CHEMISTRY 1061
Chemical Principles I
Lecture – Section 001
Spring Semester 2022
8:00-8:50 a.m. MWF
Smith Hall 100

Professor Andreas Stein
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Office hours (via Zoom):
Mondays noon–1.00 pm, Tuesdays noon–1:00 p.m.,
or by appointment

Welcome to Chemistry 1061! This syllabus and the accompanying class schedule will answer many of your questions about the course. Please read this information carefully and keep it for future reference.

The Course: Chemistry 1061/1065 is an introductory course (1061) accompanied by a lab course (1065). Together, they fulfill the Liberal Education Core Physical Science requirement (see below). They are designed to prepare students for science majors including chemistry, engineering, and the health sciences, and are the first half of a two-semester sequence. Because this course is a survey of chemical principles, it covers many different topics. The main themes of Chemistry 1061 include an advanced introduction to atomic theory; periodic properties of the elements; behavior of gases, liquids, and solids; molecular/ionic structure and bonding; aspects of organic chemistry, spectroscopy, and polymers. A student may ask, "Why is this course considered an important component of my liberal education?" A liberally educated person is one who can understand complex issues, find credible information, analyze that information, problem-solve, and draw reasonable conclusions based on facts. This course will develop these skills and prepare you to be an informed citizen and life-long learner.

Prerequisites: You should not be registered for CHEM 1061 unless you have satisfied one of the following:
(a) Passed the chemistry placement test and been formally advised to take this course, or
(b) Completed 1011 or 1015 with a grade of C- or better.
Also… you must also be registered for CHEM 1065 (the Lab) to be in CHEM 1061.
If you do not meet one of these requirements, please contact the General Chemistry Office in 115 Smith Hall immediately (624-0026; thao@umn.edu). Note that the 1065 lab is a separate course and is not covered by this syllabus.

Course Web Page: The course **Canvas** site will be used for posting the syllabus, lecture notes, percentage grades, Connect homework assignments, and other course-related material. Please ignore any letter grades listed on the Canvas site. These are automatically generated by Canvas but will not be used during the course.

Required Text: "*Chemistry: The Molecular Nature of Matter and Change*" by Martin S. Silberberg and Patricia G. Amateis (McGraw Hill, 9th Edition, 2021), packaged with access to the CONNECT homework platform. You can access the e-text via the Connect link in our class Canvas site. You can also purchase a loose-leaf hard copy through the bookstore ($26.75), should you want a paper version.

• We are making this material available because it is much more cost-effective than purchasing the physical book. Your student account will be charged $63.75 before the beginning of the semester for access. Those wishing to opt-out and purchase their textbook elsewhere are refunded after the drop/add period. All students who drop the course in the first two weeks of the semester are automatically refunded. **NOTE: If you opt-out of this, you will need to purchase your own access to Connect, which will likely be more than the $63.75.**

- **IF YOU WISH TO OPT OUT** (e.g., if you already have an earlier edition): An email will be sent to all students with opt-out instructions. The email will have the subject line "Important Course Materials Info: Charges to Your Student Account". The original email comes from ***no-reply@verbasoftware.com*** so it sometimes goes to spam. Please be on the lookout for this email! Students **have until January 28th to opt-out of the course material**. If you have additional questions contact the U of M Bookstores directly at inclusiveaccess@umn.edu

Also…you will need to register on the Connect system for access to materials pertinent to our section.

The Connect system has been linked to our Canvas site. You can find it on the left sidebar. The first time you access it, you will need to register, and the system should prompt you about the necessary steps.

Be sure to use your U of M email address. You will only receive credit if you use your U of M email address that ends with …@umn.edu. DO NOT USE AN ALTERNATE EMAIL ACCOUNT.

Online Homework (Connect): Homework will be given using the publisher's online homework system, Connect, and will count 15% toward your course grade. Each homework assignment will cover recently completed material, by chapter. The homework assignments can be found on Canvas under Assignments, and they are generally due on Sundays by 11:59 pm. The due date for each assignment is listed on the Canvas site under the assignment title. You must complete 80% of the questions in each homework assignment correctly to receive full credit for homework at the end of the semester. Any score below this mark will earn a prorated portion of credit. The homework problems for chapters 1–4 are made available to help you review, but they will not be counted as part of your homework grade. For CHEM 1061, it is particularly important that you are familiar with unit conversions, rounding numbers, significant figures, and all aspects of stoichiometry, including limiting reagents.

Additional Practice Problems: If you need more practice than the online homework problems give you, please see the list of problems from the end of each text chapter listed in the class schedule.

Attendance: Your attendance is expected and assumed at all lectures. YOU ARE RESPONSIBLE for all announcements made and for all material presented in class (whether or not it is in the text). If you need to miss any class due to Covid etc., please let me know as soon as possible beforehand, so that we can make alternate arrangements.

Examinations and Grading: Three 50-minute midterm examinations and one comprehensive 2-hour final examination will be administered in CHEM 1061. Note that the midterm exams will take place in our class room during class time. Exams will cover the material discussed in class or assigned as homework (including assigned readings of chapters). The exams will consist of multiple-choice questions. A periodic table and a number of important equations will be provided with each exam. *You must show your picture ID at each exam.* The exam schedule and important information on exam policies are given below.

First Midterm Examination: Wednesday, February 16 8:00–8:50 a.m.
Second Midterm Examination: Wednesday, March 16, 8:00–8:50 a.m.
Third Midterm Examination: Wednesday, April 13, 8:00–8:50 a.m.
Final Examination (Comprehensive): Friday, May 6, 10:30 a.m.–12:30 p.m.

In the event that we need to return to virtual instruction, exams will be given remotely via Proctorio and appropriate instructions will be provided at that time.

In order to relieve some of the inevitable stress associated with these exams, the following policy will be implemented: Exams will consist of 20 questions, but you will only need to get 18 correct in order to achieve 100%. Therefore, in effect, you can choose to ignore two questions without penalty. Note that the maximum grade will still be 100%, even if you get 19 or 20 questions correct. So, in other words,

If you get 20 questions correct, your grade will be 100%.
If you get 19 questions correct, your grade will be 100%.
If you get 18 questions correct, your grade will be 100%.
If you get 17 questions correct, your grade will be $(17/18) \times 100\% = 94.4\%$.
Etc.

Grades will be calculated from scores on the three midterm exams, the final exam, and online homework. The overall course grade will be determined as follows:

Midterm exams 1–3: 20% each
Final exam: 25%
Online homework: 15% (using Connect, typically due on Sundays before 11:59 pm)

Final letter grades will be assigned based on the overall cumulative score. The following cut-offs will be used for letter grades:

A: 85–100%
A-: 81–85%
B+: 77–81%
B: 72–77%
B-: 68–72%
C+: 64–68%
C: 55–64%
C-: 46–55%
D: 41–46%

Note that at the end, I may opt to adjust these cutoffs such that it will be possible to get a particular letter grade with a score that is lower than the range indicated above. But in no case will this adjustment hurt your grade. That is to say, *any adjustments, if applied, will only be used to improve your grade, not lower it*. In extremely borderline cases, I may also use a strong showing in the final exam to tilt a grade above the border. However, don't count on large adjustments. If you want benchmarks to aim for, these are them!

If you are registered for this course on an S/N basis, a grade equivalent to C- on the A–F scale will be required to receive an "S". A D+ or below will receive an "N". Many programs or transfer courses do not like S/N grades or will assume that they are the minimum possible grade. Requests to change grading basis after the University deadline will not be approved.

Missed Exams: Students are expected to be present and prepared to take all three exams and the final. Exams will ONLY be given on their regularly scheduled day. An unexcused absence from any of these exams will result in a score of zero being entered in the course record. In the case of illness or a true emergency, a student may be excused from one midterm exam and have a substitute score recorded for the missed exam at the end of the semester. If circumstances arise such that more than one hour exam is missed, please consult with me. If a substitute score needs to be used, it will be done according to Chemistry Department policy which states, "The unweighted average score of all the student's other exams will replace the zero from the excused midterm exam"

This procedure will only be applied in special circumstances. If you need an excused absence, note two things:

(i) Please contact me the day of the exam or as soon as circumstances allow.

(ii) You don't need a doctor's note for one-time illnesses for which you would not ordinarily be seen by a doctor. If you experience health problems which cause multiple absences, please contact me.

PLEASE NOTE: This is not a procedure which is to be used to obtain a second chance on an exam, or to put off being tested on a particular subject. This is only to be used in the case of real, legitimate illness or emergencies. Quarantining due to COVID is a legitimate excuse!

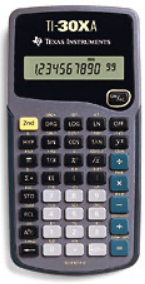
ALSO… Once you start an exam and start it, you cannot get an excused absence, even if you were sick during the test. If you are too sick on an exam day to take the test, don't take it. Instead, contact me for an excused absence.

Exam Regrades: Exam regrade requests must be submitted to the instructor by the end of the class period after that at which the exams were returned (i.e., if exams were returned on Friday, the regrade request must be submitted by the end of the class on the following Monday). It is possible, although very unlikely, that the machine-scored exam was misread. Note that you are responsible to properly record answers (and fully erase unwanted marks) on the answer form when taking the exam.

Incompletes: An **I** (incomplete) grade is only possible if a student is doing satisfactory work (C- level or better) and cannot take the final exam due to extreme, documented circumstances. The policy of the Chemistry Department is that a student may request an Incomplete grade only when (a) the student has a University-sanctioned excuse for missing the final exam and (b) the student is passing the course based on all other graded components. Assignment of an **I** requires that the instructor and student sign a contract, available in the Departmental undergraduate office, stipulating the procedure by which the **I** grade will be made up (e.g., taking a final exam from another instructor in the next semester). Failure to successfully complete the procedure outlined in the contract will result in the **I** being administratively changed by the University Registrar to an F or N (depending on the grade base) one semester (excluding summer) from the end of the semester for which the **I** grade was granted. If you need a blank copy of the form referred to above, you may get it from Nancy Thao in the General Chemistry office (thao@umn.edu).

Withdrawals: It is hoped that every student will successfully complete this course. If, however, it becomes necessary to drop the course, you must officially withdraw from the course following the rules for your college (CSE, CLA, CBS, etc.). Before withdrawing, I urge you to come and speak with me. Your situation may not be as bad as you think it is.

Calculators: Every student should have a calculator that calculates all arithmetic and trigonometric functions, logarithms, and exponentiation. The calculator must also be capable of displaying numbers in scientific notation (e.g. 6.02 x 10^{23} or 6.02E+23), because many of the numbers we deal with in this course will be too small or too large to input or display any other way.



The TI-30Xa (right) is the suggested calculator for this and all CHEM 1XXX courses, and for most intro Physics courses. The bookstore stocks this calculator for around $10. Other calculators that are acceptable include the following:

Bico 98	Casio fx-250HC	TI-30X IIS
Cascio /s-V.P M	Casio fx-300 MS	TI-30XS
Casio fx 300W	Casio fx-82 MS	TI-30XS IIS
Casio fx-115 ES	Casio S-V.P. M	TI-34 II
Casio fx-115 MS	Sentry CA 656	TI-36X
Casio fx-180P Plus	Sharp EL501W	TI-36X-Solar

If you wish to use a calculator on exams which is not on this list, please have it approved by me first. Graphing and programmable calculators or any smart devices are FORBIDDEN on exams. Their use on an exam will be considered cheating. Only calculators that are <u>not programmable</u> will be allowed during exams.

Overlapping & Back-to-Back Courses: Enrolling in overlapping or back-to-back courses that do not allow enough time to join our class meetings on time is prohibited. For more information, please see: https://policy.umn.edu/education/overlappingclasses

Teaching & Learning: The materials provided in this course are intended only for the students officially enrolled in this section and are to be used to learn and practice the course material. Disseminating class notes, videos, exams, etc. beyond the classroom community or accepting compensation (in the form of cash or in trade, such as access to a study website) undermines instructor interests in their intellectual property while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community and are not allowed. For additional information, please see: https://policy.umn.edu/education/studentresp

Student Conduct Code: As a student at the University of Minnesota you are expected to adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf.

Scholastic Dishonesty: The Board of Regents Student Conduct Code states that, "Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis." The policy in this course is **zero tolerance**. The minimum action taken in a case of scholastic dishonesty in any portion of the work in this course will be a grade of F for the course.

For University-wide policies, please see the following webpage:
https://policy.umn.edu/education/syllabusrequirements-appa
This webpage covers eleven policies related to: Student Conduct Code; Use of Personal Electronic Devices in the Classroom; Scholastic Dishonesty; Makeup Work for Legitimate Absences; Appropriate Student Use of Class Notes and Course Materials; Grading and Transcripts; Sexual Harassment; Equity, Diversity, Equal Opportunity, and Affirmative Action; Disability Accommodations; Mental Health and Stress Management; Academic Freedom and Responsibility.

HELP IS AVAILABLE

Instructor: Asking questions during office hours is a first line of defense toward overcoming conceptual problems with the course material. Get help early on so that problems do not compound. I hope to see you in person so that I can help you if you are having any difficulty.

Tutoring (some of this information may not apply due to Covid-19 restrictions): Your lab TA will have one or more office hours per week at a time and location to be announced. For students in the honors program, there will be weekly hours for chemistry-specific tutoring available in in Middlebrook Hall. Specific hours and tutors will be posted on the Honors web site at the start of the semester. You are also welcome to use the General Chemistry tutoring facilities in Smith 124. Additional tutoring services are available at the Smart Learning Commons (http://smart.umn.edu/index.html). **Please Note**: The walk-in tutorial is not intended as a routine means of getting your homework problems solved. Many students fall into the trap of seeking help too soon, before they have put sufficient thought into a problem by themselves. The result is that they never learn to solve problems on their own, and the consequences are disastrous on exams. Thus, while you are not discouraged from using the tutor room, you *are* discouraged from *over*-using it. **Tutors are instructed NOT to simply do problems for students, but rather to ask questions that will help them see how to do the problems themselves. They may also ask to see evidence that you have tried a particular problem yourself.** Generally, then, it's a good idea to bring along the work you have done on a problem. Seeing this will help the tutor figure out how best to help you. If you have any questions about this, please feel free to ask me.

Study Groups and Homework: One of the best ways to learn chemistry is to answer questions and work problems with other students. You will probably find other classmates who are interested in being a part of a study group.

Disability Accommodations: The University of Minnesota views disability as an important aspect of diversity and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. Please bring this to the attention of the instructor as soon as possible so that appropriate accommodation can be arranged. Further information is available from the Disability Resource Center at 612-626-1333 (https://disability.umn.edu/).

Student Mental Health and Stress Management: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via http://www.mentalhealth.umn.edu/.

General Chemistry Director: If you have concerns or problems regarding the lecture portion of this course that you would like to discuss with someone other than your lecturer, contact Dr. Michelle Driessen, the General Chemistry Director, in 113 Smith Hall (mdd@umn.edu, 612-624-0062).

STUDY HINTS

Step 1: READ THE TEXT BEFORE THE LECTURE. No matter how clear the lecture, if it is your first encounter with the material, you will probably not retain much of the content of the lecture. On the other hand, if you have read the relevant material in advance, at your own pace, the lecture will make a lot more sense, and it will deepen your understanding.

Step 2: COPY OVER YOUR LECTURE NOTES ON THE SAME DAY. Your notes will probably not be written in complete, coherent sentences and equations. Try to rewrite them in your own words. Any step or concept that isn't clear will stand out when you rewrite it yourself.

Step 3: WORK PROBLEMS WITHOUT LOOKING AT THE ANSWER. Be playful. Mistakes at this point can be very helpful. Try several approaches. If you need to look at an answer, come back later and do the same problem without looking it up. Working problems is one of the two best ways to test your comprehension of the material. The other is to explain a concept to others, or explain to them how to work a problem.

Problems with Examinations ("I studied 20 hours and really knew the material. Why didn't I get an A?) One of the most common student complaints concerning exams is that the exams do not resemble, or are harder than the homework problems. There are many types of problems in chemistry, such as the calculation of the molarity of a solution, that are important, straight forward and are commonly encountered stated in a familiar way. However, to try to determine whether a student understands a concept or is relying on memorization, your lecturer needs to ask the problem in a different way - and one which may confuse you. To help avoid confusion, treat the numerical problems you work in the following way:

1. Work the problem as written and determine the answer if possible. Note whether this is one of several very similar problems that were assigned.

2. Think about the problem and your answer

- in your own words, what does the problem ask?
- in your own words, what does the answer mean?
- try to restate the problem at least two different ways.
- can you make-up a similar problem? (This is not always easy or realistic to do.)
- can this problem be worked backwards? (Knowing the answer, can you calculate any of the given pieces of data?)
- can you think of a use for the information contained in the problem?
- finally, can you help another student to understand and work this problem? Study in a small group is helpful in this regard.

3. DANGER! If the working of a problem by the professor, a tutor, a friend or the solutions manual "makes sense", this does not necessarily mean that you have a good understanding of the problem and that you can readily work other problems which involve these concepts. The most reliable way to understand a problem is to work it <u>completely and correctly yourself</u> and to then take the time to reflect on what you have done as described above.

4. Rereading the text several times may not be as useful in chemistry as in other subjects. When study time is limited, it may not leave time to answer questions and work problems at the end of the chapter. You might try:

- reading the text thoughtfully once (<u>before</u> it is discussed in lecture)
- reviewing the notes after each lecture
- working problems at the end of the chapters and rereading the text as needed to help understand the problems

5. When working problems on a multiple-choice test, it is useful to eliminate answers you know are incorrect as quickly as possible. This increases your chances of making a correct "educated" guess, if you are not sure of the correct answer.

I will try to adhere to this schedule as closely as possible, but some changes may be necessary. Remember, *you* are responsible for any announcements made in class. Specific information for each exam will be announced in class. The problems listed below are suggested practice problems (9th edition of Silberberg and Amateis). They are the same problems as or similar to those on the Connect homework.

NOTE ABOUT CHAPTERS 1−4: Chapters 1–4 constitute important foundations for this course but are considered to be prerequisite knowledge. We want you to succeed in this course, so please be sure to review as needed. I will not be lecturing on this material, but don't hesitate to ask if you have questions. As always, help is available, but keep in mind that it is never a substitute for coming to terms with the material in your own way. Listed below are end-of-chapter problems from the first four chapters that you should be able to do. Note that the Connect problems for Chapters 1–4 will not be part of your homework grade.

Chapter 1: Problems **1.**1, 6, 16, 26, 30a, 34a, 36, 40, 48, 50, 55a, 56, 60, 63bc, 76ac, 80
Chapter 2: Problems **2.**4, 15, 20, 22, 23, 25, 37, 40, 42, 44, 48, 51, 57a, 58c, 72, 75, 85, 90bcd, 98, 129
Chapter 3: Problems **3.**2, 7, 9, 22, 23a, 27, 40, 59, 61, 71, 78, 79, 83, 87, 89, 93
Chapter 4: Problems **4.**5, 18, 20, 22, 23, 24a, 30*, 33b, 42, 47, 55, 63a, 71, 139

*Note: The book's answer to #4.30a is wrong. The answer should be 987g, not 9.87g.

Chapter 5: Gases and the Kinetic-Molecular Theory

Dates: W 1/19 – F 1/28 (Lectures 1–5)
Read: 5.1–5.6
Problems: **5.**8, 10, 21bc, 26, 32, 47, 51, 57, 62, 68, 74, 78, 80, 81, 82, 90, 100

Chemical Content: Introduction to course; physical states of matter; gas pressure and measurement; gas laws; ideal and real gases; kinetic-molecular theory as a model for gas behavior.

Chapter 6: Thermochemistry: Energy Flow and Chemical Change

Dates: M 1/31 – W 2/9 (Lectures 6–10)
Read: 6.1–6.6
Problems: **6.**11, 13, 21, 28, 31, 37, 42, 43, 47, 57, 70, 71, 76, 82b, 84

Chemical Content: Forms of energy and their interconversion (kinetic, potential, internal energy); heat and work; first law of thermodynamics; enthalpy changes; calorimetry; stoichiometry of thermochemical equations; Hess's law; standard enthalpies of reaction.

Date: M2/14 (Lecture 12): Review and problem solving
Date: W 2/16 (Lecture 13): **Exam 1** (Covers chapters 5–6, associated reading, homework problems).

Chapter 7: Quantum Theory and Atomic Structure

Dates: F 2/11, F2/18 – W 2/23 (Lectures 11, 14–16)
Read: 7.1–7.4
Problems: **7**.2, 7, 9, 13, 20, 23, 24 (use Bohr's formula, eq. 7.5), 28, 30, 41 ("that of a photon of green light" refers to the ordinary wavelength since we normally don't speak of the de Broglie wavelength of light), 44, 48, 49, 50, 55, 57, 58b, 64b, 92

Chemical Content: Electromagnetic radiation and electrons as waves and particles; atomic spectra and the Bohr model of the hydrogen atom; Heisenberg uncertainty principle; atomic orbitals and quantum numbers.

Chapter 8: Electron Configuration and Chemical Periodicity

Dates: F 2/25 – W 3/2 (Lectures 17–19)
Read: 8.1–8.4
Problems: **8**.11, 13, 21 (omit c), 23, 25, 31, 33, 36, 37, 40, 44, 48, 54, 56, 60, 78, 97

Chemical Content: Multi-electron atoms; electron spin; Pauli exclusion principle; building up the periodic table; electron configurations; trends in atomic properties, atomic properties and chemical reactivity.

Chapter 9: Models of Chemical Bonding

Dates: F 3/4, F 3/18 (Lectures 20, 23) (Spring Break: M 3/7 – F 3/11)
Read: 9.1–9.6
Problems: **9**.7, 10, 13, 17b, 21, 22, 25, 26, 31, 39, 40, 47, 49, 53, 63, 66, 68, 81, 89

Chemical Content: Lewis symbols and the octet rule; ionic bonding; lattice energy; covalent bonding; bond energy, bond lengths, and chemical change; electronegativity and bond polarity; metallic bonding.

Date: M 3/14 (Lecture 21): Review and problem solving
Date: W 3/16 (Lecture 22): **Exam 2** (Covers chapters 7–8, associated reading, homework problems).

Chapter 10: The Shapes of Molecules

Dates: M 3/21 – F 3/25 (Lectures 24–26)
Read: 10.1–10.4
Problems: **10**.5, 8, 10, 13a, 14b, 16, 18, 19, 26, 28, 30, 34, 37, 40b, 41, 45, 46, 55, 58, 64, 71

Chemical Content: Applying Lewis structures to molecules and ions; resonance; free radicals; formal charge; valence-Shell Electron-Pair Repulsion theory to predict molecular shapes. Molecular polarity and dipole moments.

Chapter 11: Theories of Chemical Bonding

Dates: M 3/28 – W 3/30 (Lectures 27–28)
Read: 11.1–11.3
Problems: **11**.2ab, 8, 10, 14, 20, 22, 24, 43, 47bc, 54

Chemical Content: Valence bond theory and orbital hybridization; modes of orbital overlap and types of covalent bonds (single, double, triple bonds); σ and π bonds.

Chapter 15: Organic Compounds and the Atomic Properties of Carbon

Dates: F 4/1 – W 4/6 (Lectures 29–31)
Read: 15.1–15.6
Problems: **15**.17, 19, 20, 24, 28, 57, 60, 61, 63, 70

Chemical Content: Overview of organic molecules; classes of hydrocarbons (alkanes, alkenes, alkynes, cyclic and aromatic hydrocarbons); some important classes of organic reactions; functional groups; polymers.

Date: M 4/11 (Lecture 33): Review and problem solving
Date: W 4/13 (Lecture 34) **Exam 3** (Covers chapters 9–11, 15, associated reading, homework problems).

Chapter 12: Intermolecular Forces: Liquids, Solids, and Phase Changes

Dates: F 4/8, F 4/15 – W 4/20 (Lecture 32, 35–37)
Read: 12.1–12.7
Problems: **12**.3, 7, 19, 21, 29, 39, 41, 42ab, 44, 48, 49, 63, 79, 87, 99

Chemical Content: Physical states and phase changes; equilibrium and phase changes; the nature of solids and liquids; X-ray diffraction; types of intermolecular forces: ionic, dipole-dipole forces, hydrogen bonding, and dispersion forces; the unique properties of water; liquids, solids, advanced materials.

Chapter 13: The Properties of Mixtures: Solutions and Colloids

Dates: F 4/22 – F 4/29 (Lectures 38–41)
Read: 13.1–13.6
Problems: **13**.9, 11, 12, 14, 26, 33, 36, 38, 39, 40, 46, 47, 48, 49, 58, 64b, 71, 76, 88, 94, 96, 98, 99, 103, 111a, 124, 135a

Chemical Content: Concentration units, solution energetics, factors affecting solubility, colligative properties, solution composition, vapor pressure of a solution, Raoult's Law, boiling point elevation, freezing point depression, gas solubility, Henry's Law, osmotic pressure, colligative properties of electrolyte solutions, van't Hoff i factor.

Date: M 5/2 (Lecture 42): General review

Date: F 5/6: **Comprehensive Final Exam** from 10:30 a.m. – 12:30 p.m.