MiraCosta College

CHEM 110 - GENERAL CHEMISTRY

Units Lecture	3.00	**Units Lab**	2.00	**Units Total**	5.00
Total Hrs Lecture	49.50	**Total Hrs Lab**	99.00	**Total Course Hrs**	148.50

COURSE DESCRIPTION

This first semester of a one-year general chemistry sequence focuses on the fundamental principles of chemistry. Students learn the application of these principles with special significance placed on chemical computation. Topics include atomic structure, bonding, the periodic table, nomenclature, chemical reactions, stoichiometry, thermochemistry, and bonding. The course emphasizes critical thinking, writing, problem solving, and analysis skills, and it meets requirements of chemistry, biochemistry, biology, physics, pre-dental, pre-medical, and pre-engineering majors.

ENROLLMENT RESTRICTIONS

PREREQUISITES
CHEM 108 or one year of high school chemistry or qualification through a chemistry placement exam; MATH 101 or MATH 101B or qualification through the Math Competency Exam or approved equivalent.

COREQUISITES

ADVISORIES
CHEM 108 strongly recommended if it has been four or more years since chemistry course.

OUTLINE OF COURSE CONTENT

The course will address the following topics:

LECTURE:
I. Scientific process, language, and problem solving
A. Scientific method
1. Hypothesis
2. Theory
3. Law.
B. Measurement
1. International System of Units (SI) for length, mass, volume
2. English units
3. Metric units
4. Temperature scales
5. Significant figures in calculations.
C. Dimensional analysis
1. Single and double conversions
2. Cubic conversions
3. Data as conversion factors.
D. Data analysis
1. Accuracy vs. precision
2. Systematic error
3. Random error.

II. Classification of matter
A. Elements vs. compounds
B. Homogeneous vs. heterogeneous mixtures
C. Three phases of matter
D. Separating mixtures.

III. Atoms and elements
A. Historical development of atom
B. Subatomic particles
1. Location
2. Charge

3. Significance.
C. Isotopes
1. Recognizing isotopes
2. Determining average mass of element's atoms
3. Mass spectrometry.
D. Periodic table
1. History
2. Organization
3. Common group names
4. Diatomic elements.
E. Mass of atoms
1. Atomic mass unit
2. Molar mass.
F. Chemical quantities
1. Moles
2. Conversion between number particles, moles, grams of substances.

IV. Chemical quantities
A. Percent composition
B. Empirical formula, molar mass determination
C. Chemical stoichiometry
D. Limiting reactant
E. Percent yield
F. Concentration
1. Molarity
2. Weight percent.

V. Nomenclature
A. Ionic compounds
B. Molecular compounds
C. Hydrates
D. Organic molecules.

VI. Chemical reactions
A. Balance reactions
B. Types of reactions
1. Combination
2. Decomposition
3. Single replacement
4. Double replacement
5. Oxidation/reduction.
C. Predict products of a chemical reaction
D. Provide complete ionic and net ionic reactions.

VII. Gases
A. Units of pressure
B. Basic gas laws
1. Boyle's law
2. Charles' law
3. Avogadro's law
4. Ideal gas law
5. Real gases.
C. Kinetic molecular theory

1. Temperature and velocity
2. Effusion vs. diffusion
3. Effects of size and intermolecular forces
4. Van der Waals equation.

VIII. Thermochemistry
A. First law of thermodynamics
B. Quantifying heat and work
C. Measuring enthalpy
1. Endothermic vs. exothermic
2. Standard enthalpies of formation
3. Calorimetry.

IX. Quantum mechanics
A. Electromagnetic radiation
1. Properties
2. Spectrum
B. Dual nature of matter and waves
1. Quantized energy
2. Photoelectric effect
3. de Broglie Wavelength
4. Heisenberg's Uncertainty Principle
5. Schrodinger's equations for H atom
6. Shapes of atomic orbitals.

X. Periodic properties
A. Development of periodic table
B. Electron configuration
C. Valence electrons
D. Periodic trends
1. Atomic radii
2. Ionic radii
3. Ionization (first, second, etc) energy
4. Electron affinity
5. Metallic character
6. Reactivity of alkali, halogens, etc.

XI. Chemical bonding
A. Lewis Theory
1. Lattice energies
2. Lewis Dot Structures
3. Electronegativity and polarity
4. Resonance and formal charge
5. Exceptions to the octet rule
6. Bond energies to estimate enthalpy change in reaction
7. Metallic bonding
8. Valence-shell electron-pair repulsion (VSEPR) for molecular geometry.
B. Valence bond theory
1. Overlap of atomic orbitals
2. Hybridization.
C. Molecular orbital theory
1. Electron delocalization
2. Linear combinations of atomic orbitals (LCAO)

3. Homo and heteronulear molecules.

XII. Intermolecular forces
A. Types
1. Dispersion
2. Dipole-dipole
3. Dipole-ion
4. Hydrogen bonding.
B. Effects in solutions, solids
1. Surface tension
2. Capillary action
3. Vaporization/vapor pressure
4. Sublimation and fusion
5. Heating curve of water
6. Phase diagrams of substances
7. Solubility rules.

LABORATORY:
All of the experiments performed in the laboratory portion of this course complement topics learned in the lecture. Typically, the lab experiment reinforces the material and is performed after the topic has been discussed in lecture. The pre-lab lecture before each experiment relates the experiment to previous learning, and allows students to apply the knowledge to new situations. The laboratory experiments are quantitative in nature and requirement notebook keeping and report writing for each experiment. The laboratory experiment focus on the following chemical concepts:

I. Introduction to the laboratory environment
A. Laboratory equipment
B. Laboratory safety
C. MSDS (Material Safety Data Sheets)
D. Data collection and lab notebook
E. Statistical analysis of data.

II. Separation of a mixture

III. Chemical and physical changes, measurements and graphing

IV. Counting and measuring atoms

V. Chemical reactions and percent yield

VI. Stoichiometry, theoretical yield and percent yield

VII. Acid-base titration

VIII. Detemination of the molar mass of a gas

IX. Enthalpy of neutralization

X. Atomic emission spectroscopy

XI. Periodic trend and group reactivity

XII. Covalent bonding and molecular geometry

XIII. Individual experimental design and chemical question

MiraCosta College

PERFORMANCE OBJECTIVES

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

1). Demonstrate understanding of the scientific method by applying the process to the development of an independent laboratory experiment
2). Convert between English and metric units and utilize a variety of conversion factors, including cubic factors and density, to complete dimensional analysis calculations
3). Analyze and interpret the periodic table to predict and explain an element's physical and chemical properties, based on the concepts of atomic structure, electron configurations, and periodic properties
4). Convert between number of particles, moles, and grams of a substance
5). Analyze a given chemical reaction, including the amounts of reactants, to write its balanced equation and to determine both the limiting reactant and the theoretical yield of the products, based on the concepts of molar mass and stoichiometry
6). Classify and balance various types of chemical reactions; in oxidation-reduction reactions, identify the substances that are being oxidized and reduced
7). Prepare a solution of given volume and molarity for chemical solid, weight percent solution, or a dilution calculation
8). Construct the Lewis dot structure of a compound or an ion containing multiple bond types; determine the three dimensional molecular geometry and the polarity of the molecule
9). Name ionic compounds, molecular compounds, hydrates, and basic organic (up to 10 carbons) molecules (naming to include the use of common polyatomic ions)
10). Predict the heat of a reaction using standard heats of formation and using Hess's Law
11). Discuss the intermolecular forces found in given ionic, polar covalent, and nonpolar molecules
12). Analyze the phase diagram of a substance (non water substance) and determine the normal boiling and freezing points as well as the state of the substance at a variety of temperatures and pressures
13). Contrast real and ideal gases; calculate pressure, volume, and temperature variations under standard and nonstandard conditions
14). Using the periodic table, determine the electron configuration of a given ion
15). Safely and effectively operate laboratory equipment (such as Bunsen burners, balances, hot plates, pipets, buret) using proper techniques
16). Construct, analyze, and interpret graphical data to draw conclusions that support or refute scientific hypotheses.

READING ASSIGNMENTS

Reading assignments will be consistent with, but not limited by, the following types and examples:

1). Read the course text book focusing on content development and problem solving
2). Read scientific articles found in science journals, news media, reliable online sites, and peer work to better understand the concepts presented in lecture, lab, or on a project
3). Read and interpret graphed data, both published and generated in the course
4). Read a variety of homework problems (many word problems) and in-class worksheets to develop understanding of the course material
5). Read the experimental lab manual, with emphasis on the construction of a summarized experimental write-up in a lab notebook
6). Read specific excerpts from the text to support the theory in the lab
7). Search and read online hazard analysis (MSDS searches) for chemicals to be used in laboratory.

WRITING ASSIGNMENTS

Writing assignments will be consistent with, but not limited by, the following types and examples:

1). Record experimental observations and data in a lab notebook
2). Complete comprehensive homework problems (computations, short answer, essay, interpretation of presented data) for each chapter covered in the course
3). Take comprehensive notes during lecture and laboratory sessions
4). Organize and tabulate data, provide sample calculations and statistical analyses of data, and synthesize arguments that support or refute scientific hypotheses as part of the laboratory experience.

OUTSIDE-OF-CLASS ASSIGNMENTS (READING/WRITING/OTHER)

Outside-of-class assignments will be consistent with, but not limited by, the following types and examples:

1). Complete multi-step calculations and other problem-solving exercises from assigned text homework or worksheets
2). Read concepts to be discussed in lecture and laboratory prior to class, in the form of the textbook, scientific articles, news media sources or articles online

3). Complete calculations and statistical analyses, analyze results, draw conclusion to complete an organized report for qualitative and quantitative data collected in the laboratory
4). Develop and research data-driven reports, essays, projects, and assignments
5). Develop, construct, and analyze graphical data using graphical analysis programs such as Excel
6). Deconstruct and interpret presented graphed data
7). Complete problem solving homework online, using a text-generated homework package.

STUDENT LEARNING OUTCOMES

	Learning Outcome	*Mode of Assessment*
1.	Students will analyze and interpret the periodic table to predict and explain an element's physical and chemical properties, based on the concepts of atomic structure, electron configurations and periodic properties.	Written essay question on exam, including cause and effect reasoning. Students will be given a periodic table, and instructed to compare particular property or properties of two or more elements.
2.	Students will construct the Lewis structure of a given molecule or polyatomic ion that is an exception to the octet rule, and use the Lewis structure to predict the number and types of bonds (single, double or triple) it has, and its geometry, based on the principles of covalent bonding and valence shell electron pair repulsion theory.	Diagram and interpretation problem on exam. Students will be given a periodic table and the molecular formula of a particular chemical species, and instructed to draw its Lewis structure. They will also be directed to analyze this species' Lewis structu
3.	Students will analyze a given chemical reaction, including the amounts of reactants, to write its balanced equation and to determine both the limiting reactant and the theoretical yield of the products, based on the concepts of molar mass and stoichiometry.	Written problem where students must write and balance the chemical reaction equation in symbol form, based on a written description of the reaction. Students will also construct and perform a calculation to determine which reactant is the limiting reacta

METHODS OF INSTRUCTION

Instructional methodologies will be consistent with, but not limited by, the following types or examples:

1). Lecture - traditional and small group work on content and problem solving. PowerPoint slides, overhead transparencies, chalkboard, handouts and internet sites can be used to support lecture
2). Small student workgroups can be used in the course to practice the application of presented theory to problem solving
3). Student response system (clickers) can be used to quickly assess student comprehension on a topic (can be in prose or mathematical form)
4). Think, pair, share methodology
5). Online homework can be modeled to provide instant student feedback while completing assigned homework
6). Collaborative exercises, including learning communities (provided by tutoring center), problem solving sessions, and peer groupings
7). In laboratory, students will experience traditional lecture, group discussion, collaborative processes, and individual instruction.

METHODS OF EVALUATION

Evaluation methodologies will be consistent with, but not limited by, the following types or examples:

1). Exams that may include multiple choice, fill in the blank, calculation, scientific reasoning, problem solving, application, and explanation of concepts covered in the course outline
2). Substantial writing assignments that reflect critical and creative thinking, including lab reports, written or online homework, and individual/group projects
3). Quizzes
4). Projects, individual or group in nature to include research/reflection papers or projects
5). Lab reports.

REQUIRED TEXTBOOKS

Examples of typical textbooks for this course include the following:

1). Tro, Nivaldo J. Chemistry: A Molecular Approach. 2nd ed., Pearson Prentice Hall, 2011. ISBN: 978-0321651785
2). Stanitski, Griswold, et. al. Laboratory Handbook for General Chemistry. 3rd ed., Thomson Brooks/Cole, 2007. ISBN: 978-0495018902

3). Premium Source Publishing, Laboratory Experiments for CHEM 110, 9th ed., 2010. ISBN: 1-60782-220-2.

OTHER REQUIRED INSTRUCTIONAL MATERIALS
Safety goggles, safety gloves, scientific non-graphing calculator, and quadrille notebook.

COURSE REPEATABILITY

Total Completions Allowed:	***In Combination With:***
1	