Butler Community College
Behavioral Science, Math, Science, and
Physical Education Division

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Revised Fall 2011
Implemented Spring 2012

COURSE OUTLINE
College Chemistry II

Course Description
CH 115. College Chemistry II. 5 hours credit. Prerequisite: CH 110 and MA 131, both with a C or better. 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
Zumdahl, S. *Chemistry*. ITP Education Group.

Hayden. *Student laboratory notebook*. Plymouth, MI: Hayden-McNeil Publishing. Available from Butler bookstores. May substitute other laboratory notebook with carbonless sets of pages.

Carlson, R., Karr, K., *Chemistry 2 lab manual.* Available at the Butler Bookstore

A simple calculator capable of scientific notation and logarithms.

* - For complete textbook information, refer to http://www.butlercc.bkstr.com

Supplemental Materials
Eubanks. *Preparing for ACS General Chemistry Exams.* AMSCQ Publishing.

Hummel. *Student solutions guide: Chemistry*. ITP Education Group.

Butler Assessed Outcomes
The intention is for the student to be able to:
1. Demonstrate an understanding of the scientific method.

2. Read, communicate, and understand scientific materials.
3. Show knowledge of basic math skills.
4. Apply scientific reasoning to real world problems

Learning PACT Skills that will be developed and documented in this course
Through involvement in this course, the student will develop ability in the following PACT skill area(s):

Personal Development Skills

1. Personal management
    - Through the production of either an essay or questionnaire the student will reflect on his/her personal management skills.

Analytical Thinking Skills

1. Critical thinking
    - Through the production of various mathematical, graphical, experimental and written assignments, the student will demonstrate scientific reasoning.

Communication Skills

1. Creation and delivery of messages
    - Through a variety of methods using the computer and/or internet the student will produce a product to express his/her findings in laboratory reports.

Technology Skills

1. General computer use
    - Through the production of electronic-facilitated research, preparing graphs, and manipulation of data, the student develops basic computer skills

Major Summative Assessment Task(s)
These learning outcome(s) and the Learning PACT skill(s) will be demonstrated by:

1. Writing laboratory reports which will include a purpose, observations, and analysis of the experiment using scientific reasoning.
2. Writing a research paper on an approved chemistry topic of the student's choice
3. Final assessment of the course using the American Chemical Society's national standardized exam for College Chemistry I and II.

Course Content:

I. Skills or Competencies - Actions that are essential to achieve the course outcomes:
    A. Mathematics
    B. Writing
    C. Reading
    D. Speaking
    E. Computer literacy
    F. Graphing
    G. Internet use
    H. Teamwork
II. Themes - Key recurring concepts that run throughout the course:
    A. Scientific method
    B. Scientific reasoning
III. 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

IV. 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. Word processing
I. Excel spreadsheet
J. Graphing
K. Characteristics and impact of science in the world around them

Learning Units

I. Colligative properties
A. Define the following solution terms:
1. Saturated solution
2. Unsaturated solution
3. Supersaturated solution
4. Solubility
5. Solute
6. Solvent
B. Calculate concentration in molality and mole fraction
C. Explain the factors that affect solubility
D. Explain and calculate vapor pressure using Raoult’s Law
E. Explain and calculate freezing point depression, boiling point elevation, and osmotic pressure

II. Kinetics
A. Discuss the meaning of the rate of a reaction
B. Explain the factors that affect reaction rates
C. Use the initial rate method to determine reaction order from experimental data
D. Describe the relationship between order of reaction and molecularity
E. Use experimental data to determine the rate law for a reaction
F. Compare first and second order rate reactions
G. Discuss the collision theory of a reaction rate
H. Use the Arrhenius equation to illustrate the relationship between energy of activation and rate law constant
I. Describe the relationships among the mechanism, the overall reaction and elementary steps

J. Draw and interpret energy diagrams and illustrate the affect of a catalyst on the energy diagram

III. Equilibrium principles
A. Explain how the terms reversible reaction and dynamic equilibrium are related
B. Write the general equilibrium constant expression and explain its significance
C. Explain why the concentrations of pure liquids and solids are never used in equilibrium constant expressions
D. Show how the numerical value of the equilibrium constant changes when the stoichiometric coefficients are changed or the reaction is reversed
E. Explain the differences between the terms Kc and Kp and the relation of either to Qc
F. Explain the difference between an equilibrium position and an equilibrium constant
G. Given Keq and initial concentration of reactants and/or products, calculate the final concentrations of reactants and/or products
H. List and explain the external factors that can affect equilibria
I. Using LeChateleir's Principle, explain how changes in temperature, pressure, volume, or concentration affect the equilibrium position for a chemical reaction

IV. Equilibrium of aqueous solutions
A. Name and list the common strong acids and strong bases (i.e., any hydroxide base)
B. Describe and recognize Bronsted-Lowry, Lewis, and Arrhenius Acids and Bases
C. 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
D. Use the concepts of pH, pOH, Ka, and Kb to calculate the pH of aqueous solutions of acids, bases, and their salts
E. Determine the specific species present in an aqueous solution and the concentrations of those species
F. Describe the effect of common ions and calculate concentrations of all species present in solutions of weak acids and bases
G. Describe the ionization of polyprotic acid in aqueous solution
H. 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
I. Identify titration curves for strong, weak, and polyfunctional acids and bases
J. Understand the use of volumetric methods to determine the concentrations of species in solution
K. Write an equation to express the relationship between a solid solute and its constituent ions in a saturated solution
L. Calculate the Ksp from molar solubility and molar solubility from Ksp
M. Calculate the effect of a common ion on the molar solubility of a salt

N. Predict whether precipitation will occur when salt solutions are mixed and determine the concentration of ions remaining in solution after precipitation

V. Thermodynamics
   A. Explain the similarities and differences between such terms as enthalpy, entropy, and free energy
   B. Explain how the First, Second, and Third Laws of Thermodynamics apply to chemical and physical processes
   C. Predict whether the entropy change in a given process is positive, negative, or near zero
   D. Use data tables to determine enthalpy, entropy, and free energy changes
   E. Explain how ΔH°, ΔS°, and ΔG° are related to reaction spontaneity
   F. Explain how knowledge of ΔH°, ΔS°, and ΔG° allows one to predict the conditions under which a reaction will occur
   G. Describe the relationship between the standard free energy of reaction and the equilibrium constant
   H. Calculate ΔG for a chemical reaction that occurs under nonstandard conditions

VI. Electrochemistry
   A. Describe galvanic and electrolytic cells and their operation
   B. Calculate cell potentials and determine spontaneity of oxidation/reduction reactions
   C. Understand and use Faraday's Law
   D. Understand and apply the relationship of thermodynamics to electrochemistry
   E. Understand and use the Nernst Equation
   F. Give examples of natural and/or commercial applications of electrochemical processes
   G. Use the activity series of metals

VII. Optional topics – in alphabetical order
   A. Biochemistry
   B. Coordination chemistry
   C. Descriptive chemistry
   D. Nuclear chemistry
   E. Organic chemistry

VIII. Working in the laboratory in accordance with good laboratory practices
   A. 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
   B. Follow written directions accurately
   C. Work safely and effectively, using equipment and chemicals carefully and correctly
   D. Demonstrate use of required safety and common laboratory techniques
   E. Dispose of waste products in a proper manner

IX. Gather and record qualitative and quantitative data accurately

A. Acquire data using balances and volumetric glassware
B. Make and record visual observations
C. Use computers, when appropriate, as data acquisition tools
D. List or describe experimental assumptions made and any deviations from the written experimental procedures

X. Handle and evaluate data in logical, productive, and meaningful ways
A. Create notebooks and laboratory reports that are clear, understandable, and accurately represent the date collected
B. Display computer data in a spreadsheet or graphically, as appropriate
C. Correlate observations with chemical or physical processes
D. Carry out suitable calculations with quantitative data, recognizing when data and calculates are within a reasonable range
E. Use observations of experimental data to present relevant conclusions pertaining to the experimental procedure
F. Correlate laboratory work with principal topics I through VI above

Learning Activities
Independent and collaborative learning activities will be assigned within and outside the classroom and laboratory to assist the student to achieve the intended learning outcomes. Classroom discussion, lecture, drills/skill practice, textbook reading/written assignments, and other activities at the discretion of the instructor, will also contribute to the learning process.

Grade Determination
The student will be graded on learning activities and assessment tasks. Grade determinants may include the following: tests, projects, quizzes, homework, laboratory experiments, written laboratory reports, and other methods of evaluation at the discretion of the instructor. The American Chemical Society's national standardized exam for Organic Chemistry I will be administered at the end of the semester.