DeAnza College

Credit- Degree applicable
Effective Quarter: Fall 2019

I. Catalog Information

CHEM 1A **General Chemistry** **5 Unit(s)**

(See general education pages for the requirement this course meets.)

(Not open to students with credit in CHEM 1AH.)

Prerequisite: CHEM 25 or CHEM 30A or satisfactory score on Chemistry Placement Test; MATH 114 or equivalent.

Advisory: EWRT 1A or EWRT 1AH or ESL 5.

Lec Hrs: 36.00
Lab Hrs: 72.00
Out of Class Hrs: 72.00
Total Student Learning Hrs: 180.00

An introduction to the structure and reactivity of matter at the molecular level. Application of critical reasoning to modern chemical theory and structured numerical problem solving. Development of molecular structure from rudimentary quantum mechanics, including an introduction to ionic and covalent bonding. Chemical problem solving involving both formula and reaction stoichiometry employing the unit analysis method. An introduction to thermochemistry and a discussion of the first law of thermodynamics.

Student Learning Outcome Statements (SLO)

Identify and explain trends in the periodic table.

Construct balanced reaction equations and illustrate principles of stoichiometry.

Apply the first law of thermodynamics to chemical reactions.

II. Course Objectives

A. Examine contributions by investigators of diverse cultures and times to the body of chemical knowledge, with an emphasis on physical and chemical conceptual frameworks.

B. Investigate the critical aspects of measurement.

C. Explore the historical development of understanding the structure of the atom.

D. Assess the development of the Periodic Table of Elements in light of modern atomic theory.

E. Differentiate the causes and types of molecular bonding.

F. Appraise the effect of quantum mechanics on formulation of molecular structure.

G. Employ systematic nomenclature to the identification of molecules.

H. Utilize the principles of stoichiometry to analyze compounds, chemical mixtures, and reactions.

I. Examine the prominent characteristics of solutions.

J. Classify the major types of chemical reactions.

K. Apply the essential principles of thermodynamics to chemical systems.

III. Essential Student Materials

Safety goggles

IV. Essential College Facilities

Fully equipped chemical laboratory including, at a minimum, the following: consumable chemicals, chemical balances, glassware, molecular models, melting point apparatus, laptops with data acquisition modules, fume hoods, chemical disposal facilities, lockable student storage areas, periodic tables, and laboratory technician. Lecture room with a periodic table.

V. Expanded Description: Content and Form

A. Examine contributions by investigators of diverse cultures and times to the body of chemical knowledge, with an emphasis on physical and chemical conceptual frameworks.

- **1.** Historical development of chemical principles
- **2.** Application of chemistry to topics such as environmental stewardship and traditional medicine.

B. Investigate the critical aspects of measurement.

- **1.** Comparison of SI and British systems of units
- **2.** Problem solving using dimensional analysis
- **3.** Limitations of measurement and statistical methods
  - **a.** Precision versus accuracy
  - **b.** Significant figures
  - **c.** Standard deviation

C. Explore the historical development of understanding the structure of the atom.

- **1.** Historical development of atomic theory
  - **a.** Proust's Law of Definite Proportions
  - **b.** Dalton's Law of Multiple Proportions
  - **c.** Dalton's atomic theory
  - **d.** Millikan oil drop experiment
  - **e.** Thompson cathode-ray tubes
  - **f.** Rutherford nuclear deflection experiment
- **2.** Sub-atomic structure
  - **a.** Protons, neutrons, and electrons
  - **b.** Nuclei
- **3.** Nomenclature of atoms
  - **a.** Atomic number, atomic mass, mass number
  - **b.** Isotopes
- **4.** The Bohr Model of the atom
  - **a.** Quantization of energy

- **b.** Ground and excited states
- **c.** Electronic transitions

5. Development of modern quantum theory

- **a.** Electromagnetic spectrum
- **b.** Wave-particle duality of light

6. Implications of elementary quantum mechanics

- **a.** Heisenberg Uncertainty Principle
- **b.** Wavefunctions
- **c.** The Born interpretation
- **d.** Quantum numbers
- **e.** Orbital shapes
- **f.** Nodes and degeneracy
- **g.** Electron spin
- **h.** Extension to polyelectronic atoms

7. Electronic configurations

- **a.** Hund's Rule
- **b.** The Aufbau Principle
- **c.** Pauli Exclusion Principle

8. Ions

- **a.** Cations
- **b.** Anions

D. Assess the development of the Periodic Table of Elements in light of modern atomic theory.

1. History of the Periodic Table

2. Periodic trends of the elements

- **a.** Ionization energy
- **b.** Electronic affinity
- **c.** Atomic radii
- **d.** Ionic radii
- **e.** Electronegativity

3. Survey of elemental groups

E. Differentiate the causes and types of molecular bonding.

1. Types of chemical bonds

- **a.** Covalent
- **b.** Ionic
- **c.** Metallic
- **d.** Coordinate covalent

2. Relationship of bond type to electronegativity

3. Dipole moments

4. Lattice energy
5. Bond enthalpies

F. Appraise the effect of quantum mechanics on formulation of molecular structure.

1. Lewis structures of organic and inorganic substances
   - **a.** The octet rule
   - **b.** Exceptions to the octet rule
   - **c.** Resonance structures
   - **d.** Formal charge
2. VSEPR theory
   - **a.** Molecular geometries
   - **b.** Hybridization of atomic orbitals in organic and inorganic molecules/ions
3. Molecular orbital theory
   - **a.** Bonding and antibonding orbitals
   - **b.** Sigma and pi bonds in simple organic molecules such as alkanes, alkenes, alkynes, and aromatics
   - **c.** Bond order
   - **d.** Paramagnetism
   - **e.** Homonuclear diatomic molecules
   - **f.** Heteronuclear diatomic molecules
   - **g.** Delocalized bonding in organic molecules such as benzene

G. Employ systematic nomenclature to the identification of molecules.

1. Ionic compounds with fixed cation charge
2. Ionic compounds with variable charge cations
3. Binary covalent compounds
4. Acids
5. Simple organic substances

H. Utilize the principles of stoichiometry to analyze compounds, chemical mixtures, and reactions.

1. Historical development of stoichiometry
   - **a.** Law of Conservation of Mass
   - **b.** Avogadro's Hypothesis
2. Stoichiometry
   - **a.** The mole
   - **b.** Molar mass
   - **c.** Avogadro's number
3. Percent composition of compounds
   - **a.** Calculation from combustion analysis
   - **b.** Calculation from given masses
4. Determine compound formulas

- **a.** Empirical formula
- **b.** Structural formula

5. Balance simple chemical equations
6. Identify limiting reagents
7. Calculate percent yield

I. Examine the prominent characteristics of solutions.

1. Homogeneous versus heterogeneous mixtures
2. Solvent and solute
3. Strong and weak electrolytes
4. Molarity
5. Dilution of solutions

J. Classify the major types of chemical reactions.

1. Precipitation reactions
   - **a.** Molecular equations
   - **b.** Complete ionic equations
   - **c.** Net ionic equations
2. Acid-base reactions
   - **a.** Titration
   - **b.** Equivalence point
3. Oxidation-reduction reactions
   - **a.** Oxidation states
   - **b.** Balancing oxidation-reduction reactions
4. Combustion reactions in organic substances such as hydrocarbons and alcohols

K. Apply the essential principles of thermodynamics to chemical systems.

1. State functions
2. Forms of energy
   - **a.** Kinetic and potential
   - **b.** Chemical and mechanical
3. First Law of Thermodynamics
   - **a.** Exothermic versus endothermic processes
   - **b.** Constant pressure versus constant volume
   - **c.** Hess's Law
   - **d.** Enthalpy of formation
   - **e.** The standard state
4. Calorimetry
   - **a.** Specific heat
   - **b.** Heat capacity

VI. Assignments

A. Reading

1. Required readings from the textbook in preparation for the scheduled lecture. This may include entire chapters or sections from the chapters covering topics included in this outline.
2. Required readings from the laboratory manual as a preparation for the scheduled experiment in order to provide students with familiarity about the specific laboratory protocols and related safety precautions necessary for successful completion of the experiment.

B. Writing

1. Homework assignments based on classroom discussion/lecture may include answering questions from end-of-chapter exercises or other sources as deemed appropriate by the instructor.
2. Periodic quizzes and mid-term examinations based on material discussed in lectures and/or reading assignments

C. Laboratory assignments

1. Pre-lab exercise: The pre-lab assignment for the scheduled laboratory experiment to be completed prior to beginning of each new experiment. This assignment may be identical to that provided in the laboratory manual or substituted with other appropriate assignments determined by the instructor.
2. Report: Data obtained in laboratory exercises are to be entered in the assigned laboratory manual or a laboratory notebook. Necessary calculations required to obtain the final results from the experiment must be completed in the manual or the notebook as to be determined by the instructor. Detailed lab reports incorporating results and discussions from the experiment will be required.

VII. Methods of Instruction

Lecture and visual aids
Discussion of assigned reading
Discussion and problem solving performed in class
Quiz and examination review performed in class
Homework and extended projects
Collaborative learning and small group exercises
Laboratory experience which involve students in formal exercises of data collection and analysis
Laboratory discussion sessions and quizzes that evaluate the proceedings weekly laboratory exercises

VIII. Methods of Evaluating Objectives

A. Homework assignments based on end-of-chapter problems from the primary text will be evaluated for completion to test comprehension of lectures.

B. Periodic quizzes will be used to test the comprehension of topics covered during the lecture and will be evaluated for accuracy of responses.

C. A minimum of two mid-term examinations will be used to evaluate the ability of students to a) solve problems, b) outline various concepts covered in the lecture, and c) demonstrate an understanding of reading assignments. These will be evaluated for accuracy to assess student progress in achieving various learning outcomes.

D. A comprehensive final examination in any chosen format (multiple choice questions or free response) will be based on all the course material covered during the entire quarter and evaluated for accuracy of responses.

E. Pre-lab assignments will be evaluated for completeness and level of preparedness required for safe and timely execution of laboratory protocols and experiments.

F. Report sheets and/or laboratory reports will be evaluated for successful completion of

laboratory experiments as well as accuracy of data analysis and interpretation. Students will work both individually and collaboratively towards the completion of the laboratory experiments.

G. A comprehensive laboratory examination or periodic quizzes will be used to evaluate the student understanding of the various concepts discussed in the different experiments performed during the course. Concepts evaluated will include: a) general laboratory protocol b) comprehension of data analysis and interpretation and c) critical thinking as it pertains to the scientific method

IX. Texts and Supporting References

A. Examples of Primary Texts and References

1. Silberberg and Amateis. Chemistry: The Molecular Nature of Matter and Change, 8th edition. McGraw-Hill, 2018. ISBN 978-1-259-63175-7.
2. De Anza Chemistry Department General Chemistry Laboratory Manual (https://www.deanza.edu/chemistry/Chem1A.html)

B. Examples of Supporting Texts and References

1. Silberberg, Martin. Student Solutions Manual: Chemistry: The Molecular Nature of Matter and Change, 8th edition. McGraw-Hill, 2018. ISBN 978-1259916250

X. Lab Topics

A. Laboratory methodology

1. Maintaining a laboratory notebook
2. Writing laboratory reports

B. Chemical safety

C. Chemical disposal

1. Materials safety data sheets (MSDS)
2. Laboratory environment
   - **a.** Separation of waste streams
   - **b.** Proper disposal methods
   - **c.** Environmental hazards of improper waste disposal
3. Personal safety
   - **a.** Maintaining laboratory cleanliness
   - **b.** Chemical labeling
   - **c.** Segregation of chemicals by hazard
   - **d.** Secondary containment
4. Emergency situations
   - **a.** Safety goggles
   - **b.** Limiting chemical exposure
   - **c.** Safety showers
   - **d.** Eyewash stations
   - **e.** Proper use of fire extinguishers
   - **f.** Fires
   - **g.** Earthquakes

- **h.** Evacuation procedures

D. Physical measurement

- **1.** Gravimetric analysis
  - **a.** Taring
  - **b.** Mass by difference
- **2.** Vapor pressure

E. Laboratory techniques

- **1.** Proper ignition of Bunsen burners
- **2.** Solid filtration
- **3.** Use of pipettes

F. Chemical analysis

- **1.** Gravimetric analysis of a hydrate
- **2.** Titration
  - **a.** Acid-base
    - **1.** Use of indicators
    - **2.** Relationship of endpoint to equivalence point
  - **b.** Redox
- **3.** Conductivity
- **4.** Calorimetry