

## **COURSE OUTLINE** College Chemistry II

**Course Description:** CH115. College Chemistry II. 5 hours credit. Prerequisite: CH110 with a C or better and MA131. This course will enable the student to continue learning the chemistry of metallic elements and their compounds as well as the elementary principles of analytical chemistry. The student will also learn to solve problems dealing with solution concentrations, chemical equilibrium, solubility products, buffers, thermodynamics, and electrochemistry. An introduction to nuclear and/or organic chemistry may be included. Laboratory experiments incorporate analysis, synthesis, and acquisition of quantitative and qualitative data. Three hours of lecture/recitation and four hours of laboratory per week.

**Course Relevance:** The impact of chemistry in everyday life is phenomenal. The ability to see chemistry in action on the micro (molecular) and macro scale is necessary to develop a fuller knowledge and understanding of the world around us. Chemistry will enrich the student's appreciation of the world and help him/her better understand the studies of science and the scientific methods.

### **Required Materials:**

Textbook: Zumdahl. Chemistry (7th ed.). Houghton Mifflin

Student Lab Notebook: Hayden-McNeil.

### **Learning Outcomes:**

The intention is for the student to be able to analyze scientific materials in various forms demonstrating:

1. An understanding of the scientific method
2. An ability to read, communicate and understand scientific materials
3. Knowledge of basic math skills
4. An ability to apply scientific reasoning to real world problems

### **Primary Learning PACT Skill(s) that will be DEVELOPED and/or documented in this course:**

Through the student involvement in this course, he/she will develop his/her ability in the following PACT skill areas:

1. Critical thinking
  - The student will demonstrate scientific reasoning through a variety of mathematical, graphical, experimental, and written assignments.

## 2. Writing

- The student will write laboratory reports, which include observations, and analysis of the experiment.
- The student will write a research paper on an approved topic in chemistry.

Secondary skills (developed but not documented)

Speaking  
Computer literacy  
Internet use  
Teamwork  
Ethical conduct

### **Major Summative Assessment Task(s):**

These learning outcomes and the primary learning PACT skills will be demonstrated by:

1. Write laboratory reports, including purpose, procedural, observations, and analysis of the experiment using scientific reasoning
2. Writing a research paper upon a topic of the student's choice related to chemistry
3. Final assessment of the course using the ACS standardized exam

### **Course Content:**

- I. Themes - Key recurring concepts that run throughout the course:
  - A. Scientific method
  - B. Scientific reasoning
- II. Issues - Key issues that will be addressed in this course: areas of conflict that must be understood in order to achieve the intended outcome:
  - A. The balance between the conceptual and mathematical models
  - B. The cumulative nature of science and the world
  - C. The cumulative influence of scientific discoveries and the subsequent application of the discoveries
  - D. The balance between "wet" lab chemistry and computer interfacing, collection and analysis of data
- III. Concepts – Key concepts that must be understood to address the issues:
  - A. Mathematics
  - B. Visual/conceptual
  - C. Scientific Methods
  - D. Scientific Reasoning
  - E. Modeling
  - F. Scientific writing
  - G. Scientific principles
  - H. MLA writing format
  - I. Word processing
  - J. Excel spreadsheet
  - K. Graphing
  - L. Characteristics and impact of science in the world around them
- IV. Skills/Competencies - Actions that are essential to achieve the course outcomes:
  - A. Mathematics
  - B. Writing

- C. Reading
- D. Speaking
- E. Computer Literacy
- F. Computer Spreadsheet/Graphing
- G. Internet Use
- H. Teamwork

## Learning Units

### I. Lecture

#### A. Colligative Properties

1. Define the following solution terms:
  - a. Saturated solution
  - b. Unsaturated solution
  - c. Supersaturated solution
  - d. Solubility
  - e. Solute
  - f. Solvent
2. Calculate concentration in molality and mole fraction
3. Explain the factors that affect solubility
4. Explain and calculate vapor pressure using Raoult's Law
5. Explain and calculate freezing point depression, boiling point elevation, and osmotic pressure

#### B. Kinetics

1. Discuss the meaning of the rate of a reaction
2. Explain the factors that affect reaction rates
3. Use the initial rate method to determine reaction order from experimental data
4. Describe the relationship between order of reaction and molecularity
5. Use experimental data to determine the rate law for a reaction
6. Compare first and second order rate reactions
7. Discuss the collision theory of a reaction rate
8. Use the Arrhenius equation to illustrate the relationship between energy of activation and rate law constant
9. Describe the relationships among the mechanism, the overall reaction and elementary steps
10. Draw and interpret energy diagrams and illustrate the affect of a catalyst on the energy diagram

#### C. Equilibrium Principles

1. Explain how the terms reversible reaction and dynamic equilibrium are related
2. Write the general equilibrium constant expression and explain its significance
3. Explain why the concentrations of pure liquids and solids are never used in equilibrium constant expressions
4. Show how the numerical value of the equilibrium constant changes when the stoichiometric coefficients are changed or the reaction is reversed
5. Explain the differences between the terms  $K_c$  and  $K_p$  and the relation of either to  $Q_c$
6. Explain the difference between an equilibrium position and an equilibrium constant

7. Given  $K_{eq}$  and initial concentration of reactants and/or products, calculate the final concentrations of reactants and/or products
8. List and explain the external factors that can affect equilibria
9. Using LeChateleur's Principle, explain how changes in temperature, pressure, volume, or concentration affect the equilibrium position for a chemical reaction

#### D. Equilibrium of Aqueous Solutions

1. Name and list the common strong acids and strong bases (i.e., any hydroxide base)
2. Describe and recognize Bronsted-Lowry, Lewis, and Arrhenius Acids and Bases
3. Use the definition of acids and bases to distinguish between strong and weak acids and bases, equilibrium relationships among them, and the aqueous properties of their salts
4. Use the concepts of pH, pOH,  $K_a$ , and  $K_b$  to calculate the pH of aqueous solutions of acids, bases, and their salts
5. Determine the specific species present in an aqueous solution and the concentrations of those species
6. Describe the effect of common ions and calculate concentrations of all species present in solutions of weak acids and bases
7. Describe the ionization of polyprotic acid in aqueous solution
8. Explain the buffer effect, predict the influence of added acids and bases on buffers, and use the Henderson-Hasselbach equation to calculate the concentration of species in solution
9. Identify titration curves for strong, weak, and polyfunctional acids and bases
10. Understand the use of volumetric methods to determine the concentrations of species in solution
11. Write an equation to express the relationship between a solid solute and its constituent ions in a saturated solution
12. Calculate the  $K_{sp}$  from molar solubility and molar solubility from  $K_{sp}$
13. Calculate the effect of a common ion on the molar solubility of a salt
14. Predict whether precipitation will occur when salt solutions are mixed and determine the concentration of ions remaining in solution after precipitation

#### E. Thermodynamics

1. Explain the similarities and differences between such terms as enthalpy, entropy, and free energy
2. Explain how the First, Second, and Third Laws of Thermodynamics apply to chemical and physical processes
3. Predict whether the entropy change in a given process is positive, negative, or near zero
4. Use data tables to determine enthalpy, entropy, and free energy changes
5. Explain how  $\Delta H^\circ$ ,  $\Delta S^\circ$ , and  $\Delta G^\circ$  are related to reaction spontaneity
6. Explain how knowledge of  $\Delta H^\circ$ ,  $\Delta S^\circ$ , and  $\Delta G^\circ$  allows one to predict the conditions under which a reaction will occur
7. Describe the relationship between the standard free energy of reaction and the equilibrium constant
8. Calculate  $\Delta G$  for a chemical reaction that occurs under nonstandard conditions

## F. Electrochemistry

1. Describe galvanic and electrolytic cells and their operation
2. Calculate cell potentials and determine spontaneity of oxidation/reduction reactions
3. Understand and use Faraday's Law
4. Understand and apply the relationship of thermodynamics to electrochemistry
5. Understand and use the Nernst Equation
6. Give examples of natural and/or commercial applications of electrochemical processes
7. Use the activity series of metals

## G. Optional Topics – in alphabetical order

- A. Coordination chemistry
- B. Descriptive chemistry
- C. Nuclear chemistry
- D. Organic chemistry
- E. Biochemistry

## II. Laboratory

- A. Working in the laboratory in accordance with good laboratory practices
  1. Dress in an appropriate manner as to promote safety in the laboratory, wearing a lab coat and goggles when anyone is working with chemicals in the laboratory
  2. Follow written directions accurately
  3. Work safely and effectively, using equipment and chemicals carefully and correctly
  4. Demonstrate use of required safety and common laboratory techniques
  5. Dispose of waste products in a proper manner
- B. Gather and record qualitative and quantitative data accurately
  1. Acquire data using balances and volumetric glassware
  2. Make and record visual observations
  3. Use computers, when appropriate, as data acquisition tools
  4. List or describe experimental assumptions made and any deviations from the written experimental procedures
- C. Handle and evaluate data in logical, productive, and meaningful ways
  1. Create notebooks and laboratory reports that are clear, understandable, and accurately represent the data collected
  2. Display computer data in a spreadsheet or graphically, as appropriate
  3. Correlate observations with chemical or physical processes
  4. Carry out suitable calculations with quantitative data, recognizing when data and calculations are within a reasonable range
  5. Use observations of experimental data to present relevant conclusions pertaining to the experimental procedure
- D. Correlate laboratory work with principal topics in College Chemistry II lecture

### **Learning Activities:**

Independent and collaborative learning activities will be assigned within and outside the classroom and laboratory to achieve the intended course outcomes. Classroom

discussion, lecture, and textbook reading assignments will also contribute to the learning process.

**Grade Determination:**

Grade determination may include tests, projects, quizzes, homework, written assignments and laboratory experiments. Other methods may be used at the discretion of the instructor. The ACS comprehensive exam will be administered at the end of the semester.