CHEM 1B: GENERAL CHEMISTRY

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2024
Units:	5
Hours:	3 lecture, 6 laboratory per week (108 total per quarter)
Prerequisite:	CHEM 1A.
Advisory:	MATH 48B or equivalent Precalculus II course; not open to students with credit in CHEM 1BH.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Demonstrate the ability to think critically and employ critical thinking skills.
- Read and interpret graphs and data.
- Demonstrate the quantitative skills needed to succeed in General Chemistry.

Description

Kinetic molecular theory and gas laws, intermolecular forces, chemical kinetics, equilibria, behavior of acids and bases, acid/base equilibrium, and classical thermodynamics. Laboratory parallels lecture topics and includes computer graphing techniques, chemical kinetics, equilibrium measurements, heat transfer experiments, thermodynamics of an equilibrium system, vapor pressure of liquids.

Course Objectives

The student will be able to:

1. Understand gas behavior and do a variety of gas law problems.
2. Understand and apply the postulates of kinetic molecular theory.
3. Explain changes in physical states of matter.
4. Perform a series of calculations relating to phase changes and vapor pressure of liquids.
5. Describe and analyze factors that influence rates of chemical reactions.
6. Calculate rate, concentration, or time variables based on the integrated rate laws.
7. Express equilibrium constants for chemical reactions in gas phase and in solutions.
8. Apply Le Chatelier's principle and understand how Keq and Q are related.
9. Mathematically apply equilibrium theory to a variety of problems.
10. Define, measure, and calculate pH of aqueous solutions.
11. Understand weak acids and bases and their behavior.
12. Mathematically solve acid base equilibrium problems.
13. Understand the three laws of thermodynamics and their importance in understanding energy changes.
14. Discuss the concept of entropy and its importance in chemical and physical changes.
15. Mathematically determine dH, dS, and dG for a chemical system.
16. Relate free energy changes to the equilibrium constant.
17. Collect and analyze experimental data and derive the required conclusions.
18. Analyze linear and non-linear data graphically using a computer.

Course Content

1. Gases
   a. Kinetic molecular theory
   b. Gas law problems
2. Liquids and solids
   a. Kinetic-molecular description of liquids and solids
   b. Intermolecular forces and phase changes
   c. Intermolecular forces in organic molecules
   d. Properties of liquids
   e. Clausius-Clapeyron equation
   f. Heat transfer
   g. Cubic crystal structures
      i. Coordination number
      ii. Simple cubic
      iii. Body-centered cubic
      iv. Face-centered cubic
      v. Ionic crystal structures
3. Chemical kinetics
   a. Rates of reactions
   b. Factors that affect reaction rates
   c. Integrated rate equations
   d. Reaction order
   e. Collision theory and transition state theory
   f. Arrhenius equation
   g. Catalysts
4. Chemical equilibrium
   a. Law of mass action
   b. Equilibrium constants and their uses
   c. Le Chatelier's principle
   d. Relationship between free energy and equilibrium constants
   e. Temperature dependence of equilibrium constants
5. Acids and bases
   a. Acid-base theories
   b. Properties of aqueous solutions of acids and bases
   c. Strength of acids and bases
   d. Autoionization of water and pH scales
   e. Weak acid and weak base equilibria
   f. Acid and base properties of salt solutions
   g. Acid base structure and strength
   h. Lewis acids and bases
6. Chemical thermodynamics
   a. Three laws of thermodynamics
   b. Enthalpy changes

   c. Hess's Law
   d. Spontaneity of physical and chemical changes, entropy and free energy change
   e. Temperature dependence of spontaneity

Lab Content

Laboratory develops experimental techniques, critical thinking and data analysis skills, and introduces the use of a laboratory notebook. Extensive use of graphical techniques are employed for data analysis. Laboratory topics parallel lecture topics.

1. Collection of experimental data, the lab notebook
   a. Formatting a notebook to accepted laboratory standards
   b. Recording data and observations in ink directly in notebook
   c. Recording quantitative data to the correct precision of the instrument being used
   d. Organizing data, if necessary, into columnar format for presentation
2. Graphical analysis of data
   a. Introduction to the Graphical Analysis software package
   b. Graphing of data in the required manner to observe trends and for analysis
   c. Fitting of data in either a linear or nonlinear fashion
   d. Using fitting constants to determine physical constants of a system
3. Gas behavior and gas laws
   a. Collection of volume-temperature data to demonstrate Charles' Law
   b. Graphical extrapolation to zero volume to estimate absolute zero
4. Changes in physical states of matter
   a. Use of calorimeter to experimentally determine the heat of fusion of water
5. Crystal lattices and unit cells (worksheet and group exercise)
   a. Structure of cubic crystal lattices: simple cubic, face-centered cubic, and body-centered cubic
   b. Calculation of percent space occupied (packing efficiency)
   c. Calculations relating crystal structure, density, and atomic mass
6. Investigating intermolecular forces
   a. Hydrophobic and hydrophylic substances
   b. Determining the length of a stearic acid molecule
   c. Investigation of volume and energy changes upon mixing of two liquids
7. Chemical kinetics
   a. Experimentally observe how concentration influences reaction rate
      i. Determination of reaction orders by the method of initial rates
   b. Experimentally observe how temperature influences reaction rate
      i. Graphically determine activation energy using an Arrhenius (rate constant versus temperature) graph
   c. Collect and graph concentration vs. time data for a kinetic system
      i. Use of colorimeter to measure absorbance values as a function of time for a kinetic system in solution
      ii. Collecting data for and constructing a Beer's Law graph to convert absorbance values into concentration values
      iii. Application of the integrated rated laws to concentration vs. time graphical data
      iv. Use of graphical data to find reaction order, rate constant, and half-life
      v. Calculation of concentration, rate, and time variables using integrated rate laws
8. Chemical equilibrium
   a. Experimentally find the equilibrium constant for a simple system
      i. Measurement of absorbance values for a system at equilibrium
      ii. Converting absorbance to concentration using a Beer's Law graph
   b. Calculation of equilibrium concentrations based on an experimentally determined Keq
9. Acids and bases
   a. Introduce use of pH electrode
   b. Using common household acids/bases experimentally find the pH
   c. Using pH find pOH, [OH-], and [H+]
   d. Using pH, rank acids/bases according to strength
   e. Predict the outcome of a variety of acid/base reactions
   f. Use experimental pH data to determine Ka and Kb values of various weak acids and bases
10. Thermodynamics
   a. Experimentally determine, via titration, the equilibrium constant for dissolution of a slightly soluble salt at various temperatures
      i. Use the equilibrium data to graphically determine dG, dH, and dS for the solution process
      ii. Use the results to make predictions of solubility at various temperatures
   b. Phase changes
      i. Measurement of vapor pressure versus temperature data for a volatile liquid
      ii. Interpretation of vaporization in terms of heat transfer and entropy changes
      iii. Using a Clausius-Clapeyron (vapor pressure vs. temperature) graph to determine heat of vaporization and entropy of vaporization based on experimental measurements
      iv. Investigating the thermodynamic relationship between dG, vapor pressure, and boiling point
      v. Vapor pressure calculations and prediction of boiling point for various liquids
      vi. Comparison of the vapor pressure of liquids to intermolecular forces and chemical structure

Special Facilities and/or Equipment

1. Chemistry laboratory; safety glasses; Texas Instruments 83, 84, 86, or 89 calculator; specialized hardware for digital data acquisition (Vernier LabPro system); and computers for data analysis.
2. When taught as a hybrid distance learning section, students and faculty need ongoing and continuous internet and email access.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Written lecture examinations on fundamental chemical principles: problem solving skills, conceptual understanding of the material, and ability to integrate concepts
Laboratory activities, worksheets, and reports that parallel lecture topics and include: detailed analysis of equilibrium systems, acids/bases,

thermodynamics, vapor pressure, kinetics, intermolecular forces, and crystal structure
Laboratory notebook
Written lab exams emphasizing chemical equations, problems, calculations, details of experimental techniques, and graphs
Online homework focusing on topics covered in lecture

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture
Laboratory

Representative Text(s) and Other Materials

Tro. Chemistry: Structure and Properties, 3rd ed.. 2023.

Flowers, Neth, Robinson, Theopold, and Langley. Chemistry: Atoms First, 2nd ed. (OpenStax). 2022.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Three hours per week of lecture covering subject matter from text and related material
   a. Reading and study of the textbook, related materials, and notes
2. Homework problems covering subject matter from text and related material ranging from 20-40 problems per week
3. Two hours lab lecture and four hours lab
   a. Reading and studying experimental background, theory, and procedure
   b. Lab notebook containing the purpose, background, procedure, data, analysis, and conclusions for each experiment
   c. Computer graphing and graphical analysis of experimental data
   d. Lab reports: Analysis of data involving quantitative reasoning and calculations, drawing conclusions, critical analysis of results, and integration of concepts
4. Worksheets: Problems and activities covering the subject matter. Such worksheets may be completed both inside and/or outside of lecture and/or lab

Discipline(s)

Chemistry