Learning Objectives and Worksheet V

Chemistry 1B-AL Fall 2016

~~Lecture~~ 9 Types of Chemical Bonds- General Considerations

Read pp. 596-614

This class will be devoted to the general aspects of three types of chemical bonding- ionic, covalent, and metallic. The discussion will be based on our understanding of the quantum mechanics of atomic structure, but the interactions among atoms will focus on more 'classical' concepts. Later in the quarter we will revisit covalent bonding and fully understand the quantum mechanical basis of molecular bonding and structure.

I. Lewis hypothesis

1. G.N. Lewis proposed that stable molecules would be formed if each atom attained a stable configuration of _____ electrons for H atoms and _____ electrons for other atoms. This would correspond to the _____ completely filled shell configuration for n=1 and the _____ completely filled shell configuration for n=2, 3, …

2. In order to attain these stable electronic configurations in a molecule, the atoms could _____, _____, or _____ electrons by interacting with other atoms.

Tool to construct Lewis Structure:
http://www.stolaf.edu/depts/chemistry/courses/toolkits/123/js/lewis/

Tutorial on how to draw dot structure:
https://chemistry.boisestate.edu/richardbanks/inorganic/electron-dot.htm

II. Ionic bonding

1. In ionic bonds metallic atoms with _____ IE's tend to _____ electrons to form _____ while non-metallic atoms with _____ negative EAs tend to _____ electrons to form _____.

HW#4: **29,30, 32**

2. The electronegativity of an atom is a measure of its ability to _____ its own electrons and _____ electrons from other atoms. In general _____ atoms are highly electronegative while _____ atoms are less electronegative (electropositive).

3. Strength of ionic bonding:
   i. Although Na has relatively low IE and Cl has a relatively large (negative) EA the electron transfer reaction:
   $Na\,(g) + Cl\,(g) \rightarrow Na^{+}\,(g) + Cl^{-}\,(g)$
   is **highly endothermic** (+146 kJ/mol) (i.e. neutrals more stable than ions).So, in the ionic compound NaCl(s) what factor stabilizes the ions relative to Na and Cl atoms?

HW#4: **31, 33, 34**

ii. In understanding trends in magnitude of lattice energies there are two important factors to consider.
   a. The greater the (the product of) _____ on the two ions the _____ magnitude of the lattice energy.
   b. The _____ the ions, and thus the _____ apart the charges, the _____ the magnitude of the lattice energy.

4. What are the general characteristics of ionic compounds with respect to:
   i. deformability _____
   ii. electrical conductivity _____
   iii. boiling and melting points _____

More on lattice structures: http://intro.chem.okstate.edu/1314f97/chapter8/ionSize.html

Lattice energy calculator: https://scilearn.sydney.edu.au/fychemistry/calculators/lattice_energy.shtml

III. Covalent bonding (the most general considerations)

HW#4: **35**

1. To form a complete octet an atom may
   i. Share one pair of electrons to form a 'single' covalent bond
   ii. Share more (2 or 3) pairs of electrons with another atom to form a 'multiple' (double or triple) covalent bond
   iii. Retain a pair of non-bonding electrons (a non-bonding or lone pair)

2. Covalent bonds occur between atoms of _____ electronegativity.

3. In compounds with covalent bonding the intramolecular (bonding) forces are strong but often the intermolecular (among molecules) forces are weak (especially compared to ionic compounds). This leads to the following general characteristics of compounds with covalent bonding with respect to:
   i. deformability vis a vis state of matter

   ii. electrical conductivity _____
   iii. boiling and melting points _____

4. Bonds between differing atoms are never 100% covalent or 100% ionic
   i. a bond between atom of somewhat differing electronegativity will be a _____ covalent bond where the electron pairs are shared _____

ii. in such a bond the atom with the greater electronegativity will be assigned a partial _____ charge and the less electronegative atom a partial _____ charge.

iii. The concept of valence is useful in assessing the probable atomic stoichiometry of atoms forming ionic and covalent compounds. Know the common valences of the atoms and ions described in the lecture 9 notes.

IV. Metallic bonds

1. In a metal the atoms contribute their outer shell electrons to form a 'sea of electrons' around the remaining positively charged nuclear sites.
2. This results in the following properties of compounds with metallic bonding:
   i. deformability _____
   ii. electrical conductivity _____
   iii. boiling and melting points _____

General molecule gallery: http://switkes.chemistry.ucsc.edu/teaching/MoleculeGallery.html