straighterline

Syllabus

CHEM101 | **General Chemistry I**

Course Text

No need to track down a textbook; the readings are built right into this course. We adapted the lessons from the following source:

Flowers, P., Theopold, K., Langley, R. & Robinson, W.R. (eds). (2019). *Chemistry 2d* (2nd ed.). Open Stax. https://openstax.org/details/books/chemistry-2e

Course Description

This course provides a solid foundation in the core principles of chemical science. Beginning with atoms and the periodic table, it explores electronic structure, chemical bonding, and molecular geometry, linking atomic properties to behavior. Students will study reaction stoichiometry, kinetics, energy changes, and gas behavior, along with intermolecular forces affecting liquids and solids. The course covers solutions, acid-base concepts, equilibria, entropy, free energy, and nuclear energy, concluding with an introduction to organic chemistry. This foundation prepares students for advanced studies in chemistry and related fields.

Learning Outcomes

After completing this course, students will be able to:

1. Describe chemistry's historical development, the scientific method, classify states of matter, their properties, and the influence of chemical measurements on chemical calculations.
2. Interpret Dalton’s atomic theory, calculate atomic mass and isotopic abundance, and analyze periodic table organization and trends in element properties.
3. Describe the quantum mechanical description of electrons in atoms including electron configurations and their relation to the periodic table, and the observed trends in atomic size, ionization energy, and electron affinity of elements.
4. Explain chemical bonding, Lewis structures, formal charges, bond polarity, and molecule structure prediction.
5. Classify chemical reactions, comprehend mole concepts and stoichiometry, explain factors affecting reaction rates, net and elementary reactions with rate laws, and concentration units for solution calculations.
6. Explain energy concepts, thermodynamics laws, enthalpy principles, and calorimetry techniques, enabling proficient calculation and interpretation of heat-related properties.
7. Recognize gas property relationships, apply gas laws in calculations, explaining the postulates of kinetic-molecular theory.

8. Describe intermolecular forces, crystalline structure types, defects, and phase transitions, aiding in the interpretation of phase diagrams.
9. Describe temperature and pressure effects on solubility, solution concentration measures, and the impact of solute concentration on solution properties, including osmosis.
10. Recognize Brønsted-Lowry acids and bases, evaluating aqueous solution acidity, pH and pOH calculations.
11. Describe acid-base buffers, titration curves, and interpret chemical equations and equilibrium expressions for solubility equilibria.
12. Describe entropy and Gibbs free energy, their changes, and correlate them with chemical and physical processes, spontaneity, and equilibrium constants.
13. Illustrate nuclear structure, radioactive decay types, their biological effects, and radiation measurement units and detection tools.
14. Explain methods for representing molecules in organic chemistry, and the difference between various types of organic compounds based on their characteristic properties.
15. Apply theoretical concepts to real-life scenarios through case studies and practice sets designed to enhance problem-solving and analytical skills.

Course Prerequisites

There are no prerequisites for this course.

Academic Integrity Statement

Academic integrity is the pursuit of scholarly activity in an honest, truthful and responsible manner. Violations of academic integrity include, but are not limited to, plagiarism, cheating, fabrication and academic misconduct. Failure to comply with the Academic Integrity Policy can result in a failure and/or zero on the attempted assignment/examination, a removal from the course, disqualification to enroll in future courses, and/or revocation of an academic transcript.

Course Completion Policy

In order for a course to be considered complete, all required coursework must be attempted, submitted, and graded. Required coursework consists of graded assignments. Any Academic Integrity Policy violations may prevent a course from being considered complete.

Course Evaluation Criteria

Your score provides a percentage score and letter grade for each course. A passing percentage is 70% or higher.

There are a total of 1000 points in the course:

Topic	Assessment	Points	Learning Outcomes
3	Graded Exam 1	125	1, 2, 3
6	Graded Exam 2	125	4, 5, 6
6	Midterm Exam	200	1-6
10	Graded Exam 3	125	7, 8, 9

15	Graded Exam 4	125	10-14
16	Final Exam	300	1-14

Course Roadmap

Topic 1 | Chemistry: The Science of Change

Subtopics

- The Study of Chemistry
- Classification and Properties of Matter
- Scientific Measurement
- Uncertainty in Measurement
- Using Units and Solving Problems

Assignments

- Chemistry: The Central Science
- The Scientific Method
- States of Matter
- Properties of Matter
- Case Study: Density and Buoyancy in Marine Engineering
- SI Base Units
- Derived Units: Volume and Density
- Significant Figures
- Accuracy and Precision
- Conversion Factors and Dimensional Analysis
- Practice Set: 1

Topic 2 | Atoms and the Periodic Table

Subtopics

- The Atomic Theory
- Atomic Structure
- The Periodic Table

Assignments

- Early Ideas in Atomic Theory
- Evolution of Atomic Theory
- The Proton and the Nucleus
- Chemical Symbols
- Atomic Numbers, Mass Numbers, and Isotopes
- Chemical Formulas
- Practice Set 2: Atoms and the Periodic Table
- Case Study: Atomic Number, Mass Numbers, and Isotopes in Medical Imaging
- The Modern Periodic Table

Topic 3 | Electronic Structure and Periodic Trends

Subtopics

- Quantum Theory
- Electronic Configurations and the Periodic Table
- Periodic Trends in Properties of Elements

Assignments

- The Photoelectric Effect
- Bohr’s Theory of the Hydrogen Atom
- Quantum Theory of Electrons in Atoms
- Case Study: Quantum Mechanics in MRI Technology
- Atomic Orbitals and The Aufbau Principle
- Electron Configurations and the Periodic Table
- Covalent and Ionic Radii
- Ionization Energy and Electron Affinity
- Practice Set: 3
- **Graded Exam 1**

Topic 4 | Chemical Bonds and Molecular Geometry

Subtopics

- Ionic Bonding
- Covalent Bonding
- Lewis Symbols and Structures
- Formal Charges
- Molecular Geometry and Polarity
- Molecular Orbital Theory

Assignments

- The Formation of Ionic Compounds
- Electronic Structures of Cations and Anions
- Ionic Bond Strength and Lattice Energy
- Formation of Covalent Bonds
- Electronegativity and Polarity
- Case Study: Electronegativity and Polarity in Water’s Unique Properties
- Covalent Bond Strength
- Lewis Symbols and Structures
- The Octet Rule and Exceptions to the Octet Rule
- Formal Charge Calculation
- Predict Molecular Structure Using Formal Charge
- VSEPR Theory
- Molecular Polarity and Dipole Moment
- Molecular Orbital and Energy Diagrams
- Bonding in Diatomic Molecules
- Practice Set: 4

Topic 5 | Reaction Stoichiometry and Kinetics

Subtopics

- Types of Chemical Reactions
- Mole Concept and Stoichiometry
- Concentration of Solutions
- Reaction Kinetics and Factors Affecting Reaction Rates
- Reaction Mechanism

Assignments

- Precipitation Reactions
- Acid-Base Reactions
- Oxidation-Reduction Reactions
- Formula Mass and The Mole
- Reaction Stoichiometry
- Case Study: Reaction Stoichiometry in Industrial Ammonia Production
- Reaction Yields
- Molarity
- Mass and Volume Percentage
- Chemical Reaction Rates
- Factors Affecting Reaction Rates
- Rate Laws
- Elementary Reactions
- Practice Set: 5

Topic 6 | Energy Changes in Chemical Reactions

Subtopics

- Energy and Energy Changes
- Laws of Thermodynamics
- Enthalpy

Assignments

- Energy
- Temperature and Heat
- First Law of Thermodynamics
- Second and Third Laws of Thermodynamics
- Standard Enthalpy of Formation and Combustion
- Hess’s Law
- Calorimetry
- Practice Set: 6
- **Graded Exam 2**

Topic 7 | Midterm Exam

Assignments

- **Midterm Exam**

Topic 8 | Gases

Subtopics

- The Gas Laws and Ideal Gas Law
- Reactions of Gaseous Substances and Mixtures
- The Kinetic Molecular Theory

Assignments

- The Gas Laws
- The Ideal Gas Law
- Case Study: The Ideal Gas Law in Respiratory Medicine
- Gas Density and Molar Mass
- Dalton’s Law
- Chemical Stoichiometry and Gases
- Effusion and Diffusion of Gases
- Behavior of Gases, Part I
- Behavior of Gases, Part II
- Practice Set: 7

Topic 9 | Intermolecular Forces and the Physical Properties of Liquids and Solids

Subtopics

- Intermolecular Forces
- Properties of Liquids
- Crystal Structure
- Phase Changes and Phase Diagrams

Assignments

- Forces between Molecules
- Viscosity, Surface Tension, and Capillary Rise
- Case Study: The Role of Surface Tension and Adhesion in Water Transport
- The Solid State of Matter
- The Structures of Metals
- The Structures of Ionic Crystals
- Vaporization and Condensation
- Heating and Cooling Curves
- The Phase Diagram
- Practice Set: 8

Topic 10 | Physical Properties of Solutions

Subtopics

- Factors Affecting Solubility
- Colligative Properties

Assignments

- The Dissolution Process
- Effects of Temperature and Pressure on Solubility
- Mole Fraction and Molality
- Vapor Pressure Lowering
- Boiling Point Elevation
- Freezing Point Depression
- Osmosis and Osmotic Pressure

- Case Study: Osmosis in Medical Treatments – The Role of Osmotic Pressure in IV Solutions
- Practice Set: 9
- **Graded Exam 3**

Topic 11 | Acids and Bases

Subtopics

- Bronsted-Lowry Acids and Bases
- Relative Strengths of Acids and Bases

Assignments

- Acids, Bases, and Conjugate Acid-base Pairs
- The pH Scale
- Case Study: Acid-Base Balance in the Body – The Role of pH in Blood and Its Regulation
- Acid and Base Ionization Constants
- Acid-Base Equilibrium Calculations
- Practice Set: 10

Topic 12 | Acid-Base Equilibria and Solubility Equilibria

Subtopics

- The Buffer Solutions
- Acid-base Titrations
- Solubility Equilibria

Assignments

- How Buffers Work
- Buffer Capacity
- Titration Curves
- Acid-Base Indicators
- The Solubility Product
- Case Study: The Role of Solubility Product in Drug Formulation – Ensuring Proper Dissolution and Bioavailability
- Common Ion Effect
- Practice Set: 11

Topic 13 | Entropy, Free Energy, and Equilibrium

Subtopics

- Entropy
- Gibbs Free Energy

Assignments

- Entropy and Microstates
- Case Study: The Role of Entropy and Free Energy in Metabolic

Reactions – Energy Balance in Cellular Processes
- Predicting the Sign of ΔS
- Free Energy Change
- Free Energy and Equilibrium
- Practice Set: 12

Topic 14 | Nuclear Energy

Subtopics

- Nuclear Structure and Stability
- Radioactive Decay
- Effects of Radiation

Assignments

- Nuclear Structure
- Nuclear Stability
- Case Study: The Role of Nuclear Stability and Radioactive Decay in Cancer Treatment
- Types of Radioactive Decay
- Radiometric Dating
- Applications of Radioactive Isotopes
- Biological Impact of Radiation
- Practice Set: 13

Topic 15 | Organic Chemistry

Subtopics

- Organic Compounds

Assignments

- Hydrocarbons
- Alcohols and Ethers
- Case Study: The Role of Alcohols and Ethers in Pharmaceutical Formulations
- Aldehydes, Ketones, Carboxylic Acids, and Esters
- Amines and Amides
- Practice Set: 14
- **Graded Exam 4**

Topic 16 | Final Exam

Assignments

- **Final Exam**

Assignments

- Conclusion Video
- End of Course Survey

Related Courses

CHEM101L: General Chemistry I Lab

CIV101: Western Civilization I

PSY101: Introduction to Psychology