Prerequisites for Section I

As we go through each section in the syllabus, I will try to give you a handout (or web post) that list ideas and topics that I am assuming you already know or at least been exposed to at this point of your chemical education. Much of the time, I won’t cover things given in these handouts (posts), in other cases I will cover this material, but with the assumption that I’m providing a refresher – not the first exposure to the material.

I. Fundamentals
   1. Atomic and Molecular Structure (2-3 weeks)
      a. Basic concepts from quantum theory
         • Absorption of radiation (E = h\nu; quantization of energy levels and basic idea of transitions between energy levels)
         • Typical energies and wavelengths (or inverse wavelengths) of radiation per mole of photons: visible [400 – ~ 800 nm; 2.5 eV to 1.25 eV/photon or 240 to 120 kJ/mol]; UV [<400 nm; > 2.5 eV/photon or > 240 kJ/mol]; IR [4000 – ~ 400 cm\(^{-1}\); 0.5 to 0.05 eV per photon or 50 to 5 kJ/mol]
         • Familiarity with Schrödinger Equation (not details of how to solve it), wavefunctions (\(\Psi\)), electron densities as electron “probability densities” (\(\Psi^2\))
      b. Atomic Structure — orbitals, configurations, periodicity, electronegativity scales, etc.
         • All the listed concepts you should have seen – review trends!
         • Do you know relationship between electronegativity and electron affinity and ionization energies?
         • Pauli principle – effect on atomic structure
         • Aufbau filling of orbitals
         • Hund’s rule – maximum spin multiplicity for partially filled shells
         • Valence and core electrons for the regions of the periodic table
      c. Lewis Structures — octet rule, formal charges, resonance structures
         • all three concepts should not be new and though covered here, will be assumed to be review
      d. Valence Bond Theory, Hybridization
         • sp, sp\(^2\), & sp\(^3\) hybridization and geometric preferences associated with each (linear, trigonal planar, tetrahedral)
      e. Molecular orbitals (MOs) — diatoms
         • Concepts of bonding and antibonding orbitals will be covered, but you should check out a Freshman Chem book and/or a P-chem book for a refresher before we get to this point
         • What is the relationship between bond orders and bond lengths?
         • You should know about interatomic orbital overlaps (i.e., What is a \(\sigma\) overlap? What is a \(\pi\) overlap? Under what circumstances do you get zero overlap?)
• When building up MOs from individual atom AOs, you get out as many MOs as the number of AOs you start with
• Typical energies that separate s and p valence electrons for a main-group atom (8 or more eV)

  f. Donor-acceptor interactions — Lewis acid-base bonding, metal-ligand bonding

• What is a Lewis base? What is a Lewis acid?
• Can you list (and write down Lewis structures, including shapes) some typical Lewis bases from organic chemistry? Lewis acids?