

**Chemistry 362 Mini-EXAM 1**  
Chapters 1 and 2

**Monday February 4, 2008**

**Professor Kim R. Dunbar**

**NAME:** Answer Key  
**ID:** \_\_\_\_\_

**You have 30 minutes to work this examination**

**Total Points on Exam is 85 points**

1. (10 pts)  
Briefly describe what is Inorganic Chemistry. In answering this question, bear in mind the issues that were raised in class about the differences in organic and inorganic chemistry. Name four classes of inorganic substances.

**“Inorganic Chemistry is the chemistry of the elements other than that of C combined with H, O, N, S, halogens, and the physical properties that these elements and their compounds exhibit.”**

**5 pts all or nothing for any valid definition – no I would give partial credit depending on how they articulate it.**

**The four classes are elements, ionic compounds, molecular compounds and network solids or polymers.**

**All four classes, 5 pts, three classes, 4 pts, two classes, 2.5 pts, one class, 1 pt. If they don't say precisely elements but give for examples of gases, liquids etc., you Will have to be flexible**

2. (5 pts)  
What happens to the Effective Nuclear Charge as you move from Li to F? Why? Explain in as much detail as you can.

**Effective nuclear charge increases as you move from Li to F. (2.5 pts)**

**This occurs due to the increase in the number of protons while maintaining the same electron shell (n quantum number). (2.5 pts) The charge of the nucleus is increasing while the electrons are remaining at the same level and become increasingly shielded from Li to F.**

3. (20 pts)  
**Atomic Electronic Structure**  
a. What are the two parts of the Wavefunction,  $\Psi$ , for an orbital and to what aspect of that orbital does each part contribute?

**Each wavefunction has a radial and an angular component. (4 pts) The radial component determines the size (extension into space) of the wavefunction. (3 pts) The angular component determines the shape of the wavefunction. (3 pts)**

- b. When operated on by the Hamiltonian operator,  $\hat{H}$ , the wavefunction,  $\Psi$ , yields the energy of each electron in an orbital described by four quantum numbers. What are the quantum numbers and what values can they take on?

**$n = 1, 2, 3, \dots$  (2.5 pts)**

**$l = 0, 1, 2, \dots, n-1$  (2.5 pts)**

**$m_l = -l, \dots, 0, \dots, +l$  (2.5 pts)**

**$m_s = +1/2, -1/2$  (2.5 pts)**

4. (25 pts)

**Kinetics and Thermodynamics**

a. What is meant by “the kinetics of a reaction”?

**The kinetics of a reaction refers to the rate at which reactants convert to products. (5 pts)**

b. What are five factors that affect the kinetics of a reaction?

**Temperature, concentration, solvent, pressure, presence of a catalyst (1 pt each)**

c. What is a reaction profile? Sketch a general Reaction Profile that shows Reactants going to Products and label all the appropriate parts of the diagram.

**A reaction profile is a plot of free energy (accept energy) vs reaction coordinate (essentially time). (2.5 pts)**

**Any valid diagram, need axis labeled, reactants, products,  $E_a$  (0.5 pt each)**

d. What is a catalyst and how can it change the kinetics of a reaction?

**A catalyst is a substance that facilitates a reaction by lowering the activation energy of the reaction. The catalyst emerges from the reaction unaltered. (5 pts for any valid definition)**

e. What are the meanings of the thermodynamic terms enthalpy ( $\Delta H^\circ$ ), entropy ( $\Delta S^\circ$ ), and Gibbs free Energy ( $\Delta G^\circ$ ), of a reaction? Write the equation that describes the relationship between enthalpy, entropy and Gibbs Free Energy?

**Enthalpy is the heat absorbed or evolved in a reaction. (1 pt) Entropy is the degree of order or disorder that occurs during the reaction. (1 pt) Gibbs Free Energy indicates overall thermodynamic favorability of a given reaction. (1pt)**  
 **$\Delta G = \Delta H - T\Delta S$  (2 pt)**

5. (10 pts)

Which has the higher electron affinity (highest tendency to accept an electron):

Li or **F**?      Cs or **Li**?      **F** or I?      **P** or As?      Re or **Os**?

**1 point each**

6. (5 pts)

Which of the halogens, X, would you expect to be most likely to form a cation,  $X^+$ ?

**Astatine (5 pts)**

7. (5 pts)

**The** energy necessary to break a bond is not always constant from molecule to molecule. For example:



The entropic change of the two reactions is very similar because both reactions involve one molecule going to two molecules, but the enthalpic change is different by 217 kJ/mol. Suggest a reason for this.

**O is more electronegative than Cl, so in the NOCl molecule (2pt), electron density is pulled from the N-Cl bond toward the N-O bond (2pt), weakening the N-Cl bond and lowering its energy. (1 pt)**

8. (5 pts)

What are the periodic trends that are observed for atomic radii, first ionization energy, electron affinity and electronegativity. Keep in mind that electron affinity and electronegativity are similar.

**atomic radii – decreases from left to right in a period and increases going down a column (1.5 pts)**

**first ionization energy – increases from left to right in a period and decreases going down a column (1.5 pts)**

**electron affinity – increases from left to right and decreases going down a column 0.5 pt**

**electronegativity – (same as above) increases from left to right and decreases going down a column 0.5 pt**