CHE3026, Physical Chemistry II
Syllabus, Fall 2023, Aug. 28 – Dec. 15

The second semester of Physical Chemistry could easily be called "Quantum Mechanics, Spectroscopy, and Theoretical Chemistry". Much of this course covers ideas introduced throughout General Chemistry, but with much more detail and rigor to apply to a broader range of circumstances.

Throughout this semester, I strongly encourage you to review class work regularly, practice problems daily and ask as many questions as necessary in order to succeed. Talk to me one-on-one early and often; helping students directly is one my favorite parts of my job.

Dr. Samuel Stoneburner, Assistant Professor
Office: Rohr Science 322 (enter through 330)
Email: sstonebu@pointloma.edu
Phone: 619-849-7230

Lecture location: Ryan Learning Center 102
TR: 11:05 am – 12:20 pm
Final: Thur., Dec. 14, 10:30 am – 1:00 pm

Communication: I will post information and announcements via Canvas. You should activate notifications. When I am not available in my office, the best way to reach me is by email. I will attempt to respond within one business day.

Drop-in Hours: MWF, 10:30am – 11:30am, 1:15pm – 2:00pm
TR, 8:30am – 10:00am

You do not need an appointment to meet with me during any of the above hours. If you would like to meet at another time, please email me to schedule an appointment with suggested meeting times.

Prerequisite(s): CHE 2013 (Analytical Chemistry)
PHY 1054 or PHY 2054 (General Physics II or University Physics II)
MTH 1044 or MTH 1064 (Calculus With Applications or Calculus I),

- C– or better in all prerequisite classes strongly recommended
- MTH 2074 (Calculus III) strongly recommended

Corequisite(s): CHE 3027 (lab, graded separately)

Course Description: An investigation of matter from a quantum chemistry perspective with particular emphasis on the theoretical concepts and their implications for molecular spectroscopy and computational chemistry.

Course Materials:

- *Textbook:* Engel, Quantum Chemistry and Spectroscopy Plus Modified MasteringChemistry with eText, Pearson, 4th Edition, ISBN-13: 9780138260514 (hardcover text), 9780138260477 (looseleaf text), or a Pearson+ monthly subscription (e-text only, cheapest option)
    - *CHE 3025 (P-chem I) uses the Thermodynamics textbook of Engle and Reid, which is also included in the Pearson system for this book. If you will be taking that class next semester, you may want to get a longer subscription to save money. If you still have an active subscription from taking CHE 3025 last semester, that should still work for this book.*

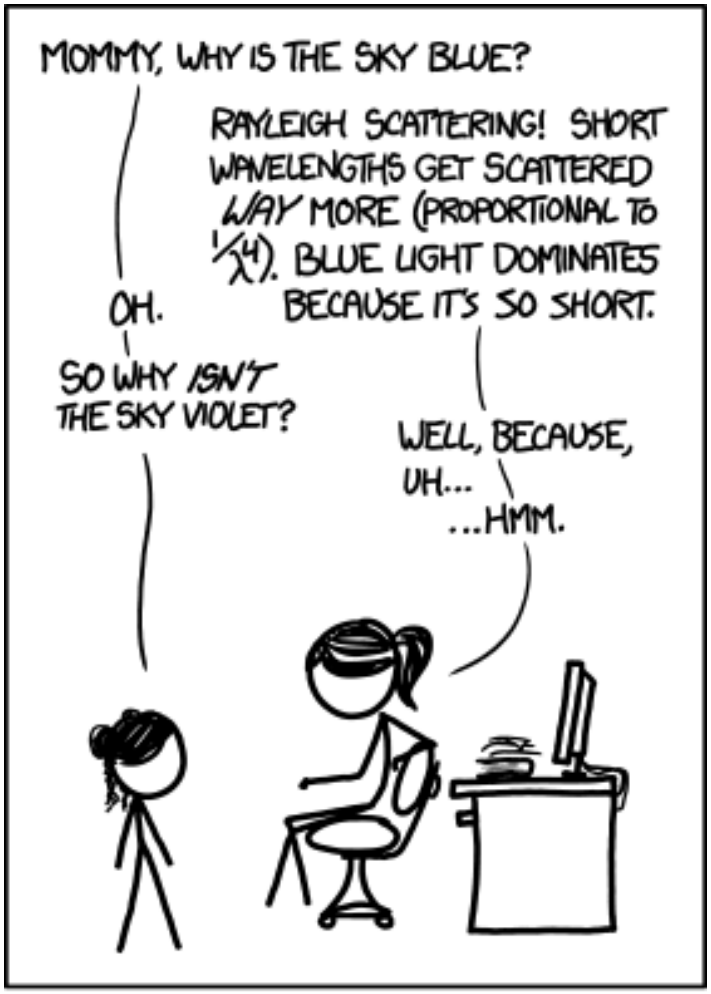
About your professor: I grew up in Michigan in the 1990s. I worked retail for 5 years, got an associate's degree during that time, and did exciting things like getting elected to the local library board and play Settlers of Catan (although we never played Catan at board meetings, sadly). While getting my bachelor's degree I majored in chemistry and math, but my most memorable lessons were from seemingly unrelated classes like art and New Testament Greek. I moved to Minnesota for grad school, where I got married, got my four kids, and my Ph.D., in that order. Before coming to Point Loma, I taught at Messiah University in Pennsylvania for three years, most of which was during the pandemic. My hobbies include plotting to take over the entire Tri-State Area and encouraging my children to play more video games.

PLNU Mission: To Teach ~ To Shape ~ To Send

Point Loma Nazarene University exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Course Learning Outcomes: Upon completion of this course, students will be able to:

- Develop more sophisticated mental models of wave functions, energy levels, atomic structures, chemical bonding, spectroscopy, and computational chemistry as grounded in the fundamentals of quantum theory
- Use fundamental exact and approximate physical systems as models for understanding more complex molecular structure and behavior
- Apply the concepts, methods, and techniques of quantum chemistry to chemical systems and make predictions for these systems



xkcd.com/1145

Grading and Assessment

"The risk I took was calculated, but man, am I bad at math." – The Mincing Mockingbird

Letter grades will be assigned according to the following scheme:

A-range	B-range	C-range	D-range	F-range
A: Any grade of 93.0% or above.	B+: 87.0-89.9 %	C+: 77.0-79.9 %	D+: 67.0-69.9 %	F: Any grade below 60.0%
	B: 83.0-86.9 %	C: 73.0-76.9 %	D: 63.0-66.9 %	
A–: 90.0-92.9 %	B–: 80.0-82.9 %	C–: 70.0-72.9 %	D–: 60.0-62.9 %	

Percent	Component
5 %	Reading surveys
5 %	Attendance
5 %	In-class activities (e.g., worksheets)
15 %	Mastering Chemistry online assignments
5 %	Philosophy/Theology response essay
15 %	Misinformation explainer project
30 %	3 Exams (10% each)
20 %	Final Exam
100 %	Total

Note: "Extra credit", "curving", or "rounding up" of the final grade should not be expected or requested. The only way to achieve a given grade is to perform well on the assignments described here. Do not ask for "extra" work to boost your grade.

Reading surveys: Every day there is a reading assignment, there will be a survey on Canvas due 10:00 pm the evening before where you tell me about any lingering questions you have. I will look at your responses before class (which I need time to do, hence the 10pm deadline) and I will do my best to address your questions in class that morning. I may respond directly on Canvas if I think the question is too specific or off-topic to address during class time.

This assignment is intended to be easy points that reward you for doing the reading while also helping me adjust each class to your needs. You will get credit for any responses that demonstrate reasonable engagement with the material. In other words, the only way to miss these points is to not say anything or to say something overly general like "I didn't understand any of it" or "I don't have any questions." If you feel like you understood everything, tell me what was interesting, or what you are now curious about.

To give you additional flexibility for weeks when you have an exam, a deadline, other life events, or in case you forget once or twice, I have set up Canvas to drop the lowest 10 scores.

Attendance: You've been in college for a while, so you know how important it is to show up to class. Attendance is also required by PLNU policy (discussed in more detail in the Policies section), so I like to give you points for it. To keep things simple as far as illness and emergencies, I won't take off points for the first five absences of the semester. After five absences, you will begin to lose points, and PLNU requires that I warn you of possible de-enrollment. (See the Attendance Policy for further information.)

I will be taking attendance on Canvas at the start of every class. If you arrive late and want to be sure to get credit on your attendance, check with me after class to ensure I don't have you absent by mistake. Being late is better than not being there at all: it will at least get you partial credit, and it won't be counted against the absences for the university attendance policy.

Note: The Canvas attendance tool doesn't allow me to "drop" the first five absences, so your score for attendance in the Gradebook may be lower during the semester than the final number. I will calculate your actual attendance grade at the end of the semester.

In-class activities: Throughout the semester there will be various practice problems and/or group worksheets. These may be scored based on accuracy, completion, or "good-faith effort", and they may be graded individually or by group. If an activity is assigned as group work, individual work will not be accepted for credit. If an activity is assigned as individual work, group work will be considered a violation of academic honesty.

Some activities will be longer than others, but there will be some sort of activity most class sessions. In order to keep consistency with the attendance grading policy, Canvas will drop your 5 lowest scores. There will be no make-up for credit if you are absent, but the activities will be made available on Canvas after class.

Mastering Chemistry online homework (access through Canvas): The Mastering Chemistry content includes assigned homework problem sets as well as pre-lecture activities, if any. Due dates will be found within the Mastering Chemistry system and on Canvas.

I carefully hand-select assignments to balance two competing concerns: practice in the most relevant concepts and problem types, and the demands on your limited time. You may need additional practice, only you can decide *which* topics. I am putting any problems that I don't assign for credit into practice assignments grouped by chapter so you can take advantage of the instant feedback, hints, and linked video tutorials on Mastering Chemistry. These are opportunities for additional practice that will not impact your grade. Using these "practice" assignments as a study tool is *strongly* recommended and I am happy to help you with any questions that may come from any of those problems.

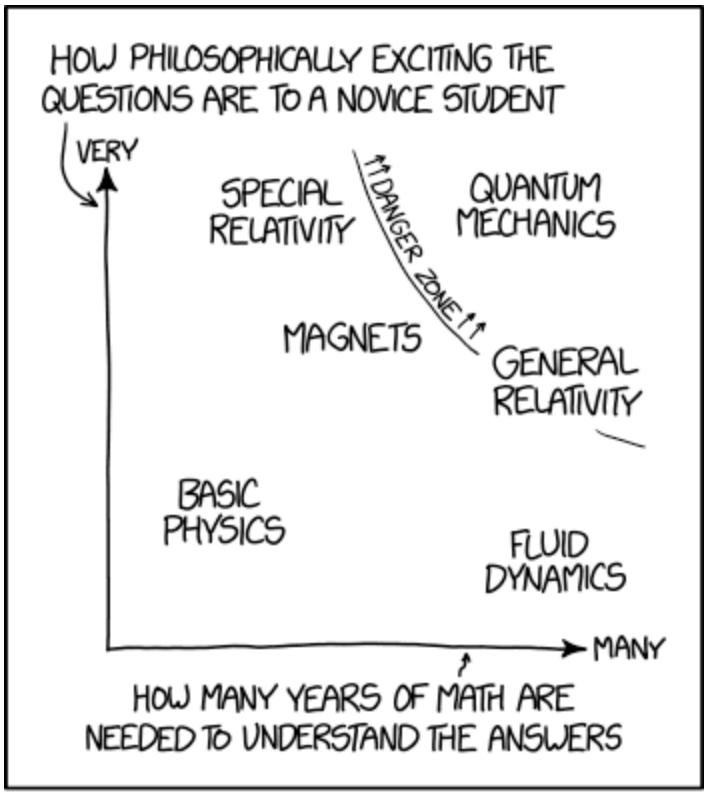
If you find yourself struggling with a problem repeatedly (e.g., 5 wrong answers to the same problem), you should come to my office hours and ask for help. A notebook with your work on previous attempts to a problem is especially helpful when you are asking for my assistance. Using a notebook also creates a written record that you can consult later as you study or seek assistance, and it can be beneficial in the event of academic integrity questions.

Philosophy/theology response essay: With any course I teach at PLNU, I try to think about how to best connect with Christian identity. Quantum mechanics has presented challenges to worldviews and belief systems since it was first proposed, and so it provides an opportunity to examine how your scientific interpretations are impacted by your beliefs in other areas, and vice versa.

You will read an article discussing some of the areas of overlap between quantum mechanics and theology. You will then write a brief response (400-500 words) reflecting on which perspectives you find most plausible, and why (including the influence of your own belief systems). Nothing about this assignment requires you to identify as Christian (or religious or spiritual in any way). The point of the assignment is to demonstrate thoughtful self-reflection about your own philosophy and/or theology of science, however that looks for you.

This assignment will be a single submission due early in the semester. You may cite other sources if you want, but it is not required. Citations should be in ACS style and will not count towards your word count.

Misinformation explainer project: There are many scientific topics that are deeply misunderstood by the general public, and often scientific terms will be used as justification for claims that are fraudulent, dangerous, or simply absurd. Quantum mechanics is especially common in terms of these kinds of citations, partly because it takes so much work to understand it correctly (see the cartoon to the right).



WHY SO MANY PEOPLE HAVE WEIRD IDEAS ABOUT QUANTUM MECHANICS

xkcd.com/1861

For this assignment, you will write an informal "explainer" article at a level suitable for the general public about some sort of incorrect understanding of a quantum mechanical topic. The goal here is not academic formality, it is to get practice in educating nonexperts in scientific ideas that impact them. For an example of the level of helpfulness and (lack of) formality I have in mind, consider XKCD's "What If?" blog. (The linked entry describes why dropping comets into the ocean is *not* a helpful solution to climate change. Quantum mechanical misunderstandings tend to be more technical, but still entertainingly absurd.)

This project will include two or three stages:

1. Topic approval (5% of overall course grade)
2. First submission of explainer article (10% of your overall course grade)
3. Second submission of explainer article (can replace first submission if desired, see below)

You have two options for determining your topic:

Option 1: Identify a popular misunderstanding of some specific idea within quantum mechanics and/or its applications. (Simply being used as a buzzword in a science fiction story is not enough; it has to be something that people are talking about in real life.) You will submit the specific topic with a brief summary of a common misunderstanding and how you will correct it.

Option 2: Prompt an AI tool like ChatGPT to explain a specific idea or application from quantum mechanics. AI is infamous for "hallucinating" (i.e., providing false information as if it is true), especially in scientific contexts. Identify all errors in the AI-generated text. You will submit the topic, the specific AI, the prompt, the AI-generated text, and a list of corrections.

I will look over your submission and offer feedback. I may approve it, tell you to change your topic, approve it conditionally (pointing out potential difficulties and requiring you to either address them in your next submission or pick a different topic). After your topic is approved, you will write the explainer article.

When you submit the explainer article, I will grade it as if it is the final submission. If you are satisfied with your grade, you can be done at that point. If you would like to try to improve your grade, you may submit a second attempt based on my feedback. If you make a second submission, I will grade it, and your grade will be whichever of the two submissions has the higher score. (In other words, there is no risk of your grade going down by making a second submission.)

xkcd.com/465

Exams: Exam days are on the course schedule at the end of the syllabus. Exams will not be moved outside of truly extraordinary circumstances. Exams will be open-book, open-notes, open-internet. You may use any calculator or website tools you want, but you may not do anything that involves communication with another person during the exam.

Final Exam: The final exam will be on Thursday, December 14th, 10:30 am – 1:00 pm and will be a closed-book ACS exam, no calculator. PLNU policy is that the final exam is required and that it must be given at the scheduled time. Travel arrangements are *not* a valid reason to request a different time.

Additional Notes and Policies

"Good men don't need rules. Today is not the day to find out why I have so many." – Doctor Who

Incompletes, late assignments and extensions: All assignments are to be submitted/turned in by the due date/time, including assignments posted in Canvas. You are responsible for making sure that your submission is complete and legible *in Canvas* (i.e., "corrupted" files will not be accepted). Late work will not receive credit. Incompletes will only be assigned in extreme circumstances such as an ongoing medical situation. PLNU policy requires that "Incomplete" grades be resolved by the end of the following semester.

I realize that there may be illness, family emergencies, or other life concerns that prevent you from being able to complete occasional assignments. I have already accounted for this in the grading scheme by dropping a certain number of lowest grades. Because I have made these allowances in advance, there will be no make-up assignments for credit. As long as you do not miss an excessive number of assignments, your grade should not be impacted.

I am willing to consider requests for extensions to deadlines, but requests must be made in advance, and they will be considered on a case-by-case basis. If you need an extension on an assignment, please email me and suggest a specific new (extended) deadline that you believe would meet your needs.

Exams can be made up in many circumstances, but you must request the make-up. If you are absent on the day of an exam and you do not request a make-up, you will receive a 0. If you are aware in advance that you must be absent at the scheduled time of an exam, arrange a make-up with me as soon as you are aware of the conflict. If you have an emergency or sudden illness on the day of the exam, email me as soon as you are able. Make-ups, when necessary, must generally be taken as soon as possible after the scheduled exam time.

PLNU Attendance and participation policy: Regular and punctual attendance at all class sessions is considered essential to optimum academic achievement. If the student is absent for more than 10 percent of class sessions (i.e., three absences for CHE 3026), the faculty member will issue a written warning of de-enrollment. If the absences exceed 20 percent (i.e., six absences for CHE 3026), the student may be de-enrolled without notice until the course withdrawal date (Nov. 3) or, after that date, receive an "F" grade.

Note: There is no such thing as an "excused" absence in CHE 3026. The attendance grade is already set up to allow for a reasonable number of absences. Please do not submit doctor's notes, as that will not change the absence and such notes frequently disclose an unnecessary level of personal medical information. Please do not ask the Wellness Center to provide a note, as they do not provide that service and have been inundated with fruitless requests in recent semesters. If you have a chronic medical condition that you anticipate may result in multiple absences, please contact the Educational Access Center (EAC) about the possibility of getting an accommodation for attendance.

Technology: The use of portable electronic devices (phones, laptops, iPads, etc.) for purposes related to the course is welcome. Using technology for unrelated purposes during class time is detrimental to your learning and to those around you. Below are some examples:

Acceptable uses of technology in class	Unacceptable uses of technology in class
• Taking notes	• Shopping
• Viewing lecture slides	• Watching Tiktok
• Looking up reference data	• Watching the World Cup
• Accessing the CHE 3026 Canvas course	• Doing work for other courses

Using technology to "multitask" during class time is detrimental to your learning and to those around you. It is also a violation of PLNU's academic behavior policy (see below). Repeatedly engaging in irrelevant activity may result in your being asked to leave the class, with a corresponding penalty to your attendance grade. If you have time-sensitive need, such as registering for courses or scheduling an appointment, speak with me beforehand and reasonable accommodations will be made.

PLNU academic behavior policy: Both faculty and students at Point Loma Nazarene University have the right to expect a safe and ordered environment for learning. Any student behavior that is disruptive or threatening is a serious affront to Point Loma Nazarene University as a learning community. Students who fail to adhere to appropriate academic behavioral standards may be subject to discipline. In the context of our course, good behavior includes being present in class (mentally as well as physically), actively participating in group work, and asking questions when you need help or clarification. See Academic Policies in the online PLNU catalog for additional definitions of different kinds of disruptive behavior and for further policy information.

Language and Belonging: Point Loma Nazarene University faculty are committed to helping create a safe and hospitable learning environment for all students. As Christian scholars we are keenly aware of the power of language and believe in treating others with dignity. As such, it is important that our language be equitable, inclusive, and prejudice free. Inclusive/Bias-free language is the standard outlined by all major academic style guides, including MLA, APA, and Chicago, and it is the expected norm in university-level work. Good writing and speaking do not use unsubstantiated or irrelevant generalizations about personal qualities such as age, disability, economic class, ethnicity, marital status, parentage, political or religious beliefs, race, gender, sex, or sexual orientation. Inclusive language also avoids using stereotypes or terminology that demeans persons or groups based on age, disability, class, ethnicity, gender, race, language, or national origin. Respectful use of language is particularly important when referring to those outside of the religious and lifestyle commitments of those in the PLNU community. By working toward precision and clarity of language, we mark ourselves as serious and respectful scholars, and we model the Christ-like quality of hospitality.

You may report an incident(s) using the Bias Incident Reporting Form.

Sexual misconduct and discrimination: Point Loma Nazarene University faculty are committed to helping create a safe learning environment for all students. If you (or someone you know) have experienced any form of sexual discrimination or misconduct, including sexual assault, dating or domestic violence, or stalking, know that help and support are available through the Title IX Office at pointloma.edu/Title-IX. Please be aware that under Title IX of the Education Amendments of 1972, I am required to disclose information about such misconduct to the Title IX Office.

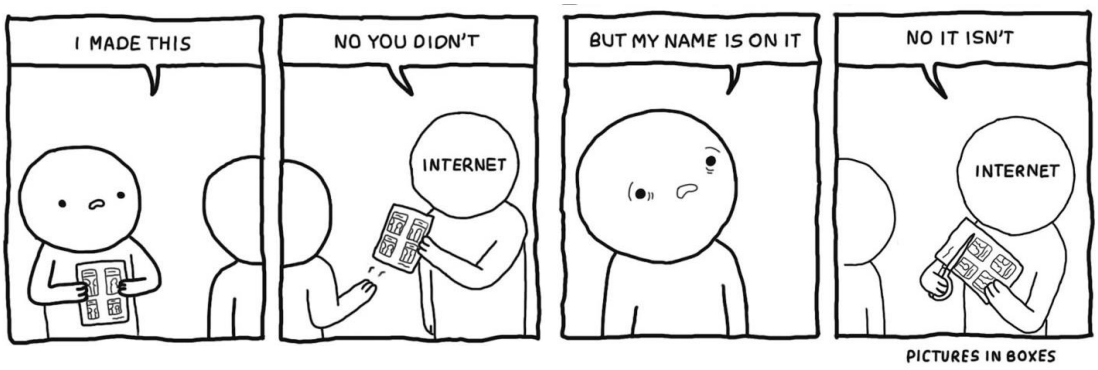
If you wish to speak to a confidential employee who does not have this reporting responsibility, you can contact Counseling Services at counselingservices@pointloma.edu or find a list of campus pastors at pointloma.edu/title-ix

PLNU academic accommodations policy: PLNU is committed to providing equal opportunity for participation in all its programs, services, and activities. Students with disabilities may request course-related accommodations by contacting the Educational Access Center (EAC), located in the Bond Academic Center (EAC@pointloma.edu or 619-849-2486). Once a student's eligibility for an accommodation has been determined, the EAC will issue an academic accommodation plan ("AP") to all faculty who teach courses in which the student is enrolled each semester.

PLNU highly recommends that students speak with their professors during the first two weeks of each semester/term about the implementation of their AP in that particular course and/or if they do not wish to utilize some or all of the elements of their AP in that course.

Students who need accommodations for a disability should contact the EAC as early as possible (i.e., ideally before the beginning of the semester) to assure appropriate accommodations can be provided. It is the student's responsibility to make the first contact with the EAC.

PLNU academic honesty policy: Students should demonstrate academic honesty by doing original work and by giving appropriate credit to the ideas of others. Academic dishonesty is the act of presenting information, ideas, and/or concepts as one's own when in reality they are the results of another person's creativity and effort. A faculty member who believes a situation involving academic dishonesty has been detected may assign a failing grade for that assignment or examination, or, depending on the seriousness of the offense, for the course. Faculty should follow and students may appeal using the procedure in the university Catalog. See Academic Policies for definitions of kinds of academic dishonesty and for further policy information.



Artificial Intelligence (AI) Policy: You are allowed to use Artificial Intelligence (AI) tools (e.g, ChatGPT, iA Writer, Marmot, Botowski, etc.) in this course. Any work that utilizes AI-based tools must be clearly identified as such, including the specific tool(s) used. For example, if you use ChatGPT, you must cite ChatGPT including the version number, year, month and day of the query and the statement "Generated using OpenAI. https://chat.openai.com/".

PLNU copyright policy: Point Loma Nazarene University, as a non-profit educational institution, is entitled by law to use materials protected by the US Copyright Act for classroom education. Any use of those materials outside the class may violate the law.

Spiritual care: PLNU strives to be a place where students grow as whole persons. To this end, we provide resources for our students to encounter God and grow in their Christian faith.
If you have questions, a desire to meet with the chaplain, or if you have prayer requests, you can contact the Office of Student Life and Formation.

State authorization: State authorization is a formal determination by a state that Point Loma Nazarene University is approved to conduct activities regulated by that state. In certain states outside California, Point Loma Nazarene University is not authorized to enroll online (distance education) students. If a student moves to another state after admission to the program and/or enrollment in an online course, continuation within the program and/or course will depend on whether Point Loma Nazarene University is authorized to offer distance education courses in that state. It is the student's responsibility to notify the institution of any change in his or her physical location. Refer to the map on State Authorization to view which states allow online (distance education) outside of California.

Academic Success

"First Thoughts are the everyday thoughts. Everyone has those. Second Thoughts are the thoughts you think about the way you think. People who enjoy thinking have those. Third Thoughts are thoughts that watch the world and think all by themselves. They're rare, and often troublesome." – Terry Pratchett

Physical Chemistry is a challenging course. Doing well may require beyond what has been required in previous courses, and you will need to assess your own understanding frequently. More generally, you should employ ***metacognition***, or thinking about your thinking. Ask yourself serious questions about how well you understand what you're studying, not just whether you could pass the next exam. Better yet, ask yourself if you could teach someone else… or *actually* teach someone else, whether it's a study buddy, a friend, a pet, or a rubber duck.

I strongly recommend watching "Strategic Learning", a talk given at PLNU in 2022 by Dr. Saundra McGuire. She is an award-winning expert in chemistry and in teaching and learning. In the linked talk, she provides a lot of practical strategies AND a broader way of thinking that will help you figure out where you need to focus your efforts.

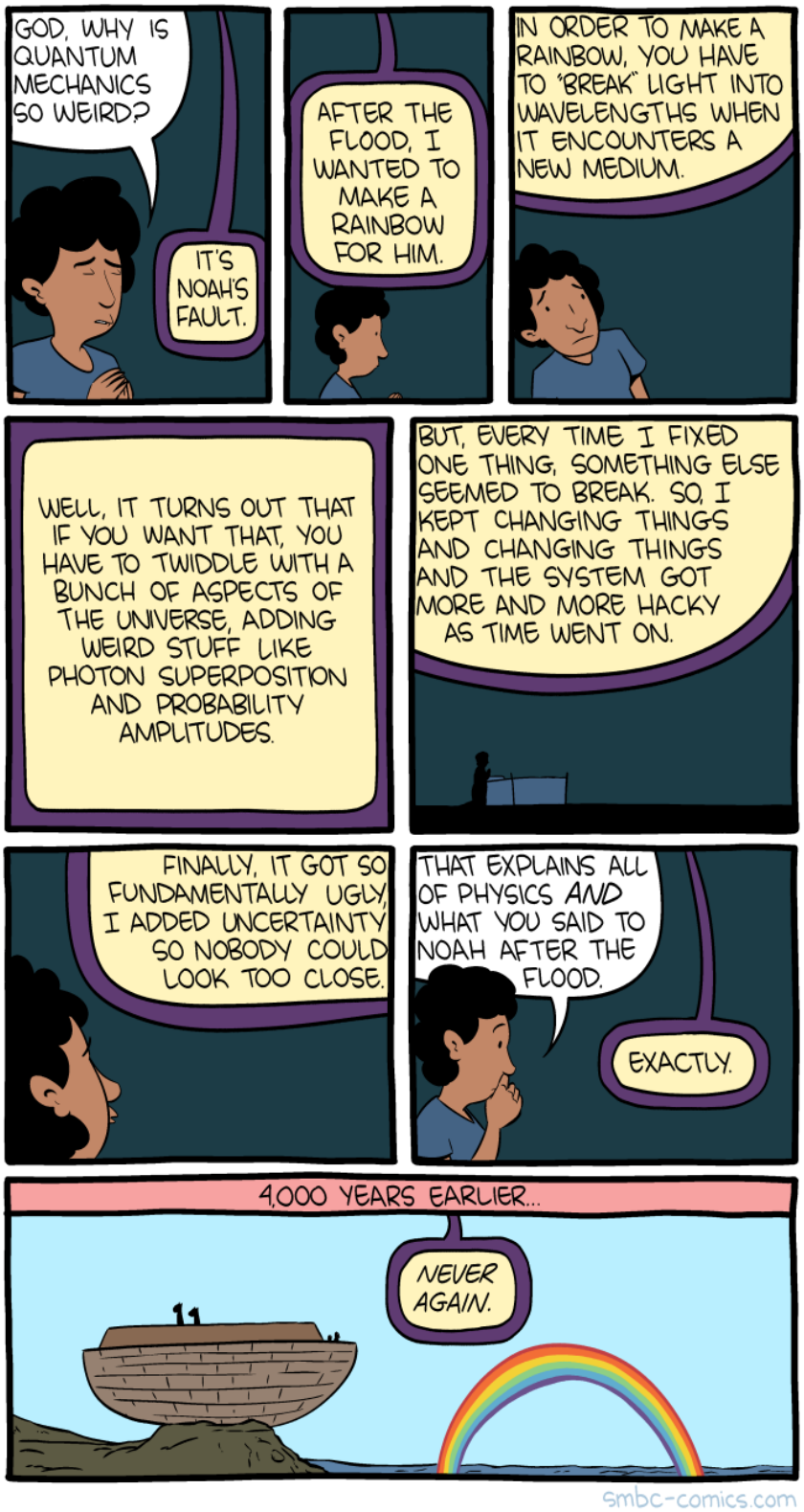
A lot of the advice you will get from me or from Dr. McGuire will feel like it will take more time than you can afford. You may actually save time over the semester as you get more practiced in good study strategies, but it is true that Physical Chemistry requires a substantial time investment.

The PLNU Credit Hour Policy states that ***2 hours of preparation per 1 hour of class time is "normal", meaning 5 hours per week (besides lecture itself)*** for the CHE 3026 lecture course. There is no shame in needing more time. If you work strategically and put effort into learning *how* to learn, you will probably understand the content much better than the student who seems to get all the right answers in the first few minutes of trying.

You can also maximize the effectiveness of your time by giving yourself a focused environment. Do not try to "multitask" with videos or social media while you are working on chemistry. ("Multitask" is a word that really means "doing a poor job of multiple tasks simultaneously".) I also recommend caution when consulting other resources on the internet. There is an abundance of misinformation online, much of it intentional. For example, I've heard from multiple teachers who put fake answers on Chegg to catch cheaters…

Finally, know that I am here to help. If you ask me questions early and often, that goes a long way towards making sure your precious time is spent as productively as possible. I want to see you succeed, and I look forward to participating in that success.

– Dr. Stoneburner



CHE 3026: Physical Chemistry I: Tentative schedule

The schedule may change during the semester. Watch Canvas for updates.

Day		Topics	Pre-Read	Lab
T	Aug 29	From Classical to Quantum	1.1-1.7	0: Math: ME1-6
R	Aug 31	The Schrodinger Equation	2.1-2.4	
T	Sep 5	Eigenfunctions, Quantum Mechanical Postulates	2.5-2.7, 3.1-3.5	1: Photo-electric
R	Sep 7	Particle in a Box	4.1-4.4	
T	Sep 12	Real-world Particle in a Box, Quantum Tunneling	5.1-5.8	No lab (write-up)
R	Sep 14	Hesienberg Uncertainty, Vectors, Coordinates	6.1-6.3, ME7-8	
T	Sep 19	Quantum Mechanical Models	7.1-7.3	2: Conju-gated dyes
R	Sep 21	Quantum Rotation, Spectroscopy	7.4-7.8, 8.1-8.2	
T	Sep 26	IR Spectroscopy	8.3-8.6, 8.8	No lab (write-up)
R	Sep 28	The Hydrogen Atom	9.1-9.6	
T	**Oct 3**	**EXAM 1: Ch. 1-8**	–	No lab (write-up)
R	Oct 5	Determinants, Many-Electron Atoms	ME9, 10.1-10.4	
T	Oct 10	Hartree-Fock Theory	10.5-10.6	3: IR
R	Oct 12	Term Symbols, Atomic Spectroscopy	11.1-11.5	
T	Oct 17	Lasers, Molecular Orbitals	11.6-11.7, 12.1-12.3	No lab (write-up)
R	*Oct 19*	*Fall Break: No class*	–	
T	Oct 24	Molecular Bonds	12.4-12.9	No lab (write-up)
R	Oct 26	Hybridization	13.1-13.5	
T	Oct 31	The Hückel Model	13.6-13.10	4a: Comp chem I
R	Nov 2	UV-Vis Spectroscopy	14.1-14.5	
T	**Nov 7**	**EXAM 2: Ch. 9-13**	–	No lab (write-up)
R	Nov 9	Fluorescence and Phosphorescence	14.6-14.14	
T	Nov 14	Computational Chemistry	15.1-15.7	5: Fluor-escence
R	Nov 16	Selection of a Theoretical Model	15.8	
T	Nov 21	Graphical Models	15.9-15.10	No lab (write-up)
R	*Nov 23*	*Thanksgiving Break: No class*	–	
T	Nov 28	Matrices, Symmetry, and Point Groups	ME10, 16.1-16.3	4b: Comp chem II
R	Nov 30	Vibrational Symmetries, Selection Rules	16.4-16.8	
T	Dec 5	NMR	17.1-17.4, 17.10	No lab (write-up)
R	**Dec 7**	**EXAM 3: Ch. 14-17**	–	
R	**Dec 14**	**COMPREHENSIVE ACS FINAL EXAM Thursday 10:30 am – 1:00 pm *(See Final Exam Schedule)***	–	No lab