# Review Sheet for Exam 4 in Chem 3610

Only topics that we have covered in class and I have assigned homework over will be covered on the exam. Although certainly not an all inclusive list, among the things you should be able to do are:

Binary Mixtures of Non-Electrolytes

- Write and explain the empirical equations for freezing point depression, boiling point elevation, and osmosis
- Derive the equation for FP depression from thermodynamic principles
- Define the process of osmosis and the related terms of hemolysis, crenation, hypotonic, hypertonic, isotonic, Osmolarity. Use these ideas to answer practical questions.
- Solve problems with the above equations.

Phase Diagrams of Mixtures

- List the 2 major types of composition diagrams – pressure and temperature
- Sketch the temp/composition and pressure/comp diagram of an ideal solution, labeling the parts

*<u>All objectives below in this section refer to temperature/composition phase diagrams</u>*

- Explain the distillation of an "ideal solution" and the concept of theoretical plates
- Sketch and explain the diagrams of a high and low boiling azeotrope and the problems involved in separation of the components by distillation
- Sketch the diagrams for partially miscible liquids with upper. lower, and upper/lower critical limits explaining the thermodynamics of each. Use the concept of the tie line to determine the <u>compositions of the phases</u> in equilibrium for a 2 phase system
- Derive the lever rule and use it to determine the <u>relative amounts of each phase</u> in a 2 phase partially miscible system
- Sketch the diagram of 2 partially miscible liquids which boil after becoming 1 phase
- Sketch the diagram of 2 partially miscible liquids which boil before becoming 1 phase
- Sketch the liquid/solid diagrams of ideal and non-ideal systems showing a eutectic point
- Answer questions in the above diagrams about the number of phases present, the compositions of those phases, the relative amounts of those phases, and possible azeotrope and eutectic points

Kinetics

- Define the study of kinetics and describe the difference in what thermodynamics and kinetics tell us about a reaction
- Define the give the reaction rate in terms of disappearance of reactants or appearance of products
- List the ways to monitor concentrations and take samples
- List and explain the factors affecting the reaction rate
- Explain the parts of the differential rate law expression
- Explain and use the method of initial rates to determine the rate law expression, by graph and by inspection
- Explain and use the method of fitting to an integrated rate law to determine the rate law expression
- Derive and use (to find time and concentrations) the 0, $1^{st}$, and $2^{nd}$ order integrated rate law expressions for species "A" becoming product P, either in a one step process where the order can be written immediately or where the order is already known for a summary equation that is multi-step. Determine the half-life equations for these integrated rate law expressions and how they differ
- Explain and use the empirical Arrhenius equation for the determination of the specific rate constant.
- Set up the integrated rate law derivation for the simple $2^{nd}$ order reaction $A+B \rightarrow P$. Use the final expression to solve problems for time and concentration of the different species.
- Define equilibrium using kinetics and derive the equilibrium constant for a simple reversible reaction. Explain the relationship between this and the thermo definition of equilibrium.

- Set up the integrated rate law derivation for the simplest consecutive reaction mechanism of A→B→C. Understand the final derived equation and be able to sketch the graph of concentration of each species versus time. Use appropriate assumptions of the rate determining step to get a simplified equation.
- Define and use the concept of the "steady state" approximation to obtain the same simplified equation as above for A→B→C. Use the concept of steady state as well as a pre-equilibrium step to analyze a simple A↔B→C reaction involving a reversible first step.
- Apply "steady state" to other reaction mechanisms to arrive at differential rate laws for multi-step reactions.
- Apply steady state to the Michaelis-Menton mechanism for enzyme action and derive the differential rate law. From the differential rate law derive and explain such factors as the Michaelis constant and maximum velocity.

In general - Equation Derivation

- Be able to derive all equations that I derived in class

In general - Mathematics

- Be able to differentiate and integrate polynomials including exponential/logarithmic functions
- Be able to take partial derivatives

*Be able to discuss the important contributions of Jacob van't Hoff to physical chemistry

## Test 4 Equations

$$m_A(l) = m_A^*(l) + RT\ln(X_A)$$

$$\Delta T = m \cdot i \cdot K$$

$$P = X \cdot K \qquad P = X \cdot P_{tot} \qquad P = X \cdot P^*$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$[A] = -kt + [A]_0$$

$$k = Ae^{\frac{-E_A}{RT}}$$

### *Constants:*

R = $8.314\frac{J}{mol \cdot K}$, $0.08206\frac{Atm \cdot L}{mol \cdot K}$, $62.36\frac{torr \cdot L}{mol \cdot K}$