Lecture Contact Hours: 48-54; Homework Hours: 96-108; Total Student Learning Hours: 144-162
Laboratory Contact Hours: 96-108; Homework Hours: 0; Total Student Learning Hours: 96-108

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

CHEMISTRY 141 – GENERAL CHEMISTRY I

3 hours lecture, 6 hours laboratory, 5 units

Catalog Description
Basic principles and concepts of chemistry with an emphasis in the areas of stoichiometry, thermochemistry, atomic structure, chemical bonding and gas laws. The laboratory is an introduction to quantitative analysis and the principles of atomic and molecular structures.

Prerequisite
"C" grade or higher or "Pass" in CHEM 120 or equivalent or the CHEM 141 assessment and "C" grade or higher or "Pass" in MATH 110 or equivalent

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Distinguish the different classifications of matter: physical states, pure substances and mixtures, elements and compounds.
2) Understand and interpret the Periodic Table including trends such as atomic size and ionization energy.
3) Classify matter into the different structural units: atoms, molecules, ions, networks.
4) Distinguish the different types of changes, physical vs. chemical, that matter undergoes.
5) Understand the structure of atoms and the nature of subatomic particles; determine the numbers of each type of subatomic particle present in a given atom.
6) Write electronic configurations of atoms and ions.
7) Determine to which class, ionic or covalent, a compound belongs as well as write the chemical formula and name of the compound.
8) Perform conversions between metric and English units; express numbers in scientific notation.
9) Understand and correctly solve problems using the unit of the mole.
10) Perform chemical calculations expressing answers to the correct number of significant figures.
11) Predict the products of chemical reactions and write balanced chemical equations for specific types of reactions.
12) Use the techniques of dimensional analysis to solve stoichiometric problems including limiting reactant and percent yield.
13) Perform stoichiometric calculations involving aqueous solutions.
14) Write electron dot structures; predict and draw the geometry of molecules and polyatomic ions.
15) Classify bonds into their various types: nonpolar, polar, ionic.
16) Predict physical properties of substances, e.g., solubility and boiling point, based on their polarity.
17) Identify common acids and bases and explain their properties, including differences between strong and weak.
18) Calculate pH and hydrogen ion concentration.
19) Plot data graphically; analyze data using computer spreadsheet programs.
20) Identify oxidation-reduction reactions and write the corresponding half reactions.
21) Perform conversions with temperature and pressure units.
22) Solve word problems involving gases; identify variables and perform calculations utilizing gas laws.
23) Understand and determine the magnitudes of angles in units of degrees.
24) Understand plane geometric figures such as triangles and squares.
25) Understand logarithms (base ten) and solve logarithmic equations.

26) Understand and solve quadratic equations.
27) Solve pairs of linear equations involving two unknowns.

Course Content

1) Stoichiometry: matter and measurement; moles; limiting reactants; molarity
2) Thermochemistry: energy and work; calorimetry; heats of formation; bond energies; Hess's law
3) Atomic Structure: Bohr theory; orbitals; quantum numbers; electron configurations; periodicity
4) Bonding: ionic bonding; Born Haber cycle; covalent bonding; Lewis structures; VSEPR theory; valence bond theory; molecular orbital theory
5) Gases: gas laws; ideal gas law; gas stoichiometry; kinetic molecular theory

Course Objectives

Students will be able to:

1) Solve stoichiometry problems involving mass, moles, mixtures, limiting reactants and solutions.
2) Calculate the enthalpies of reactions utilizing thermodynamic data, bond energies, Hess's law, and calorimetric data.
3) Apply the first law of thermodynamics to chemical systems.
4) Use Bohr's equation to calculate transition energies and ionization energies.
5) Explain and interpret Schrodinger's theory of the atom as applied to the concepts of orbitals, quantum numbers and electronic configurations.
6) Predict periodic trends in ionization energy, atomic size and electron affinity.
7) Analyze the bonding in chemical compounds using Lewis structures, VSEPR theory, valence bond theory and molecular orbital theory.
8) Classify bonds into their various types–nonpolar, polar, and ionic–and predict the polarity of molecules and their associated properties.
9) Solve gas law problems using the ideal gas law, combined gas, Dalton's and Graham's laws.
10) Interpret the structure of solids predicting the trends in lattice energy of ionic compounds.
11) Apply scientific methodology in a laboratory setting in the following ways:
    a. Properly document experimental data in a laboratory notebook.
    b. Analyze data and write a formal laboratory report.
12) Demonstrate proficiency in quantitative chemical analysis techniques.

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

1) Exams consisting of the following question types-definitions, short essay, qualitative problems, quantitative problems-that measure students' ability to explain and apply the basic chemical concepts.
2) Laboratory activities that evaluate students' ability to observe the properties of a wide range of chemical substances, to apply competent observational skills, and to demonstrate proper collection and recording of data.
3) Written laboratory reports that measure students' ability to interpret and analyze both qualitative and quantitative data.
4) Problem sets including group problem sets that enable students to apply basic chemical principles and communicate those principles.

Special Materials Required of Student

1) Safety glasses
2) Scientific calculator
3) Combination lock
4) Lab apron

Minimum Instructional Facilities

1) Smart classroom with writing board, wall-sized periodic table, overhead projector/screen, demonstration table with sink and gas tap
2) Chemistry laboratory facility including lockers for lab equipment
3) Computer network connections for Internet access and performance of computer interfaced laboratory experiments including access to laptops with Vernier interfaces and miscellaneous probes

Method of Instruction

1) Lectures are designed to explain basic concepts. Ideas are introduced by presentation of data or generation of data through lecture demonstration. Analysis and explanations of data are elicited from students by frequent questions. Applications to the real world are incorporated as much as possible.
2) Laboratory experiments (correlated with lectures) are designed to allow students to make observations of chemical phenomena. Laboratory reports and class discussions require students to explain their laboratory observations employing the concepts discussed in lectures.
3) Textbook and laboratory manual are required reading and are essential to successful solution of homework problems, performance of laboratory experiments and performance on exams.
4) Students are strongly encouraged to form study groups as well as seek help through peer tutoring and instructor's office hours.

Out-of-Class Assignments

1) Reading and homework problems, as assigned
2) Formal lab reports
3) Specialized project involving selected topics in chemistry, as required; this project may require the use of research on the internet, at the library, or other resources

Texts and References

1) Required (representative examples):
   a. Kotz, et al. *Chemistry & Chemical Reactivity*. 10th edition. Cengage, 2018.
   b. Leblanc & Villarreal. *Chemistry 142 Lab Manual*. Morton, 2018.
2) Supplemental: None

Exit Skills

Students having successfully completed this course exit with the following skills, competencies and/or knowledge:

1) Solve word problems involving heat transfer.
2) Use thermodynamic data to calculate enthalpy changes for chemical reactions, phase changes and solution processes.
3) Calculate bond energies from thermodynamic data.
4) Use Bohr's equation to calculate transition energies and ionization energies.
5) Interpret Schrodinger's theory of the atom including the concepts of orbitals, quantum numbers and electronic configurations.
6) Predict periodic trends in ionization energy, atomic size, electron affinity and acid-base properties.
7) Use molecular orbital theory to make predictions about the nature of the bonding in diatomic molecules.
8) Predict electron dot structures, formal charges, geometry, hybridization and orbital descriptions of molecules with three or more atoms including the concept of delocalized bonding.
9) Classify bonds into their various types–nonpolar, polar, ionic–and predict the polarity of molecules.
10) Predict trends in the lattice energies of ionic compounds.
11) Predict trends in bond length as a function of bond order and atomic radii.
12) Estimate enthalpies of reaction using average bond energies.
13) Solve word problems involving gases; perform calculations involving two or more variables including use of the ideal gas law.

14) For graphs of linear functions, determine the slope and intercept of the line.
15) For graphs of nonlinear functions, interpolate values from the curve.
16) Solve complex word problems including problems with two unknowns.
17) Use the technique of dimensional analysis to solve stoichiometric problems.

Student Learning Outcomes

Upon successful completion of this course, students will be able to:

1) Solve a wide variety of problems including those involving the topics of calorimetry, gases, thermodynamics, ionization energy, and lattice energy, among others.
2) Apply knowledge of a variety of theories of atomic structure and bonding.
3) Perform a variety of experimental analytical techniques in a laboratory setting to collect data; analyze data and make predictions about the nature of matter.