

## Course Description

Elements of Chemistry is a one-semester freshman course in college chemistry designed to provide a solid foundation of understanding chemical and physical concepts for the two-semester general chemistry courses (CHEM 025 and 27). It is intended for science majors who plan to take CHEM 025, but are not quite ready yet. High school chemistry is not required for this course, but CHEM 023 will be quite difficult unless you have had some chemistry before. For most students, with a solid high school chemistry background, this is a refresher course. Much of the material will be repeated later in General Chemistry courses but with a much more challenging focus on the quantitative aspects.

## Catalog Description

This course is designed for general interest in physical science and for preparation for further study in chemistry. Three class periods, one three-hour laboratory period a week, and enrollment in the Chemistry Workshop are required.

## Instructor

Prof. C. Michael McCallum  
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(209) 946-2636  
Office: CR 220  
Office Hours:, or by appointment.

## Meeting Times

Class meets TR 3:00 – 4:45 PM in CR 170. Laboratory is scheduled separately.

## Laboratory

See the (separate) laboratory schedule. Laboratory will begin Monday, Sept. 9.

## Course Materials

### Texts:

- Introductory Chemistry & related materials, 7/e, Cengage by Zumdahl & DeCoste
- Introductory Chemistry in the Laboratory, Pacific Ed, Cengage, by Zumdahl, & DeCoste

**Website:** There is a Pacific Canvas site for this class. You should be able to find the site through Canvas. In addition, we will be using CHEM 101, an on-line and in-class learning platform. Details regarding CHEM 101 will be given in class.

## Course work

Your grade for CHEM 23 will be based on your performance on Workshop/in-class exercises, examinations and in the laboratory. Lecture attendance will be considered for final grade determination. Laboratory attendance is mandatory. During the se-

mester, you will be given three exams and the Final Exam. No make-up exams will be given unless you have an University excused absence. You are expected to present a clear explanation of problem solutions in the exams. Any ambiguous and incomplete answers will prevent you from earning full credit.

### Assignment Breakdown

Chem 101, Attendance	150 points	15%
Hour Exams	3@133 points (approx)	40%
Lab work	200 points	20%
Final Exam	250 points	25%

The three hour exams will have a point sum of 400; The point total on each exam will reflect the amount of material that needs to be covered. Your final overall grade will be determined by the total of accumulated laboratory and lecture points compared to the class average. Failure of either the laboratory or the lecture portion of CHEM 023 constitutes a failing grade for the course. Any errors in grading must be brought to Prof. McCallum's attention within one week of the exam.

If the lecture grade is equal or above 60% and the lab grade is D or better, the overall grading scale (lecture + lab) is as follows:

A	> 90%
A-	87%
B+	85%
B	82%
B-	80%
C+	76%
C	70%
C-	65%
D	60%
F	< 60%

### Exam Policies

**Attendance at exams is mandatory.** Make-up exams for any of the hour exams will only be given to students who miss the scheduled exam for an officially recognized absence. **The format of the make-up exam may be different from the regular exam (e.g. oral or completely written).** Students with non-officially recognized absences are not eligible to take the make-up exam and will receive a score of 0 for the missed exam. Please note: You must have Prof. McCallum's permission to take a makeup exam and all makeup exams are given during the day determined by Prof. McCallum. You will be expected to rearrange your schedule to take the exam at the indicated time.

In accordance with University regulations copies of student work may be retained to assess how the learning objectives of the course are being met.

Students are expected to bring a Photo ID, pen, and scientific calculator to every exam!

### Tentative Lecture Schedule

Aug. 27, 29	Chapter 1 Chapter 2 Chapter 3	Introduction Measurements and Calculations Matter
Sept. 3, 5, 10, 12, 17	Chapter 4 Chapter 5 Chapter 6	Chemical Foundations Nomenclature Chemical Reactions Introduction
Sept. 19	EXAM I	Chapters 1 – 6
Sept. 24, 26 Oct. 1, 3, 8, 10, 15	Chapter 7 Chapter 8 Chapter 9 Chapter 10	Reactions in Aqueous Solution Chemical Composition Chemical Quantities Energies (10.1 - 10.6 only)
Oct. 17	EXAM II	Chapters 7 – 10
Oct. 22, 24, 29, 31 Nov. 5, 7, 12, 14, 19	Chapter 11 Chapter 12 Chapter 13 Chapter 14 Chapter 15	Modern Atomic Theory Chemical Bonding Gases Liquids and Solids Solutions (less part of 15.6 and all 15.8)
Nov. 21	EXAM III	Chapters 11 – 14
Nov. 27 – 29	Thanksgiving Break	(see below)
Nov. 26 Dec. 3, 5	Chapter 16 Chapter 17	Acids and Bases Equilibrium (possibly)
Dec. 12	Final Exam	

## **Learning Outcomes in the Cognitive Domain**

### **1. CHEMISTRY: AN INTRODUCTION.**

- Understand the importance of learning chemistry
- Define chemistry
- Understand scientific thinking
- Scientific method Describe the method scientist use to study nature:
- Develop successful strategies for learning chemistry

### **2. MEASUREMENTS AND CALCULATIONS.**

- Learn Scientific Notation.
- Learn English, metric and SI Units.
- Use the metric system to measure length, volume, and mass.
- Understand the "Uncertainty" in Measurement.
- Learn to determine the number of Significant Figures.
- Learn how to use Dimensional Analysis in Problem Solving.
- Learn Temperature scales and learn to convert from one to another.
- Define Density and its units.

### **3. MATTER.**

- Learn about Matter and its three states.
- Learn to distinguish Physical and Chemical Properties and Changes.
- Understand the definition of Elements and Compounds.
- Learn to distinguish between Mixtures and Pure Substances.
- Learn two methods of Separating Mixtures: distillation and filtration.

### **4. CHEMICAL FOUNDATIONS: ELEMENTS, ATOMS, AND IONS.**

- Learn about the relative abundances and the names of the Elements.
- Learn the Symbols of some Elements.
- Understand Dalton's Atomic Theory and law of constant composition.
- Learn about the Formulas of Compounds.
- Learn about Rutherford's experiment and the Structure of the Atom,.
- Understand the Modern Concept of Atomic Structure.
- Learn about the terms of Isotopes, atomic numbers, mass numbers and notation
- Learn about various features of the Periodic Table.
- Learn the Natural States of the Elements.
- Understand the formation of ions from their parent atoms and learn to name them.

- Learn how ions combine to form neutral compounds.

## **5. NOMENCLATURE.**

- Learn how to Name the Binary Compounds That Contain a Metal and a Non-metal (Types I and II).
- Learn how to Name Binary Compounds That Contain Only Nonmetals (Type III).
- Learn how to Name Compounds with Polyatomic Ions.
- Learn how to Name Acids, Common Acids.
- Learn how to Write Formulas from Names.

## **6. CHEMICAL REACTIONS: AN INTRODUCTION.**

- Learn to know Evidence for a Chemical Reaction.
- Learn to identify the characteristics of a chemical reaction.
- Learn to identify the information given by a Chemical Equations.
- Learn how to balance Chemical Equations for a chemical reaction.

## **7. REACTIONS IN AQUEOUS SOLUTIONS.**

- Learn to Predict Whether a Reaction Will Occur.
- Learn to identify the solid that forms in precipitation reactions.
- Learn to Describe Reactions in Aqueous Solutions.
- Learn about Reactions That Form Water: Acids and Bases.
- Learn about Reactions of Metals with Nonmetals (OxidationReduction).
- Learn How to classify various Reactions.

## **8. CHEMICAL COMPOSITION.**

- Understand the concept of Average Mass and Counting by Weighing.
- Understand the Atomic Masses and its experimental determination: Counting Atoms by Weighing.
- Understand The Mole concept and Avogadro's number.
- Learn to convert among moles, mass and number of atoms in a given sample.
- Learn the definition of Molar Mass.
- Learn to calculate Percent Composition of Compounds.
- Learn to determine Formulas of Compounds.  
Learn how to determine Empirical Formulas.
- Learn how to determine Molecular Formulas.

## **9. CHEMICAL QUANTITIES.**

- Understand the molecular and mass information given in a balanced equation.
- Learn to use balanced Equations to determine the mole ratio between reactants and moles of products

- Learn to relate masses of reactants and products in a chemical reaction.
- Understand the concept of limiting reactant
- Learn to recognize the limiting reactant.
- Learn to use limiting reactant in stoichiometric calculation.
- Learn to calculate Percent Yield

#### **10. ENERGY.**

- Understand The Nature of Energy, and the concepts of Temperature and Heat.
- Understand Exothermic and Endothermic Processes.
- Understand how energy flow affects internal energy.
- Understand how to Measure Energy Changes.

#### **11. MODERN ATOMIC THEORY.**

- Describe Rutherford's Atom.
- Understand Electromagnetic Radiation.
- Understand the Emission of Energy by Atoms.
- Understand The Energy Levels of Hydrogen: quantized energy level.
- Learn about the Bohr Model of the Atom.
- Understand how the electron's position is represented in the Wave Mechanical Model of the Atom.
- Learn about the shapes of the Hydrogen Orbitals: s, p, d.
- Learn about Further Development of the Wave Mechanical Model.
- Learn about the electron spin
- Learn about Electron configurations in the First Eighteen Atoms on the Periodic Table.
- Learn about the valence electrons and core electrons.
- Learn about Electron Configurations with  $Z > 18$  and the Periodic Table.
- Learn about Atomic Properties and the Periodic Table.

#### **12. CHEMICAL BONDING.**

- Learn about ionic and covalent bonds and explain how they are formed
- Learn about the polar covalent bonds
- Understand the nature of bonds and their relationship to electronegativity.
- Understand the Bond Polarity and Dipole Moments.
- Learn about Stable Electron Configurations and Charges on Ions.
- Learn about Ionic Bonding and Structures of Ionic Compounds.
- Learn to write Lewis Structures.
- Learn to write Lewis Structures of Molecules with Multiple Bonds.

- Understand molecular structure and bond angles.
- Learn to predict molecular geometry from the number of electron pairs using the VSEPR Model.
- Learn to predict Structure of Molecules with Double Bonds.

### **13. GASES.**

- Learn about the atmospheric pressure, and various units of Pressure.
- Understand the law that relates the Pressure and the Volume of gases: Boyle's Law.
- Understand the law that relates the Volume and Temperature: Charles's Law.
- Understand the law that relates the Volume and Moles: Avogadro's Law.
- Understand the Ideal Gas Law.
- Learn to use these laws in calculations involving gases.
- Learn about Dalton's Law of Partial Pressures to understand the relationship between partial pressure and total pressure of mixed gases.
- Understand the relationship between laws and models(theory)
- Understand the basic postulates of the Kinetic Molecular Theory of Gases.
- Understand the term temperature, and learn how the kinetic molecular theory explains the gas laws.
- Understand the molar volume of an ideal gas.
- Learn the definition of STP.

### **14. LIQUIDS AND SOLIDS.**

- Learn some of the important features of Water and Its Phase Changes.
- Learn about the interactions among water molecules
- Understand and use heat of fusion and heat of vaporization.
- Learn about dipole-dipole attraction, hydrogen bonding, and London dispersion forces.
- Understand the relationship among vaporization condensation, and vapor pressure.
- Learn about the various types of crystalline solids.
- Understand the interparticle forces in crystalline solids,
- Learn about how the bonding in metals determines metallic properties.

### **15. SOLUTIONS.**

- Understand the process of dissolving.
- Learn why certain components dissolve in water.
- Learn qualitative terms associated with the concentration of a solution.

- Understand the concentration terms: Mass Percent. Solution Composition: Molarity.
- Learn how to calculate concentration terms.
- Understand the strategy for solving stoichiometric problems for solution reactions.
- Learn how to stoichiometric calculations involved in acid-base reactions.

#### **16. ACIDS AND BASES.**

- Learn about two models of Acids and Bases: Arrhenius definition and Brønsted-Lowry definition.
- Learn about the relationship of conjugate acidbase pairs.
- Understand what acid strength means.
- Understand between acid strength and the strength of the conjugate base.
- Learn about ionization of water
- Understand pH, pOH and pH scale
- Learn to find pOH and pH for various solutions.
- Learn to calculate the pH of solutions of strong acids.
- Understand the general characteristics of Buffered Solutions.

#### **17. EQUILIBRIUM.**

- Understand the collision model of how chemical reactions occur
- Understand activation energy and how a catalyst speeds up a reaction.
- Learn how equilibrium is established.
- Learn about the characteristics of chemical equilibrium.
- Understand the law of chemical equilibrium and learn how to calculate the equilibrium constant.
- Understand the role that liquids and solids play in constructing the equilibrium expression.
- Learn to predict the changes that occur using Le Châtelier's Principle
- Learn to calculate equilibrium concentrations from equilibrium constant.
- Learn to calculate the solubility product of a salt given its solubility, and vice versa.



## General Notes

Please notify me about any special needs immediately. Those students needing accommodations due to a disability should arrange a meeting with me during office hours and provide an accommodations request letter obtained from the office of Services for Students with Disabilities (McCaffrey Center Room 137): [ssd@pacific.edu](mailto:ssd@pacific.edu) or 946-3221

Any students missing class due to an emergency or other personal circumstances should immediately contact Outreach and Academic Support Services: [referralcenter@pacific.edu](mailto:referralcenter@pacific.edu) or 946-2177.

Phones or other communication devices must be turned off (or the ringers must be turned off) during lecture. All phones/tablets/music players are prohibited during exams — the mere sight of any of these items during an exam will invoke a zero grade. Interruptions due to electronics during class will cause a zero grade on the current or next exam. Prof. McCallum reserves the right to impose a more restrictive policy toward electronics if their use causes a disruption during class.

Students should use the restroom before any exam. Students will not be allowed to leave during exams for any reason.

The most reliable way for students to succeed in Chem 023 is to keep up with the homework assignments, work in study groups with other students, and use Professor McCallum's office hours.

Questions regarding grading on exams must be brought to Prof. McCallum's attention no more than 24 hours after the exam is given back. Prof. McCallum may copy or retain exams in order to help assess long-ranged student learning (assessment).

*The University Honor Code is an essential element in academic integrity: It is a violation of the Honor Code to give or receive information from another student during an examination; to use electronic devices or outside printed material as an aid; or to submit all or part of someone else's work or ideas as one's own. If a student violates the Honor Code, the faculty member may refer the matter to the Office of Student Life. If found guilty, the student may be penalized with failure of the assignment or failure of the course. The student may also be reprimanded or suspended from the University. A complete statement of the Honor Code may be found in the Student Handbook, Tiger Lore.*