STATE UNIVERSITY OF NEW YORK
COLLEGE OF TECHNOLOGY
CANTON, NEW YORK

COURSE OUTLINE

CHEM 155 - COLLEGE CHEMISTRY II

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SCHOOL OF SCIENCE, HEALTH, AND PROFESSIONAL STUDIES
CHEMISTRY DEPARTMENT
May 2015

CHEM 155 - COLLEGE CHEMISTRY II

A. TITLE: College Chemistry II

B. COURSE NUMBER: CHEM 155

C. CREDIT HOURS: 4

D. WRITING INTENSIVE COURSE No

E. COURSE LENGTH: 15 weeks

F. SEMESTER OFFERED: Spring semester

G. HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY: 3 hours lecture, 3 hours laboratory per week

H. CATALOGUE DESCRIPTION:

This is the second semester of a two semester college level course in chemistry. Topics include: bonding, intermolecular forces, solutions, chemical kinetics, chemical equilibrium, acids and bases, free energy concepts, and nuclear chemistry.

I. PRE-REQUISITES/CO-COURSES:

Prior Chemistry – College Chemistry I (CHEM 150) or permission of instructor.

J. GOALS (student learning outcomes): By the end of this course, the student will:

Course Objective	*Institutional SLO*
1. Draw Lewis structures for elements and compounds (ionic and covalent) and determine resonance, formal charges, electron geometry, molecular geometry (shape), bond angles, polarity, and hybridization by applying Valence Shell Electron Pair Repulsion Theory (VSEPR) as well as molecular orbital theory.	2. Crit. Thinking 3. Prof. Competence
2. Identify types of intermolecular forces (ionic, dipole attraction, London forces, and hydrogen bonding); calculate enthalpy of reaction from bond energies and enthalpy of vaporization from vapor pressure using Clausius-Clapeyron equation; construct and interpret data from a heating (cooling) curve; and define dynamic equilibrium, vapor pressure and boiling and freezing point, and identify factors affect these properties of a substance.	2. Crit. Thinking 3. Prof. Competence
3. Calculate and convert from one to another solution concentrations in terms of molarity (M), molality (m), weight percent (%wt), mole fraction (x_i) and parts per million (ppm); determine solution freezing and boiling points from concentration; identify saturated, supersaturated or unsaturated solutions from	2. Crit. Thinking 3. Prof. Competence

a solubility curve; determine vapor pressure changes in a solution (Raoult's Law) and identify factors affect the aqueous solubility of a solid or liquid.	
4. Write rate law expressions for reactions, determine the overall rate order and order with respect to each reactant using concentration/time data; use integrated rate laws to calculate reactant concentration over time for different ordered reactions (zero, first, and second); apply Arrhenius's equation to rate law calculations to determine the effects temperature and activation energy have on reaction rate.	2. Crit. Thinking 3. Prof. Competence
5. Write the equilibrium constant expression for reactions and calculate the value of the Keq; convert Kc to Kp and vice versa, and determined the direction the equilibrium reaction will follow using reaction quotient and LeChatelier's principles; apply different acid/base theories (Arrhenius, Bronsted-Lowry and Lewis) to identify acids and bases in a reaction; calculate the molarity, pH, pOH, pKa and pKb for acids and bases (strong and weak); define buffers and calculate pH of buffered solutions; and determine the equivalence point and pKa of a titration curve.	2. Crit. Thinking 3. Prof. Competence
6. Define entropy and Gibbs free energy, determine entropy changes for systems and chemical reactions and determine spontaneity of a reaction or process, calculate the change in free energies using enthalpy, entropy and temperature, and use free energy determine equilibrium constants.	2. Crit. Thinking 3. Prof. Competence
7. Apply the scientific method to be able to perform experiments and to use appropriate experimental apparatus effectively, as well as demonstrate the ability to read, collect, organize, compute, evaluate and interpret quantitative and qualitative data and/or information in a laboratory setting, as well as communicate scientific results effectively in writing.	1. Communication 2. Crit. Thinking 3. Prof. Competence

K. TEXTS:

Textbook: Gilbert, T.R., Kirss, R. V., Foster, N., and Davies, G., *Chemistry*, Fourth Edition, W.W. Norton and Co. Inc., New York, NY, 2014. Access to the ***SmartWork*** online Homework Program

Laboratory Manual: Leedom, G., and Heldt, N., *College Chemistry II, Laboratory Manual, Spring 2015*, on-line via ANGEL/Blackboard.

L. REFERENCES: Internet sites too numerous to cite.

M. EQUIPMENT:

Lecture facilities for 60 students, various demonstration equipment, computers with word processing, spreadsheet and computer graphing capabilities, and laboratory facilities for 18 students per lab.

N. GRADING METHOD: A-F

O. MEASUREMENT CRITERIA/METHODS:

Exams (3)	45%
Quizzes and graded HW	15%
Lab Grade	25%
Final Comprehensive Exam	15%
*TOTAL	100%

P. DETAILED TOPICAL OUTLINE:

I. Bonding
- A. Lewis structures
  1. Formal Charges
  2. Resonance Contributing Structures
  3. Exceptions to the Octet Rule
  4. Shapes of Molecules using VSEPR Theory
  5. Polarity of Molecules
- B. Heat of Reaction from Bond Energies
- C. Atomic Orbital Hybridization
  1. sp^3, sp^2, sp hybridization of atomic orbitals to make molecular orbitals
  2. Shapes of Orbitals
  3. Shapes of Molecules
- D. Molecular Orbital Theory

II. Liquids, Solids and Intermolecular Forces
- A. Intermolecular forces
  1. London forces
  2. Dipole-dipole forces
  3. Hydrogen bonding
- B. Vapor pressure
  1. Vapor pressure
  2. Heat of vaporization
  3. Boiling point
  4. Clausius-Clapeyron equation
- C. Melting and heat of fusion
- D. Heating/Cooling curves

III. Solutions and Their Physical Properties
- A. Concentration terms
  1. Mass percent
  2. Mole fraction
  3. Molarity
  4. Molality
  5. Parts per million

B. Solutions
1. Solubility of solids and gases
2. Vapor pressure - Raoult's Law
3. Osmotic pressure
4. Freezing point depression
5. Boiling point elevation

IV. Chemical Kinetics
A. Rate of reaction
1. Rate laws and rate expression
2. Measuring the rate of reaction
3. Zero, first and second order reactions
a. Graphical determination of order of reaction
b. Integrated form of rate expression
B. Factors that affect the rate of reaction
1. Temperature
2. Concentration
3. Catalysts
4. Activation energy

V. Chemical Equilibrium
A. Dynamic equilibrium
1. Definition
2. Factors that affect the equilibrium – LeChatelier's Principle
B. Equilibrium constant expression
1. The value of Kc
2. The reaction quotient – Qc
3. Calculations involving equilibrium constant – ICE diagrams
C. Solubility product

VI. Acids and Bases
A. Acid base theory
1. Arrhenius theory
2. Bronsted-Lowry theory
3. Lewis theory
B. The pH scale
C. Strong acids/bases and weak acids/bases, Ka
D. Titration of acids/bases
E. Common ion effect in acid/base equilibria
1. Buffer solutions
2. Henderson-Hasselbalch equation
3. Changes in pH
4. Neutralization curve

VII. Entropy and Free Energy
A. Entropy - definition and examples of change in entropy

B. Free energy ΔG
   1. Spontaneous change
   2. Standard free energies
   3. Equilibrium
   4. Effect of temperature

Q. LABORATORY OUTLINE:

1. Check-in, safety, and Determination of Percent Silver in Mixture
2. Estimation of Avogadro's Number with Stearic Acid
3. Orange Oil Extraction
4. Soap Making Chemistry
5. Determination of the Vapor Pressure and Heat of Vaporization of Water
6. Relative Viscosity of Sucrose Solutions
7. Determination of Molecular Mass by Freezing Point Depression
8. Potassium Nitrate Solubility Curve
9. Factors That Affect the Rate of a Chemical Reaction
10. Chemical Kinetics
11. Titration Lab and Determination of Ka Value of a Weak Acid
12. Spectrophotometric Determination of an Equilibrium Constant
13. Determination of Vitamin C
14. Lab Practical