ALLEN COMMUNITY COLLEGE
COURSE OUTLINE
CHE 136 COLLEGE CHEMISTRY II

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I. COURSE INFORMATION

A. Chemistry 136 College Chemistry II
B. 5 credit hours
C. Kotz, P. Treichel, Townsend, and D. Treichel. *Chemistry & Chemical Reactivity.* 10th ed. Kentucky: Cengage Learning, 2019
D. Prerequisites: CHE 125 College Chemistry I with a C grade or above
E. KRSN: CHM 1020 Chemistry II with Lab

The learning outcomes and competencies detailed in this course outline or syllabus meet or exceed the learning outcomes and competencies specified by the Kansas Core Outcomes Groups project for this course as approved by the Kansas Board of Regents.

II. COURSE DESCRIPTION

College Chemistry II is an integrated lecture and laboratory course for chemistry and pre-Health Science students. This course continues the study begun in CHE125, with the areas of focus on Kinetics, Solution and reaction equilibria, Acids and Bases, Thermodynamics, Electrochemistry, Nuclear Chemistry, Organic Chemistry, and Biochemistry.

III. LEARNING OUTCOMES

A. Demonstrate a measurable understanding of colligative properties
    1. Describe the origins and relative magnitudes of intermolecular forces
    2. Relate phase behavior to nature of intermolecular forces
    3. Define saturated solution, unsaturated solution, supersaturated solution, solubility, solute, and solvent
    4. Understand and perform calculations using Henry's Law
    5. Calculate concentration in molality, molarity, mole fraction, and percent composition, and interconvert between these units
    6. Explain and calculate vapor pressure using Raoult's Law
    7. Explain other colligative properties, including freezing point depression, boiling, point elevation, and osmotic pressure
    8. Perform calculations using colligative properties, including molecular weight, freezing point depression, boiling point elevation and osmotic pressure
    9. Differentiate between the behaviors of non-ionizing and ionizing compounds in solution
B. Demonstrate a measurable understanding of 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. Determine orders of reaction for reactants from data expressing changes in concentration as a function of longer times
    5. Use the rate law to determine the overall order of a reaction
    6. Determine a reaction rate law from initial rate data
    7. Describe the relationship between order of reaction and molecularity
    8. Use experimental data to determine the rate law for a reaction
    9. Use an integrated form of the rate expression to perform calculations relating reactant or product concentration with reaction time
    10. Compare zero, first and second order rate reactions
    11. Discuss the collision theory of a reaction rate
    12. Use the Arrhenius equation to illustrate the relationship between energy of activation and rate law constant
    13. Describe the relationships among the mechanism, the overall reaction and elementary steps
    14. Identify reaction intermediates and catalysts in reaction mechanisms
    15. Draw and interpret energy diagrams and illustrate the affect of a catalyst on the energy diagram
C. Demonstrate a measurable understanding of equilibrium principles

1. Explain the relationship between the terms reversible reaction and dynamic equilibrium
2. Write the general equilibrium constant expression and explain its significance
3. Calculate Keq given equilibrium concentrations of reactants and products
4. Calculate equilibrium concentrations of reactants and products given the equilibrium concentration of other reactants and products
5. Calculate new equilibrium concentrations of reactants and products after an increase or decrease in the concentration of one of the reactants or products
6. Explain why the concentrations of pure liquids and solids are never used in equilibrium constant expressions
7. Show how the numerical value of the equilibrium constant changes when the stoichiometric coefficients are changed or the reaction is reversed
8. Explain the differences between the terms Kc and Kp and the relation of either to Qc
9. Explain the difference between an equilibrium position and an equilibrium constant
10. Given Keq and initial concentration of reactants and/or products, calculate the final concentrations of reactants and/or products
11. List and explain the external factors that can affect equilibria
12. Using LaChatelier's Principle, explain how changes in temperature, pressure, volume, or concentration affect the equilibrium position for a chemical reaction

D. Demonstrate a measurable understanding of equilibrium of aqueous solutions
   1. Use the definition of acids and bases to distinguish between strong and weak acids and bases, equilibrium
   2. Use the concepts of pH, pOH, Ka, and Kb to calculate the pH of aqueous solutions of acids, bases, and their salts
   3. Determine the specific species present in an aqueous solution and the concentrations of those species
   4. Describe the shape of acid-base titration curves for strong acid-strong base, weak acid-strong base, strong acid-week base and weak acid-weak base titrations
   5. Describe the effect of common ions and calculate concentrations of all species present in solutions of weak acids and bases
   6. Describe the ionization of polyprotic acid in aqueous solution
   7. Explain the buffer effect, predict the influence of added acids and bases on buffers, and calculate the concentrations of species in solution (using acid or base dissociation constant expressions, or Henderson-Hasselbach equation)
   8. Calculate the pH of a buffer solution outside of the buffer region
   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. Understand application of indicators in titration
   12. Write an equation to express the relationship between a solid solute and its constituent ions in a saturated solution
   13. Calculate the Ksp from molar solubility and molar solubility from Ksp
   14. Calculate the effect of a common ion on the molar solubility of a salt
   15. Predict whether precipitation will occur when salt solutions are mixed and determine the concentration of ions remaining in solution after precipitation

E. Demonstrate a measurable understanding of 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 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 ΔH°, ΔS°, and ΔG° are related to reaction spontaneity
   6. Explain how knowledge of ΔH°, ΔS°, and ΔG° allows one to predict the conditions under which a reaction will occur

7. Describe and calculate the relationship between the standard free energy of reaction and the equilibrium constant
8. Calculate ΔG for a chemical reaction that occurs under nonstandard conditions

F. Demonstrate a measurable understanding of electrochemistry
1. Describe galvanic and electrolytic cells and their operation, including the identification of half reactions at the anode and cathode
2. Write half reactions given a balanced redox reaction, and generate a balanced redox reaction given redox half reactions
3. Calculate cell potentials and determine spontaneity of oxidation/ reduction reactions
4. Understand and use-Faraday's Law
5. Understand and apply the relationship of thermodynamics to electrochemistry
6. Understand and use the Nernst Equation
7. Understand the relationship between the cell potential E and ΔG, and use this relationship in problem solving
8. Give examples of natural and/or commercial applications of electrochemical processes
9. Use the activity series of metals (optional)

G. Work in the laboratory in accordance with good laboratory practices
1. Dress in an appropriate manner as to promote safety in the laboratory, wearing appropriate laboratory attire and goggles when anyone is working with chemicals in the laboratory
2. Follow written directions accurately
3. Work safely and effectively, using equipment and chemical carefully and correctly
4. Demonstrate use of required techniques
5. Dispose of waste products in a proper manner
6. Know how to find and understand MSDS's for the chemicals used in a particular laboratory

H. 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

I. 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

J. Correlate laboratory work with principal topics in College Chemistry II lecture

IV. MAJOR CONTENT AREAS

A. Solutions and chemical kinetics
B. Chemical equilibrium and acid-base chemistry
C. Thermodynamics, electrochemistry, and nuclear chemistry
D. Organic chemistry, polymer and biochemistry

V. ASSIGNMENTS (may include but are not limited to)

A. Assignments
B. Laboratory exercises
C. Quizzes and exams
D. Final exam

VI. EVALUATION METHODS (may include but are not limited to)

A. Attendance and participation
B. Assignments

C. Lab exercises
D. Quizzes and exams
E. Final exam