CHEM 1220

General Chemistry II

Fall 2022, 4.0 credit units

Instructor	Michael Grünwald (he/him/his) michael.gruenwald@utah.edu Office: TBBC 4625 Office hours: Mon 3-4, Tue 11-12	
Teaching Assistants	Jack Sheehan u1225834@utah.edu Off.hrs: W 3-4, F 12:50-1:50, HEB1316	Samantha Curry samantha.curry@utah.edu Office hours: Wen & Thu, 9-10, HEB 1316
Time and Place	MoWeFr 2:00–2:50pm, HEB 2008 Disc. 002: TuTh 12:55–1:45pm, CSC 205 Disc. 003: TuTh 2:00–2:50pm, CSC 205 Disc. 004: TuTh 3:00–3:50pm, CSC 205	

Class Overview

Learning Objectives

The overarching goal of this course is to use fundamental atomic- and molecular-level principles to understand macroscopically observed properties and behavior of chemical systems and their application in modern chemistry.

Covered Topics (with associated textbook chapters):

- Chemical Kinetics (Chapter 14)
- Chemical Equilibrium (Chapter 15)
- Acids and Bases (Chapter 16)
- Aqueous Ionic Equilibrium (Chapter 17)
- Thermodynamics (Chapter 18)
- Electrochemistry (Chapter 19)
- Radioactivity and Nuclear Chemistry (Chapter 20)

A list of specific Learning Outcomes is provided at the end of this syllabus.

Required Materials

Text Book: Chemistry: Structure and Properties (Tro, 2nd edition), electronic access to the textbook is provided through the University's Inclusive Access program.

Calculator: A scientific calculator is required. Only *non-programmable* calculators will be allowed on exams!

Required Effort and Learning Strategies

This class requires you to develop accurate mental models of molecular motion and interactions, to describe these models using challenging mathematical concepts, and to creatively apply a number of fundamental principles in a range of different situations. To be successful in this class, you should plan to work at least 10 hours per week out of class (i.e., in addition to the lectures and discussions) on the material. Please get in touch with me if you have any concerns about your progress in class, your grade, or your ability to succeed in the class. The sooner we start a conversation, the easier it will be for us to find solutions that help you achieve your goals and succeed in class.

You might have heard this before: *Chemistry is a team sport*. While your TAs and I will do our best to explain all concepts and problem solving strategies as clearly as we can, Chemistry is best learned through open and lively discussion with others. I highly encourage you to engage with your peers as often as you can. To encourage an interactive way of learning, we will create opportunities for small group work in discussion and lecture. But I urge you to learn interactively outside of class, too. Make a habit of working on homework problems together, form a study group, attend tutoring hours (see below), etc. While many students initially experience a certain level of discomfort when discussing science with others they do not know well, the learning benefits can be tremendous. Consider also that all your future endeavors will require you to communicate your understanding and ideas verbally, and we want to encourage you to improve your skills in this area through active participation. We will strive to create a course environment that is open, friendly, and respectful, encouraging you to make mistakes and try out ideas without fear of repercussions or embarrassment. Mistakes are an inherent part of learning, and each mistake made during class is an important learning opportunity. Please respect this environment and your colleagues.

Student Mental Health Resources

Rates of burnout, anxiety, depression, isolation, and loneliness have noticeably increased during the pandemic. If you need help, campus mental health resources are available, including counseling, trainings and other support (https://studentaffairs.utah.edu/mental-health-resources/index.php).
Consider participating in a Mental Health First Aid or other wellness-themed training provided by Student Affairs' Center for Student Wellness to help contribute to creating a healthier and safer campus community. These are designed to equip you to better recognize and respond to signs and symptoms of mental health and substance abuse challenges.

Class Structure and Grading

No-screens policy

In order to create a focused learning environment, I request that you please do not interact with your devices during lecture and discussion meetings, except for class learning activities. Please use only those devices in class that contribute to learning (e.g., any type of note-taking device). I will not enforce this policy, but I expect that you follow it. Research clearly demonstrates the learning benefits of this approach.

In-person lectures and lecture notes

I will deliver most class content in the form of in-person lectures, which will cover most material contained in Chapters 14-20 in the textbook. (We will cover some topics in more detail than others.) Lecture notes (pdf) will be made available on Canvas. For the best educational experience, I highly recommend you attend lectures regularly. (See attendance policy below.)

Discussion

Discussion will be in-person every Thursday and will be led by TAs. Tuesday time slots will not be used for regular discussions, but will be reserved for exams and perhaps review sessions. During Thursday discussions, students will focus on problem solving in small groups. Attendance will be taken, as described in the attendance policy below.

Weekly Canvas quizzes

At the end of every week of classes, I will post a short timed quiz (~30 minutes) on Canvas. Students must take quizzes by themselves and neither give nor accept any outside help. In addition to the homework, these quizzes will be a primary indicator of how prepared you are for the exams.

Homework

Problem sets will be posted weekly on Canvas. Some of the problems are challenging and are designed to not only illustrate points made during lectures, but also to further develop certain ideas and to introduce new facets of a topic. Please take these problems seriously! To succeed in exams you will need to solve problems of similar caliber.

Written solutions to all problems are due Wednesday in lecture (please hand them in either before or after lecture). Late homework can be handed in on Thursday in discussion for 80% credit, or on Friday in lecture for 50% credit. No homework that is late by more than two days will be accepted. Keys will be posted on the course website and graded homework will be returned typically within a week's time.

Two notes on homework format:

- Please show your work in sufficient detail and describe your problem solving strategy in a few words. TAs will subtract points if they cannot follow your thinking and/or your math. Partial credit for imperfect solutions can only be given if you clearly document your proceedings. Keep in mind that diligently writing down all steps of a calculation has clear learning benefits!
- Please, print legibly! It is at the discretion of your TA to decide that they cannot grade a particular problem because of bad handwriting.
- Please order your pages according to problem number.

Homework grading policy: To keep grading efforts reasonable, I will select a small subset of randomly chosen problems (typically 25% of all problems) for grading. Homework scores will be calculated based only on the scores of these selected problems; other problems will be disregarded for grading purposes. (Solution keys will cover all problems, though.)

Exams

The material covered on each exam will include everything covered in lectures and in the assigned textbook chapters, except material that is explicitly excluded. An announcement of the material included in each exam will be made in class and posted on Canvas before each exam. To be fair to all, questions about what will be covered on exams will be answered in class and announced on Canvas only. No such questions will be answered by phone or email. The only legitimate excuses for missing your testing period are extenuating circumstances that are beyond your control. Examples of these circumstances are illness (including COVID-related quarantining or isolating), death in the family, or car accidents on the way to take the test. Forgetting the exam time or sleeping through your exam period are not legitimate excuses. Excuses must be accompanied with proper documentation. If you miss your exam period because of extenuating circumstances, it is your responsibility to inform your instructor in a timely fashion. Your instructor will then discuss with you appropriate measures to make up the exam within ten calendar days.

Midterm Exams will be held during discussion times. Midterm Exams will last 60 minutes and begin exactly on time – so be early! Midterms will consist of a mixture of multiple-choice and free-response/essay problems. You must bring a clearly legible University of Utah ID Card. You must also bring your calculator and a pen or pencil. You will be provided with scratch paper, a periodic table, and important equations. Exam scores are typically posted on the Canvas grade book within a week of the exam. Questions regarding credit/grading on an exam question must be presented to your professor during office hours in a timely manner. Any questions regarding exam credit will not be considered after two days subsequent to the return of the midterm itself.

The Final Exam will be given to ALL students at 3:30 pm on Monday, December 12, 2022, 1:00 – 3:00 pm, in HEB 2008. The only students who will be allowed to take the exam at an alternate time are those with an exam conflict or three (3) exams in a single day. No other exceptions will be made. You will have up to two hours to complete the exam. The key for the Final Exam will not be posted and the exam will not be returned.

Attendance

You will earn a small but significant number of points by attending each lecture (Monday, Wednesday and Friday) and each discussion (Thursday) meeting. If you miss a meeting for any reason, you will be automatically "excused"—you will not lose points. Instead, your score on the exam at the end of the unit will be weighted more heavily. You can contribute up to 25% of your total exam score through attendance. Specifically, your total score on any exam will be calculated as a weighted sum:

total points for unit exam = AT x 0.25 x MP + (1 – 0.25 x AT) x EP

In this formula, AT is the fraction of meetings you attended, MP are the *maximum* points you can achieve on the exam, and EP are the *actual* points you achieved on the exam. A few examples to illustrate this math:

- You attend all meetings for unit 1 (AT = 1) but score 0 out of 100 points on the exam (MP = 100, EP = 0) at the end of the unit. Your total points for the exam will be 25.
- You attend 12 of 16 meetings for the unit (AT = 0.75) and score 60/80 on the exam (MP = 80, EP = 60). Your total points for the exam will be 63.75.

Attendance will be taken using ZipGrade, starting on Wednesday 8/24. Details will be announced in class and on Canvas.

Academic Honesty

Any form of cheating on exams, quizzes, and homework will not be tolerated. By submitting an assignment, you are representing that it is your own work and that you have followed the rules associated with the assignment. Incidents of academic misconduct (e.g., cheating, plagiarizing, research misconduct, misrepresenting one's work, and/or inappropriately collaborating on an assignment) will be dealt with severely in accordance with the Student Code (http://www.regulations.utah.edu/academics/6-400.html). Representing another student for purposes of attendance credit in lecture or discussion is considered an act of cheating. Speaking to a fellow student about an exam question before the last testing session for that midterm exam has closed is also considered an act of cheating. A single instance of academic misconduct may result in a failing grade for the course; however, multiple instances of misconduct may result in probation, suspension or dismissal from a program, suspension or dismissal from the University, or revocation of a degree or certificate. Incidents of academic dishonesty will be dealt with severely. Anyone caught cheating on an exam will be referred to the Dean for immediate disciplinary action and should expect to receive an 'E' in the course. Additionally, a letter detailing the cheating incident will be put in the student's permanent academic file.

Grades

The final grade will be calculated from the following approximate contributions:

- Weekly Canvas quizzes 10%
- Written Homework 15%
- Unit 1 (Attendance + Midterm 1) 15%
- Unit 2 (Attendance + Midterm 2) 10%
- Unit 3 (Attendance + Midterm 3) 22%
- Unit 4 (Attendance + Final Exam) 28%

The following key will be applied to determine final grades:

Points (%)	93-100	90-92.9	87-89.9	83-86.9	80-82.9	77-79.9	73-76.9	70-72.9	60-69.9	< 60
Grade	A	A-	B+	B	B-	C+	C	C-	D	E

Final grades will not be “curved” at the end of the semester. Final grades are not posted to Canvas nor will your instructor provide you with that information. All students can access their grades (once they are posted and released) through the Registrars Office.

Class Schedule

Important Dates

Last day to drop class or elect CR/NC	Fri, 9/2
Mid-term exam 1	Tue, 9/13
Mid-term exam 2	Tue, 10/4
Last day to withdraw	Fri, 10/21
Mid-term exam 3	Tue, 11/1
Last day to reverse CR/NC	Fri, 12/2
Last day of class	Thu, 12/8
Final exam	Tue, 12/12

Preliminary schedule of lectures and exams

Date	Topic
8/22 8/24 8/26	Introduction Reaction Rates Order of Reaction
8/29 8/31 9/2	Rate Laws and Rate Constants Method of Initial Rates Integrated Rate Equations
9/5 9/7 9/9	Labor Day — No class Temperature Dependence of Rates Reaction Mechanisms
9/12 9/13 Tue 9/14 9/17	Chemical Equilibrium **Midterm 1** Chemical Equilibrium Chemical Equilibrium
9/19 9/21 9/23	Chemical Equilibrium Chemical Equilibrium Chemical Equilibrium
9/26 9/28 9/30	Acids and Bases Acids and Bases Acids and Bases
10/3 10/4 Tue 10/5 10/7	Acids and Bases **Midterm 2** Acids and Bases Acids and Bases
	Fall Break 10/9-10/16
10/17 10/19 10/21	Acids and Bases Acids and Bases Acids and Bases

10/24 10/26 10/28	Aqueous Ionic Equilibrium Aqueous Ionic Equilibrium Aqueous Ionic Equilibrium
10/31 11/1 Tue 11/2 11/4	Thermodynamics **Midterm 3** Thermodynamics Thermodynamics
11/7 11/9 11/11	Thermodynamics Thermodynamics Thermodynamics
11/14 11/16 11/18	Electrochemistry Electrochemistry Electrochemistry
11/21 11/23 11/25	Electrochemistry Electrochemistry Thanksgiving — No Class
11/28 11/30 12/2	Electrochemistry Nuclear Chemistry Nuclear Chemistry
12/5 12/7 12/9	Nuclear Chemistry Review Happy Reading Day!
12/12	**Final exam, 1:00-3:00 pm**

Learning Outcomes

Chemical Kinetics

- Apply collision theory in explaining why a reactions occur.
- Qualitatively describe the rate at which a chemical reaction occurs and possible methods of describing this rate.
- Discuss and interpret a reaction coordinate energy diagram.
- Explain and calculate average rates of reaction.
- Describe the general form of a rate law.
- Demonstrate the use of the method of initial rates to determine a rate law.
- Calculate the value of a particular rate constant and its associated units.
- Apply and solve the integrated rate law equations for various reaction orders.
- Describe how temperature, surface area, and catalysts affect the reaction rate especially in the context of kinetic molecular theory and collision theory.
- Graphically determine activation energy using the Arrhenius equation.
- Evaluate whether or not a proposed reaction mechanism is valid or consistent with observed data.
- Determine the molecularity of an elementary step of a reaction mechanism.

Chemical Equilibrium

- Discuss and explain what is meant by “dynamic equilibrium”
- Construct a sketch describing reactant & product amounts as an equilibrium is attained.
- Use the “Law of Mass Action” to write an expression for the equilibrium constant K_p and/or K_c .
- Distinguish between homogeneous and heterogeneous equilibrium systems.

- Identify the factors that can influence the value of an equilibrium constant.
- Recognize and predict the effect on the value of K_{eq} as an equilibrium equation is manipulated.
- Illustrate and apply the use of the Reaction Quotient, Q.
- Invoke and apply Le Chatêlier's Principle with regards to stressed equilibrium situations.
- Use "ICE" tables in calculations involving chemical equilibria.

Acids and Bases

- Distinguish between Arrhenius, Brønsted–Lowry and Lewis acids and bases.
- Contrast and illustrate what is meant by a strong and a weak acid (and similarly with bases).
- Explain how/why K_a is a measure of the strength of an acid.
- Explain how/why K_b is a measure of the strength of a base.
- Identify an acid-base conjugate pair and appraise why their strengths are inversely related.
- Solve for any part of an acid/base hydrolysis equilibrium, including K and pH.
- Predict whether an aqueous salt solution is acidic, basic, or neutral and confirm the prediction quantitatively using ICE tables and equilibrium constants.
- Identify Lewis acids and bases from their structures and/or within a chemical reaction.
- Rank a series of compounds by acid strength qualitatively based on molecular structure.
- Write and balance acid–base neutralization reactions.

Aqueous Ionic Equilibrium

- Define a "buffered" solution and be able to decide whether a solution can function thusly.
- Determine the pH of a buffer solution.
- Describe the term "buffering capacity" and elaborate on what can "overwhelm" a buffer.
- Delineate the features of various titration curves, including strong acid/strong base; weak acid/strong base; and weak base/strong acid titrations.
- Be able to determine the equivalence point volume and pH. Understand pH changes at all regions along a titration curve.
- Qualitatively differentiate titration curves for both monoprotic and polyprotic acids.
- Describe the theory behind how indicators function and outline their useful range.
- Determine solubility from the solubility constant K_{sp} and vice versa (K_{sp} from solubility).
- Exemplify the common-ion effect through example both qualitatively and quantitatively.
- Qualitatively determine the effect of pH on solubility.
- Examine the effect of complex ion formation as a function of Solubility.

Thermodynamics

- Paraphrase the Laws of Thermodynamics mathematically and illustrate with examples.
- Predict relative magnitudes of entropy for substances in the same phase and for the same substance in different phases.
- Predict the sign of ΔS for reactions and for changes in temperature, pressure, and volume of a system.
- Define Gibbs free energy in terms of the enthalpy and entropy of the system; $\Delta G = \Delta H - T\,\Delta S$
- Discuss spontaneity as dependent on the sign of ΔG. Determine the temperature at which a reaction will be spontaneous.
- Calculate standard Gibbs free energy of reactions via several different methods.
- Calculate changes in Gibbs free energy for reactions not at equilibrium.
- Determine the equilibrium constant from the standard Gibbs free energy and vice versa.

Electrochemistry

- Illustrate that oxidation–reduction reactions ensure charge as well as atom numbers are conserved.
- Sketch the basic components of a voltaic cell (batteries) and explain the fundamental principle that allows them to operate.
- Draw the connections between Gibbs free energy, equilibrium constants and cell potential.

- Explain how standard reduction potentials are measured and used to calculate standard and non-standard cell potentials.
- Appraise the notion that redox is the basis of batteries, corrosion, electrolytic cells, electroplating and nerve impulses.
- Apply Faraday's Law to quantify electrolytic processes.

Radioactivity and Nuclear Chemistry

- Write balanced nuclear equations to represent radio decay or transmutation events.
- Use first–order kinetics to describe the of decay of radioactive nuclei over time.
- Calculate the half-life of radioactive nuclei.
- Compare and contrast nuclear fission and nuclear fusion. Calculate nuclear binding energy or mass defect.

Additional Information and University Regulations

The Americans with Disabilities Act

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.
Please notify me of any requested accommodations within the first week of class.

Sexual Misconduct, Discrimination, and Related Retaliation

Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585- 2677(COPS).

Mandatory Reporting. The University of Utah is committed to fostering a positive and welcoming learning, working, and living environment. Sexual Misconduct, Discrimination and Retaliation are prohibited by University Policy. Faculty and staff have a responsibility to inform the Office of Equal Opportunity and Affirmative Action (OEO/AA) when made aware of incidents of sexual misconduct, discrimination, and related retaliation, to ensure that individuals impacted receive information about optionsforreporting and supportive resources. Incidents may come tothe attention of faculty and staff in any way, including through face-to-face conversations, admissions or scholarship applications or essays, a written class assignment or paper, class discussion, email, text, or social media post. This obligation applies regardless of where or when an incident occurred, including if it occurred off campus and/or before they were a member of the campus community. Additional information can be found on the OEO website or you may contact oeo@utah.edu or 801-581-8365. If you wish to seek support confidentially, please contact the Victim-Survivor Advocates 801.581.7776 or advocate@sa.utah.edu.

Campus Safety

The University of Utah values the safety of all campus community members. To report suspicious activity, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Inclusivity

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Student Names & Personal Pronouns

Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center at https://lgbt.utah.edu/campus/faculty_resources.php

Changes to the Syllabus

This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the course schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.