

Chemistry 362

Goals for Chapter 8 & 9

The Periodic Table and the Chemistry of the Elements

1. Know the classifications for the structures of the elements: monoatomic, diatomic, polyatomic and extended structures.
2. Know that elemental C has 3 allotropes, graphite, diamond and buckminsterfullerene a.k.a. bucky balls.
3. Know that Si and Ge exhibit the diamond structure but that Sn exists in an equilibrium between the gray (diamond) and the white (distorted ccp) structures.
4. Realize that most of the elements in the periodic table are metals and that they have distinct properties: High reflectivity, high electrical conductance, high thermal conductance, mechanical properties of strength and ductility.
5. Know the three main structural types of metals – ccp, hcp, and bcc – and the most important differences between these types of packing.
6. Understand the basics of the bonding in metals. The orbitals of atoms overlap the same as in a molecule, but because the energy levels are so similar, they lead to bonding orbitals that are so close together that they form a continuum of bands. Different bands are created by the overlap of different types of atomic orbitals; for example, Na with one electron in a 3s orbital will have a half-filled 3s band and an empty 3p band. The proximity (or even overlap) of the filled or partially filled bands (HOMO's or valence band) to the empty band (LUMO or conduction band) determines the conductivity of the material. *The bigger the gap between the two types of bands, the poorer the conductivity.* Metal versus semi-conductor is determined by these issues.
7. Know the issues that the book raises (and those that were raised in the notes) about the “Survey of the Elements” of the first two short rows of the periodic table.
8. Know the first ionization energy trend for Li → Ne and how to explain it.
9. Know that the first short row of elements, Li → Ne are not representative of the rest of the groups that they head. The second short row is much more representative. Know the five reasons that were put forth in your book as to why this is so.
10. Know the aspects of the chemistry of the rest of the non-transition elements in the brief manner in which chapter 8 treats them.
11. Know that the strict definition of the transition elements is “elements with partially filled d or f sub-shells”. Actually, most people usually reserve this term for the d sub-shell elements only including the so-called “coinage metals” (Cu, Ag and Au). Although the

elements themselves are d^{10} , and therefore not partially filled, in their compounds they have lost electrons and thus qualify as having a partially filled d sub-shell). Know the main characteristics of transition metals on page 266.

12. The f block elements are sometimes called the “rare earth elements” and they consist of two periods: the lanthanides and the actinides. Know that the high effective nuclear charge experienced by the f electrons of the lanthanides causes the elements from La to Lu to shrink significantly because of the poor shielding ability of the f orbitals along with increasing effective nuclear charge. The lanthanide contraction causes the second and third rows of the d-block transition metals to be of approximately the same size.

Hard and Soft Acid-Base Theory

13. Know the characteristics that determine hard acid, soft acid, hard base, soft base.
14. Be able to use HSAB to predict the outcome of a reaction. Remember that hard acids prefer to bind hard bases and soft acids prefer soft bases.

Hydrogen

15. Know the various methods of producing hydrogen as discussed in class. For example, electrolysis, the reaction of methane and water and the reaction of carbon monoxide and water.
16. Know the general reactions of hydrogen and its compounds. For example, the reduction of metal oxides to metals, reactions with metals to form hydrides, reactions of hydrides with water and the Haber-Bosch process.
17. Understand the various types of bonding that hydrogen can undergo – ionic bonding as both a cation or anion, covalent bonding with main group elements and 3-center-2-electron bonding (i.e. B_2H_6).
18. Be able to describe hydrogen-bonds and when they occur.
19. Know what a clathrate is.
20. Understand the three properties of water that are crucial to life and be able to explain why each one is important. The three properties are water’s high boiling point, the low density of ice and the ability to form hydrogen bond networks.