

# Shapes of Molecules

# VSEPR

- VSEPR stands for Valence Shell Electron Pair Repulsion.
- Since electrons all have a negative charge, they repel each other .
- Knowing that electrons will pair up to make bonds, it means that the bonds will repel each other as much as possible.
- Electrons also make non-bonding pairs or lone-pairs when there are more than 4 electrons around the central atom.

# Lewis-Dot structures

- Remember that electrons first spread out and go one on each of the four sides of the central atom, but when there are more than 4 they have no choice but to pair up.
- Lewis-Dot structures are limited to two dimensions, but atoms and molecules are of course three dimensional.
- Instead of 90 degrees being the optimum angle for the electrons to be farthest from each other in two dimensions, it is actually 109.5 degrees in 3 dimensions.

# Shapes

- To get a view of all the shapes and how many bonding pairs there are go to the following link:  
<http://intro.chem.okstate.edu/1314F00/Lecture/Chapter10/VSEPR.html>
- Double bonds reduce the number of bonding directions that a central atom can have.
- For instance, a carbon atom with one double bond will act as if it can only have three bond groups and be trigonal planer instead of tetrahedral.
- A triple bond would reduce the number of bond groups by two.

# Carbon

- Carbon only has 4 valence electrons. 2 in the s-orbital, and one in each of two p-orbitals with one p-orbital empty.
- We know that carbon can make bonds in 4 different directions with four unpaired electrons.
- This is because carbon transfers one of the s-electrons to the empty p-orbital.
- This is now called a hybridized orbital.
- So for carbon, we call it  $sp^3$  hybridization.

# Bond angles

- If a central atom makes four bonds, the angle between each bond is  $109.5^\circ$ .
- Non-bonding paired electrons repel other electrons and bonds more than other bonds do, which squeezes the other bonds closer together.
- In  $\text{NH}_3$ , the central nitrogen has a non-bonding pair which squeezes the other bonds to a  $107^\circ$  angle.
- In water, the oxygen has two non-bonding pairs which force the hydrogens at a  $104.5^\circ$  angle.