Chapter 10—Chemical Bonding 2

After this chapter, you should be able to…

- Explain what is meant by the molecular geometry as compared to the electron geometry of a molecule or ion
- Explain the basic principles and assumptions behind the VSEPR model
- Recall the shapes (names and bond angles) for repulsion of electron "pairs" about the central atom when there are 2, 3, 4, 5, or 6 electron "pairs"
    - Sketch a 3-d model of the geometry using the line/dash/wedge notation
    - Explain why the electron geometry is different from the molecular geometry when there is one of more lone-pair of electrons on the central atom
        - Explain the molecular geometry adopted by AB_2E, AB_3E, AB_2E_2, AB_4E, AB_3E_2, AB_2E_3, AB_5E, and AB_4E_2 systems (see table 10.2 on page 307)
    - Explain the deviations from the ideal angles when one of the electron "pairs" is a double/triple bond, or a lone-pair
- Given a formula, be able to write a Lewis structure and apply the VSEPR model to a compound in order to predict both its electron pair geometry and molecular geometry
- Explain when a bond is polar (has a non-zero dipole moment) in terms of electronegativity differences
    - Explain how the overall dipole moment of a molecule is obtained from the individual bond dipoles
    - From a molecular formula, predict whether a molecule will be polar or non-polar
- Describe the basic principle of Valence-Bond (VB) theory in terms of orbital overlap
    - Explain the importance of a minimum in the energy vs. distance plot for a pair of atoms
- Be able to give a VB description of the bonding in H_2, X_2, and HX molecules, where X is a halogen (F, Cl, Br, etc.)
- Explain why the bond angle of 109.5º in CH_4 is inconsistent with simple overlap of the 2s/2p orbitals of C with the 1s orbital of H

- Explain what is meant by promotion/hybridization, and how it accounts for the bonding observed in CH_4
- Recognize that four tetrahedral single-bonds will always require sp^3 hybridization using the VB model of chemical bonding

- Explain why the bond angle of 180º in $BeCl_2$ is inconsistent with simple overlap of the 2s/2p orbitals of Be with the 3p orbital of Cl
  - Explain how the promotion/hybridization model accounts for the 180º angle by formation of two sp hybrid orbitals
  - Recognize that two linear single-bonds will always require sp hybridization using the VB model of chemical bonding
- Explain why the bond angle of 120º in BF_3 is inconsistent with simple overlap of the 2s/2p orbitals of B with the 2p orbital of F
  - Explain how the promotion/hybridization model accounts for the 120º angle by the formation of two sp^2 hybrid orbitals
  - Recognize that three trigonal-planar single-bonds will always require sp^2 hybridization using the VB model of chemical bonding
- Recall that any unhybridized p orbital(s) will be perpendicular to the sp^n hybrid orbitals (n = 1, 2, or 3)
- Explain how the 3d orbitals may be hybridized along with the 3s and 3p orbitals of a 3rd period element to account for formation of >4 bonds or lone-pairs
  - Account for the formation of chemical bonds and lone-pairs in AB_5, AB_6, AB_4E, AB_3E_2, AB_5E, and AB_4E_2 compounds using the VB hybridization approach
- Given a molecular formula or Lewis structure, be able to
  - Identify the hybridization (if any) of every atom
  - Explain in terms of an orbital diagram (electrons-in-boxes) and an orbital-overlap sketch, how the single bonds are formed, and which orbitals contain lone-pairs
- Define what is meant by a σ and a π bond in terms of orbital overlap
  - Describe the bonding (using the VB approach) in a molecule containing a double or triple bond (for example: $H_2C{=}O$, $H_2C{=}CH_2$, $HC{\equiv}CH$)

    - Explain why free-rotation can occur about a σ bond, but not a π bond
- Make sure you can answer all the assigned homework problems!