AP Chemistry
Mr Winter

Unit 2 Objectives

Compound Structure and Properties

- Types of Chemical Bonds
    - Explain the relationship between the type of bonding and the properties of the elements participating in the bond
        - Electronegativity values for the representative elements increase going from left to right across a period and decrease going down a group. These trends can be understood qualitatively through the electronic structure of the atoms, the shell model, and Coulomb's law.
        - Valence electrons shared between atoms of similar electronegativity constitute a nonpolar covalent bond. For example, bonds between carbon and hydrogen are effectively nonpolar even though carbon is slightly more electronegative than hydrogen.
        - Valence electrons shared between atoms of unequal electronegativity constitute a polar covalent bond. (a) The atom with a higher electronegativity will develop a partial negative charge relative to the other atom in the bond. (b) In single bonds, greater differences in electronegativity lead to greater bond dipoles. (c) All polar bonds have some ionic character, and the difference between ionic and covalent bonding is not distinct but rather a continuum.
        - The difference in electronegativity is not the only factor in determining if a bond should be designated as ionic or covalent. Generally, bonds between a metal and a nonmetal are ionic, and bonds between two nonmetals are covalent. Examination of the properties of a compound is the best way to characterize the type of bonding.
        - In metallic solid, the valence electrons from the metal atoms are considered to be delocalized and not associated with any individual atom.
- Intramolecular Force and Potential Energy
    - Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.
        - A graph of potential energy versus the distance between atoms is a useful representation for describing the interactions between atoms. Such graphs illustrate both the equilibrium bond length (the separation between atoms at which the potential energy is lowest) and the bond energy (the energy required to separate the atoms).
        - In a covalent bond, the bond length is influenced by both the size of the atom's core and the bond order (ie. single, double, triple). Bonds with a higher order are shorter and have larger bond energies.
        - Coulomb's law can be used to understand the strength of interactions between cations and anions. (a) Because the interaction strength is proportional to the charge on each ion, larger charges lead to stronger interactions. (b) Because the interaction strength increases as the distance between the centers of the ions (nuclei) decreases, smaller ions lead to stronger interactions.
- Structure of Ionic Solids
    - Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions.
        - The cations and anions in an ionic crystal are arranged in a systematic, periodic 3-D array that maximizes the attractive forces among cations and anions while minimizing the repulsive forces.
- Structure of Metals and Alloys
    - Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.

- Metallic bonding can be represented as an array of positive metal ions surrounded by delocalized valence electrons (sea of electrons).
- Interstitial alloys form between atoms of different radii, where the smaller atoms fill the interstitial spaces between the larger atoms.
- Substitutional alloys form between atoms of comparable radius, where one atom substitutes for the other in the lattice.

- Lewis Diagrams
  - Represent a molecule with a Lewis diagram.
    - Lewis diagrams can be constructed according to an established set of principles.
- Resonance and Formal Charge
  - Represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charges to select between nonequivalent structures.
    - In cases where more than one equivalent Lewis structure can be constructed, resonance must be included as a refinement to the Lewis structure. In many such cases, this refinement is needed to provide qualitatively accurate predictions of molecules structure and properties.
    - The octet rule and formal charge can be used as criteria for determining which of several possible valid Lewis diagrams provides the best model for predicting molecular structure and properties.
    - As with any model, there are limitations to the use of the Lewis structure model, particularly in cases with an odd number of valence electrons.
- VSEPR and Bond Hybridization
  - Based on the relationship between Lewis diagrams, VSEPR theory, bond orders, and bond polarities: (a) explain structural properties of molecules and (b)explain electron properties of molecules.
    - VSEPR theory uses the Coulombic repulsion between electrons as a basis for predicting the arrangement of electron pairs around a central atom.
    - Both Lewis diagrams and VSEPR theory must be used for predicting electronic and structural properties of many covalently bonded molecules and polyatomic ions, including the following: (a) molecular geometry, (b) bond angles, (c) relative bond energies based on bond order, (d) relative bond length (multiple bonds, effects of atomic radius), (e) presence of a dipole moment, and (f) hybridization of valence orbitals of the molecule.
    - The terms hybridization and hybrid atomic orbital are used to describe the arrangement of electrons around a central atom. When the central atom is sp hybridized, its ideal bond angles are 180°; for sp^2 hybridized atoms the bond angles are 120^0; and for sp^3 hybridized atoms the bond angles are 109.5°.
    - Bond formation is associated with overlap between atomic orbitals. In multiple bonds, such overlap leads to the formation of both sigma and pi bonds. The overlap is stronger in sigma than pi bonds, which is reflected in sigma bonds having greater bond energy than pi bonds. The presence of a pi bond also prevents the rotation of the bond and leads to structural isomers.