CHM 1030 and CHM1030L

Elementary Chemistry 1 and Lab

Course Description

CHM1030	**Elements of Chemistry 1**	**(3) P**
CHM1030L	**Elements of Chemistry 1 Lab**	**(1) P**

This course and its laboratory component present elementary principles of modern chemistry, including concepts of atomic and molecular structure, chemical bonding, and properties of solutions. Also included are the principles of writing chemical formulas and balancing chemical equations. The physical behavior of gases and the concept of pH are investigated along with the importance of electrolytes and buffer systems in biological systems.

The laboratory component of Elements of Chemistry I (CHM 1030) presents experiments illustrating the elementary principles of modern chemistry to include concepts of atomic and molecular structure, chemical bonding, and properties of solutions. Students also conduct experiments that exemplify the principles of writing chemical formulas and balancing chemical equations. The physical behavior of gases and the concept of pH are investigated along with electrolytes and buffer systems. This basic chemistry course and its accompanying laboratory course is designed for both general education students and students in the Nursing and allied health professions.

Prerequisite: MAC1105, MAT1033, MTB1371 or higher level math
Co-requisite: CHM1030L must be taken with CHM1030.

Rationale

In a technological and free society, the individual is summoned to make decisions on specific uses of technologies related to physical and chemical principles. Making those decisions in a comprehensive and discerning manner requires some knowledge of fundamental physical laws and interactions. Accordingly, this course and its laboratory component use a unifying theme of atomic theory and structure to present and study basic concepts of physics and chemistry and their application to everyday life.

This course and its laboratory component support the mission of the College to enrich the lives of our students and community and to provide the highest quality of post-secondary academic education, and is one of the courses that may be taken to fulfill a portion of the general education requirement for the Associate of Arts degree.

Impact Assessment

Writing, speaking, and computational skills will be expected to be at a level commensurate with the requirements of the general education courses in communications and, especially, mathematics. Integration with other disciplines such as the physical sciences, biology and basic physiology is expected to occur naturally in discussion of societal and health issues that are related to chemistry. This course and its laboratory component serve as one of the options for non-science majors to fulfill the physical science portion of the general education requirements for the Associate of Arts degree. In addition, this course and its laboratory component are prerequisites for CHM 1031 and CHM 1031L, Elements of Chemistry II

– Physiological Chemistry and its Laboratory and for MCB 2010 and MCB 2010L, Introduction to Microbiology and its Laboratory thereby serving to fulfill the general education requirements for the Associate of Science degree in both Health Related and Biotechnology arenas. This course and its laboratory component are also part of the statewide curriculum for the Bachelor of Science in Nursing degree.

General Education Learning Outcome

Understand scientific concepts and reasoning and analyze and interpret various types of data.

SF Scientific Reasoning Critical Attributes

- Deductive and inductive inferences,
- Controlling variables,
- Use of the scientific method (gather, analyze, and synthesize data relevant to a problem),
- Application of a model to a new situation,
- Interpretations based on fundamental theories,
- Interpretation of data in both tabular and graphical form, and
- Application of specialized knowledge to a different or larger context.

Broad Course Objectives

This course and its laboratory component supports departmental goals by providing a broad general scientific background in basic chemical principles for all students. It requires students to build a conceptual base from which to interpret the physical world and the changes it undergoes and to understand the fundamental principles responsible for the behavior of matter.

The departmental objectives for student achievement are to:

- Demonstrate knowledge and understanding of the currently accepted models for interpretation of chemistry principles and communicate this knowledge in both objective and subjective forms, as well as quantitative and qualitative forms.
- Demonstrate awareness of the available science resource centers and other local and electronic sites of interest.

In order to achieve these objectives, the instructor will strive to have his/her students:

- Become acquainted with major areas of scientific work, both historical and recent, in chemistry and related physical science fields using situations that can be perceived as real.
- Be introduced to basic scientific concepts in chemistry and related fields and to the methodology by which uses of associated technologies are made in everyday life.
- Foster critical and informed decisions about uses of technology in everyday life.
- Develop a facility for expressing theoretical concepts and personal judgments on them in appropriate written and spoken English.
- Generate an understanding of the place of basic mathematics in the physical science of chemistry.
- Develop a vocabulary of terms used in chemistry.
- Recognize outstanding theories in chemistry and related fields and the outstanding contributors to the development of these theories.

- Be introduced to the place where chemical principles play a part our society and world.

Course Outline with Specific Objectives

UNIT 1: Introduction to Chemical Principles: Matter, Measurement & Metric Conversion Factors including Density and Specific Gravity

After studying chapters, lecture notes, conducting experiments 1 through 5 and reading selected materials provided below, you should be able to:

- Discuss the scientific method; define the following terms: scientific data, scientific law, scientific law, scientific hypothesis, and theory.
- Identify the three (3) physical states of matter and list in general terms the physical properties of each state of matter.
- Distinguish between physical and chemical properties.
- Classify a given change as chemical or physical.
- Distinguish between an element, compound and mixture.
- Define the terms accuracy and precision in measurements. *Accuracy is how close the measurement is to the real true value, and precision is the repeatability of numerous measurements.*
- Define the following terms: mass, volume, temperature, significant figures, density and specific gravity.
- Identify the number of significant figures in a measurement and round off the results of calculations to the correct number of significant figures.
- Express measurements in scientific notation with the correct number of significant figures.
- Identify the SI units commonly used to measure mass, volume, length and temperature and define the commonly used metric prefixes.
- Perform conversions using conversion factors and dimensional analysis
- Given any two of the following (mass, volume and density or specific gravity), calculate the unknown.
- Make conversions between Fahrenheit, Celsius and Kelvin measurements of temperature.
- Know that Chemistry deals with matter and energy.

UNIT 2: Atoms and Elements, The Periodic Law and Periodic Trends

On completion of the unit you should be able to:

- State the mass, charge and location of protons, electrons and neutrons.
- Given the atomic number of an element, draw diagrams showing the protons in the nucleus and the electrons in shells (or energy levels) around the nucleus.
- Write the electron dot formulae for the elements in groups 1 to 8 in the periodic table.
- Define valence electrons and atomic number.
- Identify the elements in the periodic which tend to form positive ions and those which tend to form negative ions.
- Given the relative abundance and isotopic masses for an element, calculate the atomic mass of that element.
- Given the atomic number and mass number of an element, calculate the number of electrons.
- Understand the following terms: atom, electron, amu, proton, neutron, electron, atomic weight, and atomic number, isotopes, mass number, elemental symbol, nuclear symbol, Electronegativity, ions.
- Given the name, write the symbol (and vice versa) for some common elements.

- Identify the elements in the periodic table which:
    - Are metals, nonmetals or metalloids.
    - Are solids, liquids and gases at room temperature.
    - Are alkali metals, alkaline earth elements, halogens and noble gases.
    - Are short-lived.
    - Are naturally occurring.
    - Exist as diatomic molecules.
    - Are classified as transition metal elements.
- List the properties of metals and non-metals
- Compare the sizes of atoms and ions of various elements.
- Know the periodic trends.

UNIT 3: Combining Elements
On completion of the unit you should be able to:

- Identify the elements in the periodic table which tend to combine to form ionic compounds.
- Explain why ionic compounds conduct electricity in liquid state, but not in solid state and explain the high melting points of ionic compounds.
- Write the molecular formula, electron dot (Lewis) structure, molecular shape and name for simple ionic and covalent compounds.
- Predict whether molecules will be polar or nonpolar.
- List the names, charge value and symbol of each of the polyatomics, **and** write the formulas of compounds which contain polyatomic ions when given the name and viceversa.
- Understand the following types of bonds: ionic, covalent, polar covalent and nonpolar covalent. Identify the type of polar bond by using the electronegativity difference.
- Correlate the group number with the valence or charge of an ion.
- Write the correct symbol for the ions formed from groups I, II, III, VI, and VII.
- Describe the octet rule.
- Distinguish between the common and systematic names for compounds.
- Describe the meaning of the classification system of binary, tertiary, and quaternary
- compounds
- Write the name given the formula and vice versa for: binary compounds, binary acids and oxy acids
- Calculate the molecular weight of a compound given the correct formula.
- Determine the number of ions liberated when ionic compounds are dissolved in water.

UNIT 4: Chemical Quantities and the Mole, Chemical Reactions, Equations and Calculations Based on equations
On completion of the unit you should be able to:

- Define Avogadro's number and the mole concept and write the number of particles in a mole.
- Calculate the formula (molecular) mass/ weight of compounds.
- Solve problems involving conversions between the mass in grams, the number of moles, and the number of formula units
- Given the formula of a compound calculate the percent composition.
- Given the composition of a compound calculate the empirical formula.
- Given the composition and molecular mass of a molecular compound calculate the molecular formula.
- Balance chemical equations.

- Interpret balanced equations in terms of moles, mass units and number of particles.
- Given the number of moles (or mass or number of particles) of one substance calculate the number of moles (or mass or number of particles) of another substance in the balanced equation.
- Define limiting and excess reactants and calculate theoretical and actual yields.
- Identify the following types of reactions:
    - synthesis
    - decomposition
    - single replacement
    - double replacement
    - neutralization
    - redox
    - precipitation
    - combustion
- Define endothermic and exothermic reactions.

UNIT 5: Energy, Molecular Forces and the States of Matter, The Gas Laws
After studying chapters in your textbook, lectures notes and conducting selected experiments in your laboratory manual, the student should be able to:

- Recognize Energy in all its forms and solve problems involving energy and energy changes.
    - Kinetic and Potential Energy
    - b. Temperature changes: Heat Capacity
    - c. Energy and heat capacity calculations
- Identify the various states of matter, as solid, liquid or gas in terms of:
    - arrangement of particles,
    - motion of particles,
    - distance between particles and relate that distance to compression,
    - attractive forces between particles,
    - shape of a substance,
    - volume, and relative density.
- Describe the behavior of a gas in terms of the kinetic molecular theory.
- Define pressure and list the difference types of units used to measure pressure and change from one unit to the other (atm., torr, mm, cm, in of Hg).
- List the four (4) variables/properties/measurements of a gas. *Pressure, Temperature, Volume, and moles of a gas.*
- Solve problems involving
    - Boyle's Law
    - Charles' law
    - Gay-Lussac's law
    - Avogadro's law
    - Combination gas law
    - Dalton's law of partial pressures
    - Ideal Gas Law
- State the meaning of Standard Temperature (ST), Standard pressure (SP) or a combination SC *[standard conditions]* or STP *[standard temperature and pressure]*.
- Calculate the volume of a gas at STP given initial volume, pressure and temperature.
- Convert the volume of a gas at STP into moles. *Use principle that at STP, every 22.4 liters of a gas is equal to one mole of a gas.*
- State the gas laws in mathematical as well as written terms

UNIT 6: Water and Important Mixtures, Solutions: Concentrations and Dilution, Osmosis and Tonicity

On Completion of this unit, you should be able to:

- Identify the types of mixtures and types of liquid mixtures as suspensions, colloidal dispersions or true solutions and list the properties of each.
- Define solute and solvent, list the factors that affect solubility and predict if an ionic solute will be soluble or insoluble in water based on solubility rules.
- Know whether a solution is saturated or unsaturated from the properties given while utilizing a "solubility curve".
- Describe the factors that affect the rate of at which a solute dissolves.
- List the components of each type of solution listed: strong and weak electrolytes, nonelectrolytes and correlate with osmotic pressure.
- Know the different ways of specifying solution concentrations and be able to solve problems involving them including solution preparation problems:
    - percent concentration,
    - molarity,
    - molality
- Calculate the millimoles in a solution whose concentration is expressed in Molarity.
- Understand dilution problems and calculate the dilution factor, final concentration or initial concentration, volume of water or amount of stock solution.
- Calculate the equivalent weight (grams) for a cation or anion.
- Describe the process of osmosis and indicate the greater "osmotic pressure", the direction in which water will flow when two solutions are separated from each other by a selectively/semipermeable membrane. Calculate the osmotic pressure of a solution.
- Determine the osmolarity of a given solution of given molarity
- Define and determine tonicity.

UNIT 7: Equilibrium, Acids, Bases & Salts: Buffer Systems, and the pH Scale

On completion of this unit you should be able to:

- Define the following terms: Thermodynamics vs. kinetics and know 3 ways to increase the rate of the reaction
- Know what an energy diagram is and know the following: transition state, activation energy, reactants, products, reaction coordinate
- Know how a catalyst works- (decrease activation energy)
- Le Chatelier's principle and equilibrium constants
- Define an acid and a base in terms of the Bronsted-Lowry and Arrhenius definitions and provide examples. and identify the properties of acids and bases.
- Classify acids by origin, number of hydrogen produced, and the presence/absence of oxygen.
- Define an acid and its conjugate base and a base and its conjugate acid
- Differentiate between strong and weak acids and between strong and weak bases.
- Name oxyacids and nonoxyacids, complete and balance neutralization reactions.
- Write an equation for the ionization of an acid. (Review from other units)
- Explain the process of titration and solve problems involving titration for mono-, di-, and triprotic acids.
- Arrange a set of pH values from the most acidic to most basic. And identify a pH value as to acidic, basic, or neutral.

- Calculate the hydrogen ion concentration, [H+]; hydroxide ion concentration, [OH]; given the Kw of water. Calculate the pH of a solution given the [H+] or [OH-].
- Identify the components of a buffer system and explain how a buffer solution works to maintain a pH level.
- List the common buffer systems in the blood that maintain correct blood pH.
- Identify the types of acidosis and alkalosis that can result from different conditions. Correlate the condition with the correct body response and compensatory mechanism. Be able to list common causes of any of the conditions.

Evaluation

A minimum of 70% of the assessment materials administered in this course will be given in a proctored environment.

CHM 1030: exams, quizzes and assignments
20% - Departmental comprehensive final exam
3-5 unit exams
Quizzes, assignments

CHM 1030L: This contributes 20% to the total CHM 1030 course grade.
5% - Departmental lab practical midterm
15% - Reports, Post laboratory assignments, attendance and performance