B. Sc Part I, Chemistry, Paper I (Inorganic Chemistry), Unit III, Chemical Bonding II

Syllabus:

Valence Shell Electron Pair Repulsion Theory (VSEPR),
Shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons:
H_2O, NH_3, PCl_3, PCl_5, SF_6, H_3O^+, SF_4, ClF_3 and ICl_2^-

Presented by :
Dr. Sumit Srivastava
Govt. Swami Atmanand PG College
Narayanpur (C. G.)

Important Points

- **VSEPR theory was given by Sidgwick and Powell in 1940 and further extended by Gillespie and Nyholm in 1957**
- **VSEPR theory describe the shapes of the simple covalent compounds**
- **Shapes of a molecule depends upon the bond pair (bp) and lone pair (lp) of the central atom of the molecule**
- **Repulsion between lp-lp, lp-bp and bp-bp of a molecule give the final geometry**
- **Minimize the energy and maximize the stability**
- **Order of repulsion : lp-lp > lp-bp > bp-bp**
- **VSEPR Theory is not applicable to ionic and coordination compounds**

Geometries (Shapes) of Assorted Molecules

Types of Molecule	bp	lp	bp + lp	Hybridisation	Structure	Bond Angle (°)	Example
AB_2	2	0	2	sp	Linear	180	BeF_2
AB_3	3	0	3	sp^2	Trigonal Planer	120	BCl_3
AB_2L	2	1	3	sp^2	V-shaped	-	$SnCl_2$, $PbCl_2$
AB_4	4	0	4	sp^3	Tetrahedral	109.5	CH_4
AB_3L	3	1	4	sp^3	Trigonal Pyramidal	-	NH_3, PCl_3
AB_2L_2	2	2	4	sp^3	V-shaped	-	H_2O, $SeCl_2$
AB_5	5	0	5	sp^3d	Trigonal bipyramidal	90 and 120	PCl_5
AB_4L	4	1	5	sp^3d	Irregular tetrahedral	-	SF_4, $TeBr_4$
AB_3L_2	3	2	5	sp^3d	T-shaped	-	ClF_3
AB_2L_3	2	3	5	sp^3d	Linear	-	ICl_2^-, XeF_2
AB_6	6	0	6	sp^3d^2	Octahedral	90	SF_6
AB_5L	5	1	6	sp^3d^2	Square pyramidal	-	ClF_5
AB_4L_2	4	2	6	sp^3d^2	Square planar	-	XeF_4
AB_7	7	0	7	sp^3d^3	Pentagonal bipyramidal	72 and 90	IF_7

H_2O Molecule

bp = 2
lp = 2
bp + lp = 4 (Hybridisation SP^3)
V-Shaped Structure
Bond angle = 104.5^o

NH_3 Molecule

bp = 3
lp = 1
bp + lp = 4 (Hybridisation SP^3)
Pyramidal Structure
Bond angle = 107^o

PCl_3 Molecule

bp = 3
lp = 1
bp + lp = 4 (Hybridisation SP^3)
Pyramidal Structure
Bond angle = 103^o

PCl_5 Molecule

bp = 5
lp = 0
bp + lp = 5 (Hybridisation SP^3d)
Trigonal bipyramidal Structure
Bond angle = 90^o, 120^o

SF_6 Molecule

bp = 6
lp = 0
bp + lp = 6 (Hybridisation SP^3d^2)
Octahedral Structure
Bond angle = 90^o

H_3O^+ Molecule

bp = 3
lp = 1
bp + lp = 4 (Hybridisation SP^3)
Pyramidal Structure
Bond angle = 107^o

SF_4 Molecule

bp = 4
lp = 1
bp + lp = 5 (Hybridisation SP^3d)
Sea-Saw shaped Structure
Bond angle = 89^o, 118^o, 177^o

ClF_3 Molecule

bp = 3
lp = 2
bp + lp = 5 (Hybridisation SP^3d)
T- shaped Structure
Bond angle = 87.6^o

ICl_2^- Molecule

bp = 2
lp = 3
bp + lp = 5 (Hybridisation SP^3d)
Linear Structure
Bond angle = 180^o

Reference Books

1. Madan, R. L., Chemistry for Degree students, B.Sc. First Year, S. Chand Publishing

2. Lee, J. D., Concise Inorganic Chemistry, Wiley

3. Puri, B. R., Sharma, L. R. and Kalia, K. C., Principles of Inorganic Chemistry, Vishal Publishing Co.

4. Huheey, J. E., Keiter, E. A., Keiter, R. L. and Medhi, O. K., Inorganic Chemistry, Principles of structure and Reactivity, Fourth Edition, Pearson Education

Thankyou