Salem Community College Course Syllabus

Course Title: College Chemistry II

Course Code: CHM 102

Lecture Hours: 2
Laboratory Hours: 4
Credits: 4

Course Description:
Chemistry II begins with periodic relationship and chemistry bonding. It deals with the Molecular structure, various properties and formations of solutions, chemical kinetics, chemical equilibrium, organic chemistry, chemical thermodynamics and nuclear chemistry. The lab experiments reinforce the lecture portion of the class as well as introduce he student to basic chemical techniques, such as making buffer solutions and performing titrations. This is a state approved General Education Science course.

Prerequisite:
CHM 101

Place in College Curriculum:
Requirement for all Science and Laboratory Industrial Technology Majors and a science elective for all other students.

Course Outline:

I. Chemical Bonds
   A. Chemical Bonds: A Preview
   B. The Lewis Theory of Chemical Bonding: An Overview
   C. Ionic bonds and Ionic Crystals
   D. Using Lewis Symbols to Represent Ionic Bonding
   E. Lewis Structures of Some Simple Molecules
   F. Polar Covalent Bonds and Electronegativity
   G. Strategies for Writing Lewis Structures
   H. Molecules that Don't Follow the Octet Rule

II. Bonding Theory and Molecular Structure
   A. The Valence-Shell Electron-Pair Repulsion (VSEPR) method
   B. Polar Molecules and Dipole Moments
   C. Atomic Orbital Overlap
   D. Hybridization of Atomic Orbitals
   E. Hybrid Orbitals and Multiple Covalent Bonds
   F. Characteristics of Molecular Orbitals
   G. Aromatic Compounds

III. Physical Properties of Solutions
   A. Some Types of Solutions
   B. Solution concentration
   C. Energetics of Solution Formation
   D. Equilibrium in Solution Formation
   E. The Solubilities of Gases
   F. Vapor Pressures of Solutions
   G. Freezing Point Depression and Boiling Point Elevation
   H. Osmotic Pressure
   I. Solutions of Electrolytes
   J. Colloids

IV. Chemical Kinetics: Rates and Mechanisms of Chemical Reactions
   A. Chemical Kinetics – A Preview
   B. The Meaning of the Rate of a Reaction
   C. Measuring Reaction Rates
   D. The Rate Law of a Chemical Reaction
   E. First-Order Reactions
   F. Reactions of Other Orders
   G. Theories of Chemical Kinetics
   H. Effect of Temperature on the Rates of Reactions
   I. Reaction Mechanisms
   J. Catalysis
   K. Enzyme Catalysis

V. Chemical Equilibrium
  A. The Dynamic Nature of Equilibrium
  B. The Equilibrium Constant Expression
  C. Modifying Equilibrium Constant Expressions
  D. Qualitative Treatment of Equilibrium: Le Chatelier's Principle
  E. Some Illustrative Equilibrium Calculations

VI. Acids, Bases, and Acid-Base Equilibria
  A. The Brønsted-Lowry Theory of Acids and Bases
  B. Molecular Structure and Strengths of Acids and Bases
  C. Self-Ionization of Water – The pH Scale
  D. Equilibrium in solutions of Weak Acids and Weak Bases
  E. Polyprotic Acids
  F. Ions as Acids and Bases
  G. The Common Ion Effect
  H. Buffer Solutions
  I. Acid-Base Indicators
  J. Neutralization Reactions and Titration Curves
  K. Lewis Acids and Bases

VII. More Equilibria in Aqueous Solutions: Slightly Soluble Salts and Complex Ions
  A. The Solubility Product Constant, K_{sp}
  B. The Relationship Between K_{sp} and Molar Solubility
  C. The Common-Ion Effect in Solubility Equilibria
  D. Will Precipitation Occur? Is It Complete?
  E. Effect of pH on Solubility

VIII. Thermodynamics: Spontaneity, Entropy, and Free Energy
  A. Why Study Thermodynamics?
  B. Spontaneous Change
  C. Entropy: Disorder and Spontaneity
  D. Free Energy (G) and Free Energy Change (ΔG)
  E. Standard Free Energy Change, ΔG°
  F. Free Energy Change and Equilibrium
  G. The Dependence of ΔG° and K_{eq} on Temperature

IX. Electrochemistry
  A. Half-Reactions
  B. The Half-Reaction Method of Balancing Redox Equations
  C. A Qualitative Description of Voltaic Cells
  D. Standard Electrode Potentials
  E. Electrode Potentials, Spontaneous Change, and Equilibrium
  F. Effect of Concentrations on Cell Voltage
  G. Batteries: Using Chemical Reactions to Make Electricity
  H. Predicting Electrolysis Reactions
  I. Quantitative Electrolysis
  J. Applications of Electrolysis

X. Introduction to Organic Chemistry
   A. Alkanes
   B. Alkenes and Alkynes
   C. Conjugated and Aromatic Compounds
   D. Alcohols and Ethers
   E. Aldehydes and Ketones
   F. Carboxylic Acids, Esters, and Amides

XI. Nuclear Chemistry
   A. Radioactivity and Nuclear Equations
   B. Naturally Occurring Radioactivity
   C. Radioactive Decay Rates
   D. Nuclear Stability
   E. Energetics of Nuclear Reactions
   F. Nuclear Fission and Nuclear Fusion
   G. Effect of Radiation of Matter

Course Performance Objective #1
The student will predict the nature of chemical bonds within a molecule.

Learning Outcomes:

1. The student will write Lewis structures for atoms, ions, ionic compounds and molecular compounds.
2. The student will describe the interactions involved for ionic, polar covalent and nonpolar covalent bonding.
3. The student will draw Lewis diagrams of a resonance structure which represents bond equivalence in a compound or polyatomic ion.
4. The student will calculate the formal charge of each atom within a molecule or polyatomic ion.
5. The student will perform Learning Outcomes #1-4 as graded homework assignments, as in class oral participation, as part of surprise quiz using short answer format, and part of a major examination using multiple choice and short answer.
6. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course performance Objective #2
The student will use quantum mechanics to explain chemical bonding and molecular structure.

Learning Outcomes:

1. The student will use the VSEPR method to predict the shapes of molecules and plyatomic ions.
2. The student will identify polar versus nonpolar molecules by looking at relative electronegativities.
3. The student will discuss Valence Bond Theory and how it pertains to optimal atomic orbital overlap.
4. The student will identify hybridization of atomic orbitals within a molecule.
5. The student will describe the difference between a sigma (σ) and a pi (Π) bond.
6. The student will define, identify, and give examples of geometric isomer.
7. The student will describe the relationship between resonance structures and delocalized bonding in increasing the stability of aromatic compounds.
8. The student will perform Learning Outcomes #1-4 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer.
9. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #3

The student will describe the concentration of a solution in various units, the solution process, factors that affect solubility and how the concentration of a solution affects its properties.

Learning Outcomes:

1. The student will calculate the concentration of solutions in molarity, molality, mole fraction, parts per million, parts per billion, parts per trillion, percent by weight, percent by volume, percent by mass/volume, and normality.
2. The student will convert the concentration of a solution from one unit to another, given the density of the solution.
3. The student will explain the solution process in terms of energy changes due to solute-solute, solvent-solvent, and solute-solvent interactions.

4. The student will predict the solubilities of substances in various solvents due to their molecular structure and intermolecular attractions.
5. The student will calculate the solubilities in a solvent, given the partial pressure of the gas over the solution and the Henry's Law constant.
6. The student will explain the effects of temperature on solubilities.
7. The student will explain the effect of solute concentration on vapor pressure, boiling point, freezing point, and osmotic pressure and will calculate any of these properties given the concentration of the solution.
8. The student will define a colloid and will compare and contrast a colloid with a true solution.
13. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
14. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #4

The student will describe rates of reactions, factors which affect the rate of reactions and the step-by-step mechanisms of various reactions.

Learning Outcomes:

1. The student will express the rate of a reaction in words, as well as in formula.
2. The student will use a graph of kinetic data to determine the average rate of a reaction, as well as the instantaneous rate of the reaction at any given point in time.
3. The student will determine the rate law of a reaction using kinetic data.
4. The student will define Zero-order, First-order, Second-order reactions, and will describe the effect on initial rates caused by doubling the concentration of one of the reactants for each of these orders.
5. The student will graph kinetic data and from the graph, determine if a reaction is zero, first, or second order with respect to a particular reactant.
6. The student will calculate the amount of reactant remaining after a given period of time, and the amount of time required to reach a certain concentration of reactant for both first-order and second-order reactions.
7. The student will calculate the rate of a reaction at any given point in time given its rate law and initial concentration of reactant.
8. The student will explain and calculate half-life for first and second order reactions.
9. The student will explain the relationship between activation energy and rate of reactions.
10. The student will use the collision theory and energy diagrams to explain how temperature affects the rate of a reaction.
11. Given the mechanism of a chemical reaction, in which either the first or second step is the rate-limiting step, the student will determine the rate law.
12. Given the rate law for a reaction, the student will identify plausible mechanisms for that reaction.
13. The student will define catalysts and explain how catalytic activity occurs for a heterogeneous catalyst, as well as for an enzyme.
14. The student will list four factors which affect enzyme activity, and explain on a molecular level how those factors affect the activity.
15. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
16. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #5

The student will describe chemical equilibrium and factors which affect equilibrium.

Learning Outcomes:

1. The student will define chemical equilibrium.
2. The student will write the Equilibrium Constant Expression from a balanced chemical equation.
3. The student will calculate the concentration equilibrium constant for a reaction given the equilibrium concentrations.
4. The student will calculate K_C for a reaction, given K_C for the reverse reaction, or a reaction in which only the coefficients vary by a common dividend.
5. The student will calculate the equilibrium concentrations of reactants or products, given the starting concentrations and the equilibrium constant.
6. The student will convert between K_C and K_P.
7. The student will calculate the reaction quotient for a reaction not at equilibrium, and from its value determine the direction it will proceed to reach equilibrium.
8. The student will describe how changes in concentration of reactants or products, temperature, and pressure affect dynamic equilibrium according to Le Châtelier's Principle.
9. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
10. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #6:

The student will describe acids and bases in reference to how they react, their strength and their concentrations in a solution.

Learning Outcomes:

1. The student will define acid and base according to the Arrhenices Theory, the Brǿnsted-Lowry Theory, and the Lewis Theory.
2. Given an acid-base reaction, the student will identify the acid, the base, the conjugate acid, and the conjugate base.
3. The student will describe the relationship between the strength of a binary acid with respect to the location of its conjugate base in the periodic table.
4. The student will describe how electronegative elements affects the relative strengths of Oxoacids, as well as Carboxylic Acids.
5. The student will look at the structure of two oxoacids or two binary acids or two carboxglic acids and identify which of the two is the strongest acid.
6. The student will define Kw, pH, pOH, pKa and pKb.
7. The student will calculate (H^+), (OH^-), pH, and pOH given any one of their values.
8. The student will calculate the pH, pOH, (H+) and (OH^-) given the Ka or Kb of the acid or base respectively and its initial concentration.
9. The student will determine if a salt solution is acidic, basic, or neutral by its ions.
10. The student will calculate the pH of a buffer solution given the initial concentrations of the compounds used to make the buffer.
11. The student will define Acid-Base indicators and will identify the pH range for several common indicators.
12. Given a titration curve, the student will identify the type of titration (e.g. strong acid with strong base…), the pKa or pKb if starting with a weak acid or weak base respectively, and the equivolence point.

13. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
14. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #7

The student will explain equilibria between slightly soluble salts and their ions in solution.

Learning Outcomes:

1. The student will define and write the expression of a solubility product constant.
2. The student will calculate the K_{sp} value from the solubility of a slightly soluble sale.
3. The student will calculate the solubility of a salt given its K_{sp} value.
4. The student will describe how to decrease the solubility of a salt by the Common-Ion effect.
5. The student will predict whether or not precipitation occurs given the concentrations of cat ion, anion, and the K_{sp} of the salt.
6. The student will describe how to separate ions from solution by selective precipitation and will define when this is feasible.
7. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
8. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #8

The student will describe thermodynamics and the relationship between spontaneity, entropy, enthalpy, and free energy, as well as between free energy change and equilibrium constants.

Learning Outcomes:

1. The student will define spontaneous and non-spontaneous reactions.
2. The student will define entropy and describe its effect on the spontaneity of a reaction.
3. The student will list and explain the first, second, and third laws of thermodynamics.
4. The student will define free energy and relate the change in free energy to the changes in entropy and enthalpy by the Gibbs equation.
5. The student will define exergonic and endergonic.
6. Given ΔG for a reaction at a given temperature, the student will calculate its equilibrium constant.
7. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
8. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #9

The student will describe the links between oxidation-reduction reactions and electricity.

Learning Outcomes:

1. The student will define, identify, and write oxidation-reduction reactions.
2. The student will balance equations for redox reactions in acidic and basic solutions.
3. The student will define voltaic cell, anode, cathode, and cell potential.
4. The student will draw cell diagrams for electrochemical cells using international conventions.
5. The student will calculate the standard cell potential, standard cathode potential or standard anode potential, given two of the three values.
6. The student will calculate the standard cell potential for a given redox equation.
7. The student will determine which redox reactions occur spontaneously by calculating standard cell potential from the half-equations.
8. The student will calculate the values of ΔG and K_{eg} at a given temperature for a redox equation by using Faraday's constant and calculated cell potentials.
9. The student will calculate the expected voltmeter readings for a voltaic cell with known concentrations of solutions.
10. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
11. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #10:

The student will learn basic organic nomenclature and structure and apply some general chemistry principles to organic compounds.

Learning Outcomes:

1. The student will define hydrocarbons, alkanes, alkenes, and alkynes.
2. The student will explain and write examples of substitution reactions and addition reactions.
3. The student will identify aromatic and aliphatic compounds.
4. The student will identify alcohols, ether, aldehydes, ketones, carboxylic acids, esters, and amides.
5. The student will define and give examples of electrophiles and nucleophiles.
6. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
7. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #11:

The student will be introduced to nuclear chemistry, focusing on radioactivity and its applications to chemistry, life sciences, and medicine.

Learning Outcomes:

1. The student will define the five types of radioactive decay.
2. The student will write simple nuclear equations.
3. The student will calculate decay constants, rate of decay, and activity given two of the three values.
4. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
5. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Section VI

Course Activities:

1. Lecture
2. Discussion
3. Problem Solving
4. Student Experimentation
5. Instructor Demonstration
6. Audio-visual Aids
7. Computer Software

Course Requirements and Means of Evaluation:

Please refer to the instructor's syllabus addendum (to be distributed in class) for specific information regarding the course requirements and means of evaluation.

Attendance Policy:

Regular and prompt attendance in all classes is expected of students. Students absent from class for any reason are responsible for making up any missed work. Faculty members establish an attendance policy for each course and it is the student's responsibility to honor and comply with that policy.

Academic Honesty Policy:

Students found to have committed an act of academic dishonesty may be subject to failure of this course, academic probation, and / or suspension from the college. See the Student Handbook for additional details.

ADA Statement:

If you have a 504 Accommodation Plan, please discuss it with your instructor. If you have any disability but have not documented it with the Disability Support coordinator at Salem Community college, you must do so to be eligible for accommodations. To contact the Disability Support Coordinator, call 856-351-2773, or email disabilitysupport@salemcc.edu to set up an appointment. To find out more information about disability support services at Salem Community College, visit www.salemcc.edu/students/student-success-programs/disability-support.

Section VII

Required Text(s): For textbook information, please see the Salem Community College Bookstore website.

Section VIII

Materials / Supplies:

None.

Additional Costs:

None.