

**Chemistry 301: Physical Chemistry I**  
Department of Chemistry & Biochemistry, Loyola University Chicago  
Fall 2020

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Instructor: Dr. Dan Killelea  
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Email: **dkillelea@luc.edu**  
Office Hours: Th 11:00 AM to noon (Chicago time) and **As requested**  
Lecture: Tu + Th 9:45 to 11:00 AM (<https://luc.zoom.us/j/94364597933>) Chicago local time  
Discussion: Tu 11:30 AM to 12:20 PM (<https://luc.zoom.us/j/99357380599>) Chicago local time  
Text<sup>†</sup>: Physical Chemistry, 11<sup>th</sup> Ed., by Atkins & de Paula

Course Prerequisites: Chemistry 222 or 224 (Organic), Physics 112 or 112k, and **Math 263** (Multivariable Calculus). If you have not completed the course prerequisites, you may be administratively dropped from the class. Please discuss this with the instructor immediately!

Please see the Sakai site for up-to-date information and posts.

**E-mail:** please use "Chem 301:" in your subject line. I will do my best to respond with 24 hours for emails Mo-Fr, 9a-4p. Later emails and weekends may be delayed.

### **Course Overview**

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Welcome to Physical Chemistry! The objective of this course is for you to gain a firm understanding of the fundamentals behind the properties and behavior of macroscopic systems. Thermodynamics is the study of how systems behave at or near equilibrium and is widely used in chemistry to quantify the energetics of chemical systems. We will start with a treatment of the gas laws. From there, we will discuss energy levels, and use that framework for statistical treatments of large numbers of particles. With the microscopic-macroscopic link in place, we will then cover The Three Laws Of Thermodynamics; we will then see how these concepts are manifest in chemistry and guide chemical reactions through concepts such as the Chemical Potential and Gibb's Energy. From there, we will focus on how the thermodynamic fundamentals give rise to the properties of solids, liquids, and gases and their mixtures and solutions. Throughout the semester, we will explore how the concepts we are studying are relevant to the critical problems facing humanity as a whole. Of the great challenges facing our society, one of the most significant is one that chemists are well suited to solve, and that is the development of new energy sources. Thermodynamics is key to understanding the obstacles in the quest for plentiful, clean fuels. The overarching goal of this course is for you, the student, to be adept at using the concepts covered in this course to critically gauge the accuracy and potential efficacy of political and scientific (!) solutions to problems that, in your lifetime, will only grow in significance.

### **Expectations for Online Instruction**

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My goal is to provide the best course instruction I can. This will require all of us to work together. We are dealing with challenging situations and it is essential that we communicate clearly. I am accessible outside our class meeting times via Skype and email. I will do my best to reply promptly.

**Synchronous class meetings:** As a courtesy to your classmates, please mute your microphone unless wishing to speak to the class. During "lecture", I expect you to be an active participant. Please ask questions, wither via Zoom chat or by speaking. You do not need to have your camera active, but you are welcome to if you wish. During "Discussion" you will be working in small groups. It is essential that you communicate are work together. If this poses issues, please let me know ASAP.

**Participation:** I will keep track of questions asked and involvement with the small group work. The more the merrier! In your small group work, your roles will rotate. Each group will have a speaker, scribe, researcher, and checker. The speaker will lead the discussion and communicate your results. The scribe will be responsible for writing down and submitting your work. The researcher will find references, and communicate with other groups. The checker will review the problems for accuracy and proper format (e.g. units and sig figs). The scribe will make note of each student's contribution.

**Assessment:** Please refer to the Academic Integrity statement on p. 5 of this syllabus. While I do not believe that students are looking for ways to cheat, it has become all too easy with predatory websites (e.g. Chegg) providing real-time answers to questions. Lucky for you, I have a Chegg account and will keep an eye out for any CHEM 301 material appearing there. IF I find Chem 301 material appearing on any such service, I will change how assessment is done to account for the availability of such coaching. **ANY USE OF ONLINE ANSWER SERVICE IS FORBIDDEN AND WILL BE TREATED AS CHEATING.**

The consequence is a grade of F for the course and a report to the Department Chair. Each assessment (test, homework, etc.) will have guidelines to what sources are allowable. Please do not deviate from these.

### Course Structure

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There are two 75-minute online synchronous lectures (Tu, Th) on Zoom. These will be recorded and available for you to review. We also have a 50-minute discussion section on Tuesday at 11:30 AM, also on Zoom. It is likely that I will mix lecture, small group work, and interviews among these times. Having some flexibility helps! As valuable as lectures and discussion may be, you will gain much more by **completing** assigned reading and problem sets **BEFORE** our meetings. By coming prepared, you will be able to fill in any remaining gaps, and can *ask questions* to better comprehend the material. I cannot overstate how much more useful the classes will be if you come into the room well prepared, and even better, with questions for me and your fellow classmates. The three keys to success in physical chemistry are reading the text, solving as many problems as possible, and *asking questions!* Ask me questions about the material in class and office hours and ask your classmates questions.

The discussion section will be small group work. You will work in small groups (3-4 people) on problems I provide as well as the assigned problems, with the goal of working with your classmates to learn the material.

### Grading

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Your grade will be determined on a basis of **800** points.

*Tests* (200 points): We will have three tests worth 100 points each. **The low test score will be dropped.** These will be the equivalent of a take-home test; you will have wither 12 or 24 hours to complete. They will be open note and book, but no outside sources will be allowed.

*Conversations* (200 Points): I will hold two 1:1 meetings with each of you during the semester to discuss various topics covered in class, and we will have a longer dialog during the final week of class after Thanksgiving break.

*Final Exam* (200 points): The final exam will be cumulative and will be worth 200 points. This will consist of both written and video components.

*Participation* (100 points): I will track your activity in the class and tabulate. Active participation in small group work and lecture will result in full credit. Excused absences (e.g. illness) will be accounted for. My expectation would be one lecture question per week (either during our meeting or by 'office hours' visit) and playing your role in the small group work. This is meant to encourage activity, not punish!

*Homework* (90 points): you will have several homework assignments to complement the material covered in class. These will not be graded for accuracy.

*Evaluation* (10 points): Successful completion (email the instructor) of the course evaluation is worth 10 points.

*There will be no make-up tests or exams given under virtually any circumstance.*

**Final Exam:** The University schedules the final exam. The final will be held on:

**Monday, December 7, 2020 at 1:00 p.m.**

You will have exactly 2 hours to complete the synchronous portion exam. Additional time will not be granted, even if you start late. There will be no make-up final exams given under any circumstance, and the exam will not be given early, either.

**Grading:** There is a maximum of 700 points, letter grades will be assigned as given below:

B+: 88–84%	A: > 92%	A–: 92–88%
C+: 76–72%	B: 84–80%	B–: 80–76%
D: 64–55%	C: 72–68%	C–: 68–64%
	F: < 55%	

## Text and Supplementary Material

The 11<sup>th</sup> edition of Atkin's Physical Chemistry is the current one. Be sure to get the full book, not a partial. If you find a previous edition (9<sup>th</sup> or later) that will be fine. I suggest getting the solutions manual was well. Please contact me ASAP if you have any concerns about the textbook; the book is pricey new and there are options to save you some money.

- Physical Chemistry: A Molecular Approach, by McQuarrie and Simon
- Physical Chemistry, 6<sup>th</sup> Ed., by Ira Levine
- MIT Open Course Ware, Thermodynamics and Kinetics. (<http://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/>) Excellent note source with video lectures.
- Physical Chemistry, Harcourt Brace Jovanovich College Outline Series, by J. Edmund White.
- Chemical Thermodynamics by Klotz & Rosenberg.
- Thermodynamics by Crooksy

Please ask instructor if you want help finding supplementary materials.

## Schedule

Note: The instructor reserves the right to make changes to the schedule, the outline below will give you an idea of the material we will cover. Any changes will be announced in class or on Sakai. Reading assignments are from Atkins & de Paula (11<sup>th</sup>) unless noted otherwise. Test dates are subject to change.

Week	Date	Lecture Topics	Reading
1	25 Aug	Introduction: What is Physical Chemistry? Ideal Gas	Prologue
	37 Aug	Ideal Gases, Kinetic Theory of Gases, and Real Gases	1
2	1 Sep		
	3 Sep	Intermolecular interactions	14 A+B
3	8 Sep		
	10 Sep		
4	15 Sep	Kinetics	17A-E
	17 Sep		<b>Test 1</b>
5	22 Sep	Schrödinger Equation, Particle in a Box, Quantization	7 B +D
	24 Sep		
6	29 Sep	Boltzmann Factors, Populations, and Partition Functions	13 A+B
	1 Oct		
7	6 Oct	First Law; heat and work	2
	8 Oct		
8	13 Oct		<b>Test 2</b>
	15 Oct	Second Law, Entropy, 3 <sup>rd</sup> Law	3 A - C
9	20 Oct		
	22 Oct	Helmholtz and Gibbs Energies	3 D-E
10	27 Oct		
	29 Oct		
11	3 Nov	Phase Equilibria and Chemical Potential	4
	5 Nov		
12	10 Nov	Mixtures	5 A - C
	12 Nov		
14	17 Nov	Chemical Equilibrium	6 A+B
	19 Nov		<b>Test 3</b>
15	24 Nov	<i>no class – Thanksgiving Holiday</i>	
	26 Nov	<i>no class – Thanksgiving Holiday</i>	
16	1 Dec	<b>Dialogs</b>	
	3 Dec	<b>Dialogs</b>	

Monday, 7 Dec: FINAL EXAM, 1:00pm to 3:00pm

## **Academic Integrity**

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All students in this course are expected to have read and to abide by the demanding standard of personal honesty, drafted by the College of Arts & Sciences, which can be viewed at:

<http://www.luc.edu/cas/advising/academicintegritystatement/>

A basic mission of a university is to search for and to communicate the truth as it is honestly perceived. A genuine learning community cannot exist unless this demanding standard is a fundamental tenet of the intellectual life of the community. Students of Loyola University Chicago are expected to know, to respect, and to practice this standard of personal honesty.

Academic dishonesty can take several forms, including, but not limited to cheating, plagiarism, copying another student's work, and submitting false documents.

Any instance of dishonesty (including those detailed on the website provided above or in this syllabus) will **immediately result in a grade of F for the entire course** and will also be reported to The Chair of The Department of Chemistry & Biochemistry who will decide what the next steps may be.

## **Absence Policy for Students in Co-Curricular Activities (including ROTC):**

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Students missing classes while representing Loyola University Chicago in an official capacity (e.g. intercollegiate athletics, debate team, model government organization) shall be allowed by the faculty member of record to make up any assignments and to receive notes or other written information distributed in the missed classes.

Students should discuss with faculty the potential consequences of missing lectures and the ways in which they can be remedied. Students must provide their instructors with proper documentation (develop standard form on web) describing the reason for and date of the absence.

This documentation must be signed by an appropriate faculty or staff member, and it must be provided as far in advance of the absence as possible. It is the responsibility of the student to make up any assignments. If the student misses an examination, the instructor is required to give the student the opportunity to take the examination at another time.

(<https://www.luc.edu/athleteadvising/attendance.shtml>)

## **Accommodations for Religious Reasons**

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If you have observances of religious holidays that will cause you to miss class or otherwise effect your performance in the class you must alert the instructor **within 10 calendar days of the first class meeting of the semester** to request special accommodations, which will be handled on a case by case basis.

## **Online Class Specifics**

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Any and all material shall not be shared; all intellectual property remains with me and/or the university.

*Recording of Lectures:* I will record our lectures (not discussions) on Zoom and share with the class. These will not, and may not, be shared outside the class.

You may not have another person or entity 'take your place' for any course-related activity.

## **Recording of Zoom class meetings**

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In this class software will be used to record live class discussions. As a student in this class, your participation in live class discussions will be recorded. These recordings will be made available only to students enrolled in the class, to assist those who cannot attend the live session or to serve as a resource for those who would like to review content that was presented. All recordings will become unavailable to students in the class when the course has concluded. *Students will be required to turn on their cameras at the start of class. Students who have a need to participate via audio only must reach out to me to request audio participation only without the video camera enabled.* The use of all video recordings will be in keeping with the University Privacy Statement shown below.

## **Privacy Statement**

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Assuring privacy among faculty and students engaged in online and face-to-face instructional activities helps promote open and robust conversations and mitigates concerns that comments made within the context of the class will be shared beyond the classroom. As such, recordings of instructional activities occurring in online or face-to-face classes may be used solely for internal class purposes by the faculty member and students registered for the course, and only during the period in which the course is offered. Students will be informed of such recordings by a statement in the syllabus for the course in which they will be recorded. Instructors who wish to make subsequent use of recordings that include student activity may do so only with informed written consent of the students involved or if all student activity is removed from the recording. Recordings including student activity that have been initiated by the instructor may be retained by the instructor only for individual use.

## **Course Repeat Rule**

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Effective with the Fall 2017 semester, students are allowed only THREE attempts to pass Chemistry courses with a C- or better grade. The three attempts include withdrawals (W).

After the second attempt, the student must secure approval for a third attempt. Students must come to the Chemistry Department, fill out a permission to register form or print it from the Department of Chemistry & Biochemistry website: <http://www.luc.edu/chemistry/forms/> and personally meet and obtain a signature from either the Undergraduate Program Director, Assistant Chairperson, or Chairperson in Chemistry. A copy of this form is then taken to your Academic Advisor in Sullivan to secure final permission for the attempt.

## **Student Accommodations**

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The Student Accessibility Center (formerly known as Services for Students with Disabilities), Sullivan Center (773-508-3700), [www.luc.edu/sswd](http://www.luc.edu/sswd), has the mission "to serve students with documented disabilities by creating and fostering an accessible learning environment," including "support[ing] faculty, staff, and administrators on matters such as ADA and Section 504 compliance, as it relates to individuals with disabilities." Please direct all questions concerning accommodations of disabilities to the Student Accessibility Center. Academic accommodations afforded to students require documentation and review. The Student Accessibility Center will issue accommodation letters for registered students to present to their instructors: accommodations are not active until students present these letters to their instructors. If students' accommodations involve attendance or deadlines, instructors and students will jointly complete and execute an Agreement Form articulating their terms. See <https://www.luc.edu/sac/faculty/facilitatingaccommodations/> for guidance about implementing various kinds of accommodations in a way that is appropriate to your class. The Student Accessibility Center stands ready to work with you.

## **Your well-being**

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If there are events occurring in your life that cause school to diminish in its priority, please discuss this with me or contact the Wellness Center (<http://www.luc.edu/wellness/index.shtml>) or the dean of students ([http://www.luc.edu/studentlife/dean\\_of\\_students\\_office.shtml](http://www.luc.edu/studentlife/dean_of_students_office.shtml)) for assistance. These are services that **your** tuition pays for and can be invaluable for your personal health and maintaining progress towards your degree. I am always willing to discuss how I can adapt the class and its materials so that you are successful.