**Chemistry 108 Course Objectives**

**Chapter 12 – Intermolecular Forces and Liquids and Solids**

1. describe the solid, liquid, and gaseous states on the atomic/molecular level
2. understand intermolecular forces: ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole, London dispersion, van der Waals, and hydrogen bond interactions/forces.
3. define and explain the origin of polarizability
4. indicate which intermolecular forces are present between different molecules and ions
5. predict relative magnitudes of intermolecular forces in a series of molecules and relate that to relative values of various physical properties
6. understand how crystalline solids are described by unit cells
7. describe with words and drawing the three cubic unit cells
8. Provide atomic-scale explanations for the origins of surface tension, capillary action, cohesion, adhesion, viscosity
9. calculate the number of spheres in a cubic unit cell of spheres
10. describe forces and properties and identify and give examples of different crystalline solid types
11. describe evaporation and the dynamic equilibrium aspects of vapor pressure
12. use the Clausius-Clapeyron equation to find T, P, or ΔHvap
13. be able to define boiling point and normal boiling point as well as explain what determines the boiling point of a substance
14. understand phase diagrams and be able to solve phase diagram-related problems
15. define molar heat of fusion (ΔHfus) and molar heat of sublimation (ΔHsub)
16. understand phase changes and the heating curve for water

**Chapter 13 – Physical Properties of Solutions**

1. define solution, solute, solvent, miscible, solvation, and hydration
2. distinguish and define unsaturation, saturation, and supersaturation
3. define the 3 interactions involved in making a solution, and explain what makes solution formation endo- or exothermic
4. explain why “like dissolves like”
5. be able to explain the effect of a change in temperature and pressure on gas solubility, and quantitatively use Henry’s Law
6. know and use quantitatively the definitions of percent by mass, molarity, and molality, including conversions between concentration units
7. know and use quantitatively Raoult’s law for a volatile solvent and non-volatile solute
8. know and use quantitatively the expression for freezing point depression and boiling point elevation of a dilute solution, including use of the van’t Hoff i factor
9. know and perform calculations with the expression for osmotic pressure of a dilute solution
10. calculate colligative properties for electrolyte/nonelectrolyte solutions, and use them to determine molar mass.

**Chapter 14 – Chemical Kinetics**

1. express the rate of a reaction in terms of the concentration of a reactant or product and time
2. obtain the rate of a reaction from a concentration/time data
3. use rate data to determine the rate law of a reaction
4. use a rate law to describe a reaction’s order
5. perform calculations using the integrated rate equation for a 0th, 1st, and 2nd order reaction
6. obtain and use the equation for half life for a 1st order reaction
7. interpret the potential energy profile of a reaction and use it to obtain activation energy and heat of reaction, including being able to identify activation energy, transition states, and the rate determining step
8. perform calculations involving the Arrhenius equation
9. use a simple mechanism to obtain the rate law of a reaction
10. distinguish between three types of catalysis, and be able to explain the role a catalyst plays in a chemical reaction

**Chapter 15 – Chemical Equilibrium**

1. understand the difference between homogeneous and heterogeneous equilibrium
2. understand the nature of dynamic equilibrium
3. give the expression for an equilibrium constant in terms of concentration or pressure for a given the chemical equation
4. calculate K for the same equilibrium system written different ways
5. calculate concentrations at equilibrium given some concentrations
6. solve for the concentrations of reactants and products at equilibrium if provided with starting concentrations and an equilibrium constant (solve ICE plots)
7. utilize the reaction quotient to predict the direction of reaction
8. apply Le Châtelier’s principle to equilibria under stress

**Chapter 16 – Acids and Bases**

1. identify and define acids, bases, conjugate acids, and conjugate bases according to Bronsted-Lowry definitions
2. define strong and weak acids and bases, and di- or polyprotic acids. Know the relation between pKa, acid, and base strength.
3. define and use Kw
4. define and use pH and pOH
5. recognize six strong acids and eight strong bases in water
6. quantitatively treat the equilibrium system: water plus strong acid or strong base
7. quantitatively treat the equilibrium system: water plus weak acid or weak base
8. calculate percent ionization of an aqueous solution of acid or base
9. quantitatively treat the equilibrium system: water plus polyprotic acid
10. provide and use the relationship between Ka, Kb, and Kw
11. relate acid strength and acid structure for simple acids and oxoacids
12. quantitatively treat the equilibrium system: water plus metal ion
13. qualitatively treat the equilibrium system: water plus anion and cation hydrolysis
14. understand the acid-base properties of salt solutions, and be able to do salt-pH related calculations
15. identify the behavior of Lewis Acids and Bases

**Chapter 17 – Acid/Base Equilibria and Solubility Equilibria**

1. quantitatively treat the equilibrium system: buffer solution
2. utilize the Henderson-Hasslebalch equation
3. obtain any pH on the titration curve of a strong acid and strong base
4. obtain any pH on the titration curve of a weak acid and strong base
5. draw the general shapes of titration curves of any strong/weak acid/base combination
6. define endpoint and equivalence point and know how an indicator works
7. quantitatively treat the equilibrium system: water plus slightly soluble salt
8. quantitatively treat the equilibrium system: water plus slightly soluble salt and common ion
9. qualitatively treat the equilibrium system: aqueous complex ion

**Chapter 18 – Thermodynamics**

1. recognize some spontaneous and non-spontaneous processes
2. understand the relationships between entropy, disorder, and probability
3. state the 3 laws of thermodynamics in equation form
4. calculate the ΔSo of a chemical reaction from standard entropies (So)
5. calculate the ΔS of an isothermal phase change if ΔH and T are given
6. calculate ΔG at standard and non-standard temperatures and use the result to predict spontaneity or equilibrium of a process
7. utilize the signs of ΔH and ΔS to predict spontaneity of a process at high and low T, and be able to calculate the minimum temperature for a reaction to be spontaneous
8. Be able to relate the following: K, Q, and ΔG

**Chapter 19 – Redox Reactions and Electrochemistry**

1. generate balanced half-reactions from redox reactions or electrochemical cells
2. balance redox equations in both acidic and basic aqueous solutions
3. identify oxidants/oxidizing agents, reductants/reducing agents, and provide oxidation numbers for typical compounds
4. define and explain corrosion, especially for iron
5. use standard reduction potentials to calculate cell emf, and determine cell reactions, polarity of electrodes, and direction of electron flow for galvanic cells
6. calculate the change in cell potential at non-standard concentrations
7. identify the reference hydrogen electrode/standard hydrogen electrode
8. define the following: galvanic cell, voltaic cell, anode, cathode, salt bridge
9. convert between cell emf, K, and ΔG
10. recognize some batteries as galvanic cells
11. predict electrolysis reactions for molten salts
12. calculate quantities of reactant and/or product for electrolysis

**Chapter 21 – Nuclear Chemistry**

1. follow a radioactive decay pathway, and determine the products of the following nuclear processes: fusion, fission, alpha-decay, beta-decay, positron emission, gamma-emission
2. relate nuclear instability to the belt of stability
3. calculate energy associated with nuclear reactions and mass defect
4. determine an object’s age using half life data