Salem Community College Course Syllabus

Course Code: College Chemistry I

Course Code: CHM 101

Lecture Hours: 2
Laboratory Hours: 4
Credits: 4

Course Description:
In this course the student will learn the basic principals of chemistry. The student will understand the theory as well as calculate the solution to mathematical problems involving measurements, properties of matter, chemical reactions, gas laws, thermochemistry, chemical bonding, and solutions. The student will understand atomic and molecular structure, states of matter, intermolecular forces, electron configurations, and basic organic chemistry structure and nomenclature. The student will use a scientific calculator to solve for unknowns. In the laboratory portion of the class, the student will use manipulative techniques which allow first hand observations of chemical transformations. The course will be taught by lecture, discussion, demonstrations, video discs, manipulative lab practice, computer simulated lab practice, and cooperative group problem solving. This is a state approved General Education Science course.

Pre-Requisite:
ENG098, if required and high school chemistry or CHM 100.

Co- Requisite:
MAT095, if required

Place in College Curriculum:
Chemistry 101 is a science elective and is required for students in all science options and the Industrial Laboratory Technology, and Industrial Hygiene programs.

Course Outline:

I. Chemistry: Matter and Measurement
   - A. Chemistry: Principles and Applications
   - B. Getting Started: Some Key Terms
   - C. Scientific Measurements
   - D. Precision and Accuracy in Measurements
   - E. Problem-Solving Method

II. Atoms, Molecules, and Ions
   - A. Laws of Chemical Combination
   - B. Atomic Theory of Matter
   - C. The Divisible Atom
   - D. Atomic Masses
   - E. The Periodic Table: Elements Organized
   - F. Molecules and Molecular Compounds
   - G. Ions and Ionic Compounds
   - H. Acids, Bases, and Salts
   - I. Alkanes: Saturated Hydrocarbons
   - J. Types of Organic Compounds

III. Stoichiometry: Chemical Calculations
   - A. Molecular Masses and Formula Masses
   - B. The Mole and Avogadro;s Number
   - C. More on the Mole
   - D. Mass Percent Composition from Chemical Formulas
   - E. Chemical Formulas from Mass Percent Composition
   - F. Elemental Analysis: Experimental Determination of Mass Percent Composition
   - G. Writing and Balancing Chemical Equations
   - H. Stoichiometric Equivalence and Reaction Stoichiometry
   - I. Limiting Reactants
   - J. Yields of Chemical Reactions
   - K. Solutions and Solution Stoichiometry

IV. Chemical Reactions in Aqueous Solutions
   - A. Some Electrical Properties of Aqueous Solutions
   - B. Reactions of Acids and Bases
   - C. Reactions that Form Precipitates
   - D. Oxidation-Reduction
   - E. Oxidizing and Reducing Agents
   - F. Some Practical Applications of Oxidation and Reduction

V. Gases
- A. Gasses: What Are They Like?
- B. The Kinetic-Molecular Theory: An Introduction
- C. Gas Pressure
- D. Boyle's Law: the Pressure-Volume Relationship
- E. Charles's Law: The Temperature-Volume Relationship
- F. Avogadro;s Law: The Mole-Volume Relationship
- G. The Combined Gas Law
- H. The Ideal Gas Law
- I. Gasses in Reaction Stoichiometry
- J. Mixtures of Gasses: Dalton's Law of Partial Pressures
- K. The Kinetic-Molecular Theory: Some Quantitative Aspects
- L. Real Gasses

VI. Thermochemistry
- A. Energy
- B. Thermochemistry: Some Basic Terms
- C. Internal Energy (*U*), State Functions, and the First Law of Thermodynamics
- D. Heats of Reaction and Enthalpy Change, ΔH
- E. Calorimetry: Measuring Quantities of Heat
- F. Hess's Law of Constant Heat Summation
- G. Standard Enthalpies of Formation
- H. Combustion and Respiration: Fuels and Food

VII. Atomic Structure
- A. The Electron: Experiments of Thomson and Millikan
- B. Atomic Models: J.J. Thomson and Ernest Rutherford
- C. Protons and Neutrons
- D. Positive Ions and Mass Spectrometry
- E. The Wave Nature of Light
- F. Photons: Energy by the Quantum
- G. Wave Mechanics: Matter as Waves
- H. Quantum Numbers and Atomic Orbitals

VIII. Electron Configurations, Atomic Properties, and the Periodic Table
- A. Multielectron Atoms
- B. An Introduction to Electron Configurations
- C. The Rules for Electron Configurations
- D. Electron Configurations: The Aufbau Principle
- E. Electron Configurations: Periodic Relationships
- F. Magnetic Properties: Paired and Unpaired Electrons
- G. Periodic Atomic Properties of the Elements
- H. Metals, Nonmetals, Metalloids, and Noble Gases
- I. Explaining the Behavior of the Elements Through Atomic Properties and the Periodic Table

IX. Chemical Bonds
- A. Chemical Bonds: A Preview
- B. The Lewis Theory of Chemical Bonding: An Overview
- C. Ionic Bonds and Ionic Crystals
- D. Using Lewis Symbols to Represent Ionic Bonding
- E. Lewis Structures of Some Simple Molecules
- F. Polar Covalent Bonds and Electronegativity
- G. Strategies for Writing Lewis Structures
- H. Molecules that Don't Follow the Octet Rule
- I. Bond Lengths and Bond Energies
- J. Alkenes and Alkynes
- K. Ploymers

X. Bonding Theory and Molecular Structure
- A. The Valence-Shell Electron-Pair Repulsion (VSEPR) Method
- B. Polar Molecules and Dipole Moments
- C. Atomic Orbital Overlap
- D. Hybridization of Atomic Orbitals
- E. Hybrid Orbitals and Multiple Covalent Bonds
- F. Characteristics of Molecular Orbitals
- G. Aromatic Compounds

XI. States of Matter and Intermolecular Forces
- A. Intermolecular Forces and States of Matter: A Chapter Preview
- B. Vaporization and Vapor Pressure
- C. Phase Changes Involving Solids
- D. Phase Diagrams
- E. Intermolecular Forces of the van der Waals Type
- F. Hydrogen Bonds
- G. Intermolecular Forces and Two Liquid Properties
- H. Network Covalent Solids
- I. Ionic Bonds as "Intermolecular" Forces
- J. The Structure of Crystals

Course Performance Objective #1

The student will classify the types of matter, properties of matter, units of measurements and steps of the scientific method as well as calculate mathematical solutions using dimensional analysis.

Learning Outcomes:

1. The student will generalize on the relationship of chemistry to other fields of science.
2. The student will list the steps to the scientific method and apply these steps to examples.
3. The student will define hypothesis, experiment, theory, and scientific law.
4. The student will classify properties of matter as physical verses chemical and extensive versus intensive.
5. The student will define and give examples of atoms, elements, compounds molecules, homogenous mixtures, and heterogenous mixtures.
6. The student will define accuracy and precision as well as discuss the difference between these two terms.
7. The student will list the SI units of measurement for length, mass, time, temperature and volume.
8. The student will define the prefixes used in the metric system and will convert measurements in one metric unit to another metric unit.
9. The student will apply the method of dimensional analysis to solve problems involving unit manipulation.
10. The student will calculate density, mass or volume of a substance given two of the three values.
11. The student will solve problems concerning percent composition by using dimensional analysis.
12. The student will define significant figures, explain their use in showing the amount of uncertainty in measurements, and will give the solution of mathematical calculations in the correct number of significant figures.
13. The student will perform Learning Outcomes #1-11 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
14. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #2

The student will outline the current atomic theory, relating major experiments and discoveries during the 18th century to the present, to the formation of the atomic theory, and will use the concept of the mole in calculations.

Learning Outcomes:

1. The student will define the Law of Conservation of Mass, the Law of Constant Composition, the Law of Definite Proportions and the Law of Multiple Proportions and apply these laws to calculations.
2. The student will list the three assumptions in Dalton's Atomic Theory.
3. The student will describe the experiments used to determine the structure of an atom.
4. The student will describe the structure of an atom including the names, relative masses, relative locations, and charges of the three subatomic particles.
5. The student will define element, isotope, atomic number, atomic mass, ion, Avogadro's constant and mole.
6. The student will give the symbol for the elements, and will use the symbol to identify the atom's number of protons, neutrons and electrons respectively.
7. The student will calculate the average atomic mass of an element using the percent natural abundance of each of its isotopes.
8. The student will describe the arrangement of the periodic table and classify elements into groups according to their location on the periodic table.

9. The student will define and give examples of ionic compound, molecular compound, empirical formula, molecular formula, and structural formula.
10. The student will perform Learning Outcomes #1-8 as graded homework assignments, as in class oral participation as part of a surprise quiz using short answer format and as part of a major examination using multiple choice and short answer format.
11. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #3

The student will describe the types of chemical compounds, will relate the chemical formula to its composition, and will name inorganic compounds given their formula and vice versa.

Learning Outcomes:

1. The student will assign the oxidation numbers to all elements in a given compound.
2. The student will write the IUPAC name of inorganic compounds given their formulas and will write their formula given the name.
3. The student will define acid, base and electrolytes, and will distinguish if a chemical compound belongs to one of these three categories.
4. The student will name simple alkanes, predict relative densities and boiling points for a series of organic compounds, and identify and classify organic compounds according to their functional groups.
5. The student will perform Learning Outcomes #1-4 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, as graded laboratory procedures, as graded formal laboratory reports of a major examination using multiple choice and short answer format.
6. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #4

The student will understand the relationship between the chemical reaction and the chemical equation, and will use information in a chemical equation to calculate theoretical quantities of chemicals involved.

Learning Outcomes:

1. The student will use atomic masses and Avogadro's constant to convert between moles, grams, and number of atoms.
2. The student will calculate the percent composition of a compound from its chemical formula.
3. The student will calculate grams, number of molecules, and moles of a given compound as well as of its individual components given any of the other values.
4. The student will write and balance chemical equations for chemical reactions.
5. The student will determine the limiting reagent and calculate the theoretical yields of a reaction, given the quantities of the reactants.
6. The student will use the chemical equation to calculate the amount of reactant necessary to yield a given amount of product, or to react completely with a given amount of another reactant.
7. The student will calculate solutions to problems relating stoichiometry, density, and percent composition.
8. The student will calculate Molarity, volume or moles given two of the three factors.
9. The student will define a solution, solute, and solvent.

10. The student will calculate and measure the quantities of substances necessary to dilute a stock solution to a required concentration.
11. The student will calculate the percent yield of a reaction from the actual yield and the calculated theoretical yield.
12. The student will define as well as identify consecutive reactions, simultaneous reactions, net reactions, reactants, products and intermediates.
13. The student will perform Learning Outcomes #1-9 as graded homework assignments, as part of a surprise quiz using short answer format, as part of graded laboratory experience, as part of a graded formal laboratory report, and as part of a major examination using multiple choice and short answer format.
14. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #5

The student will identify and generalize on the basic concepts of the three main types of reactions which occur in aqueous solutions.

Learning Outcomes:

1. The student will identify a compound as being a strong electrolyte, weak electrolyte or nonelectrolyte.
2. The student will calculate the concentration of ions in a strong electrolyte solution.
3. Using the solubility rules, the student will predict whether a reaction will occur between particular electrolytes, and if so, will write a net ionic equation for that reaction.
4. The student will define acids and bases, and will list the strong acids and bases.
5. The student will write net ionic equations to represent acid-base reactions.
6. The student will identify and write balanced oxidation-reduction reactions.
7. The student will identify the oxidizing and reducing agents in a oxidation-reduction reaction.
8. The student will calculate the concentrations of acids and bases in a solution, given titration data.
9. The student will use phenolphthalein as an indicator to titrate an unknown acidic or basic solution, and from the experimental data calculate the concentration of the solution.
10. The student will perform Learning Outcomes #1-9 as graded homework assignments, as graded laboratory experiments, as graded formal laboratory reports, as in class oral participation, as part of a surprise quize using short answer format, and as part of a major examination using multiple choice and short answer format.
11. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #6

The student will evaluate real and ideal gases according to the ideal gas law and kinetic-molecular theory.

Learning Outcomes:

1. The student will identify properties which differentiate gases from other states of matter.
2. The student will define pressure, and will convert units of pressure between atmospheres and mm of Hg.
3. The student will identify the differences between a barometer and a manometer, and will calculate the pressure of a gas using readings from a closed-end and an open-end manometer.
4. The student will define the ideal-gas equation, and rearrange it to calculate any single variable, given the other three.
5. The student will derive an equation relating any two or three quantities for moles, volume, pressure or temperature by using the ideal-gas equation, and will specify which equation is Boyle's law, Charles' law or Avogadro's law.

6. The student will derive an equation relating the density of a gas to its molecular weight, and will use the equation to calculate the density, molecular weight, pressure or temperature of a gas, given the other variables.
7. The student will calculate the partial pressure of any gas in a mixture, given the composition of that mixture.
8. The student will calculate the mole fraction of a gas in a mixture, given its partial pressure and the total pressure of the system.
9. The student will calculate the volume of a gas in a chemical reaction, given the pressure, temperature and volume of another gas in the reaction.
10. The student will list the assumptions on which the Kinetic-molecular theory of gases is based.
11. Using Graham's Law, the student will calculate the rate of diffusion or effusion, given the rate of another gas under identical conditions.
12. The student will list three major factors responsible for the deviation of real gases from the ideal behavior, and will explain how these factors affect the behavior of a gas.
13. The student will determine the value of the gas law constant by experimentation.
14. The student will determine the molecular weight of an unknown substance by laboratory experimentation.
15. The student will perform Learning Outcomes #1-12 as graded homework assignments, as graded laboratory assignments, as graded laboratory reports, as in class oral participation, as part of a surprise quiz using short answer format and as part of a major examination using multiple choice and short answer format. The student will perform Learning Outcomes #13-14 as a laboratory assignment and graded laboratory report.
16. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #7

The student will understand the basics of thermochemistry and will use measurement and calculations to determine quantities of heat, work and enthalpy changes.

Learning Outcomes:

1. The student will define heat, work, potential energy, kinetic energy, thermal energy, chemical energy, system and surroundings as they pertain to thermochemistry.
2. The student will calculate the amount of work done to or by a system, given the pressure and volume changes.
3. The student will use the specific heat of a substance to calculate the quantity of heat for a particular temperature change.
4. The student will determine the specific heat of a substance using calorimetric techniques.
5. The student will describe the first law of thermodynamics and will use this law to determine which situations would have positive or negative quantities of heat and work.
6. Using stoichiometry and heats of reaction, the student will calculate the quantity of heat used or given off for a particular reaction.
7. The student will calculate H for a reaction using Hess' Law and combustion data for the compounds involved.
8. Using heats of formation, the student will calculate H for a given reaction.
9. The student will compare various fuel sources, indicating which are the best based on their heats of combustion and environmental effects.
10. The student will perform Learning Outcomes #1-9 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer format.
11. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #8

The student will understand atomic structure and its relationship to Light and the Quantum Theory.

Learning Outcomes:

1. The student will describe the experiments and contributions of Millikan, Thomson and Rutherford in determining atomic structure.
2. The student will discuss the basic theory behind mass spectroscopy.
3. The student will calculate the wavelength, frequency or Energy of light given one of the three variables.
4. The student will explain the relationship between wavelength, frequency, and energy of light.
5. The student will define continuous, line, emission, and absorption spectra.
6. The student will calculate the mass, speed, or wavelength of a particle given two of the three variables.
7. The student will describe Heisenberg's uncertainty principle.
8. The student will identify an orbital given its quantum numbers and vice versa.
9. The student will identify the shapes of orbitals given their names or quantum numbers.

Course Performance Objective #9

The student will predict trends in atomic properties according to the arrangement of the periodic table.

Learning Outcomes:

1. The student will define group, family, and periods according to the periodic table.
2. The student will classify elements into categories based on their placement in the periodic table.
3. The student will predict electron configurations for elements based on their placement in the periodic table.
4. The student will use the periodic table to predict the charges on metal and nonmetal ions.
5. The student will predict relative atomic radii, ionization energy, electron affinity, magnetic properties, metallic character, and various physical properties based on an element's placement on the periodic table.
6. The student will perform Learning Outcomes #1-5 as graded homework assignments, as in class oral participation, and as part of a major examination using multiple choice and short answer format.
7. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #10

The student will predict the nature of chemical bonds within a molecule.

Learning Outcomes:

1. The student will write Lewis structures for atoms, ions, ionic compounds and molecular compounds.
2. The student will describe the interactions involved for ionic, polar covalent and nonpolar covalent bonding.
3. The student will draw Lewis diagrams of a resonance structures which represents bond equivalence in a compound or polyatomic ion.
4. The student will calculate the formal charge of each atom within a molecule or polyatomic ion.
5. The student will perform Learning Outcomes #1-4 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer.
6. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks

Course Performance Objective #11

The student will use quantum mechanics to explain chemical bonding and molecular structure.

Learning Outcomes:

1. The student will use the VSEPR method to predict the shapes of molecules and plyatomic ions.
2. The student will identify polar versus nonpolar molecules by looking at relative electronegativities.
3. The student will discuss Valence Bond Theory and how it pertains to optimal atomic orbital overlap.
4. The student will identify hybridization of atomic orbitals within a molecule.
5. The student will describe the difference between a sigma (σ) and a pi (π) bond.
6. The student will define, identify, and give examples of geometric isomers.
7. The student will describe the relationship between resonance structures and delocalized bonding in increasing the stability of aromatic compounds.
8. The student will perform Learning Outcomes #1-4 as graded homework assignments, as in class oral participation, as part of a surprise quiz using short answer format, and as part of a major examination using multiple choice and short answer.
9. The accuracy and quality of the student's responses will be evaluated according to the criteria presented in the lectures and the course textbooks.

Course Performance Objective #12

The student will conduct various laboratory experiments to enhance theoretical knowledge, to practice basic laboratory techniques, to learn manipulative techniques, and have hands on observation of chemical transformations.

Learning Outcomes:

1. The student will memorize and enforce the safety regulations set forth for the chemistry laboratory.
2. The student will weigh objects on the mettler balance, use volumetric glassware, pipet a desired amount of fluid from one containter to another, cut glass to make stirring rods and pasteur styled pipets, and calibrate a thermometer and 10-ml quantitative pipet.
3. The student will identify an unknown substance by measuring its density, boiling point, melting point, and solubilities in various solvents.
4. The student will separate the components of a mixture by sublimation, extraction and decanting.
5. The student will practice laboratory techniques by performing various chemical reactions on a known quantity of copper, and calculating the percent of copper retrieved after the reactions are complete.
6. The student will perform titrations to standardize an acid or base solution of unknown concentration.
7. The student will react various metallic solutions to determine the order of reactivity of the metal ions.
8. The student will calculate the ideal gas law constant by producing oxygen, and measuring the volume, pressure, moles, and temperature of the gas produced.
9. The student will calculate the molecular weight of an unknown substance by determining the change in freezing point of an aqueous solution of varying concentration.
10. The student will perform Learning Outcomes #1-9 as in class laboratory experimentation and as formal laboratory reports which include five to twelve graded questions each. The accuracy and quality of the student's performance will be evaluated according to criteria presented in the lectures, in demonstrations, and in the course textbooks.

Course Requirements and Means of Evaluation:
Please refer to the instructor's syllabus addendum (to be distributed in class) for specific information regarding the course requirements and means of evaluation.

Attendance Policy:
Regular and prompt attendance in all classes is expected of students. Students absent from class for any reason are responsible for making up any missed work. Faculty members establish an attendance policy for each course and it is the student's responsibility to honor and comply with that policy.

Academic Honesty Policy:
Students found to have committed an act of academic dishonesty may be subject to failure of this course, academic probation, and / or suspension from the college. See the Student Handbook for additional details.

ADA Statement:

If you have a 504 Accommodation Plan, please discuss it with your instructor. If you have any disability but have not documented it with the Disability Support coordinator at Salem Community college, you must do so to be eligible for accommodations. To contact the Disability Support Coordinator, call 856-351-2773, or email disabilitysupport@salemcc.edu to set up an appointment. To find out more information about disability support services at Salem Community College, visit www.salemcc.edu/students/student-success-programs/disability-support.

Course Activities:
The lecture portion of the class includes lecture, discussion, example problems, and video-disc presentation. The student is required to complete homework assignments and present problems and solutions on the board. The student will be assigned five 1-page abstracts which are to be written as summaries and opinion of articles in Science Journals or science related newspaper articles. The laboratory portion of the class includes working with a partner to perform various experiments, and independently writing a formal lab report for each experiment. The reports and abstracts must be composed and typed outside of class hours.

Required Text(s): For textbook information, please see the Salem Community College Bookstore website.

Materials / Supplies*:*
None.

Additional Costs:
None.