

## VSEPR THEORY

- Molecules are not flat entities like we have drawn them so far, they have 3D shapes
  - Shape is actually very important for chemistry/function
  - Shape can be represented in drawings
- Molecular shapes can be predicted using the Valence Shell Electron Pair Repulsion (VSEPR) model
- Each electron pair is considered a charge cloud, and the charge clouds repel each other
  - Applies to both bonding pairs and lone pairs
- The electron repulsion pushes the charge clouds as far away from each other as possible
  - Molecular shape depends on the number of charge clouds
  - Also depends on number of lone and bonding pairs
- Step 1: Write an electron-dot structures and count the number of electron charge clouds surrounding the atom of interest
  - Note that multiple bonds are counted as single charge cloud
  - Molecules with 2 charge clouds are always 180 degrees, linear
  - Molecules that are trigonal planar have angles of 120 degrees
  - Molecules with 3 charge clouds are trigonal planar or bent, 120 degrees
  - Tetrahedron has 4 charge clouds and are approximately 109.5 degrees apart
- 4 charge clouds
  - Can either be tetrahedral, trigonal planar, or bent
  - Methane is tetrahedral with bond angle of 109.5 degrees
  - Ammonia is trigonal pyramidal with bond angle of 107 degrees
  - Water is bent with bond angle of 104.5 degrees
- 5 charge clouds (0 pairs of lone electrons) = trigonal bipyramidal
  - Multiple bond angles: 90 degrees, 120 degrees, 180 degrees
  - Taking away one bond (1 pair of lone electrons) = seesaw
  - Taking away two bonds (2 pairs of lone electrons) = T-shape, 180, 90 degrees
  - Taking away three bonds (3 pairs of lone electrons) = linear
- 6 charge clouds = Octahedral, 180 degree axis, 90 degrees all around
  - SF<sub>6</sub> is octahedral
  - If it has 6 in it, it is octahedral DONT NEED TO DRAW IT
  - Taking away one bond (1 pair of lone electrons) = square pyramidal
  - Taking away two bonds (2 pair of lone electrons) = square planar
- The rules stated above can also be applied to individual atoms in larger molecules
  - There is simple more than one atom attached through a bond

- The Cambridge Crystallographic Data Centre contains structures for a lot of structures
  - Some of the ions are part of the compounds are the ones we have looked at in this class
  - It is FREE
- Ex:  $\text{CH}_3\text{Cl}$  = tetrahedral because there are 4 bonding pairs and 0 nonbonding pairs
  - If it is a positive or negative ion, make sure that the charge is indicated with brackets
- Ex:  $\text{IF}_4^-$  = square planar