

# CHEM 342: Physical Chemistry II

Dr. Dan Albert

Spring 2024

## Contact Information

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*The best way to reach me is via university email.*

## Office Hours

I have an open door policy for meeting with you outside of class. If you ever walk by my door and it is open please feel free to stop to talk about any questions, comments, or concerns you have. The following times you can be guaranteed to find me available:

- Tuesdays from 10:30 - 12:00
- Wednesdays from 2:00 - 3:30
- Thursdays from 9:00 - 11:00

*If you cannot make it to office hours please feel free to set-up an alternative time to meet with me by corresponding with me via email.*

## Course Description

Chemical kinetics, statistical mechanics, and the development and present state of quantum theory, including bonding theories, atomic and molecular spectroscopy, and methods of structure determination.

## Prerequisites

CHEM 341 with a grade of D or higher and ENGL 110.

## Course Purpose

This semester we will learn about and apply quantum mechanics to understand atomic structure, chemical bonding, and spectroscopy from first principles. Quantum mechanics can be a difficult subject to conceptualize because it is different from everyday macroscopic experiences. If you are feeling confused at certain points of the semester that is a good thing because it means you are thinking about and trying to make sense of the new material. I leave you with a few quotes about quantum mechanics from prominent (Nobel Prize Winning) physicists.

“Quantum mechanics describes nature as absurd from the point of view of common sense. And yet it fully agrees with experiment. So I hope you can accept nature as She is ...absurd.”  
- Richard Feynman

“Those who are not shocked when they first come across quantum theory cannot possibly have understood it” -Niels Bohr

These quotes are primarily talking about the philosophy of science. Quantum mechanics has well established rules that we can learn and apply, it is the philosophy that gets tricky. Lucky for us we will learn about how to apply these rules to understand the natural world and avoid the philosophy of quantum mechanics in this class. The philosophy of quantum mechanics is interesting and best enjoyed while sipping on a beverage.

*The problem solving techniques and approaches we use in this class are broadly applicable to thinking about many questions you will encounter in your life!*

## Course Learning Objectives

- Use mathematics and physics to build a quantitative understanding for chemical phenomena using quantum mechanics.
- Use quantitative results and models to build a conceptual understanding of chemical processes using quantum mechanics.
- Safely and effectively plan, carry out, and analyze quantitative laboratory experiments.
- Clearly communicate scientific results and principles through writing.

## Meeting Times

- Section 01A

Lecture: Monday, Wednesday, and Friday from 11:00 - 11:50 in 153 Roddy Hall

Laboratory: Tuesday from 1:10 - 4:00 pm in 226 Caputo Hall

## Required Materials

- Textbook: Your textbook and readings for the course is available as an Open Educational Resource and is available on D2L. The primary textbooks are “Physical Chemistry” by LibreTexts and “Free Energy” by Snee.
- Scientific Calculator: Your calculator for this course must be able to handle logarithms and exponents. This type of calculator can be found for around \$10.  
*Mobile communication devices and calculator programs/internal memory are not acceptable for use on exams*
- Safety Goggles: Available from Bookstore or Chemistry Supply Room: Caputo 330
- Regular access to a computing device with access to a word processing program, such as Microsoft Word, and a spreadsheet program, Microsoft Excel, as well as internet access for D2L (<https://millersville.desire2learn.com/>) and university email.

## Title IX

Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment, comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, et seq., and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University’s Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member’s reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.

Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at <http://www.millersville.edu/socialreq/title-ix-sexual-misconduct/index.php>

## Class Environment

I value a learning environment that is engaging, respectful, and helpful. I ask that you help maintain a learning environment that meets these goals for everyone in the class. Anyone whose behavior is disruptive of the learning environment will be asked to leave.

My goal is for you to feel comfortable, appreciated, fairly treated, and encouraged to challenge yourself and obtain success. *Please come talk to me if there is anything I can do to help support you in achieving success.*

## Grading

Your grade in this course will be calculated using the following components.

| Category                  | Percentage of Grade (%) |
|---------------------------|-------------------------|
| Daily Problem Sets        | 12                      |
| Data Analysis and Writing | 12                      |
| Regular Exams             | 36                      |
| Final Exam                | 15                      |
| Laboratory Assignments    | 25                      |
| Total                     | 100                     |

Your final grade will be determined using the above grading scheme.

In order to pass CHEM 342 you must have a passing grade in both the lecture (Problem Sets, Data Analysis and Writing, Regular Exams, and Final Exam) and laboratory portions of the class. The cut-off percentages for each grade are given below. I reserve the right to lower grade cut-offs, but under no circumstances will the grade cut-offs be higher than those listed below.

| Grade Cut-off (%) | Letter Grade |
|-------------------|--------------|
| 93                | A            |
| 90                | A-           |
| 87                | B+           |
| 83                | B            |
| 80                | B-           |
| 77                | C+           |
| 73                | C            |
| 70                | C-           |
| 67                | D+           |
| 63                | D            |
| 60                | D-           |
|                   | F            |

## Daily Problem Sets

Daily problem sets will be given out at the end of most class periods and due at the beginning of the next class period. These short problem sets are designed to work on skills for course

success and will include conceptual problems, mathematical problems, and short writing assignments. Each daily problem set is designed to be completed in less than an hour. All detailed solutions can be accessed via D2L (<https://millersville.desire2learn.com/>)

## Data Analysis and Writing

Three Data Analysis and Writing Assignments will be given throughout the semester. These assignments will involve various combinations of data analysis, calculations, primary literature reading, and writing. You will have more than one week to complete these assignments. They are designed to each take about 5 hours. You should not wait to the last minute to do these as they are more involved assignments than Daily Problem Sets and not efficiently worked in one sitting.

## Regular Exams

Three regular exams will be given during our regular lecture meeting times. Each exam will contain one or more of the following types of questions: multiple choice, short answer, and worked problems. All exams in this course are considered cumulative, but will focus on the material covered since the last exam. Each regular exam is worth 12 percent of your final grade. The dates of our three regular exams are 2/16, 3/22, and 4/26.

*If your percentage grade on the final exam is higher than your lowest percentage regular exam score, your percentage grade on the final will replace your lowest regular exam score. For example, if you earn a 60% on Exam 1, a 85% on Exam 2, a 95% on Exam 3, and an 80% on the Final Exam, your 60% on Exam 1 will be replaced and become an 80% (your percentage score on the Final Exam).*

## Final Exam

A two hour cumulative final exam will be given at the end of the semester. The final exam will be a comprehensive ACS physical chemistry exam (CHEM 341 and CHEM 342). Dr. Albert has the ACS Physical Chemistry study guide available in his office for student use. Details regarding exam grading will distributed during the semester. The final exam will take place on Friday May 3rd from 8 - 10 am in 153 Roddy Hall.

## Laboratory Assignments

A detailed description of all laboratory assignments will be distributed at the first lab.

## Attendance, Absences, and Make-Ups

Attendance at every lecture and lab is expected. If you must miss a lecture, please see a fellow classmate for notes. I will post all handouts and presentations during the semester to D2L.

*You are expected to hand-in assignments on time. I understand extenuating circumstances occur that will prevent you from turning in assignments. If you experience extenuating circumstances that prevent the on-time completion of assignments, it is your responsibility to contact me ASAP (typically before the assignment is due) and arrange for an alternative due date. Some examples of special extenuating circumstances are given below.*

- Required religious observation
- Participation in a Millersville University athletic event
- Armed forces related training or drills
- Medical Illness/Emergency
- Death in the family
- If you feel that you have a special circumstance that is of similar importance to the items listed above, please come talk with me as soon as possible and I will work with you to try and find a solution

## Academic Honesty

The Millersville University Academic Honesty Policy states that:

*Students of the University are expected to be honest and forthright in their academic endeavors. To falsify the results of one's research, to steal the words or ideas of another, to cheat on an examination, to allow another person to commit, or assist another in committing an act of academic dishonesty, corrupts the essential process by which knowledge is advanced.*

The entire academic honesty policy can be found at <http://www.millersville.edu/english/faculty/academic-integrity/index.php>

All work that is turned in for a grade should be completed individually by the person whose name appears on the work. Students found to have violated the academic honesty policy will receive a score of zero on the assignment. Repeated instances of academic misconduct will be given the harshest punishment.

## Suggestions for Course Success

My expectation is that you are working on CHEM 342 material for a minimum of 10 hours every week outside of class. This effort needs to be consistent throughout the semester to get the most out of this course. If you find yourself putting in the work outside of class and still having difficulty with any part of the course, you should arrange to come meet with me as soon as possible so that we can work together to help you be successful. Here are my suggestions for being successful in this course.

- Work on physical chemistry a little bit every day.
- Read the textbook and work example problems before coming to class.
- Have a notebook and pencil with you to work through derivations while reading.
- Attend, participate, and take notes at all lectures and recitations.
  - Ask questions during class. I love to get questions during class.
  - Take notes to capture key points and ideas.
- Re-Read the textbook after class and fill-in your notes with additional details.
- Work problems from the end of the chapter everyday.
  - The way you work through a problem matters.
  - Try to work problems by minimally looking at your notes or the textbook.
  - Starting problems is the most difficult part. Give yourself five minutes.
  - Solve problems from start to finish by yourself.
- Utilize helpful resources.
  - Form study groups.
  - Stop by my office and ask questions. We can always find a time to meet.
  - Use materials available on D2L.

## Important Dates

| Date      | Event  |
|-----------|--|
| 1/23      | Last Day to Add or Drop a Course Online            |
| 3/2- 3/10 | No Classes   |
| 3/29      | Last Day to Withdraw from Course and Receive a 'W' |
| 5/3       | CHEM 342 Final Exam at 8 am                        |

## Course Schedule

The instructor reserves the right to change this schedule as needed. Any changes will be communicated via an in-class announcement.

| Week | Topics                              | Reading      | Problem Sets and Exams              | Laboratory Assignments                        |
|------|-------------------------------------|--------------|-------------------------------------|---|
| 1/15 | Probability and Boltzmann           | 17.1 - 17.3  |                                     |   |
| 1/22 | Beginning of Quantum Mechanics      | 1.1 - 2.3    |                                     |   |
| 1/29 | Particle in a Box                   | 3.1 - 3.9    | <b>Data Analysis and Writing #1</b> |   |
| 2/5  | Postulates of Q.M.                  | 4.1 - 4.6    |                                     | <b>Kinetic Parameters Lab Report</b>          |
| 2/12 | Simple Q.M. Models                  | 5.1 - 5.9    | <b>Exam #1 on 2/16</b>              |   |
| 2/19 | Application of Q.M. Models          | 5.1 - 5.9    |                                     | <b>Partitioning Thermodynamics Lab Report</b> |
| 2/26 | Hydrogen Atom                       | 6.1 - 6.7    | <b>Data Analysis and Writing #2</b> |   |
| 3/4  | SPRING BREAK                        |              |                                     |   |
| 3/11 | Approximation Methods               | 7.1 - 7.4    |                                     | <b>Experiment #1 Lab Report</b>               |
| 3/18 | Multi-electron Atoms                | 8.1 - 8.11   | <b>Exam #2 on 3/22</b>              |   |
| 3/25 | Bonding in Diatomics                | 9.1 - 9.16   |                                     | <b>Computational Lab Report</b>               |
| 4/1  | Computational Chemistry & Molecules | 10.1 - 11.3  |                                     |   |
| 4/8  | Molecular Symmetry                  | 12.1 - 12.9  |                                     | <b>Experiment #2 Analysis</b>                 |
| 4/15 | Molecular Spectroscopy              | 13.1 - 13.14 | <b>Data Analysis and Writing #3</b> |   |
| 4/22 | Statistical Thermodynamics          | 18.1 - 18.11 | <b>Exam #3 on 4/26</b>              |   |
| 4/29 | FINAL EXAM                          |              | <b>Final Exam on 5/3 at 8:00 am</b> | <b>Experiment #3 Analysis</b>                 |