Course Name: General Chemistry II

Course Number: CHE* E122

Credits: 4

Catalog description: A continuation of CHE* E121. Topics include chemical kinetics and equilibria, ionic equilibria, solubility product principles, chemical thermodynamics, electrochemistry, oxidation-reduction and an introduction to organic and nuclear chemistry and the chemistry of the elements and their compounds. The laboratory will include an introduction to semi-micro qualitative analysis. The laboratory program stresses the acquisition of skills in data gathering and in the interpretation of data. Safe manipulation of materials and the development of skill in the use of laboratory apparatus are stressed. 3 hours of lecture and 3 hours of laboratory.

Prerequisites: CHE*E121 and MAT* E172 or equivalent

General Education Competencies Satisfied:

HCC General Education Requirement Designated Competency Attribute Code(s):

☒ **SCKX** **Scientific Knowledge & Understanding**

Additional CSCU General Education Requirements for CSCU Transfer Degree Programs:

☒ **SCRX** **Scientific Reasoning**

Discipline-Specific Attribute Code(s):

☒ **SCI** **Science elective**

Course objectives:

General Education Goals and Outcomes:

☒ **Scientific Knowledge & Understanding:** Students will gain a broad base of scientific knowledge and methodologies in the natural sciences. This will enable them to develop scientific literacy, the knowledge and understanding of scientific concepts and processes essential for personal decision making and understanding scientific issues.

☒ **Scientific Reasoning (*for CSCU Transfer Degree Programs*):** Students will become familiar with science as a method of inquiry. Students will develop a habit of mind that uses quantitative skills to solve problems and make informed decisions.

Course Specific Objectives:

Lecture:

1. Demonstrate the ability to correctly use complex chemical nomenclature and molecular models to describe, interpret and predict physical and chemical phenomena.
2. Explain the basic principles, which underlie physical and chemical change and use them to predict physical and chemical behavior.
3. Identify and quantitate the relationships among chemical principles such as Kinetics, Equilibrium and Thermodynamics.
4. Compare the findings of classical vs. recent experiments/observations in chemistry and how these findings were used to refine or replace existing chemical theory.
5. Apply basic statistics, algebra and logarithms in the solving of chemical problems and the treatment of chemical data.
6. Evaluate the results obtained from quantitative methods for accuracy and/or reasonableness.

Laboratory:

1. Accurately use measuring devices such as balances, volumetric glassware, thermometers, UV/VIS Spectrophotometers, IR Spectrophotometers and melting point apparatus to gather data in the chemistry laboratory.
2. Perform laboratory operations such as titrations, synthesis, identifications and classifications.
3. Plan and carry out chemical processes that illustrate and amplify the theoretical concepts examined in the lectures.
4. Plan, collect, correlate and present data to confirm chemical theory and make quantitative predictions about the composition of matter.
5. Analyze the results of a chemical laboratory experiment for accuracy and or precision using basic statistics.
6. Correct data for instrumental and personal error both of which are inherent in the measurement of 'real' quantities.
7. Work safely in the laboratory following all instructor and professionally recommended safety guidelines, disposing of chemical waste in an environmentally responsible manner.

Course Content:

Lecture:

Liquids and Solids

1. Intermolecular forces
2. Solubility predictions based on structure
3. Liquid-vapor equilibrium
4. Phase diagrams
5. Colligative properties

Rate of Reaction

1. Definition
2. Concentration dependence
3. Order of reactions
4. Activation energy
5. Temperature effect
6. Reaction mechanism
7. Catalysis

Gaseous Equilibrium

1. The equilibrium constant
2. General expression for K
    a. Gases only
    b. Solids or liquids as well as gases
    c. Aqueous solutions
3. Relations between K's
4. Calculating K
5. Applications
6. Effect of changes in conditions on equilibrium (LeChatelier's Principle)

Acids, Bases and Salts

1. Bronsted-Lowry model
2. Equilibria between H^+ and OH^-, K_w
3. pH, pOH, $[H^+]$ and $[OH^-]$
4. Weak acids and bases
5. K_a, K_b, K_f

Acid-Base and Precipitation Equilibria

1. Acid-base titrations
2. End point and equivalence point
3. Choice of indicator
4. Buffers

5. K_{sp}

Complex Ions and Coordination Compounds

1. Definitions
2. Lewis acids and Lewis bases
3. Ligands

Reaction Spontaneity

1. Enthalpy and Entropy
2. ΔS and ΔH
3. Free Energy, Gibbs-Helmholtz
4. Calculation of ΔG^o from ΔS^o and ΔH^o
5. Calculation of ΔG^o at 25°C from ΔG_f^o
6. Calculation of ΔG from ΔG^o
7. Relation of ΔG^o and K

Electrochemistry

1. Voltaic cells
2. Cell notation
3. Standard voltages
4. Balancing Redox Reactions in Acid and Base
5. Relative strengths of redox agent
6. Calculating E^o
7. Relation among E^o, ΔG^o and K
8. Nernst equation
9. Electrolytic cells
10. Commercial cells

Nuclear Chemistry

1. Natural radioactivity
2. Induced radioactivity
3. Rate of decay
4. Mass-energy relations
5. Fission
6. Fusion

Introduction to Organic Chemistry

1. Hydrocarbons
2. Nomenclature
3. Functional groups
4. Polymers
5. Infrared spectroscopy

Laboratory:

Introduction

1. Discuss safety procedures
2. Explain use of safety equipment
3. Locker assignments and check-in.
4. Explain how to maintain a laboratory notebook.

Analytical Balances

1. Review of care and operation

Colligative Properties

1. Molar mass determination by freezing point depression
2. Boiling point elevation

Synthesis and Purification of Simple Organic Compounds

1. Suction devices
2. Solubility and Intermolecular Forces
3. Melting Point determination

UV/VIS Spectrophotometry

1. Use of Spectrophotometer
2. Beer's Law Calibration using Linear Regression
3. Use of MS Excel to perform linear regression
4. Calculation and Meaning of Correlation Coefficient
5. Use of volumetric glassware
6. Quantitative Analysis of various analytes

Rate of Reaction

1. Experimental determination of reaction order
2. Calculation of the Rate Constant "k"

Equilibrium

1. Meaning
2. LeChatelier's Principle
3. Determination of the Equilibrium Constant K_{eq}

Acid/Base Chemistry

1. Acid/Base Indicators
2. Calibration of digital pH meter
3. Measurement of pH
4. Buffer construction and calculations
5. Acid/Base Titration
6. Molar Mass determination

Qualitative Analysis of Organic Functional Groups

1. Tollens' test

2. Melting point
3. Test for unsaturation
4. Test for alcohols

Infrared Spectroscopy

1. Theory
2. Functional group assignments in infrared spectra
3. Unknown identification by functional group peaks
4. Unknown identification by comparison to known spectra in an electronic spectral database

Oxidation/Reduction

1. Redox Titration to determine percent composition of mixture
2. Electrolysis to determine Equivalent Mass of unknown

HCC Safety Standard

Instruction covering all safety rules and guidelines will be provided by the instructor during the first laboratory session. The safety features of the individual laboratory will also be highlighted by the instructor. Students are expected to read and understand the rules of the HCC Science Laboratory Student Safety Contract. The students will then sign this contract signifying that they have been instructed and understand the requirements for safety pertaining to their course. The student and instructor will each keep a copy of this contract. Students must come to the laboratory prepared for the laboratory activity. Students must abide by the safety rules and guidelines which may include wearing personal protection equipment. Failure to do so may result in removal from the laboratory by the instructor.

Date Course Created:

Date of Last Revision: 02/27/2017