Chemistry 410
Physical Chemistry
Syllabus

last update: Spring 2025 for Chem 410B

Course calendar

Class meetings:

- **lecture:** MWF 12-12:50pm **in GMCS-328** I will try to record the lectures on Zoom and post each link on Canvas with a day of the lecture. Please be aware of these **attendance policies**:
  - Attendance in-person is not required for the lecture portion of any class meeting. I will not be taking attendance.
  - Credit will only be given for daily questions answered during the period they are open, typically the first 3-5 minutes of class. You do not have to be in the classroom to answer these questions.
  - **Attendance in-person is required for all exams and drills**. Information on missed assignments is below.
- **additional contact hours:**
  - Monday 5-5:50pm; online via Zoom. In weeks which have an exam, these sessions will be semi-organized review sessions.

  Other weeks, this is just an online office hour.
  - Wednesdays 10:30-11:30am, in-person in CSL-310.

Instructor:

- Andrew Cooksy (he/him): lecture, CSL-310.

Materials:

The materials will be available through Aztec Bookstore. Any format (e-book, hardbound, looseleaf) for the textbook is fine.

- **CHEM 410B Textbook:** *Physical Chemistry: Thermodynamics, Kinetics, and Statistical Mechanics* by Cooksy.

Day1Ready

Some or all of the required course materials for this class are provided in a digital format by the first day of classes and are free through the add/drop date. Your SDSU student account will then be charged a special reduced price for use of the materials for the remainder of the semester unless you opt-out of the content by 11:59 PM on the add/drop date. Please visit the bookstore's Day1Ready site for additional information about pricing, digital subscription duration, print add-ons, opting out, and other frequently asked questions.

- The textbook and online homework will be available through the Canvas Day1Ready link.
- If you buy a textbook separately, you will also need access to the Mastering Chemistry online homework system. **For Chem 410B,** you probably do not need to buy Mastering again if you took CHEM 410A with me. The publisher provides two semesters of access for Mastering, and they count Chem 410A and 410B as two halves of the same course for these purposes.
- **Solutions to all of the end-of-chapter problems:** are available online at no charge from Pearson.
- **Canvas** will be used to post announcements, assignment scores, and final grades. Please be aware that I keep a separate gradebook, where I make adjustments such as dropping low scores, and therefore *point totals evaluated by Canvas are not the numbers I use to assign grades.*

Syllabus Contents

Course Content

Condensed to one sentence, the entire course (Chem 410A and 410B) covers principles of atomic and molecular structure, molecular interactions, statistical mechanics, chemical thermodynamics, and chemical kinetics.

Catalog Description

CHEM 410A. Physical Chemistry (4)
Three lectures and three hours of laboratory. Prerequisites: Chemistry 232, 232L, 251; Mathematics 252 (Mathematics 150, 151; 252 or Physics 195, 195L, 196, 196L for chemistry teaching major); Physics 195, 195L and 196, 196L. Recommended: Physics 197 and 197L. Theoretical principles of chemistry with emphasis on mathematical relations. Theory and practice in acquisition and statistical analysis of physical measurements on chemical systems.

CHEM 410B. Physical Chemistry (3)
Three lectures. Prerequisites: Chemistry 232, 232L, 251, 410A. Theoretical principles of chemistry with emphasis on mathematical relations. Theory and practice in acquisition and statistical analysis of physical measurements on chemical systems.

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Student Learning Objectives:

In this two-semester course, encompassing Chem 410A and Chem 410B, we will examine in detail the theoretical framework that justifies *all* chemical laws. **The overall goal of the course** is to help you develop your own *intuition* for how chemistry works, in the subsequent courses you take and later in your career, by showing how all of the major concepts in chemistry are linked by a common set of laws from physics and math. If we are successful, this course will help all the other courses you take in this department *make more sense*. For example, we will not only be able to calculate the ΔH of a reaction, we will understand *why* one reaction is exothermic and another is endothermic.

The student successfully completing the course will be able to accomplish the following outcomes.

Outcome	Justification	Activity	Assessment
Analyze diverse chemical systems and reduce them to their principal chemical and physical components and interactions for the purposes of mathematical description.	Chemists use this approach to break down complex questions about new materials and/or new environments into simpler questions that can often be answered in sequence to better undrestand the system. With this skill, you will be able to help guide your own research projects in Chem 498, and in whatever career you choose after you graduate.	Students will be presented with derivations of fundamental principles through lecture and reading, with example applications discussed with the class as time permits.	New applications of these principles will be presented as word problems for the students to solve on examinations.

Predict the outcome of molecular processes (including diffusion, interaction with radiation, and chemical reaction) from a set of initial conditions.	Being able to predict the outcome of a process will let us make crucial decisions, like whether or not an experiment is likely to succeed. New experiments are often expensive, time-intensive, and sometimes hazardous. It's important to know how likely it is to succeed in order to use our resources wisely.	Lecture will demonstrate how principles of chemistry and physics aid in predicting the dynamics of molecular systems. Students will practice applying these concepts in online homework problems with unlimited attempts.	New systems and initial conditions will be presented as problems for the students to solve on examinations.
Calculate or estimate structural properties of individual molecules and small groups of molecules using principles of quantum mechanics. (Chem 410A)	Knowing these properties of molecules allows us to make informed decisions on potential solutions when faced with challenges such as climate change, which is largely caused by how much energy is absorbed by vairous molecules in the atmosphere.	Lecture will demonstrate how quantum mechanics describes systems at the molecular scale. Students will practice applying these concepts in online homework problems with unlimited attempts.	New applications of these principles will be presented as word problems for the students to solve on examinations.
Use Excel and Maple to carry out several basic operations for the analysis and visualization of scientific data (Chem 410A lab).	Alumni of our program in a panel discussion in 2019 mentioned that learning how to use Excel in Chem 410A was among the most important skills they learned in our program. This introduction shows you how to use spreadsheets to carry out calculations on very large sets of data, which is a crucial skill in most chemistry-related jobs. Excel is a standard tool in analyzing the contents of a water sample, determining the efficacy of a drug, and presenting your results to others.	Students will work through several guided problems of growing complexity in data analysis, data presentation, and numerical simulations.	Most activities will include a final component where data is given to the student to analyze as part of their score for the day's project. In addition, quizzes on selected topics will be presented throughout the semester following the guided portion of the relevant lab.
Calculate or estimate dynamic properties of large sets of molecules using principles of statistical mechanics, chemical thermodynamics, and reaction kinetics. (Chem 410B)	One of the central parts of the intuition that we want to develop is to grasp how the properties of a single molecule affect its behavior in very very lagre groups of molecules. Knowing what information is important to retain and what information we can sacrifice to simplify the system will allow us to make the connection between the two limits.	Lecture will demonstrate how classical physical chemistry describes systems at the laboratory scale. Students will practice applying these concepts in online homework problems with unlimited attempts.	New applications of these principles will be presented as word problems for the students to solve on examinations.
Describe the contribution and cultural context of a scientist or group of scientists relevant to the course material, outside the context of modern era Europe and the US.	We want to be aware of (a) how science is important to everyone and how everyone can make important contrbutions to our scientific understanding, and (b) how culture or other aspects of our own backgrounds may influence our interests in, approaches to, and even understanding of science.	Research outside the lecture class, biosketches in the book, and office hour discussions with the instructor will provide ideas for biosketch subjects.	The student will research and write a short biosketch of an individual or group from outside modern era Europe and the US who has contributed to modern physical chemistry.

Meeting these objectives should allow the student to eventually build a meaningful intuition regarding chemical behavior based on a unified foundation of chemical theory.

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Prerequisites

Physical chemistry is a fairly demanding course, and we spend little time reviewing material from the foundation courses that come earlier. Enforcing the prerequisites allows us to better match the course to those students who have at least partly established that foundation through their prior coursework. We do not enforce all the prerequisites at registration because this would make it impossible for many qualified transfer students to register. However, students who do not fulfill the course requirements listed as detailed below may be **dropped from the course** by the instructor:

- **MATH 151, PHYS 196, and CHEM 232** and their prerequisites (MATH 150, PHYS 195, CHEM 200 and 201). To take

CHEM 410A, a student must have already passed all of these courses. Concurrent enrollment is not sufficient. If you are missing only the **PHYS 196L** lab, you may enroll in CHEM 410A, but you *must* either have completed or be enrolled in PHYS 196L to register for CHEM 410B.

- **MATH 252, CHEM 251**. We are currently enforcing these prerequisites. If seats are still available by the first day of classes, we *may* relax this requirement. If one of these courses (but not both) is the only thing blocking you from registering for CHEM 410A and you would like to enroll in 410A, email me. You will have to be concurrently enrolled in the missing class to be eligible for CHEM 410A.
- **CHEM 410A** is a prerequisite for CHEM 410B.

If you satisfy any of these requirements by coursework at a different institution, it may be necessary to show the transcripts for that work to the instructor.

CHEM 410 is not a math class, and so I try to avoid unnecessarily lengthy mathematics in the problems. Usually. However, mathematics is our principal tool, and you need to be very comfortable with elementary algebra, geometry, and calculus (up to derivatives, simple integrals, and power series). The math is all manageable one step at a time, but there will sometimes be many steps.

This *is* pretty much a physics class, however. In Chem 410A in particular we will call on results from mechanics and electromagnetism to justify some of our conclusions about atomic and molecular structure. You are probably familiar with the concepts if you've taken first-year physics, and we will introduce (but rarely prove) any equations from physics that we'll need before we use them.

There is an introductory chapter ("Chapter A") to the text that summarizes the prerequisites we will rely on most often. Your texts for previous math and physics courses should help you if you're rusty in those areas.

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Topics

The Chem 410A/B sequence covers the fundamental physics of chemical systems, including structure, energetics, and interactions of molecules. The material can be applied to inorganic, organic, and biochemical molecules and reactions. In fact, most of the important results in physical chemistry will already be familiar to you from general chemistry. If you find the details of our work in this class obscure the results, you may want to go back and look at the relevant section of a general chemistry text.

The primary reference for the course is still the lectures themselves. No material is covered on the tests that has not been discussed in class, and occasional lecture topics may appear on the tests even if they are not included in the reading. But if you read ahead, you may find the lectures more useful, and your note-taking may be reduced to adding comments to the text rather than transcribing the entire lecture.

Organization

Physical chemistry examines chemical phenomena both on the scale of individual atoms and molecules (the microscopic limit) and on the scale of thousand-gallon chemical reactors (the bulk or macroscopic limit) and bigger, as well as everywhere in between. In this class, we build from the microscopic limit to the macroscopic:

1. quantum mechanics of atoms
2. quantum mechanics of molecules
3. molecular interactions at microscopic scale
4. statistical mechanics and extrapolation to the macroscopic limit
5. thermodynamics and bulk properties of non-reactive systems
6. bulk reaction thermodynamics and kinetics.

This differs from the organization of most textbooks in the field, which start with classical thermodynamics and kinetics, and then introduce quantum mechanics and statistical mechanics in the second half. I hate that, so instead we're using my own textbook as your reference. But no single teaching style or book works for everyone, so you might wish to look through other textbooks titled *Physical Chemistry* available at Love Library.

A more detailed breakdown of the course follows the chapters of the 2-volume textbook in sequence:

Chemistry 410A: Microscopic Systems	
Physical Chemistry: Quantum Mechanics and Molecular Interactions	
chap	**topic**
Part I: Atomic Structure	
1-2	Introduction to quantum mechanics
3	One-electron atoms
4	Many-electron atoms

Part II: Molecular Structure	
5	Chemical bonds
6	Molecular symmetry
7	Electronic states
8	Vibrational states
9	Rotational states
Part III: Intermolecular Interactions	
10	Intermolecular forces in gases
11	Clusters and macromolecules
12	Structure of liquids
13	Structure of solids
Chemistry 410B: Macroscopic Systems	
Physical Chemistry: Thermodynamics, Stat Mech, and Kinetics	
Part I: Extrapolation to Macroscopic Systems	
2	Introduction to statistical mechanics
3	Partitioning the energy
4	Stat mech and molecular interactions
5	Mass transport
6	Energy transport
Part II: Non-reactive Macroscopic Systems	
7	Introduction to thermodynamics
8	Energy and enthalpy
9	Entropy
10	Phase transitions
11	Solutions
Part III: Reactive Macroscopic Systems	
12	Chemical thermodynamics
13	Chemical kinetics: elementary reactions
14	Chemical kinetics: multistep reactions

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Conduct of Class

- Lectures will be **conducted in-person and streamed** via Zoom at the scheduled meeting times (MWF 12-12:50pm).
- I plan to record the lectures and store them for later viewing. Please understand that errors or technical issues may interfere. I will try to re-record any missing videos, but the best way to be sure you catch the lecture material is to join us synchronously, either in person or by Zoom.
- You may be able to ask questions using Zoom's chat feature, but during lecture I will try to keep everyone on Zoom muted (except me).
- You do not need to have your Zoom camera or microphone for this class.
- If you do have your camera on, please dress appropriately.
- As I understand it, the recorded lecture includes the chat, including "private" chat messages, so please keep your messages relatively professional and polite.
- All students must take exams and drills in-person. But otherwise, if you do not wish to remain in the classroom for the lecture, I will not be offended if you come to class only for the assignment. Exams begin at the start of class, about noon, and drills start at about 12:40pm.

Please ask questions. During lecture, I will try to monitor the Zoom chat, but I will more easily respond to questions from students present in the lecture room. If we really are in too much of a hurry, or if I just can't come up with a better explanation than I've already given, we may need to postpone the discussion until office hours. However, if the class is quiet, it only

encourages me to keep talking and talking and talking. Don't think I won't.

Please always disable any noisy electronic devices you have, such as cell phones and watch alarms, while we are in class so that they will not disturb us during lecture or lab. If you must use your phone during lecture, please stay away.

I prefer not to invest class time in discussing course administrative matters. Of course you may ask me to justify any aspect of the syllabus, but please reserve those questions for office hours or email, outside of our limited lecture time.

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Grading Scheme

Overall Grading Scheme

Final grades will be assigned on the following scale:

A ≥85%

B 70%—85%

C 55%—70%

Lecture Grading Scheme

#	assignment	points each	points total	% lecture grade
1	office hour visit	5 pts	5	extra credit
6	homework sets	20 pts (drop lowest score)	100	10%
≈50	daily quiz questions	1–4 pts	50	5%
4	drills	20 pts	80	8%
6	20-minute exams	100 pts (drop lowest score)	500	50%
1	cumulative final	250 pts	250	25%
1	biosketch	20 pts	20	2%

Lab Grading Scheme (410A only)

The lab grade is based on several 10-point labs, and a few quizzes. The lab instructors (not always the same person as the lecture instructor) will determine the grading scale for the labs, and at the end of the semester the total lab scores will be normalized to the lecture grading scale below (so that for example a high B in lab is converted to a high B on the lecture grading scale). The final score will then be computed as
0.25 × (normalized lab score) + 0.75 × (lecture score).

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Assessments

Drills

These are 10-minute quizzes on the most basic material, mostly review material from prerequisite classes such as General Chemistry. These are sometimes directly relevant to the lecture material, and the dates on which they are given may be changed during the semester to accommodate the variable lecture schedule. Because it should not be necessary to spend a lot of time preparing for these, I may give a drill on only three day's notice. Drill material will usually *not* be reviewed in lecture, but you can always ask about this material during office hours.

- 410A drill topics may include:
  - unit analysis and conversions,
  - stoichiometry,
  - reasonable values for physical quantities,
  - basic integrals and derivatives,
  - electron configurations for atoms,
  - Lewis structures and VSEPR theory for molecules.
- 410B drill topics may include:
  - more unit conversions and reasonable values,
  - more basic calculus, including power series approximations,
  - balancing chemical reactions,
  - calculating enthalpies, energies, and entropies of reaction,
  - elementary kinetics with rate laws.

There will be an opportunity on each drill (since the time limit is fairly loose on those) to provide feedback about the course.

Problem Sets (Online Homework)

One problem set of online *Mastering Chemistry* homework problems will be assigned before each exam. I will make available a number of problems, worth 1 or 2 points each, with a maximum score of 20 points per problem set. You are encouraged to try as many problems as you can manage, but you only need to complete *20 points' worth* of problems to get full credit. These will normally be due the **Monday** before each exam, and the initial problems will be posted about two weeks before that. I may continue to add problems to the set up until it is due, but you will have at least one full week to work to complete your 20 points. No credit will be given for late problem sets, so please get your 20 points done before the due date.

Most of these will be based on the more straightforward lecture material. The primary goal of the homework is to encourage students to prepare for the exam more than two days in advance. The homework problems are **not** intended to exactly represent problems that will appear on the exams. Studying solutions to these assignments *alone* will be of only partial benefit in preparing for the exams.

The homework also provides an opportunity to illustrate some applications drawn from material covered in lecture, and these may contain tougher mathematics than will be necessary on the exams. If you're spending more than 15 minutes on one problem and not making progress, please come to the office hours or email me or use the Blackboard discussion forum.

Daily quiz

I hope to have one or two short questions per class, except on days when an exam or drill is scheduled. Each quiz will generally have some credit for participation and 1-2 points for the right answer. Like the homework, there is a maximum number of possible points, in this case 50 over the entire semester, but multiple chances to get those points. If you miss a class, or have an isolated case of technical trouble, we won't worry about it because you will make up the points another time. Although I will *not* be taking attendance, you should still attend class fairly often to be sure of getting all 50 points.

Biosketch

This assignment is not for many points, and you should not budget more than 1-2 hours over the entire semester to work on this. If you enjoy the topic, of course you may invest more time.

Modern science draws from thousands of years of human experience with nature from all over the world. Science continues to benefit from the research of scientists with a rich variety of backgrounds, bringing new perspectives and new applications of scientific discovery to their fields of study.

Write a very brief (up to one page) biographical sketch of a researcher working in physical chemistry or a closely related area, whether present day or from history, who has contributed or is currently working in an area that you find especially interesting. Choose someone working outside the European/US/Canadian world of the last 500 years. Find a scientist working in Asia, Africa, Mexico, or South/Central America, OR a figure or culture from history anywhere in the world, roughly 1500 CE or earlier. For our purposes, Eastern Europe (including Russia and the former Soviet Union) is still Europe. You should include

1. Their name (if known) and basic biographical information including where and when they live or lived;
2. What it is about their area of study you find interesting (for example, potential real-world applications of the work);
3. How you think their culture may have influenced their interests or their approach.

You do not need to provide references, but you must use your own words. Wikipedia will be an acceptable source, but -- again -- you **must** use your own words. Using a few different sources can help you arrive at your own way of saying things.

Deadline: The paper will be due any time during the semester before the last day of class. Details for the final submission will be give later. I will be happy to provide feedback if you get it to me early in the semester, and you may continue to revise until we both agree that it looks good.

Format: This will be a very short exercise in formal writing. I plan to correct grammar and spelling (please see below) the way I do when I read a student's thesis or a paper I am reviewing for a scientific journal. If you have any questions or concerns about that at all, please submit a draft early enough for my review so that I can give you examples of what I would look for. Please let me know if a few minutes during a Monday office hour on some general guidelines would be appropriate. The final document should conform to the following guidelines:

- One page maximum (ok to go a little over);
- 10-12 point Times New Roman, Calibri, or Ariel font;
- Title (name of your biosketch subject) and your name at top of page, centered;
- Text only, no graphics;
- Complete sentences; correct grammar and spelling.

The final grade will be based on these criteria:

- Choice of subject consistent with guidelines given above
- Format consistent with guidelines given above
- Content consistent with guidelines given above

Office Hour Visit

For 5 extra credit points, come by any of my office hours **before exam 2**. If you don't have a chemistry question, just introduce yourself and maybe give me an idea what career choices you're considering, or what research topics interest you. I know the department faculty projects pretty well, and we can discuss options for the Chem 498 research requirement. You don't need to stay long, but I'd like you just to come by and say hello and get 5 points. The offer of points expires after exam 2, because the goal of this is to encourage students to at least give the office hours a try and see if they help.

Exams and Final

There will be six 20-minute exams and one 2-hour final. CHEM 410B has an additional, *optional* ACS final exam. The following instructions accompany all exams and the final:

- Keep the exam closed until instructed to begin.
- Write your name on this page but not on any other page.
- Silence any potentially noisy electronic devices you have.
- Keep your eyes only on your own work.
- You may not access the internet or communicate with anyone but the instructor during the exam.
- Show all your work, using only the exam papers, including the back of this sheet if necessary.
- For any final numerical answers, specify the correct units (if any) and use an appropriate number of significant digits.
- **Stop writing and close your exam immediately when the instructor ends the exam.**
- Attempt all the questions.
- You are permitted to consult your own notes and our textbook during the exams. E-books may be consulted during the exam, but they must be downloaded rather than accessed online.
- The exams will begin with several short-answer problems, dealing with the most fundamental concepts in as straightforward a manner as I can manage. This section will count for 40% of the exam. Partial credit is not necessarily available on these problems.
- There will then be longer problems (2-3 on the 20-minute exams, 6 or more on the final) which count towards the remaining 60% of the available points. These problems draw from more specific topics and require varying amounts of math. Partial credit is always available on these problems. These are not all intended to be of equal difficulty, but the prepared student will recognize the questions they know how to answer.

Although the exams are all open-book, you **must** come to them prepared. You will have time only for very brief consultation of your notes. Attached to each 20-minute exam are what I deem all necessary tables, constants, and complicated equations. The final exam will offer you almost twice as much time per question, so will feel less rushed. But in my experience, the added time does not tend to greatly raise students' scores.

The 20-minute exam on which you get your lowest score will be dropped from calculation of the final grade. If you are unable to take an exam for any reason, that exam will become your dropped score. There are no make-up exams. Please beware of purposely dropping any exam to make room in your schedule for something else. Throughout the two-semester sequence, what we cover on one exam is always based on material that the previous exams covered, so it doesn't pay to purposely neglect any section of the course.

The final exam will review all of the course material for the semester, and provides an opportunity to improve recorded scores on *some* problems from the short exams. Your exam scores are recorded question-by-question. After writing the final, I will match some of those questions to questions on the 20-minute exams which covered the same topic. If you score higher on one such question on the final than you did on the corresponding question on the 20-minute test, I will raise your grade on the 20-minute test. But don't count on a lot of help from this: because there are not nearly as many questions on the final as on the set of 20-minute tests, the final will not be able to correct substantially for routinely poor performance on the 20-minute tests. Also, the final is not capable of changing grades as much as one might think. The wide grade ranges of the grading scheme (compared to the typical 10-point scheme) make it unlikely that any one assignment (even the final exam) will shift the final total by a whole letter grade.

ACS final exam in CHEM 410B

Two final exams will be offered in CHEM 410B only:

- My own final exam, in the same format as the 20-minute exams, covering only the material from CHEM 410B and given on *the last two days of class*. This is the official final exam for the course, and attendance at this exam is mandatory.
- An ACS standardized, multiple choice examination in physical chemistry, covering material from *CHEM 410A and CHEM 410B*. This exam will be offered during the 2-hour slot scheduled for our final exam, to adhere to the testing procedures stipulated by the ACS. Attendance at this exam is optional (because it covers material from 410A as well as 410B) but encouraged.

Your best score of the two finals will be your score on the final for CHEM 410B. Therefore, it cannot hurt your grade to take the ACS exam. A review of CHEM 410A material will be offered. Scores from the earlier, official final exam will be made available only after the ACS exam. (It's unlikely that the regular exam will be graded before the ACS exam anyway.)

Missed Assignments

This course cannot always be your top priority, and in consideration of this, the lowest score from each of (a) the problem sets

and (b) the 20-minute exams are dropped. If you do not turn in one of these assignments for any reason, that becomes the dropped assignment. This is intended to accommodate emergencies such as illness, as well as professional obligations such as out-of-town conferences. Make-up drills *are* available; email me to schedule a time convenient to both of us outside of class (such as during office hours).

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Support

SDS Accommodation

Students who may qualify for special accommodations for these assignments should first seek authorization by contacting the Student Disability Services office at 619-594-6473 (Calpulli Center, Suite 3101). Students with that authorization should then contact me as early as possible so that we can agree on a suitable protocol for drills, quizzes, labs, and exams. We cannot retroactively apply special consideration for assignment scores. You are welcome to email me if you would like to set up an appointment outside regular office hours for that discussion.

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Additional Hours: Examples Session and 410A Calculus Boot Camp

We have a lot of material to cover, and we will cover almost all of it. Lectures are therefore rather fast-paced, and it is often not possible to work through example problems during class time. To make up for this, please take advantage of my office hours to go over lecture material, sample problems, and to review quizzes and exams.

Examples Session. In addition to the regular office hours, a totally optional examples session is held each Monday evening (starting the second or third week of class) from 5-6pm. This allows us to go over additional problems, and at a more leisurely pace. New material for tests is never introduced at these sessions, and attendance is not expected or required. If you choose to come, you may arrive and leave anytime during the session, but please bring questions about the material or suggestions for problems to work through.

Calculus Boot Camp (Chem 410A only). A 3-day, 7am-8am review of basic calculus, focusing on the rote methods for dealing with the calculus we encounter in this class rather than focusing on the mathematical theory. This is completely optional. Nothing is graded, and no sign-up or regular attendance is required. The idea is to provide a chance for students who are concerned about their calculus skills to exercise them before it really matters. I do not try to make this interesting; it's just math drills, available for those who feel they might benefit from it and who don't mind getting up early to see if it helps.

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Studying Physical Chemistry

You've reached a level of coursework where there's no reliable formula for success. I will be trying to grade each student based on their understanding of fundamental concepts that underlie all of chemistry, and their ability to apply those concepts to different situations. This is a lot to ask. I appreciate that your time is limited, and you want your study time to be wisely used, but it will be up to you to find what works best. It is possible to study many hours and still be disappointed by performance on the exam, so you need be honest with yourself about how to make your studying most effective. For example, reading the homework problems and then reading the solutions can feel very rewarding, but often does not prepare a student for the demands of putting together the solution on their own. Detailed solutions to many problems in the book are provided in the solutions manual, but I always try to write new problems and new *kinds* of problems for the exams.

To pass the course it is usually enough to make sure that you can do the basic calculations. Study the major equations we have used and that are listed at the end of each chapter, and know what each variable represents. Make sure you can convert between the different unit systems we use, and be familiar with the order of magnitude of common quantities.

To get an A, you will need to demonstrate that you can apply the principles we cover to new situations of my choosing. That requires testing yourself not just on how to use particular equations, but on why those equations work for particular situations, and what would happen if the situations were different. My hope is that an A will reflect a deep grasp of the most fundamental ideas in chemistry. I hope you'll agree that this is a goal worth considerable effort.

My recommendations (for what they're worth):

1. **Work lots of problems, but don't spend a lot of time on any particular one.** The most difficult part of a good exam problem is right at the beginning: seeing what concepts we've covered that relate to the question. For that purpose, I think it's more valuable to see lots of different examples than to go into depth on a few.
2. **Don't assume that understanding a solution is the same as being able to solve a problem.** It is much easier to make sense out of a solution that is presented to you than to come up with another similar solution on your own. Concentrate on how *how you would start solving the problem* that particular way. What in the problem makes it clear which equations are useful?
3. **Don't spend a lot of time memorizing a particular approach.** Learning recipes for solving particular kinds of problems (a strategy that works well in General Chemistry) is only a small part of succeeding in Physical Chemistry. Some of these problems can be solved by rote, but not the really interesting ones, and I try to make the exam questions interesting.
4. **Try to ask yourself *qualitative* questions about the material.** This is difficult, but once you get to the point that you can solve the purely numerical problems, you should be able to ask yourself what that answer means. Would the final value be larger or smaller if you changed the system somehow (more massive particle, bigger container, ...)? What if we asked the

same question, but about a different system? These are the kinds of questions I ask myself when coming up with the problems.
5. **Make the lectures worthwhile by reading ahead** if you can, and asking questions in lecture when you need to.
6. **Study with others and ask each other questions** about the material. Test each other. The end-of-chapter problems begin with a set of "discussion questions." These would be terrible exam questions because they look mostly for qualitative, essay-like solutions (difficult to grade), but they are suggestions for the sort of questions you should be asking each other.
7. **Come to office hours and/or the Monday afternoon examples session,** at least once, early in the semester. Find out if either of these is helpful before you look for alternatives. This will also be helpful if you might want a letter of recommendation from me later on.
8. **Keep thinking about the material.** The material should make sense, if you can give yourself the time to think it through. That's the most rewarding thing about the class -- it shows how chemistry all fits together into one cohesive picture.

Ultimately, the only way to guarantee success in the course should be to understand the material really, really well. Try to honestly assess your own understanding of the material, for example by seeing how reliably you can productively start to solve problems at the end of each chapter, and use that as your guide to what study techniques work best for you.

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General Notes

Land Acknowledgment

For millennia, the Kumeyaay people have been a part of this land. This land has nourished, healed, protected and embraced them for many generations in a relationship of balance and harmony. As members of the San Diego State University community, we acknowledge this legacy. We promote this balance and harmony. We find inspiration from this land, the land of the Kumeyaay.

Essential Student Information

- Compliance with CSU/SDSU vaccination and facial covering policies is required.
- Your SDSU email address will be used for all course-related communications.
- The Student Conduct Code prohibits conduct disruptive to instruction, including academic dishonesty and the unauthorized recording, dissemination, or publication (including on websites or social media) of lectures or other course materials.
- SDSU provides disability-related accommodations via the Student Ability Success Center (sascinfo@sdsu.edu, sdsu.edu/sasc). Please allow 10-14 business days for this process.
- The Family Educational Rights and Privacy Act (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. I will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the semester or used as examples for future students or the wider public.
- As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. I am required to share information regarding sexual violence on SDSU's campus with the Title IX coordinator, Gail Mendez (619-594-6464), who will contact you to let you know about support services at SDSU and possibilities for holding accountable the person who harmed you. If you do not want the Title IX Officer notified, you can speak confidentially SDSU's Sexual Violence Victim Advocate (619-594-0210) or Counseling and Psychological Services (619-594-5220, psycserv@sdsu.edu).
- Class rosters are provided to the instructor with the student's legal name. Please let me know if you would prefer an alternate name and/or gender pronoun.
- Need help finding an advisor, tutor, counselor, emergency economic assistance, or other support? Contact the SDSU Student Success Help Desk Monday through Friday, 9:00 AM to 4:30 PM.
- For technical or computing assistance, contact the Library Computing Hub.

Inclusion in this Course

The science that we will be discussing is blissfully independent of geography or era, remaining as valid (we believe) on planets halfway across the universe as much as here and for billions of years behind us and yet to come. However, the concepts that we will be spending most of our time on in physical chemistry were formulated and recorded primarily in rather specific places and times, in the US and Western Europe over the last 200 years. But it matters that the science itself exceeds these narrow boundaries, and people of all backgrounds and cultures have contributed to the early development of the science we use today, and continue to contribiute to its growth now.

As scientists, we must all pay attention to the biases that may cause us to misinterpret data, to dismiss potentially valid alternatives, to see from only one perspective. It is our obligation to overcome these biases as much as possible to examine nature with an unfiltered eye. Part of that obligation is appreciating that everyone in the classroom, even the instructor, has a history that has shaped our perspective such that our experience is necessarily limited, and we broaden our ability to understand the world by each of us bringing our perspective to the classroom. Please feel free to ask questions and challenge assertions, but always with respect for others and the understanding that we are all there to learn from one another.

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Add/Drop Procedures

If you are unable to enroll in the course because you are blocked, or the sections are full, or the schedule number is hidden, email me. To drop the course, use my.SDSU.

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Academic Honesty

Students are expected never to represent someone else's work or AI work as their own, nor to assist others in doing so. Violations of this rule will be documented and may result in grade reduction (including failure) and disciplinary review by the University. Please see the SDSU academic honesty page for further information.

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