El Camino College

COURSE OUTLINE OF RECORD - Official

I. GENERAL COURSE INFORMATION

Subject and Number: Chemistry 1B
Descriptive Title: General Chemistry II

Course Disciplines: Chemistry

Division: Natural Sciences

Catalog Description: This course details the chemistry of elements and their compounds in periodic groupings, transition metal complexes, chemical equilibrium, chemical thermodynamics, kinetics, aqueous solutions, net ionic equations, oxidation – reduction equations, electrochemistry and nuclear processes. In the laboratory, qualitative analysis of common metallic and nonmetallic ions will be performed, as well as additional experiments on selected lecture topics.

Conditions of Enrollment:

Prerequisite

Chemistry 1A
with a minimum grade of C

Recommended Preparation

eligibility for English 1A

Course Length: [X] Full Term [ ] Other (Specify number of weeks):
Hours Lecture: 5.00 hours per week [ ] TBA
Hours Laboratory: 4.00 hours per week [ ] TBA
Course Units: 5.00

Grading Method: Letter
Credit Status Associate Degree Credit

Transfer CSU: [X] Effective Date: Prior to July 1992
Transfer UC: [X] Effective Date: Prior to July 1992

General Education:

El Camino College: 1 – Natural Sciences
Term: Other:

CSU GE:

B1 - Physical Science

Term: Other:

B3 - Laboratory Sciences

Term: Other:

IGETC:

5A - Physical Science with Lab

Term: Other:

II. OUTCOMES AND OBJECTIVES

A. COURSE STUDENT LEARNING OUTCOMES (The course student learning outcomes are listed below, along with a representative assessment method for each. Student learning outcomes are not subject to review, revision or approval by the College Curriculum Committee)

1. On a written exercise, given the names of chemical compounds, students will be able to write the correct reactant formulas, states of matter (when required), identify reaction type, predict the product formulas and balance the chemical equation
2. Students will be able to create (via molecular models or drawings) accurate representations of compounds. The representations will contain appropriate bonds, lone pairs, and geometry.
3. Students will adhere to safety protocol in the laboratory regarding eye protection. Students will follow the proper procedure regarding wearing goggles in the laboratory, and keeping them on to protect their eyes.

The above SLOs were the most recent available SLOs at the time of course review. For the most current SLO statements, visit the El Camino College SLO webpage at http://www.elcamino.edu/academics/slo/.

B. Course Student Learning Objectives (The major learning objective for students enrolled in this course are listed below, along with a representative assessment method for each)

1. Equilibrium. The student will
   - I. describe what is meant by dynamic equilibrium in a chemical system.
   - II. write the equilibrium constant expression terms of concentrations (K_c) for a reaction.
   - III. given K_p or K_c determine the other.
   - IV. given an equilibrium constant determine the equilibrium concentrations or vice-versa.
   - V. calculate a reaction quotient, Q, and compare it to the equilibrium constant to predict the direction in which a reaction proceeds toward equilibrium.
   - VI. use Le Chatelier's principle to make qualitative predictions concerning the direction equilibrium is shifted when the system is disturbed.
   - VII. relate acid and base strength to structure and calculate pH, pOH, $[H_3O^+]$, $[OH^-]$ for strong and weak acids and bases.
   - VIII. calculate the K_a, pK_a, K_b, and pK_b, of a weak acid or base given the concentration of the acid or base, and vice-versa.
   - IX. describe the ionization of a polyprotic acid in aqueous solution and calculate the concentrations of the different species present in such a solution.
   - X. predict which ions hydrolyze and whether salt solutions are acidic, basic, or neutral.

XI. calculate values of K_a for cations, K_b for anions from ionization constants of their conjugates and from K_w for water.

XII. calculate the pH values of salt solutions in which hydrolysis occurs.

XIII. describe the effect of common ions on the ionization of weak acids and bases and calculate the concentrations of all species present in solutions of weak acids or bases.

XIV. describe the conditions necessary for a buffer and carry out all calculations related to buffer systems.

XV. explain how acid-base indicators work.

XVI. construct a titration curve for any combination of strong and weak acids and bases.

XVII. on titration curves be able to mark the equivalence point, pK_a or pK_b, and the buffer region.

XVIII. write the solubility product expression, K_{sp}, and from the K_{sp} calculate the solubility and vice-versa.

XIX. calculate the effect of common ions on the aqueous solubilities of sparingly soluble salts.

XX. write equations showing the effect of complex ion formation on the other equilibrium processes such as solubility equilibria.

XXI. use precipitation reactions in a qualitative analysis scheme and draw conclusions about the presence or absence of ions in an unknown from experimental observations.

Objective Exams

2. Chemical Thermodynamics. The student will

I. state the Laws of Thermodynamics.

II. relate `Delta` U to ΔH.

III. explain what is meant by entropy and predict whether entropy increases or decreases for certain processes.

IV. explain what is meant by the term spontaneous as related to chemical reactions, and predict whether a reaction will be spontaneous.

V. state the relationship between free energy, enthalpy and entropy and calculate any of these properties.

VI. use tables of standard free energy, enthalpy and entropy values to calculate the change in one of these values for a reaction under standard conditions.

VII. predict the signs of enthalpy, entropy and free energy of simple processes.

VIII. compute equilibrium constants from free energy values.

Quizzes

3. Chemical Kinetics. The student will

I. discuss the factors that control the rate of a reaction and qualitatively predict the effect of a change on the overall rate.

II. derive the differential rate law of a reaction from a set of experimental data.

III. determine graphically or through calculation the value of the rate constant, k.

IV. graphically determine the order of a species in a reaction.

V. utilize the integrated rate law to determine the concentration of a species at any given time and vice-versa.

VI. determine if a proposed reaction mechanism is consistent with the observed rate law.

VII. identify reactants, intermediates, catalysts and products in a reaction mechanism.

VIII. discuss and apply the various theories of kinetics: collision, transition state.

IX. interpret a reaction coordinate diagram- identify rate determine step, intermediates, transition states, activation energies.

X. use the Arrhenius equation to calculate rate constants at other temperatures.

XI. discuss the effect of catalysis on rates of chemical reactions.

Homework Problems

4. Electrochemistry. The student is expected to already know how to balance oxidation-reduction equations by oxidation number and half-reaction methods. The student will

I. describe the construction and operation of voltaic and electrolytic cells.

II. use tabulated standard potentials to determine the potential of a cell and predict whether the reaction is spontaneous.

III. state and use equations that relate standard free energy, cell potential and equilibrium constant.

IV. use Faraday's laws to relate the quantity of chemical change produced by a given amount of charge.

V. state and use the Nernst equation.

VI. describe qualitatively how changes in the system affect the overall cell potential.

VII. apply the principles of electrochemistry to corrosion and its prevention.

Objective Exams

5. Metals. The student will

I. compare and contrast the properties and reactions of the representative elements in various groups.

II. state ways in which the transition elements differ from the representative elements and know the trends in their properties.

III. state the major uses for the transition metals.

IV. write distinctive names based on formulas of coordination compounds and complex ions, and distinctive formulas based on names.

V. draw plausible structures for complex ions from information conveyed by their names and formulas.

VI. describe the types of isomerism found amoung coordination compounds and identify the possible isomers in specific cases.

VII. use valence bond theory to describe the structure and bonding of complex ions.

VIII. explain the basis of crystal field theory in bonding in complex ions.

IX. use the spectrochemical series to make predictions about d level splitting and the number of unpaired electrons in complex ions.

X. Explain the origin of color of complex ions.

XI. cite ways in which complex ion equilibria are used in the qualitative analysis scheme.

Objective Exams

6. Nuclear Chemistry. The student will

I. name the different types of radiocactive decay processes and describe the characteristics of their radiation.

II. write nuclear equations for radioactive decay processes.

III. calculate the rate of decay, half-life, or number of radioactive nuclei given any two of the three quantities.

IV. determine the age of a material using ^{14}C dating.

V. perform calculations involving binding energies and mass defects.

VI. discuss nuclear fission, fusion, and the effects of radiation.

VII. discuss the uses of nuclear energy.

Multiple Choice

7. Industrial Chemistry. The student will

I. discuss selected topics in chemistry such as petrochemical industry, polymers, pesticides and metallurgy.

Quizzes

8. Laboratory. The student will

I. become more proficient in the use of volumetric glassware such as a buret, pipet, volumetric flask, pH meter, digital multimeter, spectrophotometer and a variable voltage/current DC power supply with experiments designed to reinforce lecture topics.

II. become more proficient in the use of computers for scientific data graphing and analysis.

III. perform the following experiments in a sequence that allows for covering the relevant lecture concepts before conducing the experiment:

i. Compute graphing and calculations using Microsoft Excel© or a comparable spreadsheet program that students have access to

ii. Chemical kinetics of a crystal violet/hydroxide reaction

iii. Chemical kinetics of an iodine/peroxydisulfate reaction

iv. Chemical equilibrium: Le Chatelier's principle

v. Hydrolysis of salts and pH of buffer solutions

vi. Determination of a solubility product constant

vii. pH titration of a weak unknown acid (student unknowns are issued)

viii. Introduction to qualitative analysis of some common cations and anions (student unknowns are issued)

ix. Electrochemical cells

x. Electrolysis, Faraday's constant and Avogadro's number

xi. Coordination compounds reactions and molecular models, or Synthesis of cobalt(III) coordination compound and molecular models.

Laboratory reports

III. OUTLINE OF SUBJECT MATTER (Topics are detailed enough to enable a qualified instructor to determine the major areas that should be covered as well as ensure consistency from instructor to instructor and semester to semester.)

Lecture or Lab	Approximate Hours	Topic Number	Major Topic
Lecture	5	I	I. Introduction and Review A. Nomenclature B. Net Ionic Equations 1. acid-base

			2. precipitation 3. redox 4. complexation C. Lewis diagrams and valence electron shell pair repulsion (VSEPR) model 1. relationship between structure and acid/base strength
Lecture	12	II	II. Thermodynamics A. 1st law of thermodynamics 1. internal energy ΔU 2. ΔU versus ΔH 3. review of enthalpy i. Hess' Law ii. enthalpy of formation iii. enthalpy of combustion iv. use of bond energies 4. thermochemical diagrams B. Disorder 1. laws of thermodynamics 2. entropy i. absolute entropy ii. entropy changes C. Free Energy 1. spontaneity 2. standard versus non-standard state
Lecture	12	III	III. Kinetics A. Theories 1. collision 2. transition state B. Energy pathways C. Reaction rates 1. determination of rate 2. determination of differential and integrated rate laws 3. rate equations, half-life, and rate constant D. Factors influencing reaction rates E. Reaction mechanisms 1. determination of rate law from mechanism
Lecture	8	IV	IV. Chemical Equilibrium A. Equilibrium constants 1. K_c vs K_p B. Homogeneous equilibria-gas phase 1. calculations 2. quadratic equation vs successive approximation C. Reaction quotient D. Factors influencing equilbria 1. Le Chatelier's principle 2. kinetic vs thermodynamic control

Lecture	18	V	V. Ionic Equilibrium A. Weak Acid-Base Equilibria 1. equilibrium constants i. K_a and K_b ii. equilibrium concentration iii. pH and K_w 2. percent ionization 3. common ion effect 4. buffer solutions 5. hydrolysis B. Polyprotic Acids 1. equilibrium concentrations 2. pH of solutions C. Titration Curves 1. strong acid vs strong base 2. strong acid vs weak base / weak acid vs strong base 3. polyprotic acids 4. acid-base indicators D. Solubility Equilibria 1. solubility product, K_{sp} 2. K_{sp} and solubility 3. common ion effect 4. K_{sp} and precipitation 5. K_{sp} and dissolving of precipitates E. Complex Equilibria 1. complex formation i. stability constants 2. use to prevent or dissolve precipitates F. Redox Equilibria
Lecture	9	VI	VI. Electrochemistry A. Electrolysis 1. cell construction 2. Faraday's Law 3. electroplating B. Voltaic Cells 1. cell construction and notation 2. cell potential 3. electromotive series C. Nernst Equation D. Applications 1. corrosion 2. production
Lecture	10	VII	VII. Metals A. Periodic Review 1. trends B. Representative Metals

			1. alkali metals, alkaline earth metals, p-block elements, zinc family i. properties ii. preparation iii. uses iv. compounds and reactions C. Transition metals 1. properties and trends 2. reactions of selected transition metals
Lecture	6	VIII	VIII. Coordination Compounds and Complex Ions A. Properties B. Nomenclature and Geometry C. Stability D. Bonding in Complex Ions 1. valence bond 2. crystal field theory i. calculation of crystal field splitting energy 3. spectrochemical series
Lecture	6	IX	IX. Nuclear Chemistry A. Nuclear Stability 1. mass, energy and nuclear binding energy 2. isotopes B. Half-life 1. dating C. Nuclear Reactions 1. radioactivity 2. nuclear equations 3. nuclear fission 4. nuclear fusion D. Uses
Lecture	4	X	X. Selected Topics. Possibilities A. Metallurgy B. Polymers C. Pesticides D. Petrochemical Industry
Lab	72	XI	XI. Laboratory A. Computer graphing and calculations using a spreadsheet program B. Kinetics of crystal violet reaction C. Chemical equilibrium: Le Chatelier's principle D. Hydrolysis of salts and pH of buffer solutions E. Determination of a solubility product constant F. pH titration of a weak unknown acid G. Introduction to qualitative analysis of some common anions and unknown determinations H. Electrochemical cells

			I. Electrolysis, Faraday's constant and Avogadro's number J. Coordination compounds reactions and molecular models, or Synthesis of cobalt (III) coordination compound and molecular models
Total Lecture Hours	90		
Total Laboratory Hours	72		
Total Hours	162		

IV. PRIMARY METHOD OF EVALUATION AND SAMPLE ASSIGNMENTS

A. **PRIMARY METHOD OF EVALUATION:**

Problem solving demonstrations (computational or non-computational)

B. **TYPICAL ASSIGNMENT USING PRIMARY METHOD OF EVALUATION:**

A certain reaction is 5.00 times faster at 98.0°C than it is at 25.0°C. Calculate the activation energy for the reaction.

C. **COLLEGE-LEVEL CRITICAL THINKING ASSIGNMENTS:**

1. Consider the reaction: H_2 (g) + I_2 (g) ↔ 2 HI (g)

   A reaction mixture in a 3.67 L flask at a certain temperature initially contains 0.763 g H_2 and 96.9 g I_2. At equilibrium, the flask contains 90.4 g HI. Calculate the equilibrium constant (K_c) for this reaction.

2. The reaction $C_4H_9Br + OH^- \rightarrow C_4H_9OH + Br^-$ follows a rate law of $-d[C_4H_9Br]/dt = k[C_4H_9Br]$. Traces of $C_4H_9^+$ are found in the reaction solution. Propose a mechanism for the reaction. Desribe how the observations support your mechanism.

D. **OTHER TYPICAL ASSESSMENT AND EVALUATION METHODS:**

Essay exams

Objective Exams

Other exams

Quizzes

Written homework

Laboratory reports

Homework Problems

Multiple Choice

Completion

Matching Items

True/False

V. INSTRUCTIONAL METHODS

Demonstration
Discussion
Laboratory
Lecture
Other (please specify)
Problem-solving sessions

Note: In compliance with Board Policies 1600 and 3410, Title 5 California Code of Regulations, the Rehabilitation Act of 1973, and Sections 504 and 508 of the Americans with Disabilities Act, instruction delivery shall provide access, full inclusion, and effective communication for students with disabilities.

VI. WORK OUTSIDE OF CLASS

Study
Answer questions
Required reading
Problem solving activities

Estimated Independent Study Hours per Week: 8

VII. TEXTS AND MATERIALS

A. **UP-TO-DATE REPRESENTATIVE TEXTBOOKS**
El Camino College. Catalyst: The Prentice Hall Custom Laboratory Program for Chemistry. Prentice Hall, 2008.
Petrucci, et al.. General Chemistry: Principles and Modern Applications. 11 ed. Pearson, 2016.

B. **ALTERNATIVE TEXTBOOKS**

C. **REQUIRED SUPPLEMENTARY READINGS**

D. **OTHER REQUIRED MATERIALS**
Scientific calculator
Safety goggles
Research style laboratory notebook with duplicate pages

VIII. CONDITIONS OF ENROLLMENT

A. Requisites (Course and Non-Course Prerequisites and Corequisites)

Requisites	Category and Justification
Course Prerequisite Chemistry-1A	Sequential

B. Requisite Skills

Requisite Skills
Be able to write not ionic equations for double displacement (neutralization, precipitation and molecular product formation) and acid/base reactions. CHEM 1A - Aqueous solutions: The student will a. explain solubility in terms of properties of both solute and solvent. b. determine concentrations of solutions quantitatively and experimentally. c. give qualitative and quantitative descriptions of solution properties as a function of solute type and solute concentration. d. classify solutes as strong, weak, or nonelectrolytes. e. write net ionic equations for chemical reactions.
Write formulas for chemical compounds given the names, and vice versa. CHEM 1A - The student will be more proficient in a. the use of scientific terminology. b. the naming and writing of chemical formulas for inorganic compounds: binary nonmetal compounds, salts, acids and bases. c. writing and classifying chemical equations for elementary chemical reactions. d. performing stoichiometric calculations involving chemical reactions.
Know basic types of chemical reactions and how to predict their products. CHEM 1A - The student will be more proficient in a. the use of scientific terminology. b. the naming and writing of chemical formulas for inorganic compounds: binary nonmetal compounds, salts, acids and bases. c. writing and classifying chemical equations for elementary chemical reactions. d. performing stoichiometric calculations involving chemical reactions.
Identify the oxidation number of an atom in a compound or ion. CHEM 1A - Oxidation-Reduction: The student will a. determine oxidation numbers. b. balance oxidation-reduction equations. c. identify oxidizing and reducing agents.
Balance redox reactions by the half-reaction method. CHEM 1A - Oxidation-Reduction: The student will a. determine oxidation numbers. b. balance oxidation-reduction equations. c. identify oxidizing and reducing agents.
Perform stoichiometric (solution) and solution concentration calculations. CHEM 1A - The student will be more proficient in a. the use of scientific terminology. b. the naming and writing of chemical formulas for inorganic compounds: binary nonmetal compounds, salts, acids and bases. c. writing and classifying chemical equations for elementary chemical reactions. d. performing stoichiometric calculations involving chemical reactions. CHEM 1A - Aqueous solutions: The student will a. explain solubility in terms of properties of both solute and solvent. b. determine concentrations of solutions quantitatively and experimentally. c. give qualitative and quantitative descriptions of solution properties as a function of solute type and solute concentration. d. classify solutes as strong, weak, or nonelectrolytes. e. write net ionic equations for chemical reactions.
Write electron configurations for atoms and ions. CHEM 1A - Structure: The student will a. provide a historical picture of the development of atomic theory. b. be able to state the fundamentals of quantum theory; assign quantum numbers and construct orbital diagrams. c. predict and explain periodic trends of elements in terms of electronic configurations. d. describe and illustrate the structure and bonding of molecules by constructing Lewis

structures, sketching and labeling the molecular geometries of a molecule, describing the hybridization of the atoms involved, and determining polarity. e. predict and explain properties of molecules in terms of structure and bonding. f. predict and explain properties of conductors, semiconductors and insulators in terms of structure and bonding.
Write Lewis structures, including resonance forms and molecular geometry. CHEM 1A - Structure: The student will a. provide a historical picture of the development of atomic theory. b. be able to state the fundamentals of quantum theory; assign quantum numbers and construct orbital diagrams. c. predict and explain periodic trends of elements in terms of electronic configurations. d. describe and illustrate the structure and bonding of molecules by constructing Lewis structures, sketching and labeling the molecular geometries of a molecule, describing the hybridization of the atoms involved, and determining polarity. e. predict and explain properties of molecules in terms of structure and bonding. f. predict and explain properties of conductors, semiconductors and insulators in terms of structure and bonding.
Understand the concepts of molecular orbital theory. CHEM 1A - Structure: The student will a. provide a historical picture of the development of atomic theory. b. be able to state the fundamentals of quantum theory; assign quantum numbers and construct orbital diagrams. c. predict and explain periodic trends of elements in terms of electronic configurations. d. describe and illustrate the structure and bonding of molecules by constructing Lewis structures, sketching and labeling the molecular geometries of a molecule, describing the hybridization of the atoms involved, and determining polarity. e. predict and explain properties of molecules in terms of structure and bonding. f. predict and explain properties of conductors, semiconductors and insulators in terms of structure and bonding.
Understand and apply Arrhenius, Bronsted-Lowry and Lewis acid/base concepts. CHEM 1A - Acids and bases: The student will a. compare and contrast acid-base theories b. predict acid strengths based on structure. c. write and classify acid-base reactions.

C. Recommended Preparations (Course and Non-Course)

Recommended Preparation	Category and Justification
Non-Course Recommended Preparation eligibility for English 1A	In order to succeed in the course, students must be able to read a college level textbook and answer essay questions explaining chemistry concepts and principles.

D. Recommended Skills

Recommended Skills
Read and apply critical thinking skills to college-level expository prose for the purposes of writing and discussion ENGL A - Read and apply critical thinking skills to college-level expository prose for the purposes of writing and discussion.
Select and employ reading strategies to interpret the content of a college-level textbook, with special focus on constructing a thesis statement and providing valid support. ENGL A - Read and apply critical thinking skills to college-level expository prose for the purposes of writing and discussion. ENGL 84 -

Select and employ reading strategies to interpret the content of a college-level textbook, with special focus on constructing a thesis statement and providing valid support.

E. Enrollment Limitations

Enrollment Limitations and Category	Enrollment Limitations Impact

Course created by J. E. McQuerrey and J. c. Hileman on 02/01/1965.

BOARD APPROVAL DATE:

LAST BOARD APPROVAL DATE: 12/18/2017

Last Reviewed and/or Revised by Soshanna Potter on 01/31/2012

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