

VSPER Theory

Molecular Structure

12.8-12.10

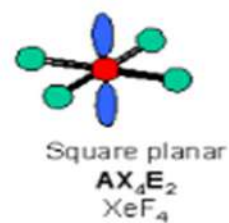
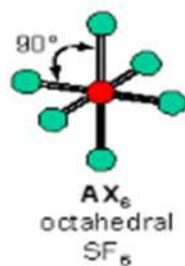
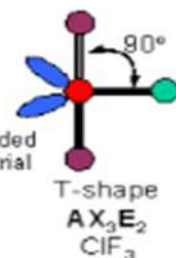
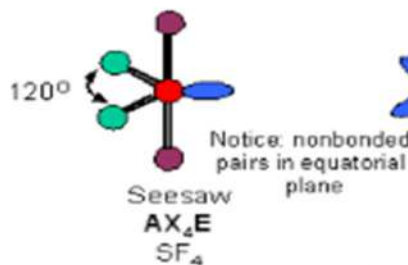
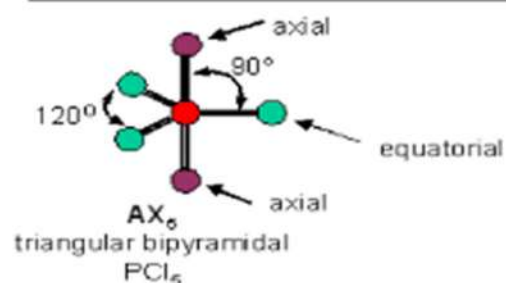
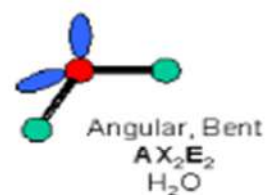
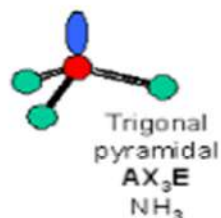
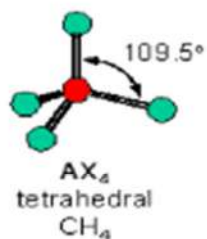
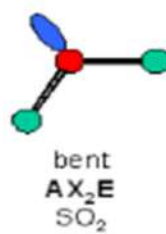
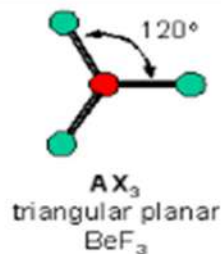
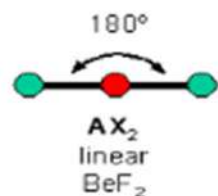
VSEPR Theory

- Based on Lewis structures we can know the shape or “geometry” of molecules
- The theory that predicts geometry (based on Lewis structures) is abbreviated VSEPR
- VSEPR (pronounced “vesper”) stands for Valence Shell Electron Pair Repulsion
- VSEPR, as the name suggests, predicts geometry based on the repulsion of electron pairs (in bonds or by themselves)
- Atoms and lone pairs repel one another and therefore take up space, thus, resulting structures have atoms maximally spread out

VSEPR overview

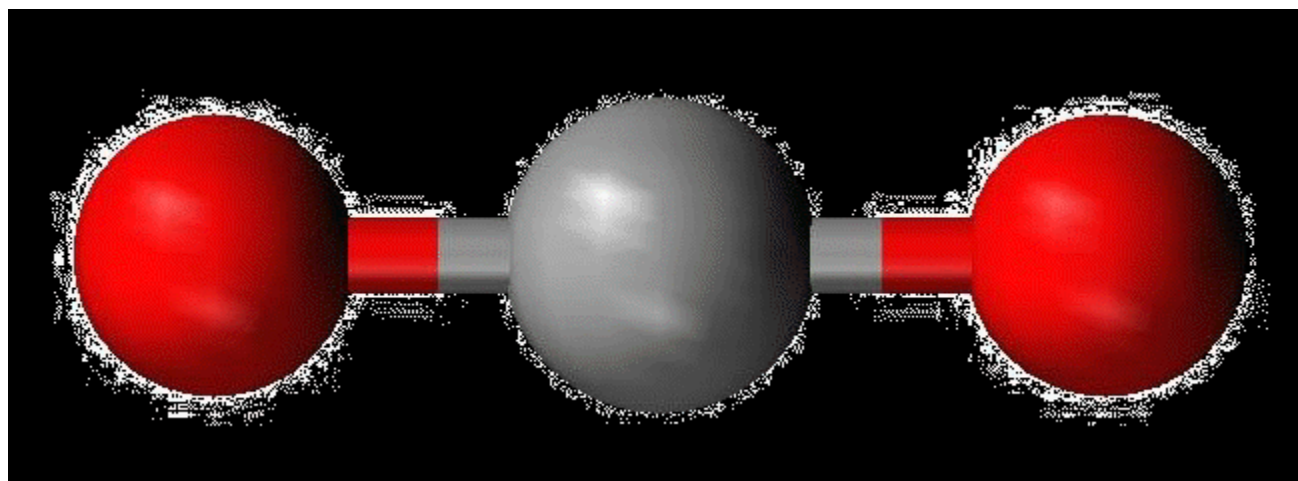
- Geometric/molecular structure: 3D arrangement of atoms in a molecule.
- Sometimes the molecules are represented by AX_Y , where Y is the # of peripheral atoms
 - AX_2 = linear
 - AX_3 = planar triangular
 - AX_4 = tetrahedral (tetra = 4 faces)
 - AX_5 = trigonal bipyramidal (2 pyramids)
 - AX_6 = octahedral (octa = 8 faces)

Electron Density and Molecular Geometry



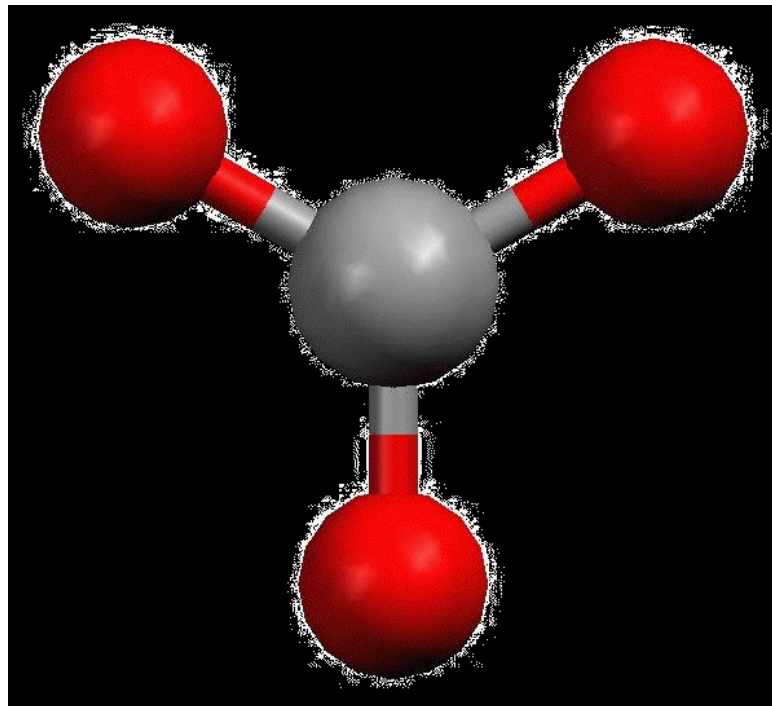
Linear Structure

- All atoms in a line
- AX_2
- Ex. CO_2
- Bond angle 180°



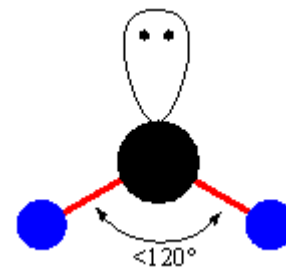
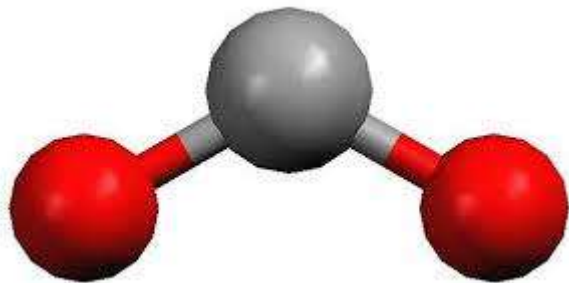
Trigonal Planar

- Planar/flat- all 4 atoms in same plane
- AX_3
- Ex. BF_3
- Bond angle=
 120°



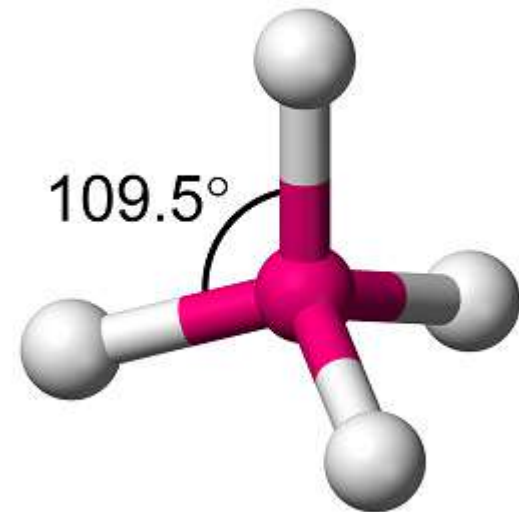
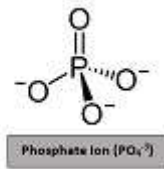
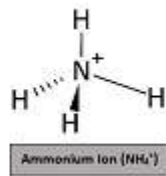
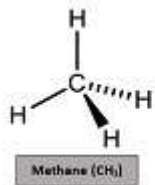
Bent

- Bent/ “v-shaped”
- Due to lone pair of electrons
- AX_3E
- Ex. Bond Angle 120°



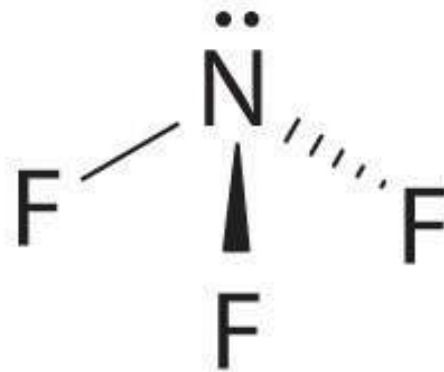
Tetrahedral

- Ex. Fig 12.11 on pg 364
- CH_4
- AX_4
- Bonds connecting H atoms define 4 identical triangular faces of a tetrahedro



Trigonal Pyramidal

- AX_3E
- 4 atoms 1 lone pair on central atom
- Ex. NH_3



Angular Bent

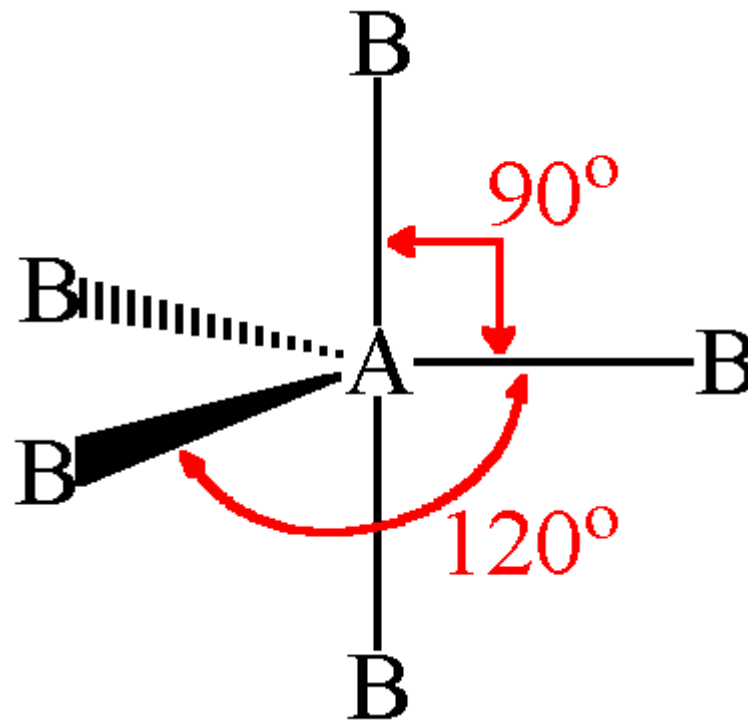
- AX_2E_2
- 3 atoms, 2 lone pairs on central atom
- Ex. H_2O
- Bond angle 105°



Trigonal Bipyramidal

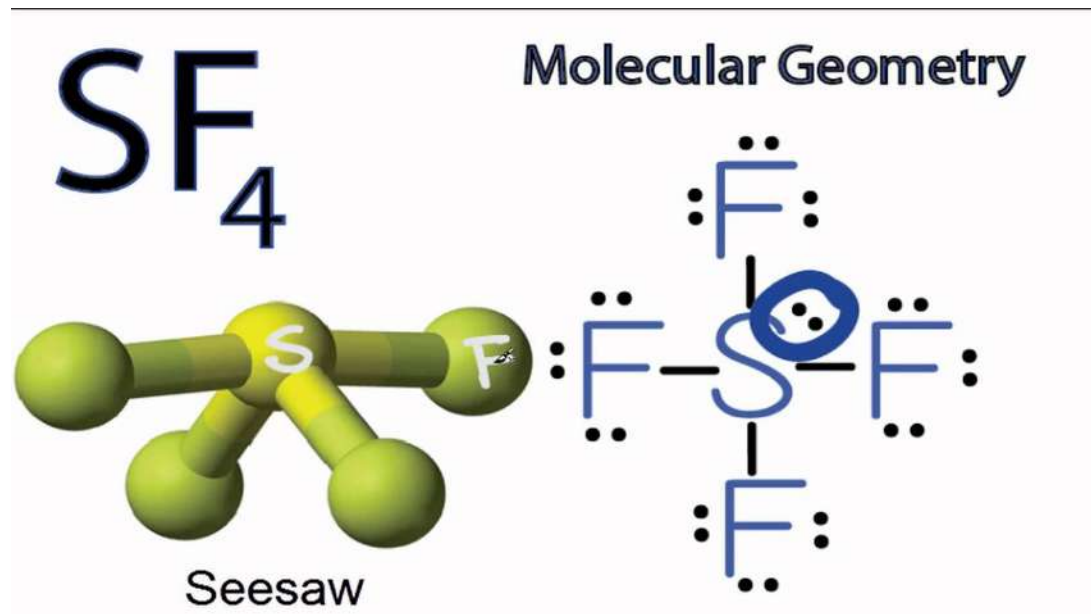
- AX_5
- 5 atoms around a central atom
- Ex. PCl_5

central atom
must be able to
break octet rule



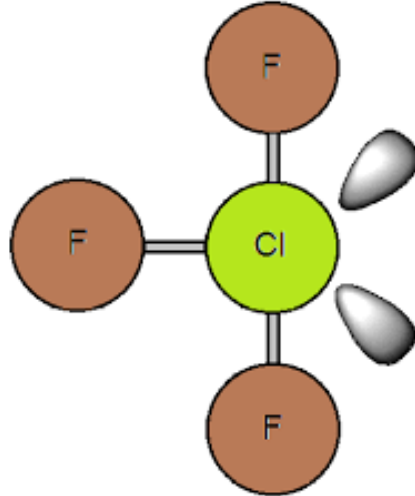
See Saw

- AX_4E
- 4 atoms around a central atom w/ 1 lone pair
- Ex. SF_4



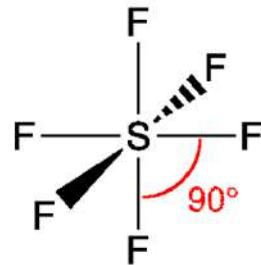
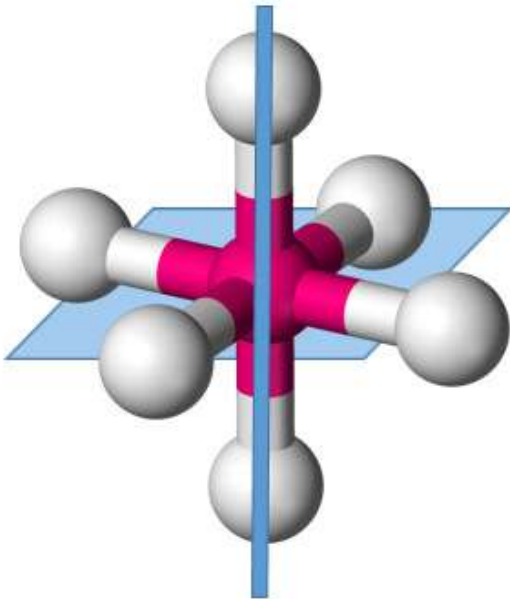
T-shaped

- AX_3E_2
- 3 atoms around central atom with 2 lone pairs
- Ex. ClF_3



Octahedral

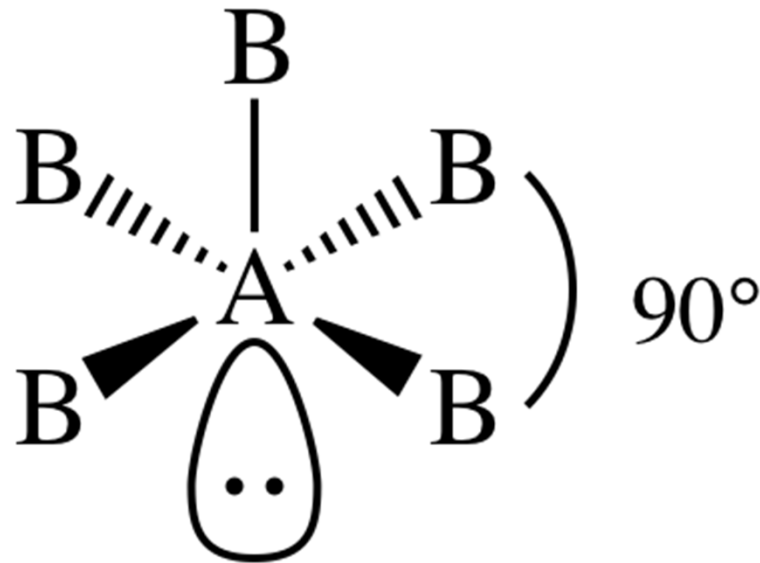
- AX_6
- 6 atoms around a central atom
- Ex. SF_6
- Central atom must be able to break octet rule!



The F-S-F angles are all 90°

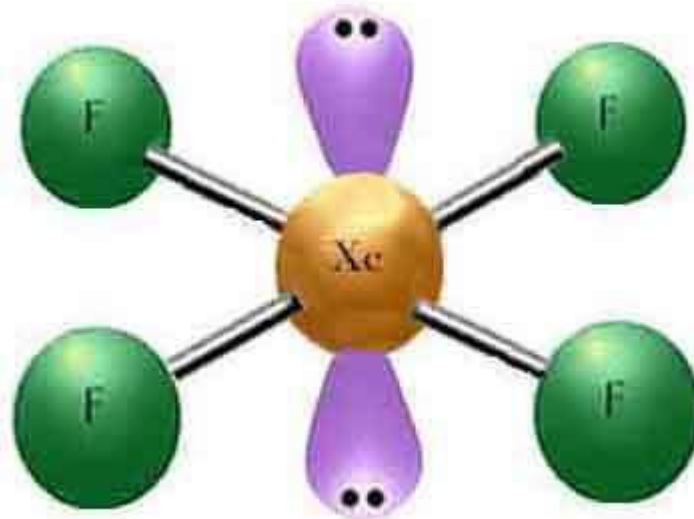
Square Pyramidal

- AX_5E
- ex. IF_5
- 5 atoms around central atom with 1 lone pair



Square Planar

- AX_4E_2
- Ex. XeF_4
- 4 atoms around central atom with 2 lone pairs



Steps for Predicting Molecular Structure Using VSEPR Model

1. Draw the Lewis structure for the molecule
2. Count electron pairs, arrange in way minimizing repulsion (as far apart as possible)-remember 3D
3. Determine the positions of the atoms from the way electron pairs are shared.
4. Determine the name of molecular structure from position of atoms (and lone electron pairs)

Rules for Predicting Using VSEPR Model

| Number of Pairs | Name of Arrangement |
|-----------------|---------------------|
| 2 | Linear |
| 3 | trigonal planar |
| 4 | tetrahedral |

When 1/more e pairs are unshared(lone pairs)-
see Table 12.4 on pg. 370 for names.