

# Virginia Western Community College

## CHM 111

### General Chemistry I

#### Prerequisites

MTE 1, MTE 2, MTE 3, MTE 4, MTE 5, MTE 6, MTE 7, MTE 8 and MTE 9; and a placement recommendation for ENG 111, co-enrollment in ENF 3/ENG 111, or successful completion of all developmental English requirements. High school chemistry or CHM 5 recommended but not required. Part I of II

#### 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 Transfer course.

**Semester Credits: 4**

**Lecture Hours: 3**

**Laboratory Hours: 3**

#### Required Materials

##### **Textbooks:**

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

General Chemistry I Lab Manual. Upshaw. 1<sup>st</sup> Edition. VWCC. In-house manual available at bookstore.  
Lab Notebook. Hayden. McNeil. ISBN: 9781930882744

Safety Goggles

#### Course Outcomes

**At the completion of this course, the student should be able to:**

- Make accurate observations and measurements, to collect and correlate data, and to draw conclusions based on the data.
- Approach problem solving in a logical and organized fashion, focusing on the importance of units and the mole concept.
- Show skill in the language of chemistry, the writing and interpretation of chemical formulas and equations both qualitatively and quantitatively.
- Understand the fundamental principles of matter and energy, such as the particulate nature of matter, the relationship between the properties of substances to the making and breaking of chemical bonds and the energy aspect of chemical reactions.
- Appreciate and understand the impact of chemistry on our lives, food, health, prosperity and environmental quality.

## 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 Chemical Changes
- 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 Weighing Them

### Molecules, Compounds, and Chemical Equations

- Hydrogen, Oxygen, and Water
- Chemical Bonds
- Representing Compounds: Chemical Formulas and Molecular Models
- An Atomic-Level View of Elements and Compounds
- 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 Intermolecular Forces

### Thermochemistry

- Chemical Hand Warmers
- The Nature of Energy: Key Definitions
- The First Law of Thermodynamics: There is No Free Lunch
- Quantifying Heat and Work
- Measuring  $\Delta E$  for Chemical Reactions: Constant-Volume Calorimetry
- Enthalpy: The Heat Evolved in a Chemical Reaction at Constant Pressure
- Constant-Pressure Calorimetry: Measuring  $\Delta H_{rxn}$
- Hess's Law and Other Relationships Involving  $\Delta H_{rxn}$
- 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

<u>Experiment Number</u>	<u>Experiment Title</u>	<u>Page</u>
1	Safety, Check-in, and Measurements	4
2	Temperature and Heating of Water	8
3	Paper Chromatography	12
4	Density	17
5	Fractional Crystallization	22
6A	The Synthesis of Alum	30
6B	The Analysis of Alum	35
7	Conductometric Titration and Gravimetric Determination	41
8	Ideal Gas Law	49
9	Thermochemistry	53
10	Analysis of an Unknown Chloride	58
11	Food Dye Forensics	62
12	Research Presentation	70
13	Lab Practical	72
14	Molecular Models	73

## 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 glasses 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.