Physical Chemistry II: Thermodynamics and Reaction Kinetics
Syllabus for Spring 2023 Term

GENERAL INFORMATION

RUTGERS CATALOG DESCRIPTION

50:160:345-346 Physical Chemistry I,II (3,3): Thermodynamics with chemical applications, kinetics, quantum mechanics, statistical mechanics, transport, and structure. **Prerequisites for 50:160:345:** 50:160:116 & 50:160:126 (Chemical Principles II + Lab), 50:640:221 (Calculus III), 50:750:131-134 (Elements of Physics I & II + Labs). **Prerequisite for 50:160:346:** 50:160:345.

Course Format: Lectures

Instructor: **Dr. Guillaume Lamoureux**
Office: Joint Health Sciences Center 216C
Office Hours: Immediately after the Tuesday lectures
Any other time: By appointment
Email: guillaume.lamoureux@rutgers.edu
Website: http://lamoureuxlab.org/teaching.html

Lectures: Tuesdays and Thursdays from 9:35 to 10:55
Location: CNS-213

Textbook: **Atkins, De Paula & Keeler, *Atkins' Physical Chemistry*, 11th Edition.** (The textbook is available for sale at https://universitydistrict.bncollege.com and for short-term loans at the Robeson Library Reserve. If you are considering using an earlier edition of the book, please check with the instructor first.)

Review Material: In preparation for the course, please review the following chapters from **N. J. Tro, *Chemistry: Structure and Properties*, 2nd Edition** (or the equivalent chapters from any other General Chemistry textbook):
- Stoichiometry (Chapter 7)
- Thermochemistry (Chapter 9)
- Gases (Chapter 10)
- Liquids and Solids (Chapter 11)
- Solutions (Chapter 13)
- Chemical Kinetics (Chapter 14)
- Chemical Equilibrium (Chapter 15)

COURSE OBJECTIVES

This course is an introduction to thermodynamics and reaction kinetics. After passing the course, the student will be able to (1) apply the principles of thermodynamics to situations involving physical transformations and chemical reactions, and (2) analyze reaction kinetics data, extract rate constants, and interpret their significance. The following topics will be covered: (1) properties of gases, (2) internal energy, enthalpy & the First Law, (3) entropy, free energy & the Second and Third Laws, (4) phase equilibrium, (5) simple mixtures, (6) chemical equilibrium, (7) molecular motion in gases and liquids, (8) theory of reaction rates and experimental techniques, and (9) reaction mechanisms.

COURSE GRADE

The final grade for the course is composed as follows: **18% for the assignments, 21% for the first midterm exam, 21% for the second midterm exam, and 40% for the final exam**. The minimum passing grade for the course is 60%.

COURSE MATERIAL
All material for the course (except the textbook) will be posted on "Canvas" (https://canvas.rutgers.edu). Please consult the website regularly and set your notifications so that you get informed of any updates.

BEFORE EACH LECTURE
Students are expected to read the appropriate sections of the textbook ahead of time.

EXAMINATIONS
The midterm exams will be held on **February 16** and **March 23**. The final exam date is set by the Office of Scheduling and will be announced later during the term. If a student is absent from a midterm exam, he/she must produce a note appropriately signed (e.g., by a doctor or an employer) on letterhead paper. This note must be delivered to the instructor no later than one week after the exam date. If the absence is not valid, the student will receive a mark of zero for the missed exam. If it is valid, the two other exams will be worth 82% of the final grade.

ACADEMIC INTEGRITY
Rutgers University takes academic dishonesty very seriously. By enrolling in this course, you assume responsibility for familiarizing yourself with the Academic Integrity Policy and the possible penalties (including suspension and expulsion) for violating the policy. As per the policy, all suspected violations will be reported to the Office of Community Standards. Academic dishonesty includes (but is not limited to): cheating, plagiarism, aiding others in committing a violation or allowing others to use your work, failure to cite sources correctly, fabrication, using another person's ideas or words without attribution, re-using a previous assignment, unauthorized collaboration, sabotaging another student's work. If in doubt, please consult the instructor. Please review the Academic Integrity Policy at http://academicintegrity.rutgers.edu.

STUDENTS WITH DISABILITIES
Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the registration form at https://webapps.rutgers.edu/student-ods/forms/registration.

GRADED ASSIGNMENTS
There will be 3 graded homework assignments during the term. Each assignment will be due one week after it is handed out. Late assignments will be deduced **10% per day late**. Any assignment handed in more than 5 days late will be given a grade of zero. If you need more time to complete an assignment, ask the instructor for an extension before the deadline.

PRACTICE PROBLEMS
A list of suggested practice problems from the book will be provided with each section. It is the student's responsibility to use these problems to practice in applying the course material.

SOME ADVICE
Note-taking: Take copious notes and keep expanding them as you study and practice the material. Note-taking during class and when reading the textbook is an important exercise in itself. Given the nature of the material (equations and graphs), notes are best taken using either a notebook or loose sheets of paper (numbered, kept in a folder). **Reading/studying:** It is best to read the material on your own first but make sure you eventually meet with your classmates to revise the important con-

cepts and compare your understanding with theirs. The best way to understand something is to try explaining it to somebody else. When you read the textbook, keep track of any question you have. **Practice problems:** It is very unlikely that you will be successful in this course if you do not do the practice problems. Make the most of the time you spend on each practice problem by asking yourself: What are the concepts or skills being learned? What other similar questions could be asked on the topic? How would the solution/answer change if piece of information "X" in the statement of the problem was changed to "Y"? Could the problem be posed in more general/specific terms?

CALENDAR OF LECTURES

Please note that this calendar may change as the semester proceeds. The chapter numbers refer to the 11th edition of the textbook.

Date	Topics	Reading
Jan. 17	Introduction, The perfect gas	1A
Jan. 19	The kinetic model, Real gases	1B & 1C
Jan. 24	Internal energy, Enthalpy	2A & 2B
Jan. 26	Internal energy, Enthalpy (cont'd)	
Jan. 31	Thermochemistry	2C
Feb. 2	Thermochemistry (cont'd)	
Feb. 7	Entropy	3A & 3B
Feb. 9	Entropy (cont'd)	3C
Feb. 14	Problems in class	
Feb. 16	**Midterm Exam #1 (covers Chapters 1 and 2)**	
Feb. 21	Helmholtz and Gibbs energies	3D
Feb. 23	Combining the First and Second Laws	3E
Feb. 28	Phase diagrams, Phase transitions	4A & 4B
Mar. 2	Phase diagrams, Phase transitions (cont'd)	
Mar. 7	Mixtures, The properties of solutions	5A & 5B
Mar. 9	Phase diagrams of binary systems: liquids	5C
Mar. 14	SPRING RECESS (no classes)	
Mar. 16	SPRING RECESS (no classes)	
Mar. 21	Problems in class	
Mar. 23	**Midterm Exam #2 (covers Chapters 3, 4, and 5)**	
Mar. 28	Chemical equilibrium	6A & 6B
Mar. 30	Transport in gases, Motion in liquids	16A & 16B
Apr. 4	Rates of chemical reactions	17A
Apr. 6	Integrated rate laws	17B
Apr. 11	Reactions approaching equilibrium	17C
Apr. 13	Arrhenius equation	17D
Apr. 18	Reaction mechanisms	17E
Apr. 20	Examples of reaction mechanisms	17F
Apr. 25	Examples of reaction mechanisms (cont'd)	
Apr. 27	Problems in class	
TBA	**Final Exam (cumulative)**	