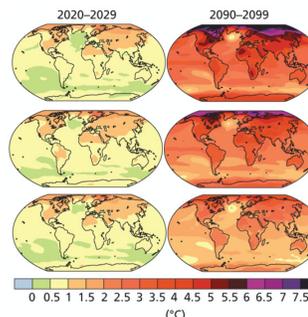


## CHEM 302 – Physical Chemistry II Spring 2022 Syllabus

**Instructor:** Kristin Wustholz (she/her), ISC 2041, kwustholz@wm.edu

**Class Meetings:** MWF 10:00 – 10:50 am, ISC 1127; R 6:00 – 6:50 pm, Small 110 (optional help sessions). If needed, our Zoom room is: 963 3053 5735, passcode: entropy

**Office Hours:** F 2:00 – 3:00 pm, ISC 2041 unless otherwise noted; *Other times are available, please email to setup an appointment.*



**Required Text:** *Thermodynamics, Statistical Thermodynamics, and Kinetics 4e*, by Thomas Engel and Philip Reid, Pearson, ISBN-13: 978-0134804583 is required. *Alternatives to this edition may be used, but students are responsible for any differences (e.g., in problem sets, page numbering, chapter organization, etc).* Other course information and materials will be posted on Blackboard.

**Learning Goals:** In this course we will examine three major topics in physical chemistry: thermodynamics, statistical mechanics, and kinetics. Specific learning goals are to: (1) understand and apply the laws of thermodynamics, which describe the behavior of matter and the transformation between different forms of energy on a macroscopic scale, (2) use statistical mechanics to derive thermodynamic properties from a microscopic perspective, and (3) use kinetics to understand reaction timescales and mechanisms. An emphasis is placed on connecting physical-chemistry concepts to the “real world” and current research.

**Prerequisites:** Just like CHEM 301, this course requires calculus. The math tutorial given on the first day is intended to provide a quick way to brush up on these skills. The Math Essentials (ME) sections in your textbook are also excellent. Another optional source: *Applied Mathematics for Physical Chemistry*, 3<sup>rd</sup> edition, by James R. Barrante, Pearson Prentice Hall, New Jersey (2012).

**Grades:** There will be seven problem sets, three exams, and a comprehensive final exam. Your grade will be computed as follows

Exam 1:	200 pts, 28% of grade
Exam 2:	200 pts, 28% of grade
Exam 3:	200 pts, 28% of grade
Problem Sets:	115 pts, 16% of grade
Final Exam:	200 pts, 28% of grade

There is an extra 28% in the above total because your lowest mid-term exam score will automatically be dropped. However, students must take all exams to pass this class. There is not a formal participation grade, but it is essential that you are an active participant in this course. Be inquisitive, ask questions, and come to help sessions and/or office hours. Final grades will be established with a typical grade scale (A = 100-93, A- = 92-90, B+ = 89-87, B = 86-83, B- = 82-80, etc).

**Exams:** Exams are scheduled to take place on Fridays (2/25, 3/25, 4/22) at 10 – 10:50 am in ISC 1127. Make-up exams are not typically permitted. However, excused absences submitted in writing and in advance, or due to significant extenuating circumstances, will be accommodated at the instructor’s discretion and in consultation with the Dean of Students. The comprehensive final exam is scheduled for May 9, 2022 at 2:00 – 5:00 pm. Students are responsible for adhering to any SAS-approved time limits.

**Problem Sets:** Learning physical chemistry is all about working the problems. Therefore, 7 problem sets will be assigned and evaluated throughout the semester. *You are strongly encouraged to work with others on the problem sets.* Discuss your problem-solving strategies. Small groups consisting of 2 – 4 students should submit the completed problem set as a single PDF file on Blackboard with the first page listing the name of each contributor. The presence of your name indicates that you are seeking credit for an equal contribution to the problem set. Solutions to the problem sets will be posted on Blackboard just after the due date. Therefore, late work will not receive credit. Each problem set is worth between 10 and 20 points and is graded for completion, accuracy, and a “challenge point”. The challenge point is harder to get. Once you are done with the Challenge question, you should reflect upon what your answer means and write it in a few sentences labeled “Challenge”. Motivation: answers are meaningless without context. Also, exams will have short-answer and multiple-choice components that test your understanding of challenging concepts.

## **Policies**

### *Classroom*

Together we will create and maintain an atmosphere of mutual respect in which everyone's ideas and questions are heard. We are all expected to honor the William & Mary Healthy Together Community Commitment. To ensure consistent mask wearing, no food or drink may be consumed in the classroom – please step outside for breaks. Please let me know if I have made a mistake with the pronunciation of your name or have used incorrect pronouns.

### *Late Work & Student Absences*

Late submission of problem sets and make-up exams are typically not permitted. I am prepared to be flexible with these policies to a reasonable degree for religious accommodations or if you are significantly impacted by illness or other extenuating circumstances. Exceptions to these policies will be at the instructor's discretion in consultation with the Dean of Students (757-221-2510, deanofstudents@wm.edu). Barring technical issues, I will record lectures and post them to Blackboard as a supplemental resource. These recordings may not be reproduced, shared with those not in the class, or uploaded to other online environments. Lecture notes will also be posted to Blackboard. If a sufficiently high proportion of the class is unable to attend class in person, we will meet remotely via Zoom.

### *Instructor Absences*

If the instructor is unable to teach in-person, we will hold class meetings via Zoom on a temporary basis. If this absence occurs on an exam date, then another faculty member will administer the in-person exam and I will be available on Zoom to answer any questions that arise.

### *Honor Code*

The student Honor Code is an important part of what makes William & Mary a special community. I expect you to observe the Honor Code fully and faithfully. For this class: you may use any resource to complete the problem sets. However, unauthorized assistance/collaboration or use of unauthorized materials during exams constitutes a Level III violation of the Honor Code.

### *Student Accessibility Services*

William & Mary accommodates students with disabilities in accordance with federal laws and university policy. Any student who feels they may need an accommodation based on the impact of a learning, psychiatric, physical, or chronic health diagnosis should contact Student Accessibility Services staff at 757-221-2509 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation. For more information, please see [www.wm.edu/sas](http://www.wm.edu/sas).

**Feedback:** Your constructive feedback is most welcome. Filling out evaluations at the end of the semester is helpful for next year's students, but not so helpful for you. Another mechanism is to complete a Google form (distributed about halfway through the semester), send me an email, etc. Whether it is something small (e.g., if my writing is too small) or big (e.g., you think I explained a concept incorrectly) – your feedback will be taken seriously. It's also very helpful for me to hear what's working for you!

**Tips from Former CHEM 302 Students:**

- Start the problem sets early and work in groups. Students tell me that they learn more by helping each other. Be sure, however, that before the exam you can redo the problem sets on your own and take practice exams, both without the answers in front of you.
- Take time each week to keep up with the material rather than cramming just before the exam.
- Students have said that recopying lecture notes, re-doing problems, attending office hours and optional review sessions, listening to recorded lectures, and taking blank practice exams are ways to improve problem-solving skills and understanding of the material. Students report that reading the textbook and skimming problem sets does not sufficiently prepare them for exams.
- Take advantage of the challenge point to reflect on your understanding of the underlying concepts. Dig deep. What does your answer mean? This will help you prepare for concept questions on the exams.
- If you think that you will benefit from extra practice, come to the help sessions and office hours. These times are devoted for you to improve your skills and help you to succeed.
- To prepare for exams:
  - START EARLY
  - Attend every class and take active notes
  - Take the practice exam early to identify weak spots
  - Brain map on a whiteboard
  - Work with friends to explain concepts to each other and talk through ideas
  - Go to office hours and ask questions
  - TRUST yourself!! That was probably my biggest issue was doubting myself on the exams, you are smart and you can do it!!
- From the instructor: Factors beyond course content can influence student performance in STEM courses, especially when challenging material (ahem, pchem) is encountered. Practicing a growth mindset rather than a fixed mindset has been shown to improve performance. "I'm bad at math" -> "I can improve my math skills by doing more practice problems" If you're struggling with this practice, let's talk!

<https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-020-00227-2>

**CHEM 302 Approximate\* Course Schedule**

Week	Topics	Reading	Important Dates
1/26	Thermodynamics Definitions, Ideal and Real Gases, 1 <sup>st</sup> Law	1.1-1.5, 7.1-7.2	Mandatory CHEM 302L Meeting 1/27 (Small 110)
1/31	Work, Heat, Reversibility, Heat Capacity, State vs. Path Functions	2.1 – 2.9, 2.11 – 2.14, ME3	Help Session 2/3 Add/drop deadline 2/4
2/7	Internal Energy, Enthalpy Thermochemistry, Calorimetry	3.1-3.2, 3.4-3.5, 4.1-4.6	PS1 due 2/7 Help session 2/10
2/14	Entropy, Spontaneity, 2 <sup>nd</sup> and 3 <sup>rd</sup> Laws	5.1-5.3, 5.5-5.10	PS2 due 2/14 Help session 2/17
2/21	Helmholtz and Gibbs Energies	6.1-6.11	PS3 due 2/21 Help session 2/24 <b>Exam 1: 2/25</b>
2/28	Mixing, Chemical Potential	6.1-6.11	Help session 3/3
3/7	Equilibrium, Phase Equilibria	8.1-8.3, 8.5-8.6	PS4 due 3/7 Help session 3/10
3/14	<i>Spring Break – No Classes</i>		
3/21	Quantization of Energy, Probability	12.1-12.6	PS5 due 3/21 Help session 3/24 <b>Exam 2: 3/25</b>
3/28	Microstates, Configurations, Boltzmann Distribution	13.1-13.5	Withdraw deadline 3/28
4/4	Molecular and Ensemble Partition Functions	14.1-14.10	Help session 4/7
4/11	Statistical Thermodynamics: Energy, Heat Capacity, Equipartition	17.6-17.8	PS6 due 4/11 Help session 4/14
4/18	Entropy, Enthalpy, Gibbs Energy, Ideal Gas Law, Equilibrium	17.3-17.5, 20.5, 20.8-20.9, 21.6, 2.10-2.11	PS7 due 4/18 Help session 4/21 <b>Exam 3: 4/22</b>
4/25	Chemical Kinetics	18.1-18.10, 18.13-18.15	
5/2	Complex Reaction Mechanisms	19.1, 19.4, 19.9- 19.10	PChem Jeopardy 5/6

\*Some dates may need to change, but I will not make due dates or exams earlier.