Virginia Western Community College
CHM 111
General Chemistry I

Prerequisites

MTE 1-9 MDE 60, or placement recommendation for MTH 161 or higher; and a placement recommendation for EDE 11/ENG 111, or successful completion of all developmental English requirements. High school chemistry or CHM 5 recommended but not required.

Course Description

Explores the fundamental laws, theories, and mathematical concepts of chemistry. Designed primarily for science and engineering majors. Requires a strong background in mathematics. Students must earn a grade of C or higher in the lecture portion of the course to earn an overall grade of C or higher. Part I of II. This is a Passport and UCGS transfer course.

Semester Credits: 4 **Lecture Hours: 3** **Laboratory Hours: 3**

Required Materials

Textbooks:

General Chemistry: Atoms First. Young, Vining, Day, and Botch. 1st Edition. Cengage Unlimited. ISBN: 9780357700006

General Chemistry I Lab Manual. Upshaw. 1st Edition. VWCC. In-house manual available at bookstore.
Lab Notebook. Hayden. McNeil. ISBN: 9781533956606

Safety Goggles

Course Objectives

Upon completing the course, the student will be able to:

Matter and Measurement

- Employ the scientific method, explain measurements and uncertainty, and use dimensional analysis and problem solving in conversion questions. Describe the phases and classifications of matter.
- Apply significant figures in calculations and measurements.

Atoms, elements and moles

- Explain atomic theory. Explain the organization of the Periodic Table and predict periodic properties of the elements. Describe Isotopes and calculate average atomic mass.
- Explain molar mass and the mole concept: convert between mass, moles, number of molecules, number of atoms, and molarity.

Nomenclature and chemical reactions

- Use Chemical Nomenclature. Use the periodic chart to predict the ionic charge of the main group elements. Apply the rules for nomenclature to write formulas as well as name: ionic compounds, binary molecules and acids.
- Predict the solubility of ionic compounds. Describe and predict properties of electrolytes. Write and balance chemical equations. Write net ionic equations and predict products for precipitation and acid/base reactions. Explain Redox and redox reactions. Assign oxidation states.

Stoichiometry
- Determine empirical and molecular formulas. Demonstrate an understanding of stoichiometry by calculating theoretical yield, actual yield, percent yield and limiting reagent.

Electronic Structure of the Atom
- Explain the electronic structure of the atom. Show how light and spectroscopy led to the understanding of the wave-particle duality. Explain quantum numbers and apply quantum numbers to depict electron configurations of neutral atoms and ions.
- Recognize the periodic properties of electronegativity, electron affinity, ionization energy, and ionic or covalent radius from the position of the element in the Periodic Table.

Chemical Bonding
- Differentiate between ionic, polar covalent and covalent bonds.
- Draw Lewis structures for covalent compounds and use VSEPR concepts to predict: a) bond angles b) geometry c) polarity. Apply formal charge to understand resonance and determine the best Lewis structure.
- Apply hybrid orbital theory to predict hybridization and explain pi and sigma bonding. (optional: M.O. Theory)

Thermochemistry
- Describe and employ basic Thermochemistry. Explain enthalpy. Use Hess's law and enthalpies of formation to calculate heats of reactions. Perform calorimetry calculations. Distinguish between endothermic and exothermic processes and do energy calculations that accompany reactions.

Gases
- Apply the Kinetic Theory of Gases. Use the Gas laws to do gas law calculations. Explain the difference between real and ideal gases.

Laboratory Skills
- Perform a minimum of 8 "wet" supervised hands-on labs per semester.
- Work in the lab safely. Wear Splash resistant goggles, proper clothing and closed toed shoes.
- Properly handle and dispose of chemicals.
- Read and analyze an SDS.
- Properly collect hazardous waste.
- Recognize basic laboratory equipment.
- Make measurements using the correct number of significant figures.
- Utilize notebook skills (especially data acquisition, data handling and data analysis). Students will perform a minimum of 2 wet labs using a lab notebook. The notebook needs to include an introduction, procedure, data table and conclusion.
- Utilize spreadsheets to graph (plot) and analyze data and do basic error analysis.
- Students will write 1 formal lab report using proper scientific analytical writing. The formal lab report must include good data analysis.
- Use volumetric glassware, including a buret.
- Perform accurate titrations.
- Use basic lab equipment including: balance, hot plate and thermometer.
- Connect topics discussed in lecture and lab observations.

Major Topics to be Included

Matter and Measurement
Atoms, elements and moles
Nomenclature and chemical reactions
Stoichiometry
Electronic Structure of the Atom
Chemical Bonding
Thermochemistry
Gases
Laboratory Skills

Topical Description

Matter, Measurement, and Problem Solving

- Atoms and Molecules
- The Scientific Approach to Knowledge
- The Classification of Matter
- Physical and Chemical Changes and Physical and Chemical Properties
- Energy: A Fundamental Part of Physical and ChemicalChanges
- The Units of Measurement
- The Reliability of a Measurement
- Solving Chemical Problems
- Use Dimensional Analysis
- Apply Significant Figures in Calculations and Measurements

Atoms and Elements

- Imaging and Moving Individual Atoms
- Modern Atomic Theory and the Laws That Led to It
- The Discovery of the Electron
- The Structure of the Atom
- Subatomic Particle: Protons, Neutrons, and Electrons in Atoms
- Describe Isotopes
- Finding Patterns: The Periodic Law and the Periodic Table
- Atomic Mass: The Average Mass of an Element's Atoms
- Molar Mass: Counting Atoms by WeighingThem

Molecules, Compounds, and Chemical Equations

- Hydrogen, Oxygen, and Water
- Chemical Bonds
- Representing Compounds: Chemical Formulas and Molecular Models
- An Atomic-Level View of Elements andCompounds
- Ionic Compounds: Formulas and Names
- Molecular Compounds and Acids: Formulas and Names
- Formula Mass and the Mole Concept for Compounds
- Composition of Compounds
- Determining a Chemical Formula from Experimental Data

- Writing and Balancing Chemical Equations
- Organic Compounds

Chemical Quantities and Aqueous Reactions

- Climate Change and the Combustion of Fossil Fuels
- Reaction Stoichiometry: How Much Carbon Dioxide?
- Limiting Reactant, Theoretical Yield, and Percent Yield
- Solution Concentration, Molarity, and Solution Stoichiometry
- Types of Aqueous Solutions and Solubility
- Precipitation Reactions
- Representing Aqueous Reactions: Molecular, Ionic, and Complete Ionic Equations
- Acid-Base and Gas-Evolution Reactions
- Oxidation-Reduction Reactions
- Describe and Predict Properties of Electrolytes

Gases

- Breathing: Putting Pressure to Work
- Pressure: The Result of Molecular Collisions
- The Simple Gas Laws: Boyle's Law, Charles's Law, and Avogadro's Law
- The Ideal Gas Law
- Applications of the Ideal Gas Law: Molar Volume, Density, and Molar Mass of a Gas
- Mixtures of Gases and Partial Pressures
- Gases in Chemical Reactions: Stoichiometry Revisited
- Kinetic Molecular Theory: A Model for Gases
- Mean Free Path, Diffusion, and Effusion of Gases
- Real Gases: The Effects of Size and IntermolecularForces

Thermochemistry

- Chemical Hand Warmers
- The Nature of Energy: Key Definitions
- The First Law of Thermodynamics: There is No FreeLunch
- Quantifying Heat and Work
- Measuring ΔE for Chemical Reactions: Constant-Volume Calorimetry
- Enthalpy: The Heat Evolved in a Chemical Reaction at ConstantPressure
- Constant-Pressure Calorimetry: Measuring ΔH_{rxn}
- Hess's Law and Other Relationships InvolvingΔH_{rxn}
- Enthalpies of Reaction from Standard Heats of Formation

The Quantum-Mechanical Model of the Atom

- Schrödinger's Cat
- The Nature of Light
- Atomic Spectroscopy and the Bohr Model
- The Wave Nature of Matter: the de Broglie Wavelength, the Uncertainty Principle, and Indeterminacy
- Quantum Mechanics and the Atom
- The Shapes of Atomic Orbitals

Periodic Properties of the Elements

- Nerve Signal Transmission
- The Development of the Periodic Table
- Electron Configurations: How Electrons Occupy Orbitals
- Electron Configurations: Valence Electrons and the Periodic Table
- The Explanatory Power of the Quantum-Mechanical Model
- Periodic Trends in the Size of Atoms and Effective Nuclear Charge
- Ions: Electron Configurations, Magnetic Properties, Ionic Radii, and Ionization Energy
- Electron Affinities and Metallic Character

Chemical Bonding I: The Lewis Model

- Bonding Models and AIDS Drugs
- Types of Chemical Bonds
- Representing Valence Electrons with Dots
- Ionic Bonding: Lewis Symbols and Lattice Energies
- Covalent Bonding: Lewis Structures
- Electronegativity and Bond Polarity
- Lewis Structures of Molecular Compounds and Polyatomic Ions
- Resonance and Formal Charge
- Exceptions to the Octet Rule: Odd-Electron Species, Incomplete Octets, and Expanded Octets
- Bond Energies and Bond Lengths
- Bonding in Metals: The Electron Sea Model

Chemical Bonding II: Molecular Shapes, Valence Bond Theory, and Molecular Orbital Theory

- Artificial Sweeteners: Fooled by Molecular Shape
- VSEPR Theory: The Five Basic Shapes
- VSEPR Theory: The Effect of Lone Pairs
- VSEPR Theory: Predicting Molecular Geometries
- Molecular Shape and Polarity
- Valence Bond Theory: Orbital Overlap as a Chemical Bond
- Valence Bond Theory: Hybridization of Atomic Orbitals
- Explain pi and sigma bonding
- Molecular Orbital Theory: Electron Delocalization (optional)

Laboratory Topics

ADA Statement

https://www.virginiawestern.edu/wp-content/uploads/2024/12/Syllabus-Statement_ADA.pdf

Title IX Statement

https://www.virginiawestern.edu/wp-content/uploads/2024/12/Syllabus-Statement_Title-IX-2025.pdf

Notes to Instructors

1. Please note that a three-hour time slot is allotted to the laboratory and the student should be aware that this time will be fully utilized. The laboratory time is used not only for experimentation, but may also be used for demonstrations, movies, and problem solving. Whenever time permits, homework problems will be worked out in the beginning of the laboratory and the student is expected to participate.
2. Attendance in the laboratory is mandatory at the scheduled time. In case of an unavoidable situation, the student should contact the instructor beforehand to be excused and to see if any arrangements can be made to make up the laboratory. It may or may not be possible. Approved safety goggles must be worn in the laboratory ***over the eyes*** as required by state law. Long pants and close-toed shoes are required. The student must show completed pre-lab (title, introduction, procedure, and data table(s)) in their laboratory notebook at the beginning of the experiment.
3. Laboratory reports are due at the beginning of the next lab period. The report consists of the data report sheets included in the lab manual or handout. To aid not only the instructor but also especially the students, reports will not be accepted two weeks after the lab was assigned. Completion of the lab experiment followed by turning in the data and calculations on the due date with appropriate write-up insures a good grade. Grading scales for laboratory reports are at the professor's discretion, but will count towards the overall grade for the course.
4. There will be 1000 total points available that will come from 4 in class exams, 1 cumulative final exam, homework, and lab:
   700 points exams, 200 points lab, and 100 points homework. Since exams and homework are part of the lecture, the requirement of a C or better in the course is as follows:
   For an A, 900 points are required, with a minimum of 560 points coming from the lecture portion.
   For a B, 800 – 899 points are required, with a minimum of 560 points coming from the lecture portion.
   For a C, 700 – 799 points are required, with a minimum of 560 points coming from the lecture portion.
   The 560 is 70% of the 800 points coming from exams and homework.
5. The following lab skill expectations have been established for successful transfer to 4-year colleges in Virginia:
   a. Perform a minimum of 8 "wet" supervised hands-on labs per semester.
   b. Work in the lab safely. Wear Splash resistant goggles, proper clothing and closed toed shoes.
   c. Properly handle and dispose of chemicals.
   d. Read and analyze an SDS.
   e. Properly collect hazardous waste.
   f. Recognize basic laboratory equipment.
   g. Make measurements using the correct number of significant figures.
   h. Utilize notebook skills (especially data acquisition, data handling and data analysis). Students will perform a minimum of 2 wet labs using a lab notebook. The notebook needs to include an introduction, procedure, data table and conclusion.
   i. Utilize spreadsheets to graph (plot) and analyze data and do basic error analysis.
   j. Students will write 1 formal lab report using proper scientific analytical writing. The formal lab report must include good data analysis.
   k. Use volumetric glassware, including a biuret.
   l. Perform accurate titrations.
   m. Use basic lab equipment including: balance, hot plate and thermometer.
   n. Connect topics discussed in lecture and lab observations.