Chemical Thermodynamics and Kinetics
Course Syllabus – Fall 2021

Courses: **CHEM 4110**, **CHEM 4110 HON**, and **CHEM 6110**
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Office Hours: Please email me (sgozem@gsu.edu) if you would like to set up a time to meet in person or online.

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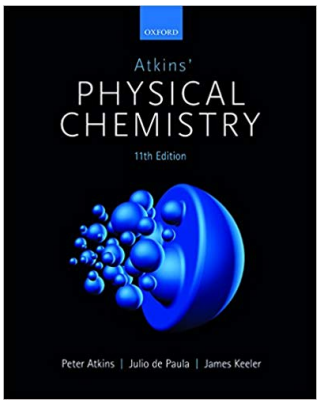
Instruction Mode: Face-to-face. Lectures MWF, 9:30-10:20 am in Classroom South 150.

Course Prerequisites: This course relies on chemistry, physics and math concepts from Chem 1212K; Math 2212; Phys 2211K, and Phys 2212K.

Course overview: The course has six modules, each lasting around 2-3 weeks. Each module is largely self-contained.

Textbook: "**Physical Chemistry**" by Peter Atkins, Julio de Paula, and James Keeler, 11th Edition, Oxford University Press, 2017, ISBN 9780198769866. A few notes and tips:



- It is possible to complete the course without having the textbook. However, this is an excellent resource that explains all the topics from the class, often in a way that complements the lectures.
- The textbook is available from a number of resources online, both as a rental and to buy. You might be able to grab a cheaper copy if you buy early, before semester starts.
- An older edition is fine.
- The full Atkins book has ~900 pages and has a black and blue cover. However, the publishers also have released the same book in three volumes. Most of the material in this course is from volume 1. Please be sure to get either the full textbook or volume 1 (both have black/blue covers, other editions use different colors).
- If you plan to take Chem 4120 next spring, you may need the Atkins book again. In that case, it might be a good idea to invest in the full book and/or rent for longer.

Student Resources: Resources accompanying the Atkins textbook, including additional information and the student solutions manual, are available at https://oup-arc.com/access/pchem11e-student-resources#tag_a-deeper-look.

Course Description: "Chemical Thermodynamics and Kinetics" is a 3-credit semester course that covers the principles of thermodynamics, transport and kinetics. These topics serve as the basis for interpreting and interrelating the properties of matter. Focuses 1-6 and 17 from the textbook will be covered in this course.

Course Objectives: The overall objective is to understand the behavior of matter and transformation between different forms of energy as they relate to expansion and compression of gases, phase transitions, and chemical reactions.

Homework, Extra Problems, and No-credit Practice Problems: For each module, everyone will be assigned required homework. Homework will be available on iCollege at the start of each module and will typically be due the following Friday (11 days later, don't forget to submit before the deadline!). Homework can be attempted as many times as you like to fix wrong answers for partial credit, but students must re-answer all questions in each attempt. Note that some questions on the exams will be very similar in format to homework questions. Mastering homework will go a long way towards better performance on exams. Chem 4110 HON and Chem 6110 students will also be assigned additional problems. Finally, optional no-credit problems will be available for everyone wanting extra practice.

Exams: There will be six exams in this course, one for each module. The lowest exam score will be curved to the average of the other five exams. These exams will not be given at any time other than the scheduled lecture period.

Each exam will primarily test your knowledge of the corresponding module. However, a few of the questions on each exam may come from previous modules.

There will be no other midterm or final exam.

Exam policies:
- The quizzes will be open-book, so you may use the book, your notes, and your calculator during exams. Please consider that you will not have a lot of time to browse through your book/notes, so use your time wisely.
- Cell phones must be turned OFF (not just silent) during all exams and quizzes. Cell phones must not be in any place that is visible to you or me during the exam. In case of an emergency where you anticipate you might need your phone turned on during your exam, you must clear that with me first. You cell phones may **not** be used in place of a calculator for the quizzes.
- I reserve the right to move anyone during quizzes and exams without explanation. I typically use this simply to spread people out. If you are asked to relocate, please gather your test and move to the newly assigned seat as quietly as possible.

Exam make-up policy:
- At the end of the semester, there will be one make-up exam available that can be taken by anyone who has missed an exam during the semester. This exam will be comprehensive. The difficulty of the exam will be similar to other exams.
- Note that if you miss one exam, you also simply have the option to use it as your drop grade and not take the make-up exam. That exam will be assigned a grade equal to the average of the other five exams in that case.
- If you miss two exams during the semester, you can make up one and use the other as the drop grade.
- Any additional exams missed will be assigned a grade of zero.

Discussion Forums: For each module, there will be two discussion forums:
- One forum is for questions and answers. Questions about lectures, homework, and additional practice problems can be discussed here. All students can either post questions or reply to questions. However, please do not give direct answers to homework questions.
- The second forum is for resources. Feel free to post any relevant reading material, videos, websites, or notes you found useful.

Participation: Participation will primarily be assessed based on contributions to the discussion forum (although, active participation during lectures may eliminate the need for online discussion). Simply:
No participation = no point.
Minimal participation (viewing posts but not contributing) = partial points.
Posting to the discussion forums = full points.

Grading:
The grade breakdown for this course is as follows:

Module	%
1	15
2	15
3	20
4	15
5	15
6	20

Here is the breakdown of grades for each individual module:

	Chem 4110 (%)	Chem 4110HON/6110 (%)
Participation	5	5
Homework	45	30
Exam	50	50
Extra problems	0 (not required)	15

The following plus/minus grading system will be used for everyone:

Grade	**%**
A+	98+
A	90-98
A-	87-90
B+	84-87
B	80-84
B-	75-80
C+	70-75
C	65-70
C-	60-65
D	50-60
F	< 50

Last day to withdraw is **Tuesday, October 12th, 2021**
The University requires faculty, on a date set by the Provost after the mid-point of the course,
1. to give a WF to all those students who are on their rolls but no longer taking the class, and
2. to report the last day the student attended or turned in an assignment.

Student Integrity Policy: All exams and assignments must represent the student's individual, unaided efforts. Receiving unauthorized outside information or offering unauthorized information to another student during an examinations or assignments is cheating. This includes the use of online "tutoring" or "study" tools while solving assignments, such as Chegg, which counts as unauthorized help. Any suspected offenses will be referred to the Department of Chemistry and the College of Arts and Sciences for appropriate action. Please refer to GSU's policy on academic dishonesty for more information:
https://deanofstudents.gsu.edu/files/2019/07/Academic-Honesty-Policy.pdf

Accommodations: Students who wish to request accommodation for a disability may do so by registering with the Access and Accommodation Center. Students may only be accommodated upon issuance by the Access and Accommodation Center of a signed **Accommodation Plan** and are responsible for providing a copy of that plan to instructors of all classes in which accommodations are sought.

Family Educational Rights and Privacy Act: In keeping with USG and university policy, this course website will make every effort to maintain the privacy and accuracy of your personal information. Specifically, unless otherwise noted, it will not actively share personal information gathered from the site with anyone except university employees whose responsibilities require access to said records. However, some information collected from the site may be subject to the Georgia Open Records Act. This means that while we do not actively share information, in some cases we may be compelled by law to release information gathered from the site. Also, the site will be managed in compliance with the Family Educational Rights and Privacy Act (FERPA), which prohibits the release of education records without student permission. For more details on FERPA, go here.

Course Evaluation: Your constructive assessment of this course plays an indispensable role in shaping education at Georgia State. Upon completing the course, please take time to fill out the online course evaluation.

Modules and course schedule:

The course syllabus provides a general plan for the course; please note that deviations may be necessary.

If you miss the deadline for homework or can't attend exams for reasons outside of your control (i.e., emergencies) please notify me as soon as you could.
Holidays: Labor Day: Monday, Sept 6. Thanksgiving Break: Nov 22-Nov 27.

Module	Chapters in book	Start date	HW Due date	Exam Date	% of final grade
1	Focus 1	08/23	09/10	09/13	15
2	Focus 2	09/13	09/24	09/27	15
3	Foci 3+4	09/27	10/15	10/18	20
4	Focus 5	10/18	10/29	11/1	15
5	Focus 6	11/1	11/12	11/15	15
6	Focus 17	11/15	12/06*	12/10*	20

*Irregular dates (does not fall on a Friday Homework or Monday Exam as usual)

The following pages will list specific learning outcomes and tasks for each module.

Module 1 (M1): Introduction to physical chemistry, the ideal gas laws, and kinetic theory

Outcomes:

- Become familiar with the course structure on iCollege as well as the course syllabus.
- Identify different subfields of physical chemistry and their relationship.
- Define some basic but important terms that will be used throughout this course.
- Review the ideal gas laws.
- Gain a molecular-level perspective of temperature, pressure, and volume.
- Derive the ideal gas law from a molecular model.
- Compare the behavior of ideal and real gases.
- Determine the conditions under which real gases behave as ideal gases

Tasks:

1. Attend M1 lectures
2. Read Focus 1 in the textbook.
3. Post questions, answers, comments, or resources in the M1 discussion forum.
4. Complete the M1 homework and submit by due date.
5. Take the M1 exam.

Module 2 (M2): The first law of thermodynamics + thermochemistry.

Outcomes:

- Define internal energy and enthalpy and how they relate to state properties.
- Define the first law of thermodynamics.
- Differentiate between state and path functions and how to relate them.
- Apply concepts and laws of thermodynamics to physical and chemical processes.

Tasks:

1. Attend M2 lectures.
2. Read Topics 2A-2E in the textbook.
3. Post questions, answers, comments, or resources in the M3 discussion forum.
4. Complete the M2 homework and submit by due date.
5. Take the M2 exam.

Module 3 (M3): Entropy, the second and third laws of thermodynamics, and phase transitions.

Note: this is a three-week module.

Outcomes:

- Define entropy and how it relates to other state functions of a system.
- Explain the second and third laws of thermodynamics.
- Define free energies and how they relate to other state functions of the system.
- Combine the first and second laws of thermodynamics through the Maxwell relations.
- Define the phase rule and interpret phase diagrams.
- Determine the factors that affect the positions and shapes of phase diagrams.

Tasks:

1. Attend M3 lectures.
2. Read Topics 3A-3E and 4A-4B in the textbook.
3. Post questions, answers, comments, or resources in the M3 discussion forum.
4. Complete the M3 homework and submit by due date.
5. Take the M3 Exam.

Module 4 (M4): Simple Mixtures.

Outcomes:

- Apply concepts and laws of thermodynamics to describe mixtures.
- Define colligative properties and relate them to state functions.
- Interpret liquid mixture phase diagrams and apply them to understand distillation.
- Differentiate between real and ideal behavior of liquids.
- Define activity and account for deviations from ideality using activity.

Tasks:

1. Attend M5 lectures.
2. Read Topics 5A-5C and 5F in the textbook.
3. Post questions, answers, comments, or resources in the M5 discussion forum.
4. Complete the M5 homework and submit by due date.
5. Take the M4 Exam.

Module 5 (M5): Chemical Equilibria.

Outcomes:

- Apply concepts from thermodynamics to describe chemical equilibria and how they respond to external factors.
- Define different equilibrium constants and how they relate to each other and to state functions.
- Apply concepts from thermodynamics to describe electrochemical cells and to define cell potentials.
- Relate cell potentials to other state functions and external factors.

Tasks:

1. Attend M5 lectures.
2. Read Topics 6A-6D in the textbook.
3. Post questions, answers, comments, or resources in the M5 discussion forum.
4. Complete the M5 homework and submit by due date.
5. Take the M5 exam.

Module 6 (M6): Kinetics: Chemical reaction rates.

Outcomes:

- Define reaction rates and rate constants and their relation to concentrations.
- Derive integrated rate laws for different reaction mechanisms.
- Understand rates of chemical reactions near equilibrium.
- Relate rates of chemical reactions to temperature.
- Determine expressions for rates of chemical reactions for different reaction mechanisms, with examples.

Tasks:

1. Attend M6 lectures.
2. Read Topics 17A-17F in the textbook.
3. Post questions, answers, comments, or resources in the M6 discussion forum.
4. Complete the M6 homework and submit by due date.
5. Take the M6 exam.