AP Chemistry – Chemical Bonding

Bonding – attractive forces that hold atoms together and make them function as a single unit

DO not get bonding forces confused with IMFs (bonding forces are within a molecule and IMFs are between 2 molecules)

Bond Energy

- Bond Energy is the energy required to break a bond

Endothermic process!!!!

(positive ΔH, energy in…)

**Remember that energy is released when bonds are formed

Bond Polarity

- Polarity starts with En differences

** Polarity can also occur b/c of 3-D shapes of molecules (VSEPR)… or can be cancelled because of 3-D symmetry (draw the structure!!!)

Nonpolar covalent	ΔEn = 0 to 0.4
Polar covalent	ΔEn = 0.4 to 1.67
Ionic	ΔEn = > 1.67

Bond Orders

Bond order describes number of electron pairs between two atoms

There are only two types of bonding pairs – sigma(σ) and pi(π)

Type of Bond	Bond Order	
Single	1	σ
Double	2	σ + π
Triple	3	σ + π +π

Ionic Bonding Characteristics

◆electrons that are transferred between atoms having high differences in electronegativity

◆compounds containing a metal and a nonmetal

◆strong coulombic attractions between positive and negative ions (higher charges = higher attractions)

◆crystalline structures that are solids at room temperature

◆ions that form a crystal lattice structure

◆melt at high temperatures

◆ substances that are good conductors of electricity in the molten (when melted) or aqueous state

Covalent Bonding Characteristics

◆the sharing of electrons between atoms having small differences in electronegativities

◆nonmetals attracted to other nonmetals

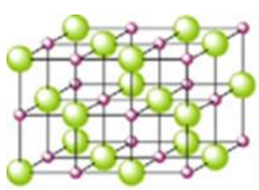
◆formulas that are given in the true ratios of atoms (molecular formulas; $C_6H_{12}O_6$)

◆substances that may exist in any state of matter at room temperature (solid, liquid, or gas)

◆compounds that melt at low temperatures

◆substances that are <u>not</u> conductors of electricity

Lattice Energy



Latice formed by ionic compounds (pos/neg)

The larger the charges, the higher the attraction, the more energy is needed to separate (higher lattice energy)

Coulombs Law!!!!!

Metallic Bonding Characteristics

◆ substances that are metals

◆ a "sea" of mobile or delocalized electrons surrounding a positively charged metal center. Non-directional attraction to electrons allows for malleability and ductility (ions can be "pushed" or moved around with force)

◆ an attraction between metal ions and surrounding electrons

◆formulas written as a neutral atom (Mg) when is solid state and as ions when aqueous (Mg^{+2})

◆a range of melting points—usually depending on the number of valence electrons

◆substances that are excellent conductors of electricity since the electrons in the "sea" are free to move

Bond Length

Bond Type	Length
Single (C-C)	143
Double (C=C)	122
Triple (C≡C)	113

More energy required to break shorter bonds, so triple bond would be expected to have higher bond energy than single bond

Formal Charge (FC)

The difference between the number of VE and number of e^- assigned to atom

The more electronegative atoms should have a negative formal charge ½

$$\text{Formal Charge} = VE - (\#\text{ lone } e^- - \frac{\text{Bonding } e^-}{2})$$

-Generally a FC above (+/-) 2 is not accepted

FC can be used to validate Lewis dot Structures and to determine which is most likely

Drawing Lewis Dot Structures (Covalent)

T.B.O. method - total valence e^-, pick central atom and attach all others, subtract bonding e^- from total, complete octet of outer atoms (except H) and subtract from total e^-, any e^- left go on central atom.

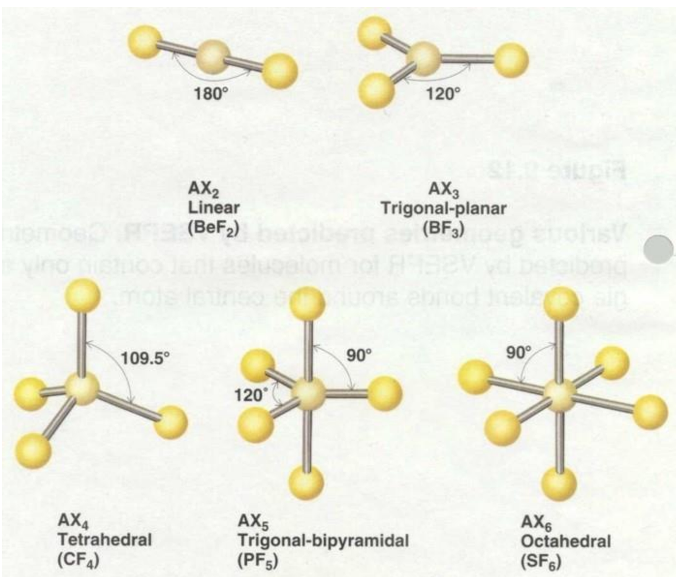
Lastly, check octet of central atom and if necessary move outer lone pair e^- into bond to form double/triple bond

Don't' forget about….

C N O P S

VSEPR (3-D structure of a molecule)

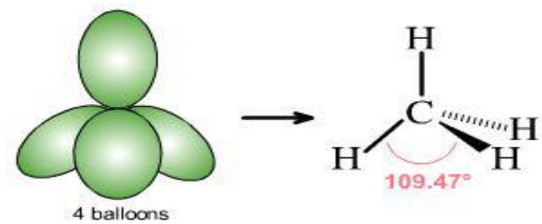
Use T.B.O. to draw these!!!!!

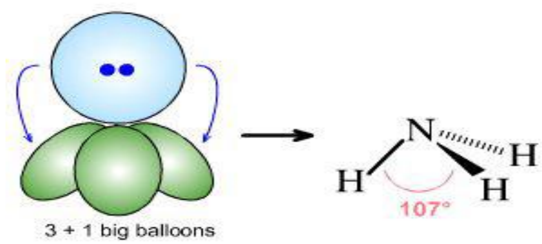


Know the name of the shapes and the bond angles!!!!!!!

How Lone Pairs Affect Bond Angles

Lone pair e^- on a central atom have increased e^- repulsion with other bonding e^-





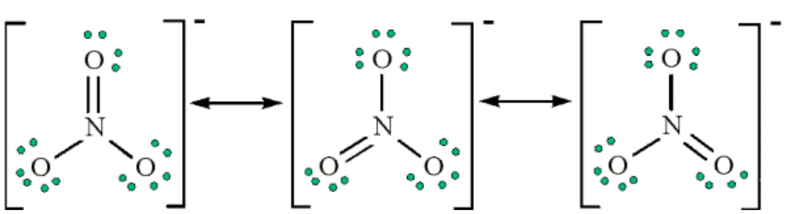
Lone Pairs **ALWAYS** decrease bond angles because of the electron repulsions!

Resonance Structures

Occur when double bonds in a molecule are not symmetrical

In reality the bond "jumps" around positions and has an equal chance of occurring at any of the possible positions

If asked to draw resonance... don't freak out just draw the molecule over and switch the position of the double bond



Hybridization

Really this is just a way to explain why we do not see different orbitals in bonding (difference between an s and a p)

Just count bonding sites!!!!!

Bonding sites	Hybridization	Geometry
1	s	-----
2	sp	Linear
3	sp^2	Δ pyramidal
4	sp^3	Tetrahedral
5	sp^3d	Δ bipyramidal
6	sp^3d^2	Octahedral