

CHEM 1A: GENERAL CHEMISTRY

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2023
Units:	5
Hours:	3 lecture, 6 laboratory per week (108 total per quarter)
Prerequisite:	Satisfactory score on the chemistry placement test or CHEM 25; Intermediate Algebra or equivalent.
Advisory:	MATH 48A or equivalent Precalculus I course; not open to students with credit in CHEM 1AH.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Area III: Natural Sciences
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- A student who successfully masters the material in Chemistry 1A at Foothill College will apply the scientific method in lab experiences to interpret information and draw conclusions.
- A student who successfully masters the material in Chemistry 1A at Foothill College will demonstrate the ability to think critically and employ critical thinking skills.
- A student who successfully masters the material in Chemistry 1A at Foothill College will be able to read and interpret graphs and data.
- A student who successfully masters the material in Chemistry 1A at Foothill College will demonstrate the quantitative skills needed to succeed in General Chemistry.

Description

Fundamental chemical principles with an emphasis on physical and chemical properties, stoichiometry, chemical reaction types, kinetic molecular theory, thermochemistry, modern atomic theory and atomic structure, chemical bonding and bonding theory, and molecular shapes. Laboratory component parallels lecture topics and also includes chemical nomenclature, basic chemical equations, stoichiometry, unknown analysis, and fundamentals of oxidation and reduction.

Course Objectives

The student will be able to:

- classify matter and distinguish between chemical and physical properties of matter.
- understand the SI system of units and be able to convert between the English and metric systems of units.
- solve problems using dimensional analysis and report the correct number of significant figures in measured and calculated quantities.
- understand and be able to apply the laws of chemical combination.
- understand the fundamental assumptions of Dalton's atomic theory and be able to describe the structure of the atom.

- understand the terminology and function of the periodic table.
- name and write formulas for ionic compounds, binary molecular compounds, acids, and some simple organic compounds.
- write, balance, and classify chemical equations and recognize patterns of chemical reactivity to predict the products of a chemical reaction.
- write net ionic equations for precipitation, acid-base, and oxidation-reduction reactions.
- understand the meaning and uses of the mole and of Avogadro's number.
- perform stoichiometry calculations and understand the concept of a limiting reactant.
- understand the nature of energy and be able to calculate the energy changes associated with chemical reactions.
- understand Hess's Law and be able to use it to determine heats of reactions.
- explain the electronic structure of atoms using aspects of quantum theory.
- identify the relationship between the periodic table, atomic structure, and periodic properties of the elements.
- understand the basic concepts of chemical bonding.
- construct and identify the geometry and polarity of simple organic molecules and polyatomic ions.
- describe covalent bond formation in terms of the valence-bond theory.

Course Content

- Classification and Properties of Matter
 - Physical states of matter
 - Pure substances and mixtures
 - Physical and chemical properties
 - Intensive and extensive properties
- Units and Unit Conversions
 - SI, metric, and English units
 - Mass, length, volume, temperature, and density
 - Temperature scales
- Problem Solving
 - Significant figures
 - Conversion factors
 - Dimensional analysis
- Laws of Chemical Combination
 - Law of conservation of mass
 - Law of constant composition
 - Law of multiple proportions
- Atomic Theory of Matter
 - Dalton's atomic theory
 - The discovery of subatomic particles
 - Rutherford's nuclear theory
 - Basic atomic structure
 - Atomic number and mass number
 - The atomic mass scale, isotopes, and average atomic mass
 - Mass spectrometry and isotopic abundance
- Electronic Structure of Atoms
 - Electromagnetic radiation
 - Wave-particle duality of light
 - Quantization of energy and photons
 - The photoelectric effect
 - Atomic emission spectra and the Bohr model of the hydrogen atom
 - The wave nature of matter
 - The quantum mechanical picture of the atom
 - Heisenberg uncertainty principle
 - Quantum numbers

- c. Atomic orbitals
- 5. Many-electron atoms
 - a. Energies of orbitals
 - b. Electron spin and the Pauli exclusion principle
 - c. Electron configurations of atoms and ions
- G. Periodic Properties of the Elements
 - 1. Development of the periodic table
 - 2. Periodic properties of the elements
 - a. The concept of effective nuclear charge
 - b. Atomic and ionic radii
 - c. Ionization energy
 - d. Electron affinity
 - e. Group trends for metals and nonmetals
- H. The Periodic Table
 - 1. Periods and groups
 - 2. Metals, nonmetals, and metalloids
 - 3. Predictable ion formation
- I. Nomenclature and Chemical Formulas
 - 1. Molecular compounds and molecules
 - 2. Ionic compounds and formula units
 - 3. Names and formulas of ionic and binary molecular compounds
 - 4. Names and formulas of common binary acids and oxyacids
 - 5. Names and formulas of some simple organic compounds
- J. Chemical Reactions
 - 1. Combination, decomposition, and combustion reactions
 - 2. Solubility of ionic compounds and precipitation reactions
 - 3. Acid-base reactions
 - a. Arrhenius theory
 - b. Bronsted-Lowry theory
 - c. The strength of acids and bases
 - d. Organic acids and bases
 - 4. Oxidation-reduction reactions
 - a. Oxidation numbers
 - b. The activity series
- K. Ionic Equations
 - 1. Strong electrolytes, weak electrolytes, and nonelectrolytes
 - 2. Spectator ions and net ionic equations
- L. The Mole
 - 1. The mole and Avogadro's number
 - 2. Molar mass
 - 3. Mass percent composition
 - 4. Empirical formulas from analyses
- M. Quantitative Information from Balanced Equations
 - 1. The concept of stoichiometry and mole ratios
 - 2. Mole-mole, mole-mass and mass-mass calculations
 - 3. The concept of a limiting reactant
 - 4. Theoretical yield and percent yield
 - 5. Solution stoichiometry
 - a. Molarity
 - b. Dilution of solutions
 - c. Titration calculations
- N. Basic Concepts of Chemical Bonding
 - 1. Chemical bonding
 - a. Valence electrons
 - b. The octet rule
 - c. Ionic bonding
 - d. Covalent bonding
 - e. Covalent bond polarity and electronegativity
 - 2. Lewis structures for simple molecules and polyatomic ions
 - a. Formal charge
 - b. The concept of resonance
 - c. Resonance in organic molecules
 - d. Exceptions to the octet rule
- 3. Energetics of bond formation
 - a. Ionic bonding and lattice energy
 - b. Covalent bond energies and bond lengths
 - c. Enthalpies of reactions using covalent bond energies
- O. Molecular Geometry
 - 1. Valence-shell electron-pair repulsion theory
 - 2. Covalent bond polarity and dipole moments
 - 3. Molecular geometry and polarity of simple molecules and polyatomic ions
- P. Bonding Theory
 - 1. Valence-bond theory
 - a. Covalent bond formation
 - b. The concept of hybrid orbitals
 - c. Sigma and pi bonds
 - d. Delocalized bonding
 - e. Organic bonding models
- Q. Energy and Chemical Reactions
 - 1. Energy, heat, and work
 - 2. System and surroundings
 - 3. The First Law of Thermodynamics and internal energy changes
 - 4. Units of energy
 - 5. Enthalpy
 - 6. Exothermic and endothermic processes
 - 7. Stoichiometry calculations using thermochemical equations
 - 8. Specific heat capacity and constant-pressure calorimetry
- R. Hess's Law
 - 1. State functions
 - 2. Enthalpies of reaction
 - 3. Enthalpies of formation

Lab Content

- A. Exploring Measurements, Significant Figures, and Graphing
 - 1. Learn the difference between precision and accuracy and between systematic and random errors
 - 2. Understand the relationship between precision of a measured quantity and significant figures
 - 3. Effectively collaborate with a group to understand the uses and limitations of common general chemistry laboratory equipment
 - 4. Gain experience in the essentials of good graphing such as proper scaling and labeling of axes, generating descriptive and purposeful titles, and understanding the definition and utility of slopes and intercepts
 - 5. Compare an experimental value for a graphically determined density of water with the accepted value referenced in the CRC Handbook of Chemistry
- B. Determining and Comparing the Densities of a Soda and a Diet Soda
 - 1. Become familiar with the scientific method of investigation
 - 2. Formulate and test a hypothesis
 - 3. Gain experience in the proper use of electronic balances, graduated cylinders, volumetric pipets, and burets
 - 4. Experimentally determine the density of an assigned soda using three different volume measuring devices
 - 5. Organize the pooled density results in a scatter graph to visualize the precision and range of the three different volume measuring devices
 - 6. Effectively communicate within a group to determine which density results should be retained in the calculated average result
- C. Determining the Purity of a Hydrate in an Unknown Mixture
 - 1. Gain experience in effectively using a Bunsen burner
 - 2. Use gravimetric analysis to determine the mass percent purity of a hydrate in an unknown mixture

3. Deduce the impact of several theoretical procedural errors on the experimentally determined mass percent purity
- D. Exploring Solubility Rules, Types of Reactions, and Net Ionic Equations

1. Effectively collaborate with a partner to perform numerous reactions in aqueous solution and detail the observed results
2. Use qualitative observations to predict the products of numerous reactions in aqueous solution and classify each reaction as one of four general types

3. Discover rules of solubility for some ionic compounds in water by analyzing observations and looking for trends and patterns

4. Become proficient at writing net ionic equations

E. Standardizing a Sodium Hydroxide Solution

1. Become familiar with the principles and techniques involved in titrations

2. Use a primary standard to determine the molarity of a sodium hydroxide solution to be used in a subsequent procedure

3. Perform at least three trials to ensure precise results

F. Determining the Molar Mass of an Unknown Solid Acid

1. Gain experience in writing an experimental procedure and organizing data and results

2. Use a previously standardized sodium hydroxide solution to determine the molar mass of an unknown solid acid

3. Refine the proper use of a buret and the application of solution stoichiometry

4. Deduce the impact of several theoretical procedural errors on the experimentally determined molar mass

G. Determining Heats of Reaction using Calorimetry Data

1. Learn some fundamental principles of thermochemistry

2. Use a simple calorimeter and a digital thermometer to measure the temperature change through the course of an assigned reaction

3. Calculate the enthalpy change of the assigned reaction using calorimeter data

4. Critically evaluate the pooled results and effectively argue for which results should be retained in the reported averages

5. Experimentally assess the validity of Hess's law and whether the amount of heat given off or absorbed by a reaction is an intensive or extensive property

H. Exploring Light, Color, and Emission Spectroscopy

1. Understand the Bohr model of the hydrogen atom and its limitations

2. Understand the relationship between the energy, frequency, and wavelength of light

3. Investigate the light emitted by different light sources, including various element discharge tubes plus an incandescent light source, and draw corresponding emission spectra showcasing observed wavelengths of light

4. Match calculated wavelengths using Bohr's equation with observed wavelengths

5. Observe the characteristic colors emitted by various elements when placed in a flame

I. Synthesizing and Characterizing the Composition of an Unknown Green Crystal

1. Understand the recrystallization process of purification and become familiar with the methods of decantation and gravity filtration

2. Calculate a percent yield for the synthesis and propose reasonable procedural errors to account for a less than 100% yield

3. Apply the principles and techniques involved in titrations to a redox reaction to deduce the mass percent of oxalate in the green crystal

4. Perform a dilution and a prepare a solution of precise molarity using volumetric pipets and flasks

5. Become familiar with the operation of a spectrophotometer and use absorption data to graphically determine the mass percent of iron in the green crystal

6. Use gravimetric analysis to determine the mass percent of water in the green crystal

Special Facilities and/or Equipment

A. A chemistry laboratory, safety goggles or Visorgogs, a scientific calculator, and a Mastering Chemistry access code for online homework.

Method(s) of Evaluation

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

- A. Online homework assignments
- B. Written laboratory assignments
- C. Laboratory quizzes
- D. Lecture exams
- E. Comprehensive final examination

Method(s) of Instruction

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

- A. Lecture
- B. Laboratory

Representative Text(s) and Other Materials

Tro, Nivaldo J. *Chemistry: Structure and Properties*. 2nd ed. Pearson, 2018.

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

- A. Homework assignments
 1. There are 40-60 homework problems for each of the twelve chapters covered in this course, roughly half of which are completed and graded online.
- B. Laboratory assignments
 1. There are 9 experiments administered in this course during the biweekly two-hour laboratory sessions for which a pre-laboratory assignment, a data sheet, a calculations sheet, and a post-laboratory assignment are all collected and graded by the instructor.
 2. There are 3 worksheets administered in the laboratory sessions that more richly cover some of the key course concepts, all of which are collected and graded by the instructor.
- C. Additional coursework
 1. The careful and regular reading and rereading of the text and lecture notes is essential to passing this course.
 2. There are several practice worksheets provided by the instructor that showcase more challenging problems and may be completed in-class or as additional homework.

Discipline(s)

Chemistry