

SYLLABUS
CHEMISTRY 101
Fall, 2011

Survey of Chemical Principles

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Office Hours:
Wednesday 10:00–11:30 AM
Thursday 1:30–3:00 PM
(and by appointment)

Teaching Assistant: Jason P. Safko, jpsafko@gmail.com

Text: R. D. Pike, Elements of Chemistry and Technology, in preparation for Flat World Knowledge Publishing. Draft version of the book chapters are available free-of-charge through Blackboard.

Scope of the Course: This course will cover many of the basic principals which make up “General Chemistry.” In addition, there will be emphasis on the scientific method and the relation of chemistry to our society, environment, health, and industry. There will also be numerous scientific demonstrations intended to enhance your education and amusement.

Intended Audience: This course is intended for those students who have had little or no previous experience in chemistry (*i.e.* those who have had one year of high school chemistry or less). It is not intended for science majors or premedical students and does not satisfy any science major requirements. The course satisfies GER 2A. Students enrolled in Chem 101 may choose to enroll in Chem 101L (*Chemistry Laboratory I*) to satisfy the GER 2 laboratory requirement.

Lectures: Tuesday, Thursday, 9:30–10:50 AM, Integrated Science Center room 1127. I do not take attendance. However, I strongly encourage you not to miss lectures since the exam material will come directly from the lectures. Also, I will have some sense of your attendance based on the quizzes.

Quizzes: (20%) A very short quiz will be given each Thursday class period, except 8/25, 9/22, 10/13, and 10/27. Your lowest two quiz scores are dropped, so you can miss two quizzes without penalty.

Examinations: (15% for the lower score, 25% for the higher score) 9/22, 10/27.

Make-up tests are not typically permitted. If you must miss an exam, please let me know your reason at least one week in advance. If your reason is valid, we will arrange for you to take the exam early. All questions regarding grading of exams and quizzes must be raised within one week following return of the material. No scores will be changed thereafter.

Final Examination: (25%) Partly cumulative. December 14, 9:00 AM, ISC 1127.

Group Projects: (15%): Student groups, consisting of approximately five members each, will research and prepare a presentation on a topic in chemistry. Topics may be chosen from a list of suggestions which will be distributed and must be approved by the instructor. The groups' work will be presented to the class at the end of the semester. The final exam will include some questions taken from the presentations.

Chemistry 101 Course Outline (text chapters in parenthesis):

Course Introductory Topic: "Chemistry as Problem-Solving"

I. Observation and Measurement in Chemistry (Chapter 1)

Introductory Topic: "Epistemology in Science"

- A. Historical Foundations of Chemistry
 - 1. Greek and medieval chemistry
 - 2. 18th Century chemistry: Priestly, Lavoisier, and Dalton
 - 3. 19th Century chemistry: Gay-Lussac, Avogadro, and Cannizzaro
- B. The Scientific Method
- C. Quantitative and Mathematical Tools in Science
 - 1. "Système International" (SI) units
 - 2. Significant figures and exponential notation
- D. Units Cancellation Calculations
- E. Natural Laws, Fundamental Constants, and Math

II. The Nature of Matter (Chapter 2)

Introductory Topic: "Natural = Safe, Chemical = Toxic?"

- A. Structure of the Atom
 - 1. Brief history of atoms and particles
 - 2. Subatomic particles
 - 3. Atoms and isotopes
 - 4. Nuclear fusion and stars
 - 5. Atomic force microscopy
- B. The Periodic Table
 - 1. Spectroscopy and the elements
 - 2. Electron shell and subshell filling
 - 3. The periodic table: metals, semimetals, and non-metals
 - 4. The periodic table: prediction of ion formation and valence
- C. Gases: Particles Moving in a Vacuum
 - 1. Atomic mass, molecular mass and the mole
 - 2. Density
 - 3. Kinetic molecular theory
 - 4. Pressure, volume, temperature, amount

III. Ions, Redox Reactions, and Batteries (Chapter 3)

Introductory Topic: "How Chemistry Might Solve the Planet's Energy Woes"

- A. What are Chemical Bonds?
- B. Ions and Ionic Bonding
 - 1. Electronegativity
 - 2. Ion formation: behavior of electrons
 - 3. Ionic compounds: microscopic structure and macroscopic properties
 - 4. Ionic compounds: formulas and nomenclature
- C. Oxidation-Reduction Chemistry
 - 1. Reactions involving electron transfer
 - 2. Voltaic and electrolytic reactions

3. Some examples of batteries and electrolysis

IV. Covalent Chemistry (Chapters 4, 5, and 6)

Introductory Topic: "Diamond, Graphite, Bucky balls, Nanotubes, and Graphene"

A. Covalent Bonding

1. Electron sharing
2. Covalent compounds: formulas and nomenclature
3. Lewis dot structures and the octet rule
4. Lone pairs of electrons, molecular shape, and polarity
5. Multiple bonds and resonance
6. Polyatomic ions and solubility

B. Organic Compounds

1. Alkanes
2. Alkenes, alkynes, and aromatics
3. Amines and chirality
4. Alcohols and ethers
5. Aldehydes and ketones
6. Carboxylic acid analogs

C. Covalent Reactions

1. Stoichiometry
2. Limiting reactant and percent yield

D. Chemical Energetics

1. Forces between particles
2. Chemical storage of energy: "bond dissociation energy"
3. Heat flow: "enthalpy"
4. Disorder: "entropy"
5. The big picture: "free energy" and spontaneity

E. Combustion, Explosion, and Cancer

V. Water and the Environment (Chapters 7 and 8)

Introductory Topic: "Chemistry, Energy, and Pollution"

A. Solutions

1. Solutions, suspensions, and colloids
2. Energetics of solution
3. Units of solubility
4. Ion concentrations in solution

B. Chemical Equilibrium

1. Equilibrium between states of matter
2. Reversibility in chemical reactions
3. Equilibrium constants
4. LeChâtelier's principle

C. Acids and Bases

1. What makes substances acidic or basic?
2. Conjugate acids & bases and dissociation constants
3. Water: amphoteric, autoionizing, and leveling
4. pH

5. Neutralization reactions, titrations and buffers

D. Environmental Chemistry

1. Water pollution: metals
2. Water pollution: organics
3. Water treatment
4. Air pollution: smog, the ozone layer, acid rain, and global warming

VI. Biochemistry (Chapters 9 and 10)

Introductory topic: "Chemical analysis in biology"

- A. The Periodic Table in Biology
- B. Ions and Cells
- C. Carbohydrates
- D. Lipids and Membranes
- E. Amino Acids, Proteins, and Enzymes
- F. Nucleic Acids

VII. Energy (Chapters 11 and 12)

Introductory Topic: "The Dangers of Radiation"

- A. Metals and Semimetals
 1. Types of solids: amorphous and crystalline
 2. Types of crystalline solids: ionic, network covalent, molecular covalent, metallic
 3. Conduction and semiconduction
 4. Glass
- B. Our energy options
 1. Our energy needs
 2. Petroleum: chemical energy
 3. Mechanical energy: wind, water, and geothermal
 4. Solar energy
 5. Nuclear energy