Physical Chemistry II: CHEM 384
Spring 2025

Instructor: Leanna Giancarlo
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Lecture: MWF 10:00 – 10:50 am, Jepson Science Center 219

Office Hours: M 1:00 – 2:30 pm; W 9 – 9:50 am, 1:00 – 2:30 pm; F 2:00 – 3:00 pm; or by appointment

PASS (Peer Assisted Study Skills): F 1 – 2 pm, Jepson Science Center 425

Required Materials:

- Quantum Chemistry and Spectroscopy, (4th ed., Engel)
- Thermodynamics, Statistical Thermodynamics & Kinetics (4th ed., Engel and Reid)
- Coursepack for CHEM 384 (available as a pdf file on Canvas)
- small white board (8.5" x 11"), dry erase markers and eraser
- calculator with scientific notation and exponential functions – you will only be able to use non-graphing calculators on all quizzes and exams. TI-30X calculators are available in the Bookstore

Recommended Materials:

- Mathematics for Physical Chemistry (3rd ed., Mortimer)

Course Description:

This course is designed to provide the fundamental concepts of physical chemistry. Two main areas will be stressed: Chemical Kinetics (rate expressions and reaction mechanisms) and Quantum Mechanics. This course expands upon the elementary notions of atomic structure, bonding, reaction rates, and spectroscopy introduced in earlier coursework. Physical chemistry uses extensive mathematical tools to probe the intricate interactions involved in chemical systems. Thus, in order to succeed, problem-solving skills must be practiced and developed. Physical chemists are employed in such disparate fields as financial consultants, corporation executives, professors, etc. due to their well-developed problem-solving skills.

Course-Specific Learning Objectives:

After completing this course, a student should be able to

- describe chemical kinetics for zeroth, first and second order reactions and compare to reaction mechanisms
- evaluate Schrodinger's equation for chemically significant problems

- use quantum mechanical principles to describe chemically important motions and systems, including translation, vibration, rotation and atoms and molecules

Grading: Grades will be based on the following

	Points	**Total**
Hourly Examinations (3)	200	600
Team Activities		100
Online PrePs		50
Cumulative Final Exam	250	250
		1000

Students with an exam grade of 72 or less will receive a midsemester report of unsatisfactory.

Points to overall grade conversions:

Points accumulated	**Letter Grade**	**Points accumulated**	**Letter Grade**
≥ 930 points	A	929 – 900 points	A-
899 – 870 points	B+	869 – 830 points	B
829 – 800 points	B-	799 – 770 points	C+
769 – 730 points	C	729 – 700 points	C-
699 – 650 points	D+	649 – 600 points	D
below 600 points	F		

Honor System:

All graded work (hourly exams, online exercises, team activities, extra credit assignments, *graded* assignments, final exam) must be your own. You are not permitted to use any online homework aids or artificial intelligences to assist in any graded work. You may not use any previously graded work for this course. Online PrePs (general chemistry and mathematics reviews) and any other online work are deemed pledged by your submission. All written work must have the Honor Pledge written in full and your signature. You must use **these** words and sign the pledge: I hereby declare upon my word of honor that I have neither given nor received any unauthorized help on this work.

It is recommended that the *suggested* problems (i.e., not submitted for a grade) be done individually and then with a study group when questions arise. **No late assignments will be accepted**. Please, discuss difficulties with the homework problems or lecture material with me.

Class Attendance:

Class attendance is highly recommended. The material discussed in lecture frequently has a different emphasis from that provided by the textbook. Also, time has been set aside in the course schedule to discuss

example problems and practice problem-solving with your peers with instructor guidance. Students are responsible for all covered materials during a missed class. Missed exams **will not** be made up except in the event of an excused absence due to an emergency. (Immediate notification of the instructor is mandatory). Lateness to lecture is distracting, and students should attempt to be on time. Lateness to an exam will result in less time allowed for completion of the exam.

Team Activities:

Team activities in this course will take two different formats: First, at the end of each chapter (or topic), there will be between 5 and 10 assigned problems to be completed by students in teams of 2 or 3. Teams will be chosen at the beginning of the semester for the entire term. Individual students are strongly encouraged to attempt the problems alone and then meet with the team to discuss a final solution. (This also enables you to check each other's work.) These problems are due to the instructor for a grade 2 lectures after the lecture material on that topic has been completed (e.g. if chapter 1 is completed on Monday, then the problems are due on Friday of the same week). No late assignments will be accepted. Only one submission is required per team; however, all members of the team must sign the submission in order to receive a grade. (A student who does not sign the handed-in work will receive a grade of zero.) You must also individually complete an evaluation of team work for you and your teammates. Failure to do so (or complete the assignment as a team) will result in a grade reduction of up to 3 points per assignment.

Second, specific topics in lecture will be flipped: outside of the classroom, students will watch a video, read the textbook material, and complete recommended practice problems (posted on Canvas). If a student needs more information on a given topic, they can either re-view the lecture or view other online lectures and/or re-read the material in the textbook. Students will be encouraged to practice the concepts with problems but will not be completing graded individual homework; however, students must bring their practiced problems with them to class or submit them via email in advance of class. During class, students' knowledge will be assessed with in-class team activities. These exercises are designed to prompt critical thinking (and discussion) about the key concepts learned outside of the classroom in the lectures and textbook. I will move around the classroom during this problem-solving process and address any misconceptions or challenges students experience. The assigned class problems will be completed by the team and submitted by the end of the period.

Online PrePs:

At the beginning of each chapter, approximately 5 questions (generally, multiple choice or fill-in-the-blank format) will be posted on Canvas. These questions review topics that were covered in prerequisite courses, such as Calculus I and II, Physics, and General Chemistry. The answers must be submitted through Canvas by the assigned date and time (usually, before the next lecture). You may use textbooks and notes from these courses or others to complete the quizzes; however, you may not consult with anyone other than your instructor about them. Electronic submission constitutes your abiding by the Mary Washington Honor Code.

PASS (Peer Assisted Study Skills)/ Extra Credit:

Extra credit in this course can be earned through attendance at Peer Assisted Study Skills sessions held by the instructor. These hour-long sessions are meant to bolster your study, math and/or chemistry skills. There will be one session per week (as noted above); for each weekly attendance you will receive 2.5 points toward your final grade up to 35 points total. At these sessions, you will work out suggested problems individually or with a partner with the instructor present to assist you. For you to receive credit (the 2.5 points), you must be present for the entire PASS session. Students who are disruptive will lose credit for that session; continual disruptions will result in your removal from PASS for the rest of the semester and the denial of any extra credit points associated with your attendance.

Disability Resources:

The Office of Disability Resources has been designated by the university as the primary office to guide, counsel, and assist students with disabilities. If you receive services through the Office of Disability Resources and require accommodations for this class, please provide me a copy of your accommodation letter via email or during a meeting. I encourage you to follow-up with me about your accommodations and needs within this class. I will hold any information you share with me in the strictest confidence unless you give me permission to do otherwise.
If you have not made contact with the Office of Disability Resources and have reasonable accommodation needs, their office is located in Seacobeck 005, phone number is (540) 654-1266 and email is odr@umw.edu. The office will require appropriate documentation of disability.

Title IX Statement:

University of Mary Washington faculty are committed to supporting students and upholding the University's *Policy on Sexual and Gender Based Harassment and Other Forms of Interpersonal Violence.* Under Title IX and this Policy, discrimination based upon sex or gender is prohibited. If you experience an incident of sex or gender based

discrimination, we encourage you to report it. ***While you may talk to me, understand that as a "Responsible Employee" of the University, I MUST report to UMW's Title IX Coordinator what you share***. If you wish to speak to someone confidentially, please contact the below confidential resources. They can connect you with support services and help you explore your options. You may also seek assistance from UMW's Title IX Coordinator. Please visit UMW's Title IX website to view UMW's policy and to find further information on support and resources.

Class Recordings and Materials:

Classroom activities in this course may be recorded by students enrolled in the course for the personal, educational use of that student only, and may not be further copied, distributed, published, or otherwise used for any other purpose without the express written consent of the course instructor. All students are advised that classroom activities may be taped by students for this purpose. Distribution or sale of class recordings or recorded lecture videos is prohibited without the written permission of the instructor and other students who are recorded.

Any class materials (any document or other item provided by or made available by the instructor to students enrolled, including but not limited to coursepacks, lecture videos, annotated lectures, handouts, laboratory experiments, quizzes, exams, review sheets or past exams) provided for this course (in the coursepack, during class or lab, or posted on Canvas or YouTube) are for the personal, educational use of that student only, and may not be further copied, distributed, published, or otherwise used for any other purpose without the express written consent of the course instructor.

Distribution or sale of any and all class materials (any document or other item provided by or made available by the instructor to students enrolled, including but not limited to coursepacks, lecture videos, annotated lectures, handouts, laboratory experiments, quizzes, exams, review sheets or past exams) provided for this course (in the coursepack, during class or lab, or posted on Canvas or YouTube) is prohibited without the written permission of the instructor. Distribution without permission is a violation of copyright law.

This policy is consistent with UMW's Policy on Recording Class and Distribution of Course Materials.

Basic Needs Security:

Learning effectively and engaging wholly in class is dependent upon our basic security and having our fundamental needs met: having a safe place to sleep at night, regular access to nutritious food, and some assurance of safety. If you have difficulty affording groceries or accessing sufficient food

to eat every day, or if you lack a safe and stable place to live, please contact Chris Porter, Assistant Dean of Students, at cjporter@umw.edu. Additionally, the Gwen Hale Resource Center is a free resource on campus, providing food, toiletries and clothing to any member of our community. It is open Monday, Tuesday and Friday from 1pm-6pm, on the 5th floor (floor A for Attic) of Lee Hall, or resource@umw.edu . Finally, you are always welcome to talk with me about needs, if you are comfortable doing so. This will enable me to provide any resources I may possess.

Other "Helpful" Information:

The tentative schedule below is how I see the course arranged. It is not set in concrete. If there is material that you, as a class, find confusing, we will spend more time on that topic. The exam dates will remain set according to the schedule. If all of the "scheduled" material has not been presented prior to the exam, the exam will include only what has been covered.
Success in chemistry requires work on your part. Successful students typically spend a minimum of 1 hour per day on chemistry. This time is devoted to reviewing notes, attempting the suggested/assigned problems and reading ahead for the next lecture. Some of their "secrets" include (but are not limited to)

- reading the material prior to class.
- attending the lectures.
- taking good notes.
- asking questions. (The only "stupid" question is the one that goes unasked.)
- solving the suggested problems for each chapter. (Attempting extra problems is also a great idea. "Practice makes permanent.")
- consulting your peers when you are struggling with the solution to a suggested problem. (First, they may have a different slant or see the problem in a different light. Second, scientists typically work in teams. Each member of the team is responsible for a particular aspect of the problem; therefore, each scientist must understand what each of the other members of the team does and have requisite background knowledge.)
- enlisting the aid of the instructor (office hours or appointments, before/after class).
- reviewing the appropriate sections of the text and all notes after class.
- attempting all suggested and assigned problems (team activities) by yourself
- reviewing topics from prerequisite courses

Course Outline:

Topic	Chapters and/or Sections
Chemical Kinetics	Chapter 18 Chapter 19 in Engel and Reid
Review of Classical Physics	Chapter 1 in Engel
Fundamentals of Quantum Mechanics	2.1, 2.3 – 2.7, 3.1 – 3.4, 6.1, 6.3
Applications of the Schrödinger Equation:	Chapter 4
Translational Motion (Particle in the box)	5.3, 5.5 - 5.8
Applications of the Schrödinger Equation:	7.1 – 7.5, 7.7
Vibration and Rotation (Harmonic Oscillator, Rigid Rotor)	
Vibrational, Rotational Spectroscopy	8.3 – 8.5, 8,7, 8.8
Applications of the Schrödinger Equation:	Chapter 9
Hydrogen Atom	
Assumptions in Quantum Mechanics	
Many Electron Atoms	10.1, 10.2, 11.1, 11.3 – 11.4
Molecules and Bonding	12.1 – 12.4, 12.6 – 12.9, 13.1 – 13.4
Electronic Spectroscopy	11.4 – 11.6; 14.1, 14.4 – 14.9

1/13 Chapters 18/19	1/15 Chapters 18/19	1/17 Chapters 18/19
1/20 NO CLASS: MLK Day	1/22 Chapters 18/19	1/24 Chapters 18/19
1/27 Chapters 18/19	1/29 Chapters 18/19	1/31 Chapter 1
2/3 Chapter 1	2/5 Chapters 2/3	2/7 Chapters 2/3
2/10 Chapters 2/3	2/12 Chapter 4/5	2/14 **EXAM 1**
2/17 Chapters 4/5	2/19 Chapter 4/5	2/21 Chapter 4/5
2/24 Chapter 4/5	2/26 Chapter 7	2/28 Chapter 7
3/3 SPRING BREAK	3/5 SPRING BREAK	3/7 SPRING BREAK
3/10 Chapter 7	3/12 Chapter 7	3/14 **EXAM 2**
3/17 Chapter 8	3/19 Chapter 8	3/21 Chapter 8
3/24 Chapter 8	3/26 Chapter 9	3/28 Chapter 9
3/31 Chapter 9	4/2 Chapter 9	4/4 Chapters 10/11
4/7 Chapters 10/11	4/9 Chapters 12/13	4/11 Chapters 12/13
4/14 Chapters 12/13	4/16 Chapters 12/13	4/18 **EXAM 3**
4/21 Chapters 11/14	4/23 Chapters 11/14	4/25 Research & Creativity Day

Cumulative ACS Final Exam: Friday, May 2, 2025; 8:30 – 11:00 am