Virginia Western Community College
CHM 112
General Chemistry II

Prerequisites
CHM 111

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. Part II of II

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

Required Materials

Textbook:
Principles of Chemistry – A Molecular Approach with Mastering Chemistry Access Code. Tro. 3rd edition. Pearson Publishing. ISBN: 9781323402641
Chemical Principles in the Laboratory – Customized. Slowinski, Wolsey, Masterton. 11th edition. Cengage. ISBN: 9781337051057
Lab Notebook. Hayden. McNeil. ISBN: 9781930882744

Course Outcomes

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

- Distinguish between oxidation and reduction reactions, balance redox equations, and apply redox reactions to the operations of electrochemical cells.
- Exhibit an understanding of acids, bases, pH, and buffers and relate to their importance in industrial and life processes.
- Demonstrate an understanding of reaction rates and homogeneous and heterogeneous equilibria and solve problems involving their concepts.
- Explain why certain reactions occur spontaneously in terms of enthalpy, entropy, and free energy changes.
- Classify the name hydrocarbons and the common hydrocarbon derivatives, develop and respect the role that organic compounds play in our lives.
- Identify the types of nuclear reactions and radiation and discuss the advantages and disadvantages of nuclear energy.

Topical Description

Chapter 11: Liquids, Solids, and Intermolecular Forces

- 11.1 Water, No Gravity
- 11.2 Solids, Liquids, and Gases: A Molecular Comparison
- 11.3 Intermolecular Forces: The Forces That Hold Condensed States Together

- 11.4 Intermolecular forces in Action: Surface Tension, Viscosity, and Capillary Action
- 11.5 Vaporization and Vapor Pressure
- 11.6 Sublimation and Fusion
- 11.7 Heating Curve for Water
- 11.8 Phase Diagrams
- 11.9 Water; An Extraordinary Substance
- 11.10 Crystalline Solids: Until Cells and Basic Structures
- 11.11 Crystalline Solids: The Fundamental Types
- 11.12 Crystalline Solids: Band Theory

Chapter 12: Solutions

- 12.1 Thirsty Solutions: Why You Should Not Drink Seawater
- 12.2 Types of Solutions and Solubility
- 12.3 Energetics of Solution Formation
- 12.4 Solution Equilibrium and Factors Affect Solubility
- 12.5 Expressing Solution Concentration
- 12.6 Colligative Properties: Vapor Pressure Lowering, Freezing Point Depression, Boiling Point Elevation, and Osmotic Pressure
- 12.7 Colligative Properties of Strong Electrolyte Solutions

Chapter 13: Chemical Kinetics

- 13.1 Catching Lizards
- 13.2 The Rate of a Chemical Reaction
- 13.3 The Rate Law: The Effect of Concentration on Reaction Rate
- 13.4 The Integrated Rate Law: The Dependence of Concentration on Time
- 13.5 The Effect of Temperature on Reaction Rate
- 13.6 Reaction Mechanisms
- 13.7 Catalysis

Chapter 14: Chemical Equilibrium

- 14.1 Fetal Hemoglobin and Equilibrium
- 14.2 The Concept of Dynamic Equilibrium
- 14.3 The Equilibrium Constant (K)
- 14.4 Expressing the Equilibrium Constant in Terms of Pressure
- 14.5 Heterogeneous Equilibria: Reaction Involving Solids and Liquids
- 14.6 Calculating the Equilibrium Constant from Measured Equilibrium Concentrations
- 14.7 The Reaction Quotient: Predicted the Direction of Change
- 14.8 Finding Equilibrium Concentrations
- 14.9 Le Châtelier's Principle: How a System at Equilibrium Responds to Disturbances

Chapter 15: Acids and Bases

- 15.1 Heartburn
- 15.2 The Nature of Acids and Bases
- 15.3 Definitions of Acids and Bases
- 15.4 Acid Strength and the Acid Ionization Constant (K_a)
- 15.5 Autoionization of Water and pH

- 15.6 Finding the $[H_3O^+]$ and pH of Strong and Weak Acid Solutions
- 15.7 Base Solutions
- 15.8 The Acid-Base Properties of Ions and Salts
- 15.9 Acid Strength and Molecular Structure
- 15.10 Lewis Acids and Bases

Chapter 16: Aqueous Ionic Equilibrium

- 16.1 The Danger of Antifreeze
- 16.2 Buffers: Solutions That Resist pH Change
- 16.3 Buffer Effectiveness: Buffer Range and Buffer Capacity
- 16.4 Titrations and pH Curves
- 16.5 Solubility Equilibria and the Solubility Product Constant
- 16.6 Precipitation
- 16.7 Complex Ion Equilibria

Chapter 17: Free Energy and Thermodynamics

- 17.1 Nature's Heat Tax: You Can't Win and You Can't Break Even
- 17.2 Spontaneous and Nonspontaneous Processes
- 17.3 Entropy and the Second Law of Thermodynamics
- 17.4 Heat Transfer and Changes in the Entropy of the Surroundings
- 17.5 Gibbs Free Energy
- 17.6 Entropy Changes in Chemical Reactions: Calculating ΔS^o_{rxn}
- 17.7 Free Energy Changes in Chemical Reactions: Calculating ΔG^o_{rxn}

Chapter 18: Electrochemistry

- 18.1 Pulling the Plug on the Power Grid
- 18.2 Balancing Oxidation-Reduction Equations
- 18.3 Voltaic (or Galvanic) Cells: Generating Electricity from Spontaneous Chemical Reactions
- 18.4 Standard Electrode Potentials
- 18.5 Cell Potential, Free Energy, and the Equilibrium Constant
- 18.6 Cell Potential and Concentration
- 18.7 Batteries: Using Chemistry to Generate Electricity
- 18.8 Electrolysis: Driving Nonspontaneous Chemical Reactions with Electricity
- 18.9 Corrosion: Undesirable Redox Reactions

Chapter 19: Radioactivity and Nuclear Chemistry

- 19.1 Diagnosing Appendicitis
- 19.2 Types of Radioactivity
- 19.3 The Valley of Stability: Predicting the Type of Radioactivity
- 19.4 The Kinetics of Radioactive Decay and Radiometric Dating
- 19.5 The Discovery of Fission: The Atomic Bomb and Nuclear Power
- 19.6 Converting Mass to Energy: Mass Defect and Nuclear Binding Energy
- 19.7 Nuclear Fusion: The Power of the Sun
- 19.8 The Effects of Radiation of Life
- 19.9 Radioactivity in Medicine

Chapter 20: Organic Chemistry

- 20.1 Fragrances and Odors
- 20.2 Carbon: A Unique Element
- 20.3 Hydrocarbons: Compounds Containing Only Carbon and Hydrogen
- 20.4 Alkanes: Saturated Hydrocarbons
- 20.5 Alkenes and Alkynes
- 20.6 Hydrocarbon Reactions
- 20.7 Aromatic Hydrocarbons
- 20.8 Functional Groups
- 20.9 Alcohols
- 20.10 Aldehydes and Ketones
- 20.11 Ethers
- 20.12 Amines
- 20.14 Polymers

Laboratory Topics

Experiment Number	Experiment Title	Page
1	Spot Tests for Some Common Anions	1
2	Determination of Iron by Reaction with Permanganate – A Redox Titration	9
3	Qualitative Analysis of Group III Cations	15
4	Preparation of Aspirin	23
5	Chemical Kinetics	31
6	Determination of Solubility Product Constant (Two week lab)	37
	Determination of Solubility Product Constant (cont'd.)	37
7	The Standardization of Basic Solution and the Determination of the Molar Mass of an Acid	43
8	Properties of Systems in Equilibrium – LeChatelier's Principle	51
9	pH, Buffers and Their Properties	63
Handout	Hydrocarbons	
11	The Alkaline Earth and the Halogens – Two Families in the Periodic Chart	73
12	Electrolysis	81
Handout	Reaction of Certain Organic Compounds (optional)	
Handout	Polymers	

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.

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.