

Chemistry 432 - Physical Chemistry II

Course Syllabus

Spring, 2025

1. Instructor: Dr. David L. Freeman
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Office Hours: MWF 11. If you are unable to make normal office hours, please let me know in person or by email so that we can make an appointment.
2. Scheduling: MWF 10, Beaupre 105 A
3. Text:
 - (a) Thomas Engel, "Quantum Chemistry and Spectroscopy," Pearson, Benjamin Cummings, 2019, Fourth Edition
 - (b) Thomas Engel and Philip Reid, "Thermodynamics, Statistical Thermodynamics and Kinetics," Pearson, Benjamin Cummings, 2019, Fourth Edition
4. Prerequisites: CHM 192 or CHM 112, MTH 142, PHY 112 or 204, CHM 431. Knowledge of the material in these courses will be assumed.
5. Course requirements:
 - (a) Hour Exams (Wednesday, February 19; Friday, March 7; Friday, April 4; Wednesday, April 23. All exam dates subject to change.) 400
 - (b) Final exam (Friday, May 2, 8:00 - 10:00 AM) 200
 - (c) Total 600

Grades will be determined on a curve. Incompletes will be given only for documented medical reasons. In the case of an exam missed for a valid medical reason, discuss options with the instructor. If an exam date is canceled owing to weather or any other reason, the exam will be given on the next date the class meets.

6. Course Goals:

As can be made clear by examining your textbooks, physical chemistry is subdivided into a number of distinct topics. Last semester you learned the laws of thermodynamics which govern the behavior of chemical systems at equilibrium. This semester we will extend our understanding of the laws of chemistry to the microscopic and non-equilibrium domains.

One of the major cultural and intellectual achievements of the twentieth century has been the discovery of the laws of quantum mechanics. Although a complete introduction to quantum theory requires one year, we will be able to *understand some of the principles of quantum mechanics and the implications of the theory to chemistry*. This is our first course goal. Closely allied with a discussion of the laws of quantum theory is *to understand elementary atomic and molecular electronic structure*. This second course goal is a consequence of quantum mechanics. Another consequence of quantum theory has been the field of spectroscopy. *Understanding how spectroscopy is used to determine the microscopic properties of molecules* is our third course goal. Although much insight can be obtained from the microscopic laws of nature, it is important to learn the connection between the microscopic laws and the thermodynamics you learned last semester. We meet this goal in an approximate way by studying kinetic theory. Kinetic theory not only gives an ideal-gas molecular description to some of the macroscopic laws of nature, but kinetic theory is also useful in meeting the last goal of CHM 432. Our final course goal is to leave the equilibrium domain *to begin to obtain an understanding of non-equilibrium phenomena*. We shall study non-equilibrium phenomena within the context of the kinetic theory of matter and the study of chemical reaction kinetics.

7. Web Access:

In this course all problem sets, problem set solutions, quiz solutions and exam solutions are to be posted on Brightspace. No paper copies of the problem sets are to be distributed.

8. Course outline¹:

<u>Topic</u>	<u>Book Chapter</u>
1. Review of Classical Mechanics and the Quantum Nature of Matter	(a) 1, 6.3
2. The Schrödinger Equation	(a) 2.2-2.5
3. The Postulates of Quantum Mechanics	(a) 3
4. Simple Quantum Systems	(a) 4, 5.5
5. Vibrational and Rotational Motion	(a) 7
6. Vibrational and Rotational Spectroscopy of Diatomic Molecules	(a) 8.1, 8.3-8.6, 8.8
7. The Hydrogen Atom	(a) 9
8. Many-electron Atoms	(a) 10.1-10.4
9. Atomic Spectroscopy	(a) 11.1-11.4
10. Chemical Bonding	(a) 12, 13.8
11. Molecular Electronic Spectroscopy	(a) 14.1-14.4, 14.6-14.8
12. Kinetic Theory	(b) 16, 17
13. Chemical Kinetics	(b) 18
14. Final Exam	Comprehensive

¹(a) = “Quantum Chemistry and Spectroscopy,” (b) = “Thermodynamics, Statistical Thermodynamics and Kinetics”

9. URI Information

- (a) Viral Illness Precautions Statement - The University is committed to delivering its educational mission while protecting the health and safety of our community. Students who are experiencing symptoms of viral illness should NOT go to class/work. The Centers for Disease Control and Prevention (CDC) recommends that all people who are experiencing viral illness should stay home and away from others until symptoms improve and they are fever free (without medications) for 24 hours. They should take added precautions for the next 5 days.
- (b) Academic Honesty - Students are expected to be honest in all academic work. A student's name on any written work, quiz or exam shall be regarded as assurance that the work is the result of the student's own independent thought and study. Work should be stated in the student's own words, properly attributed to its source. Students have an obligation to know how to quote, paraphrase, summarize, cite and reference the work of others with integrity. [Faculty are encouraged to include details regarding course-specific expectations, including the use of generative AI tools.]
- (c) Excused Absences - Absences due to serious illness or traumatic loss, religious observances, military service, or participation in a university sanctioned event are considered excused absences. Students are responsible for work missed during an excused absence but will not be penalized by grading or assignment/exam make-up policies. Students should notify faculty in advance of absences due to religious observance or university-sanction events, and as soon as possible for other absences See University Manual sections 8.51.11-8.51.16 for details.
- (d) Mental Health and Wellness - We understand that college comes with challenges and stress associated with your courses, job/family responsibilities and personal life. URI offers students a range of services to support your mental health and wellbeing, including the URI Counseling Center, TELUS Health Student Support App, the Wellness Resource Center, the Psychological Consultation Center, the URI Couple and Family Therapy Clinic, and Well-being Coaching.
- (e) Land Acknowledgement - The University of Rhode Island land acknowledgment is a statement written by members of the University community in close partnership with members of the Narragansett Tribe. The statement recognizes and pays tribute to the people who lived on and stewarded the land on which the University now resides. The statement seeks to show gratitude and respect to Indigenous people and cultures and build community with the Narragansett Nation and other Native American tribes. University of Rhode Island Land Acknowledgment The University of Rhode Island occupies the traditional stomping ground of the Narragansett Nation and the Niantic People. We honor and respect the enduring and continuing relationship between the Indigenous people and this land by teaching and learning more about their history and present-day communities, and by becoming stewards of the land we, too, inhabit.

- (f) Anti-Bias Syllabus Statement - We respect the rights and dignity of each individual and group. We reject prejudice and intolerance, and we work to understand differences. We believe that equity and inclusion are critical components for campus community members to thrive. If you are a target or a witness of a bias incident, you are encouraged to submit a report to the URI Bias Resource Team at www.uri.edu/brt. There you will also find people and resources to help.
- (g) Disability, Access, and Inclusion Statement - Your access in this course is important. Please send me your Disability, Access, and Inclusion (DAI) accommodation letter early in the semester so that we have adequate time to discuss and arrange your approved academic accommodations. If you have not yet established services through DAI, please contact them to engage in a confidential conversation about the process for requesting reasonable accommodations in the classroom. DAI can be reached by calling: 401-874-2098, visiting: web.uri.edu/disability, or emailing: dai@etal.uri.edu.
- (h) Academic Enhancement Center (AEC) - All Academic Enhancement Center support services for Spring 2025 begin on January 27th and are offered at no added cost to undergraduate students. Visit uri.edu/aec for more information about our programs described below. Appointments can be scheduled in TracCloud located in Microsoft 365.
- (i) STEM & Business Tutoring Get peer tutoring for many 100 and 200 level STEM, Business, Nursing, and Engineering courses. Choose weekly or occasional sessions through TracCloud or visit the Drop-In Center in Carothers Library LL004.
- (j) Academic Skills Development Meet one-on-one with a peer academic coach to build habits and strategies around time management, goal setting, and studying. Contact Heather Price (hprice@uri.edu) for more information. Click here for more details. UCS 160 and UCS 161 are 1 credit courses designed to improve your academic skills and strategies. Consider enrolling in one of these courses! Contact David Hayes (davidhayes@uri.edu) with any questions or to schedule a professional staff academic consultation.
- (k) Undergraduate Writing Center Receive peer writing support at any stage of your writing process. Schedule in-person or online consultations through TracCloud or stop by Roosevelt Hall Room 20 -new location! Click here for more details.

- (l) Center for Career and Experiential Education - The Center for Career and Experiential Education (CCEE) supports undergraduate students with career preparation through one-on-one advising, 24-7 online resources, career education courses, and career events that prepare you for life after graduation and connect you with employers and community partners. Your Career Education Specialist (CES) is available to meet with you all year long, as early as your first-year, both in-person and virtually, to assist with exploring your career options, resume and cover letter writing, interview preparation, job and internship search, and more. We use Handshake to connect you to on and off campus jobs and internships and RhodyServes to connect you with volunteer opportunities in RI. Our team on the first floor of Roosevelt Hall can help you learn how to use Handshake effectively to find amazing opportunities. For more information or to meet with a CES, go to uri.edu/career.
- (m) Rhody Outpost Basic Needs Pantry - Food insecurity affects up to 30% of college students. That means you might not have enough food to get through a day or week, you don't have money to purchase groceries or personal products, or you are primarily eating foods that don't provide a lot of nutrition because they're all you can afford. This can all impact your academic success. Rhody Outpost provides URI students who are food insecure with emergency food services and resources. The Outpost is housed at the Dining Services Warehouse at 10 Tootell Road, between Flagg Road and West Alumni Avenue. We are open every Monday and Wednesday from 3-5pm. Any student in need should fill out an intake form. If you have questions about food or housing insecurity, contact Barbara Sweeney, Coordinator of Food Security Outreach, at barbara.sweeney@uri.edu, or 401-874-5633. We want to help all students succeed and make URI a place with #NoRamHungry.