongest, H_2H_2 should have anti - not gauche configuration.