CHM 1025 & CHM 1025L

Introduction to Chemistry

Course Description

CHM 1025  Introduction to Chemistry (3)  P
CHM 1025L Introduction to Chemistry Laboratory (1)  P

This introductory course is intended to introduce students to the study of chemistry by building concepts and skills related to investigating the structure and nature of matter, and its potential for change. The student will learn basic characteristics of matter, fundamental energy concepts, the principles of chemical nomenclature and stoichiometry, and begin to build a 3-dimensional visualization of the molecular world. The laboratory experience is an integral part of the course and will provide students with the opportunity to develop their skills in making observations, taking measurements, designing experiments, and communicating their data, results and conclusions in oral written and graphical form. The math reasoning skills and spatial visualization required in this course presumes prior experience with algebra and geometry.

Pre-requisite: College Algebra (MAC 1105) or its equivalent
Co-requisite: CHM 1025 & CHM 1025L must be taken together

Rationale

The study of chemistry enables students to build an interpretive and predictive model for understanding the properties of matter in all its forms and the potential for change through chemical reactions. Many students come to college ill prepared for the study of chemistry and this course will allow them to explore the subject without all of the details of College Chemistry, and/or to prepare themselves for further study of the subject. To that end, this course supports the college mission of providing the highest quality post-secondary education leading to the Associate of Arts degree, and further to a baccalaureate degree.

The application of the scientific methodology to the study of matter and its potential for change promotes the opportunity for keen environmental awareness and a competent use of technology. The result will be a student capable of critical analysis, logical reasoning and problem solving using both mathematical and graphing tools.

Impact Assessment

Success in the course is highly dependent on math reasoning skills learned in College Algebra, and the foundation provided by high school science courses. It is offered as one of the options for students to meet the 3-hr minimum requirement in the physical sciences portion of the general education requirements for the Associate of Arts degree, and it is intended to provide the background required for success in College Chemistry. The laboratory experience is integral to success in the course; lecture and lab must be taken together.
**Broad Course Objectives**

This course supports the departmental goal of providing a foundation in the sciences for students to build upon for life-long learning or as a basis for further study in science. It provides students with an opportunity to develop an understanding of the atomic model for interpreting chemical phenomena, scientific reasoning skills, and mathematical and graphical analysis skills using modern computer technology.

In order to achieve these objectives, the instructor will strive to:

1. Extend students’ ability to apply mathematics and math reasoning to chemistry
2. Enable students to develop their critical reasoning skills
3. Expand students’ experience with characteristic properties and chemical changes
4. Extend students’ vocabulary of science concepts and terms
5. Illustrate the methodology of scientific inquiry and
6. Reinforce students’ verbal, mathematical and computer skills.

**Topical Outline with Specific Objectives**

I. Mathematical Skills

A. Systems of Measurement and unit analysis
B. Scientific Notation
C. Significant figures
D. Data interpretation and analysis:
   - direct proportions
   - inverse proportions
   - linear equations
   - accuracy and precision

**Learning Outcomes**

It is expected that the student will:

1. Use SI units and their accepted alternatives in chemistry
2. Demonstrate skills in measuring mass, volume and temperature
3. Describe the imprecise nature of all measurements
4. Use graphing techniques to represent or analyze experimental data
5. Determine the number of significant figures in a measured quantity and relate to the uncertainty.
6. Round off calculated results to the appropriate number of significant figures.
7. Correctly determine the unit of a derived quantity.
8. Show proficiency in using exponential notation.
II. Energy and Energy Changes

A. Stability/reactivity and energy content
B. Relationships to electrostatic force (Coulomb’s Law)
C. ∆H, endothermic, exothermic, relationship to bond making and bond breaking

Learning Outcomes
It is expected that the student will:
1. Explain what happens to the energy of a system as it becomes more stable or less stable.
2. Show an understanding of force and energy.
3. Use Coulomb’s Law to predict the effect on the force of attraction or repulsion when charges or distances between ions are changed.
4. Show an understanding of exothermic and endothermic by applying the terms correctly to various types of physical or chemical changes.

III. Classification of Matter
Emphasis on nano-macro visualization

A. Pure substances: elements and compounds
B. Mixtures: homogeneous and heterogeneous
C. States of Matter
D. Physical properties and its uses in the separation (purification) and identification of substances
E. Chemical properties/chemical changes
   1. Distinguish physical from chemical changes; extensive from intensive properties
   2. Define BP, MP (FP), sublimation point

Learning Outcomes
It is expected that the student will:
1. Define matter.
2. Describe and distinguish different types of matter (both macro and nanoscale views)
3. Describe the states of matter in terms of macroscale properties as well as nanoscale structure, interparticle distances and motion, and energies.
4. Classify a given material as an element, compound or mixture using the properties of the material.
5. Relate the observable (macroscopic) characteristics and properties of elements compounds and mixtures to the concept of atoms and molecules.
6. Relate heat changes that occur during a phase change to the energy required or released when separating or combining species that attract or repel.
7. Describe several ways that substances may be separated from one another. i.e. filtration, distillation, chromatography, etc.
IV. **Atomic Structure**

A. Dalton’s Theory  
B. Atoms as fundamental units of elements; molecules as fundamental units of molecular compounds: and ions as fundamental units of ionic compounds.  
C. Law of Conservation of Mass  
D. Law of Definite Proportions  
E. Subatomic particles: discovery, characteristics  
F. Atomic Number, mass number isotopes

**Learning Outcomes**

It is expected that the student will:  
1. Define atom, molecule and ion.  
2. Describe early models of the atom.  
3. Describe the relative position, mass and charge for the proton, neutron and electron.  
4. Calculate the number of subatomic particles for an atom or monoatomic ion given the mass number and the charge.  
5. Show how the Law of Conservation of Mass & of Definite Composition are explained in terms of Atomic Theory

V. **The Periodic Table**

A. Organization of the modern periodic table  
B. Elements as metals, nonmetals, and noble gases (emphasize stability)  
C. Names of common families in the periodic table

**Learning Outcomes**

It is expected that the student will:  
1. Classify elements as metal, nonmetal, or metalloid and locate them on the periodic table.  
2. Identify the following families of elements: alkali metals, alkaline earth metals, halogens and noble gases.

VI. **Compounds: Molecular and Ionic**

A. ID formulas from nature of elements  
B. Nomenclature of ionic compounds  
C. Nomenclature of binary molecular compounds  
D. Lewis Dot Structures and valence electrons

**Learning Outcomes**

It is expected that the student will:
1. Define covalent and ionic bonding.
2. Define valence electrons.
3. Demonstrate a knowledge that bonding involves valence electrons.
4. Draw electron dot diagrams for atoms.
5. Identify from a chemical formula whether a compound is molecular (covalent) or ionic.
6. Draw electron dot diagrams and structural formulae for simple molecules and ions and deduce the molecular formula.
7. Develop a vocabulary of common monoatomic ions (symbols and charges) and select polyatomic ions.
8. Name ionic compounds from a formula and write the formula given the name.
9. Name covalent compounds given the formula using the Greek prefix naming system and write the formula given the name.

VII. Introduction to Compound Stoichiometry

A. The mole concept
B. Formula mass
C. Avogadro’s number, number of atoms, ions, formula units, molecules

Learning Outcomes
It is expected that the student will:
1. Define the mole
2. Determine the molar mass of an element or compound
3. Perform calculations relating the number of particles, moles and mass
4. Compare and contrast molecular and empirical formulas
5. Calculate the empirical formula of a compound from its % composition

VIII. Introduction to Reaction Stoichiometry

A. Basics of a chemical reaction or stoichiometric equation
B. Apply the law of conservation of mass to a stoichiometric equation i.e. balance chemical reactions including enthalpy
C. Introduction to common reaction types: synthesis, decomposition, replacement combustion and acid-base.

Learning Outcomes
It is expected that the student will:
1. Define reactants and products
2. Observe and record changes that occur during a chemical reaction
3. Gather experimental data that lead to the law of conservation of mass
4. Apply the law of conservation of mass to a formula equation of a reaction to demonstrate that atoms are conserved in the reaction
5. Balance chemical reactions
6. Define exothermic and endothermic reactions
7. Classify reactions as endothermic or exothermic based on experimental observations
8. Relate energy changes to bond breaking and formation
9. Write equations for chemical reactions including the energy term
10. Classify, predict products and write balanced equations for the following types of reactions:
   • synthesis
   • decomposition
   • single replacement
   • double replacement
   • combustion
   • acid-base neutralization

IX. Intro to Kinds of Physical/Chemical Changes

A. Ionic and molecular dissolutions - Intro to equilibrium
B. Intro to acid/base reactions - Intro to equilibrium
C. Simple Redox

Learning Outcomes
It is expected that the student will:
1. Write aqueous ionic and molecular dissolution equations
2. Write the names and formulas of some common acids: HCl, H₂SO₄, HNO₃, HC₂H₃O₂
3. Write simple aqueous molecular ionization equations

XI. Molecular Structure

A. Isomers
B. Basic VSEPR (limit to linear, trigonal planar, and tetrahedral)
C. Electronegativity and molecular polarity
D. Relationship between molecular polarity and physical properties such as boiling pt. melting pt. and solubility

Learning Outcomes
It is expected that the student will:
1. Given a simple molecular formula, draw the different structural isomers possible.
2. Use basic VSEPR to determine the molecular geometry and bond angle of simple molecules.
3. Define electronegativity and use it to classify bonds as polar or nonpolar.
4. Relate molecular geometry to molecular polarity. Be able to classify linear,
trigonal planar, and tetrahedral molecules as polar or nonpolar.
5. Explain the relationship between molecular polarity and physical properties.

The Laboratory Component

A. Lab Safety
B. Measurement and communication
C. Scientific methodology
D. Classify matter and its observed changes
E. Relate molecular models to chemical changes

Learning Outcomes
It is expected that the student will:
1. Be able to describe how and when to use each piece of equipment
2. Describe common laboratory hazards and procedures or techniques to deal with such hazards.
3. Produce a list of rules of safe laboratory conduct.
4. Display a conscious safety attitude in the laboratory.
5. Demonstrate skills in measuring mass, volume, and temperature.
6. State the acceptability of numerical results of a lab experiment with regard to the uncertainty of the results.
7. Communicate results and data in clear and understandable forms
8. Show an understanding of the principles in good experimental design.

Evaluation

The evaluation design is left to the individual instructor but it should contain a real-time assessment of both laboratory and reasoning skills and at least a portion of every test should involve written responses and/or detailed solutions to problems. The final exam must be comprehensive and focus on the concepts and skills required for entry into the College Chemistry sequence.

25 October 2004