Course Acronym:	CHEM
Course Number:	1B
Descriptive Title:	General Chemistry II
Division:	Natural Sciences
Department:	Chemistry
Course Disciplines:	Chemistry
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.
Prerequisite:	Chemistry 1A with a minimum grade of C
Co-requisite:	
Recommended Preparation:	Eligibility for English 1A
Enrollment Limitation:	
Hours Lecture (per week):	3
Hours Laboratory (per week):	6
Outside Study Hours:	6
Total Course Hours:	162
Course Units:	5
Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable
Transfer CSU:	Yes
Effective Date:	Prior to July 1992
Transfer UC:	Yes
Effective Date:	prior to 1992
General Education: ECC	Area 1 - Natural Sciences
Term:	
Other:	
CSU GE:	Area B1 - Physical Universe and its Life Forms: Physical Science, Area B3 - Physical Universe and its Life Forms: Laborator Activity
Term:	
Other:	

IGETC:	Area 5A - Physical Science
Term:	
Other:	
Student Learning Outcomes:	**SLO #1 Equation Writing** 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. **SLO #2 Structural Representations of Compounds** 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. **SLO #3 Lab Safety** 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.
Course Objectives:	1. **Equilibrium. The student will** a. describe what is meant by dynamic equilibrium in a chemical system. b. write the equilibrium constant expression terms of concentrations (Kc) for a reaction. c. given Kp or Kc determine the other. d. given an equilibrium constant determine the equilibrium concentrations or vice- versa. e. calculate a reaction quotient, Q, and compare it to the equilibrium constant to predict the direction in which a reaction proceeds toward equilibrium. f. use Le Chatelier's principle to make qualitative predictions concerning the direction equilibrium is shifted when the system is disturbed. g. relate acid and base strength to structure and calculate pH, pOH, [H3O+], [OH-] for strong and weak acids and bases. h. calculate the Ka, pKa, Kb, and pKb, of a weak acid or base given the concentration of the acid or base, and vice-versa. i. describe the ionization of a polyprotic acid in aqueous solution and calculate the concentrations of the different species present in such a solution. j. predict which ions hydrolyze and whether salt solutions are acidic, basic, or neutral. k. calculate values of Ka for cations, Kb for anions from ionization constants of their conjugates and from Kw for water. l. calculate the pH values of salt solutions in which hydrolysis occurs. m. 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. n. describe the conditions necessary for a buffer and carry out all calculations related to buffer systems. o. explain how acid-base indicators work. p. construct a titration curve for any combination of strong and weak acids and bases.

q. on titration curves be able to mark the equivalence point, pKa or pKb, and the buffer region.
r. write the solubility product expression, Ksp, and from the Ksp calculate the solubility and vice-versa.
s. calculate the effect of common ions on the aqueous solubilities of sparingly soluble salts.
t. write equations showing the effect of complex ion formation on the other equilibrium processes such as solubility equilibria.
u. use precipitation reactions in a qualitative analysis scheme and draw conclusions about the presence or absence of ions in an unknown from experimental observations.

2. **Chemical Thermodynamics. The student will**
   a. state the Laws of Thermodynamics.
   b. relate `Delta` U to H.
   c. explain what is meant by entropy and predict whether entropy increases or decreases for certain processes.
   d. explain what is meant by the term spontaneous as related to chemical reactions, and predict whether a reaction will be spontaneous.
   e. state the relationship between free energy, enthalpy and entropy and calculate any of these properties.
   f. 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.
   g. predict the signs of enthalpy, entropy and free energy of simple processes.
   h. compute equilibrium constants from free energy values.

3. **Chemical Kinetics. The student will**
   a. discuss the factors that control the rate of a reaction and qualitatively predict the effect of a change on the overall rate.
   b. derive the differential rate law of a reaction from a set of experimental data.
   c. determine graphically or through calculation the value of the rate constant, k.
   d. graphically determine the order of a species in a reaction.
   e. utilize the integrated rate law to determine the concentration of a species at any given time and vice-versa.
   f. determine if a proposed reaction mechanism is consistent with the observed rate law.
   g. identify reactants, intermediates, catalysts and products in a reaction mechanism.
   h. discuss and apply the various theories of kinetics: collision, transition state.
   i. interpret a reaction coordinate diagram- identify rate determine step, intermediates, transition states, activation energies.
   j. use the Arrhenius equation to calculate rate constants at other temperatures.
   k. 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**
    a. describe the construction and operation of voltaic and electrolytic cells.
    b. use tabulated standard potentials to determine the potential of a cell and predict whether the reaction is spontaneous.
    c. state and use equations that relate standard free energy, cell potential and equilibrium constant.
    d. use Faraday's laws to relate the quantity of chemical change produced by a given amount of charge.
    e. state and use the Nernst equation.
    f. describe qualitatively how changes in the system affect the overall cell potential.
    g. apply the principles of electrochemistry to corrosion and its prevention.
5. **Metals. The student will**
    a. compare and contrast the properties and reactions of the representative elements in various groups.
    b. state ways in which the transition elements differ from the representative elements and know the trends in their properties.
    c. state the major uses for the transition metals.
    d. write distinctive names based on formulas of coordination compounds and complex ions, and distinctive formulas based on names.
    e. draw plausible structures for complex ions from information conveyed by their names and formulas.
    f. describe the types of isomerism found amoung coordination compounds and identify the possible isomers in specific cases.
    g. use valence bond theory to describe the structure and bonding of complex ions.
    h. explain the basis of crystal field theory in bonding in complex ions.
    i. use the spectrochemical series to make predictions about d level splitting and the number of unpaired electrons in complex ions.
    j. Explain the origin of color of complex ions.
    k. cite ways in which complex ion equilibria are used in the qualitative analysis scheme.
6. **Nuclear Chemistry. The student will**
    a. name the different types of radiocactive decay processes and describe the characteristics of their radiation.
    b. write nuclear equations for radioactive decay processes.
    c. calculate the rate of decay, half-life, or number of radioactive nuclei given any two of the three quantities.
    d. determine the age of a material using 14C dating.
    e. perform calculations involving binding energies and mass defects.
    f. discuss nuclear fission, fusion, and the effects of radiation.
    g. discuss the uses of nuclear energy.
7. **Industrial Chemistry. The student will**
    a. discuss selected topics in chemistry such as petrochemical industry, polymers, pesticides and metallurgy.

	8. **Laboratory. The student will** a. 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. b. become more proficient in the use of computers for scientific data graphing and analysis. c. perform the following experiments in a sequence that allows for covering the relevant lecture concepts before conducing the experiment: d. i. Compute graphing and calculations using Microsoft Excel© or a comparable spreadsheet program that students have access to e. ii. Chemical kinetics of a crystal violet/hydroxide reaction f. iii. Chemical kinetics of an iodine/peroxydisulfate reaction g. iv. Chemical equilibrium: Le Chatelier's principle h. v. Hydrolysis of salts and pH of buffer solutions i. vi. Determination of a solubility product constant j. vii. pH titration of a weak unknown acid (student unknowns are issued) k. viii. Introduction to qualitative analysis of some common cations and anions (student unknowns are issued) l. ix. Electrochemical cells m. x. Electrolysis, Faraday's constant and Avogadro's number n. xi. Coordination compounds reactions and molecular models, or Synthesis of cobalt(III) coordination compound and molecular models.
Major Topics:	**I. Thermodynamics (8 hours, lecture)** A. 1st law of thermodynamics 1. internal energy ΔU 2. ΔU versus ΔH 3. review of enthalpy a. Hess' Law b. enthalpy of formation c. enthalpy of combustion d. use of bond energies 4. thermochemical diagrams B. Disorder 1. laws of thermodynamics 2. entropy a. absolute entropy b. entropy changes C. Free Energy 1. spontaneity 2. standard versus non-standard state **II. Kinetics (9 hours, lecture)** 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

III. Chemical Equilibrium (6 hours, lecture)

A. Equilibrium constants
   1. Kc vs Kp

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

IV. Ionic Equilibrium (15 hours, lecture)

A. Weak Acid-Base Equilibria
   1. equilibrium constants
      a. Ka and Kb
      b. equilibrium concentration
      c. pH and Kw
   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, Ksp
   2. Ksp and solubility
   3. common ion effect
   4. Ksp and precipitation
   5. Ksp and dissolving of precipitates

E. Complex Equilibria
   1. complex formation
      a. stability constants
   2. use to prevent or dissolve precipitates

F. Redox Equilibria

V. Electrochemistry (6 hours, lecture)

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

VI. Coordination Compounds and Complex Ions (6 hours, lecture)

A. Properties
B. Nomenclature and Geometry
C. Stability
D. Bonding in Complex Ions
    1. valence bond
    2. crystal field theory
        a. calculation of crystal field splitting energy
    3. spectrochemical series

VII. Nuclear Chemistry (4 hours, lecture)

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

VIII. Laboratory (108 hours, lab)

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

	A. Molecular Models J. Coordination compounds reactions or Synthesis of cobalt (III) coordination compound and molecular models. K. Determination of an Equilibrium Constant
Total Lecture Hours:	54
Total Laboratory Hours:	108
Total Hours:	162
Primary Method of Evaluation:	2) Problem solving demonstrations (computational or non-computational)
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.
Critical Thinking Assignment 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 (Kc) for this reaction.
Critical Thinking Assignment 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. Describe how the observations support your mechanism.
Other Evaluation Methods:	Completion, Essay Exams, Homework Problems, Laboratory Reports, Matching Items, Multiple Choice, Objective Exam, Other Exams, Quizzes, True/False, Written Homework
Instructional Methods:	Demonstration, Discussion, Lab, Lecture
If other:	Problem-solving sessions
Work Outside of Class:	Answer questions, Problem solving activity, Required reading, Study
If Other:	
Up-To-Date Representative Texts:	Lab Manual: El Camino College. Catalyst: The Prentice Hall Custom Laboratory Program for Chemistry. Prentice Hall, 2008. (Discipline Standard) Main Text: Petrucci, et al. General Chemistry: Principles and Modern Applications. 11 ed. Pearson, 2016. (Discipline Standard)
Alternative Texts:	
Required Supplementary Readings:	
Other Required Materials:	
Requisite:	Prerequisite
Category:	sequential
Requisite course(s): List both prerequisites and corequisites in this box.	Chemistry-1A

Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).	**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.
Requisite Skill:	
Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable	
Requisite course:	
Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s).	
Requisite Skill:	Eligibility for English 1A
Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). If applicable	**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**. **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.** Read and apply critical thinking skills to college-level expository prose for the purposes of writing and discussion.
Enrollment Limitations and Category:	

Enrollment Limitations Impact:	
Course Created by:	J. E. McQuerrey and J. c. Hileman
Date:	02/01/1965
Original Board Approval Date:	SPRING 1965
Last Reviewed and/or Revised by:	Miguel Jimenez
Date:	09/19/2023
Last Board Approval Date:	12/18/2023
Effective Term:	FALL 2024