CHEMISTRY 201 – fall, 2014 SECTION TUV

General Chemistry I: Tuesday and Thursday 6:00-9:50 pm
Lecturer: Prof.Qi Zeng Office: PSE Main Office
Email: qzeng4@ccc.edu
Office hours: Thursdays 5:00 to 6:00 PM Room 3834
Prerequisites: Grade of C or better in Chemistry 121 or one year of high school chemistry, and eligibility for Math 140 or higher
Required Materials: Textbook: Chemistry: A Molecular Approach, Volume 1, 2nd Ed. By Nivaldo J. Tro ISBN: 978-1-269-41399-2
Mastering Chemistry: All students must purchase a VALID access code for *Mastering chemistry* program.

- Homework will be assigned in *Mastering chemistry*.
- Course ID: ZENGCHEM201F14

Scientific Calculator: A scientific calculator with exponential notation and logarithms is **required** for homework, lab reports, quizzes, and examinations.

Laboratory Manual: Professor will upload lab handouts on blackboard. Please download and print the material before lab.

- Chemical splash goggles: Indirectly vented. Must seal completely around the face. Shield-type or glasses-type are not allowed.

Lectures: There will be two lectures per week: Tuesday, and Thursday 6:00- 9:50 pm in Room 3831. Lab will be held once a week on Thursdays in the same room.

Attendance: Students are expected to attend both lecture and lab on time. Students who are not present will be noted for attendance record.

The subject matter of each lecture and the corresponding pages in the textbook are listed in the calendar. Students with disabilities who require accommodations for access and participation in this course should visit the **Truman College Disability Access Center (DAC)**. DAC verifies needs pursuant to the American Disabilities Act (ADA), determines student academic accommodations, and issues accommodation letters. The center is located in room 1428 with phone number: (773) 907-4725. Linda Ford is the director. **TRIO Student Support Services** is for low-income students, first generation college students, or students with disabilities who need academic support: room 1435, 773-907-4797. Registration is required at the start of each semester. **Student Success and Leadership Institute** is for students who need various other support services to achieve their educational goals: room 1435, 773-907-4714.

Homework and Quizzes: A homework problem set will be assigned every Thursday through Mastering Chemistry, and will be due the following Thursday at 11:00PM. **There will be NO makeup homework**. The quiz will be given at the beginning of class covering the material from the previous class if the student is not present at the end of the class the quiz will not be graded. **There will be NO makeup quizzes.**

Exams: There will be three hour exams and a final which will be held during the final week. Exam I will be held on the week 7 and will cover Chapters 1-4. Exam 2 will be held on the week 11 and will cover Chapters 5-7. Exam 3 will be held on week 15 and will cover Chapter 8-11. Please check the syllabus for exact exam date. **There will be NO makeup Exams.**

CCC Rules:

1. Food consumption and/ or smoking is prohibited in the classroom.
2. All cellphones or I-anything have to be TURN OFF during class.
3. Only pencils and scientific calculators are ALLOWED on examinations.
4. CHEATING would not be allowed or tolerated in any form, the result will be a ZERO in the exam, quiz or laboratory experience and report.

Lab Notebooks:

Bound notebook is required for all labs that will be turned in at the end of the semester. Lap reports will consist of a pre-lab section, in-lab section and a post-lab section. A pre lab is required for all labs and will be checked before you begin the experiment for that class period. A poorly prepared or not prepared pre-lab will disqualify students to start any lab. THIS SHOULD BE WRITTEN (NOT TYPED) ON YOUR LAB NOTEBOOK BEFORE THE LAB.

Pre Labs:

1. Title: The full title of the experiment should be clearly written on the first page of the lab notebook entry.
2. Introduction: A brief (five- to ten-sentence) introduction to the experiment should be written at the top of the page. The introduction should state the goals and objectives of the laboratory and describe what data will be collected and how that data will be used to arrive at conclusions at the completion of the laboratory. If hypotheses can be made about the outcome of the experiment beforehand, they should be stated here.
3. Chemicals Table (or Reaction Table): Make a table of the chemicals (reagents, starting materials, etc.) that will be used during the experiment. List the chemicals and their formula, structure, molar mass and physical state. If it will be useful to know a reagent's melting point, boiling point, density or other physical property, include that information as well. For experiments involving chemical reactions or where stoichiometry is important, the quantity of each reagent used should be listed and the number of moles (or millimoles) should be calculated for each quantity.
4. Calculations & Equations: Write out all relevant equations with variable definitions that are applicable to the experiment. Write out calculations that can be done ahead of time (e.g., determining the theoretical yield; determining limiting reagent).
5. Anticipated Procedure: Make a numbered list of the tasks that you must complete during the experiment. This list does not have to be exhaustive, but should accurately summarize all aspects of the procedure you are going to complete that

day. During the lab, you may deviate from this outline as the requirements change in response to observations that you are making and data that your are collecting.

In-Lab:

Observations: Here, the more details you record, the more complete this sections will be.

Use all of your senses—except taste!—when making observations. Make notes about the state of your reagents (e.g., physical state, color, smell) where appropriate, what happens when reagents are mixed (e.g., color changes, gas evolution), and temperature changes. Also, use this section to accurately record data that the manual asks you to collect during the experiment (e.g., masses, volumes, pH). Be as precise in your measurements as possible. If calculations are required in order to continue with the experiment, you may also do that math in this section while listing that procedural step in the Procedure section.

Post-Lab:

1. Questions: Most experiments in the lab manual pose questions at the end of the manuscript. These should be answered carefully and completely.
2. Calculations: If calculations are required using the data that was collected during the experiment, these should be clearly written here. Where applicable, write the full equation being used at the start of each calculation. Show all work for full credit. Write any new chemical equations that are relevant.
3. Conclusions: Finally, your post-lab should contain a small paragraph stating the conclusions that you were able to reach during the laboratory experiment. These conclusions should be well supported by the data that you collected and by the calculations that were written in both the Observations column and the Calculations section above. In other words, analyze the data; explain how the results of the experiment(s) led you to the stated conclusions. Also, discuss whether any hypotheses that were postulated in the pre-lab section were supported or unsupported.

Grades: The grade for the course will be calculated as follows:

Final 100 points

Hour exams 300 points

Homework 200 points

Quizzes (9) 90 points

Lab Reports 100

Attendance 110 points

TOTAL: 900 pts

- Attendance: Attendance and participation in all lectures and Labs is mandatory. All of the material covered during class lecture periods and in discussion sessions is examinable.

Course syllabus:

Date		Reference
8-26	Lecture: Course Introduction, Basic Chemistry Review Placement Assessment. Review the test questions.	Handout
8-28	Lecture: Matter: Its Properties and Measurements (The Scientific method, Classification of Matter, Density, Percent Composition, Significant Figures) Lab: Check In and Safety Rules, Mystery white powder	Chapter 1 Lab handout
9-2	Lecture: Basic Chemistry Calculations and Concepts(The Nuclear Atom, Chemical Elements, Introduction to the Periodic Table, Mole/mass calculations)	Chapter 2
9-4	Lecture: Maintaining a laboratory notebook, writing conclusions and reflections. Lab: Simple qualitative analysis	Lab handout
9-9	Lecture: Molecules, compounds and chemical equations (nomenclature, chemical composition, classifying and balancing chemical equations) Quiz 1 Basic chemical concepts	Chapter 1, 2 & 3
9-11	Lecture: Chemical Reactions (predicting products, activity series, solubility properties) Lab: Single and Double Displacement Reactions	Chapter 4 Lab handout
9-16	Lecture: Chemical quantities (stoichiometry)	Chapter 4
9-18	Lecture: Problem solving (stoichiometry) Lab: Qualitative analysis	Chapters 4 Lab handout
9-23	Lecture: Acid-base and redox reactions	Chapters 3 & 4
9-25	Lab: Some nonmetals and their compounds – preparation and properties Quiz 2: Chemical reactions and stoichiometry	Chapter 3 & 4 Lab handout
9-30	Lecture: Reactions in aqueous solutions (solutions, precipitation, acid-base, redox, stoichiometry, titrations)	Chapter 4
10-2	Lecture: Reactions in aqueous solutions (focus on redox) Lab: The alkaline earths and the halogens	Chapter 4 Lab handout
10-7	Quiz 3: Solutions Lecture: Review for exam 1	
10-9	Exam 1 : Chapters 1-4 Lecture: Introduction to gas behavior (gas pressure, simple gas laws, ideal gas law)	Chapter 1-4 Chapter 5

10-14	Lecture: Properties of gases (gas stoichiometry, gas mixtures, kinetic molecular theory of gases)	Chapter 5
10-16	Lab: Molar mass of a volatile compound	Lab handout
10-21	Quiz 4: Ideal gas law Lecture: Gas effusion, non-ideal gases, partial pressure	Chapters 5
10-23	Lecture: Thermochemistry (Heat, calorimetry) Lab: Introduction to thermodynamics in the laboratory	Chapter 6 Lab handout
10-28	Lecture: Thermochemistry (Hess's Law, standard enthalpies of formation, fuels) Lab notebooks are due for first evaluation. (Rubric)	Chapter 6
10-30	Quiz 5: Thermodynamics Lecture: Thermodynamics	Chapter 6
11-4	Problem solving practice Quiz 6: Thermodynamics: Hess's law	Chapter 5 & 6
11-6	Exam 2: Chapters 5-6	
11-11	Lecture: Introduction to quantum chemistry Lab: Simulation of the photoelectric effect	Chapter 7 Lab handout
11-13	Lecture: Quantum theory: Three experiments, quantum numbers Lab: Atomic spectra	Chapter 7 & 8 Lab handout
11-18	Lecture: Periodic properties Lab: Graphing ionization energies	
11-20	Quiz 7: Atomic theory and periodic properties Lecture: Chemical bonding Lab: Molecular geometry and shape	Chapter 7 & 8 Chapter 9 & 10 Lab handout
11-25	Quiz 8: Molecular geometry Lecture: Bond energies	
11-27	No Class Thanksgiving Recess	
12-2	Lecture: Intermolecular forces: Phase diagrams Lab: Heating and cooling curves	Chapter 11 Lab handout
12-4	Lecture: Solutions and their physical properties (solution concentrations) Quiz 9: solutions and their physical properties	Chapter 12
12-9	Exam 3: Chapters 7-12 Lab check out and clean up	
12-11	Review Comprehensive final examination (begins at 9:30 am)	

	Laboratory notebook is DUE! All homework and extra assignments are due. This is the last day to turn in anything.	
	Final class: Student conferences, discussion of final grade	

* These dates can be subject to change.

Learning Outcomes and Course Objectives

Learning Outcomes for Chemistry 201

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

- Solve quantitative chemistry problems and demonstrate reasoning clearly and completely. Integrate multiple ideas in the problem solving process.
- Describe, explain and model chemical and physical processes at the molecular level in order to explain macroscopic properties.
- Classify matter by its state and bonding behavior using the Periodic Table as a reference.
- Apply important theories such as the Kinetic Molecular Theory of Gases or the Quantum Mechanical Theory of the Atom to the solution of general chemistry problems.
- Perform general chemistry laboratory experiments using standard chemistry glassware and equipment and demonstrate appropriate safety procedures.
- Record, graph, chart and interpret data obtained from experimentation and use that information to correctly identify/analyze assigned unknown substances.

Course Objectives for Chemistry 201

At the completion of this course, the successful student will be adequately prepared to take the subsequent course: General Chemistry II (Chemistry 203), and be able to do the following:

Topics marked with (R), review, should have been covered by the student in a Basic Chemistry course.

Scientific Method

- (R) Describe the scientific method.
- (R) Define and explain the terms: law, hypothesis, and theory.

Chemical Calculations

- (R) Use exponential notation.
- (R) Do mathematical calculations involving significant figures.
- (R) Differentiate between mass and weight.
- (R) Convert from the English system to the metric system (& vise versa) common units of length, mass, volume, and temperature.
- (R) Use the metric system in calculations.

Heat and Temperature

- (R) Differentiate between heat and temperature.
- (R) Do simple calculations of heat changes using specific heat.

- Define and use the terms standard state, standard enthalpy change, molar enthalpy of formation.

Density

- (R) Solve problems using density as the relationship between mass and volume.

Properties of Matter

- (R) Use and define (describe or explain) basic chemical concepts with respect to properties of matter: physical states of matter, physical and chemical properties of matter, physical and chemical changes, the law of conservation of mass, the law of conservation of energy, the law of definite composition, classification of elements.
- (R) Distinguish between pure substances (elements and compounds) and mixtures (homogeneous and heterogeneous).
- List the names and chemical symbols of at least 48 elements.

Atomic Theory and Structure, Molecular Theory and Structure

- (R) Distinguish between ionic and molecular compounds.
- (R) Determine the number and types of atoms represented in a chemical formula.
- Use basic chemical nomenclature for inorganic compounds.
- Write the formulas of binary ionic compounds, common binary molecular compounds, and at least 12 common acids, 4 common bases, inorganic ternary compounds using 15 common polyatomic ions.
- Use oxidation numbers to distinguish oxidation states of metals in compounds.
- (R) Balance chemical equations given the formulas of the reactants and products.
- Calculate the oxidation number of each element, given the formulas of the reactants and products.
- Balance redox equations using oxidation numbers.
- (R) List the basic principles of Dalton's atomic theory and indicate how the theory has been further developed in this century.
- (R) State the basic properties of the subatomic particles: protons, neutrons, and electrons.
- (R) Describe the Rutherford atom.
- (R) Define atomic number, mass number, and isotopes.
- (R) Define the atomic mass unit and Avogadro's number.
- (R) Use the conversion factor from grams to amu in simple calculations.
- Calculate the average atomic mass from isotopic masses and percent abundances.
- (R) Apply the terms: metals, nonmetals, alkali metals, alkaline earth metals, metalloids, transition metals, noble gases, halogens, and inner transition metals to the arrangement of elements in the periodic table.
- (R) Describe the arrangement of the elements in the periodic table.
- (R) Use the periodic table to predict formulas of compounds.
- (R) Define the terms anion, cation, and polyatomic ion.

- Describe how ionic and covalent bonds are formed.
- Calculate the oxidation number of each element in a chemical formula.

Mole-Mass Calculations

- (R) Calculate the percent composition of compounds, given the formulas.
- (R) Calculate the empirical formula, given the percent composition.
- (R)Calculate the empirical formula of compound given the mass of the sample, the mass of CO_2 and mass of H_2O produced in a combustion reaction.
- (R) Distinguish between empirical and molecular formulas.
- (R) Explain the concepts of the chemical quantity, the mole, and relate it to counting of atoms and molecules.
- (R) Convert mass in grams to moles, formula units, molecules (and/or atoms) using atomic weights, formula weights, and molecular weights.
- List the basic rules which predict whether a salt is soluble in water.

Stoichiometry

- Write the balanced equations describing several examples of combustion, acid-base, precipitation, and exchange reactions. Write the equations in the molecular, total ionic and net ionic format.
- (R) Explain the information given by the balanced chemical equations.
- Perform stoichiometric calculations from a given chemical equation.
- Use calculations determine the limiting reagent, how much excess reagent is left, and the theoretical and percentage yield of each product.

Solutions

- List the properties of solutions and distinguish true solutions from heterogeneous and colloidal mixtures.
- Define solubility, percent concentration, molarity, mole fraction, and molality.
- Explain factors affecting solubility and the rate of dissolving.
- Write molecular, total ionic and net ionic equations which show that the solution is the reaction medium.
- Use percent concentration, molarity, and molality in stoichiometric calculations.

Gases

- List the basic principles of the Kinetic Molecular Theory of gases.
- (R) Describe the measurement of pressure using a barometer.
- (R) Use four kinds of pressure units in calculations and convert from one to another.
- Calculate pressure, volumes, and temperatures of gases using Boyle's law, Charles' Law, the Combined Gas Law, and Dalton's Law of Partial Pressures.
- (R) Calculate Kelvin temperatures from Centigrade and vise versa.
- (R) Define standard conditions of temperature and pressure.

- Use the Ideal Gas Law to calculate density and molecular weight of a gas.
- Use the gas laws in chemical stoichiometric calculations.
- Define and distinguish between diffusion and effusion.

Energy and Light

- Define and explain the terms electromagnetic radiation, wavelength, frequency, wave amplitude, spectrum, and nodes.
- Describe the Bohr hydrogen atom; describe the hydrogen atom in terms of simple quantum mechanics.
- Perform calculations using the equation $\lambda\nu = c$.
- Explain the source of the atomic line spectra.
- Describe the properties of light.

Molecular Orbital Theory

- Write electronic configurations of the first 50 elements; show the diagrams of their electronic structure, and indicate the spin of each electron.
- Sketch the shape of the s, p and d orbitals.
- Identify the 4 quantum numbers for any electron in an atom.
- Predict which atoms or ions are paramagnetic and which are diamagnetic using the electronic configurations.
- State the Pauli Exclusion Principle, Hund's rule, and the Aufbau principle.
- (R) Define ionization energy and be able to rank using the periodic table.
- Use ionization energy trends to predict the stability of electronic configurations and the tendency for outer shell electrons to undergo changes in order to form compounds.
- (R) Define electronegativity: show how it varies with respect to the periodic table.
- (R) Use electronegativity to estimate the polarity of bonds.
- Show the trends of atomic and ionic sizes on the periodic table.
- State the octet rule, including exclusions.
- Write Lewis electron dot structures for simple covalent compounds and polyatomic ions.
- Use double and triple bonds to show structures of molecules and ions; use resonance to describe equivalent bonds.
- Use the Valence Shell Electron Pair Repulsion theory to describe electron pairs geometry, molecular geometry, hybridization, and bond angles.
- Predict the polarity of bonds and molecules.
- Define bond order and bond dissociation energy; use bond energies to estimate reaction enthalpies.
- Calculate the formal change of an atom in a molecule or ion, and use it to predict the most reasonable resonance structures.
- Explain the difference between oxidation number and formal change.
- Explain simple valence bond theory.
- Use the concepts of orbital overlap, sigma and pi bonds, hybrid orbitals to explain the strength and orientation of covalent bonds.

Properties of Solutions

- Use molarity in calculations concerning the dilution of solutions.
- Explain at least two examples of colligative properties.
- Calculate the freezing point depression and the boiling point elevation due to the addition of a nonvolatile molecular solute to a pure solvent.

Acids and Bases

- List at least four properties each for acids and bases.
- Explain the behavior of acids and bases in terms of the Arrhenius and Brønsted/Lowry theories.
- Write equations for acids and bases showing conjugated acid/base pairs.
- List at least five common strong acids and five common strong bases.
- Given an acid, write the formula of the conjugate base, and vise versa.
- Write complete equations for at least two examples of each of the following reactions: acid + base, acid + metal, acid + metal oxide, acid + carbonate.
- Given the formula of a salt, write the formulas of the acid and the base which would react to form the salt.
- Distinguish between electrolytes and non-electrolytes, strong and weak electrolytes. List at least three examples of each.
- Define pH. Given a pH value, state whether the solution is acidic, basic, or neutral.
- Given a pH value calculate the H^+ concentration, and vise versa.
- Estimate pH and pOH values without the use of a calculator given H^+ concentration and/or OH^- concentration.
- Given a pOH value calculate the OH^- concentration, and vise versa.
- Convert from H_3O^+ concentration to pH then to pOH then to OH^- concentration.

Laboratory and Evaluations

- Perform simple tasks in the laboratory. Perform ten laboratory experiments.
- Carry out laboratory measurements and calculations using the correct significant figures.
- Perform the necessary calculations, prepare any required graphs and answer the questions for each experiment.
- Achieve a grade of at least 50% for the final comprehensive examination.
- Record all data in ink directly onto the data sheet or in the laboratory notebook.
- Prepare a lab report including a summary.
- On any quizzes and exams answer short essay questions.

Teaching and Learning Goals Established by Truman College

Taking a course in Chemistry helps a student achieve all of the following general education goals. How this occurs is explained below.

- Communicate effectively in both written and oral forms

  Students will keep a laboratory notebook and learn to record careful observations, draw appropriate conclusions and reflect on what they have learned.

- Gather, interpret and analyze data

  Students will learn to collect data in the laboratory, create graphs, compare quantitative data and draw conclusions about the data obtained.

- Demonstrate the ability to think critically, abstractly and logically

  The Scientific Method is predicated upon deductive and inductive logical reasoning. Students will study applications of the scientific method to information gathered by the scientific community. Students will read articles about chemical discoveries. Abstract thinking is developed in many ways in chemistry from the use of symbols and models to the use of mathematics to solve a variety of problems.

- Work with a variety of technologies

  Students use computers, data acquisition equipment, microscopes, digital imaging devices, media, the Internet, podcasts, digital balances, all in the pursuit of scientific knowledge.

- Exhibit social and ethical responsibility

  This very serious goal is addressed on many levels in the chemistry course, from the discussion of the importance of careful and precise measurements that could affect the life of a patient to the discussion of what happened when the space ship Challenger exploded or a grain elevator explodes - we examine the role of responsible use of chemical knowledge.

- Perform productively in the workforce

  Because Chemistry education is comprehensive in utilizing the body (kinesiology), the mind (both spatial and analytical reasoning) and the heart (looking at the connection of chemistry to the world) it is an excellent course to prepare individuals for the workforce.

- Demonstrate the ability to learn independently

Students are given independent projects to complete in the course. They are also given questions to research independently. Reporting these results to the class develops their ability to speak confidently to their peers.

- Gain awareness of their role in the global community

By discussing the way that chemistry is connected to other occupations and careers we develop student awareness about their career choice and its dependencies on a basic understanding of chemistry.