

CHEM 301-001: Physical Chemistry – Semester 1
Fall 2019
Loyola University Chicago

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Office hours: Tuesdays, 1:30 – 3:00 pm Wednesdays, 2:30-3:30 pm
STEM Resource Center STEM Resource Center
Other times by appointment Except 8/28, 9/25, and 10/9

Class Meeting Times: Lecture: Tuesday and Thursday 10:00 – 11:15 am, Flanner Hall, Room 105
Discussion: Thursday, 8:55 – 9:45 am, Flanner Hall, Room 105

Course Description

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 probability in order to be able to discuss 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. Finally, we will study kinetics and mechanisms. While thermodynamics tells us how systems behave at or near equilibrium, kinetics gives us an idea of the process by which systems get to equilibrium, the conditions under which this can occur, and the time needed to reach equilibrium. 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 and kinetics are 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.

Norms of Course Proceedings

The classroom is to be a safe place to question and explore ideas. Student and teacher voices are important to this work. Collegial disagreement can be a healthy part of this process, but must always include respect for all members of the class.

Course activities will be designed to help students reach the goal of learning chemistry content and developing thinking skills. This will more often be driven by the use of data and reasoning to discover concepts and solutions rather than the identification and exchange of facts and algorithms.

Class sessions will begin and end on time. All students should attend class regularly, including discussion sections, and participate in class discussions. Multiple absences could affect one's ability to learn chemistry during this semester. Anticipated absences should be discussed with the instructor two class days before the absence. Proper documents may be requested to verify the reason for any absence. This is particularly relevant to days missed that include an in-class assessment for which a student is asking for a make-up.

Class time is designed to engage students in activities that advance their understanding of chemistry. Electronic media, including cell phone, texting devices, laptops, and tablets should be used only as they enhance the activity of the class. In general, cell phones and texting devices should be turned off during class time. If you expect that you might receive an emergency phone call or text during class, please set your phone so that it will not distract other participants in the course and sit in a place where you can easily step into the hallway to answer a call if necessary.

Email messages and other electronic communication among students in the course should be respectful, appropriate, and professional. The instructor will respond to emails and phone messages as quickly as possible and at a minimum within 24 hours except on weekends. Only emails from your Loyola University account will be accepted, and the instructor will only send emails to your Loyola University account. Communications received after 3:00 pm Central Time on Friday or over a weekend will be answered on Monday morning at the latest.

Completed course assignments must be submitted at the beginning of class on the due date. Late assignments will not be accepted without proper verification of reasons.

Course Prerequisites: CHEM 222 or 224 (Organic Chemistry), PHYS 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!

Required Resources

- (1) Engel & Reid (2019). *Thermodynamics, Statistical Thermodynamics, and Kinetics 4th ed.* Pearson Education, Inc. ISBN: Print version: 9780134804583, 0134804589; E-book: 9780134814650, 0134814657; Loose leaf: 9780134814612. Any format is acceptable.
- (2) Shepherd, T., Garrett-Roe, S.G., Moog R.S. (2019). *Thermodynamics, Statistical Mechanics & Kinetics: A Guided Inquiry*. Provided on the first day of class.
- (3) *Sakai Connection*, sakai.luc.edu – the course is: **CHEM 301 001 F19**
This syllabus is posted on Sakai. Supplemental materials may be posted under the Resources section of Sakai.

Course Repeat Rule

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.

Course Evaluation

Grades will be assigned in the course according to the following sources:

Table 1. Grade Criteria

Criteria	Maximum Percent Value
Participation and group responses	10%
Homework	12%
Tests	48%
Final Exam	30%

Participation and group responses will be an important part of the class. This work will be a combination of individual and group work. Students must be present during class sessions, including discussion sections, in order to receive credit for these assignments. Participation involves completing assignments and using pertinent data to take part in group work, add to discussions, and make reasoned conclusions or decisions. This will include being able to ask questions of others and to evaluate arguments and conclusions made by others.

Homework will be assigned each week. While you can work with classmates on homework, you need to ensure that you understand how to do the assigned problems so that you are able to do them without help from others. Short answers must be your own synthesis and represent your understanding of the question. Homework is due at the beginning of class on the due date. Late assignments may not be accepted, and verification of reasons for late assignments may be requested.

Tests will be administered at four different points during the course. Each will primarily reflect the content and concepts developed during prior class sessions but may integrate prior content as well.

Final Exam

The *Final Exam* will be designed to assess students comprehensive knowledge of concepts developed during the work of the semester.

The University sets the schedule for all final exams. **The final will be held on:**

Tuesday, December 10, 2019, from 1:00-3:00 pm

in Flanner Hall, Room 105. You will have exactly 2 hours to complete the exam. Additional time will not be granted, even if you arrive late. There will be no make-up final exams given under any circumstance, and the exam will not be given early, either. Instructors may not reschedule final exams for a class for another day and/or time during the final exam period. There can be no divergence from the posted schedule of dates for final exams.

If you have four (4) final examinations scheduled for the same date, you may request to have one of those exams rescheduled. If you have four final examinations scheduled for the same date, you should e-mail a petition to Adam Patricoski, Assistant Dean for Student Academic Affairs, CAS Dean's Office (apatricoski@luc.edu).

Grading: Grades will be assigned according to the grading scale presented below.

B+: <90% - 88%	A: ≥92%	A-: <92% - 90%
C+: <80% - 78%	B: <88% - 82%	B-: <82% - 80%
D+: <70% - 68%	C: <78% - 72%	C-: <72% - 70%
	D: <68% - 60%	F: <60%

Course Schedule

The course will meet in accordance with the official Academic Calendar, which can be found at www.luc.edu/academics/schedules. Students should complete the Pre-Activity portions of the activities BEFORE the date they will be completed in class and read the sections of Engel & Reid AFTER the day they are listed. Generally, Critical Thinking Questions are completed during class. Exercises that are assigned as part of the group's report to be submitted at the end of each class are also completed during class. You are encouraged to complete other Exercises to reinforce your understanding of the concepts. At times, these may be assigned as homework.

Table 3. Proposed Semester Topics & Schedule

Dates	Topics
Week 1: August 26-30	Tuesday, August 27: Measureable Properties, Real and Ideal Gases (Shepherd, F.1; Engel & Reid, Chapters 1 and 7.1-4)
	Thursday, August 29: The Kinetic Molecular Theory and Probability and Multiplicity (Shepherd, E.1; F.2; Engel & Reid, Chapter 16 and Chapter 12.1-2)
Week 2: September 2-6	Tuesday, September 3: Driving Force (Shepherd, CA F.2, F.3; Engel & Reid, Chapter 5.1)
	Thursday, September 5: Entropy, Probability, the Boltzmann Distribution, and the Partition Function (Shepherd, SM.1, SM.2; Engel & Reid, Chapters 13, 12.3-6, and 15.4-5)
Week 3: September 9-13	Tuesday, September 10: Molecular Partition Function (Shepherd, SM.3; Engel & Reid, Chapter 14)
	Thursday, September 12: Heat Transfer and Entropy (Shepherd F.4, F.5; Engel & Reid, Chapters 1.3, 2.2, 2.11, 15.4-5)
Week 4: September 16-20	Tuesday, September 17: Exam 1
	Thursday, September 19: Temperature and Work (Shepherd, E.5, F.6; Engel & Reid, Chapter 2.3, and 2.6-9)
Week 5: September 23-27	Tuesday, September 24: Variable Changes (Shepherd, F.7, E.7; Engel & Reid, Chapter 3.1 and 3.5)
	Thursday, September 26: Path Dependence and Energy Transformations (Shepherd, E.7, F.8; Engel & Reid, Chapter 2.1, 2.4, 2.5, 2.11, and 5.2)
Week 6: September 30- October 4	Tuesday, October 1: Microscopic Energy Changes (Shepherd, F.9; Engel & Reid, Chapter 3.1)
	Thursday, October 3: Processes and Cycles (Shepherd, F.10, E.10; Engel & Reid, Chapters 5.1-5 and 5.10-13)
Week 7: October 7-11	Tuesday, October 8: Fall Break
	Thursday, October 10: Boundary Changes and Legendre Transforms (Shepherd, F.11, E.11; Engel & Reid, Chapters 3.1-4)
Week 8 October 14-18	Tuesday, October 15: Exam 2
	Thursday, October 17: Laboratory Conditions and Working Equations (Shepherd, F.12, E.12; Engel & Reid, Chapters 5.11 and 6.1-3)

Week 9: October 21-25	Tuesday, October 22: Composition Changes (Shepherd, F.13; Engel & Reid, Chapter 6.3-4)
	Thursday, October 24: More Cycles and Reaction Equilibrium (Shepherd, E.13, F.14; Engel & Reid, Chapter 6.5-11, and 6.13-14)
Week 10: October 28- November 1	Tuesday, October 29: Temperature Dependence of Equilibrium (Shepherd, E.14; Engel & Reid, Chapter 6.5, 6.7-14)
	Thursday, October 31: Phase and Solution Equilibria (Shepherd, F.15, F.16; Engel & Reid, Chapter 8.1 and 8.5-6)
Week 11: November 4-8	Tuesday, November 5: Vapor-Solution Equilibrium (Shepherd, E.16; Engel & Reid, Chapter 8.1 and 8.5-6)
	Thursday, November 7: Colligative Properties and Solid-Solution Phase Diagrams (Shepherd, F.17, E.17; Engel & Reid, Chapter 9.6-8)
Week 12: November 11-15	Tuesday, November 12: Exam 3
	Thursday, November 14: Phase Rule (Shepherd, E.15; Engel & Reid, Chapter 8.2-3)
Week 13: November 18-22	Tuesday, November 19: Introduction to Kinetics (Shepherd, K.1; Engel & Reid, Chapter 18.1-5)
	Thursday, November 21: Activation Energy (Shepherd, K.2; Engel & Reid, Chapter 18.5, 18.9, and 18.)
Week 14: November 25-29	Tuesday, November 26: Transition Theory (Shepherd, K.3; Engel & Reid, Chapter 18.14)
	Thursday, November 28: Thanksgiving
Week 15: December 2-6	Tuesday, Exam 4
	Thursday, December 5: Complex Reaction Mechanisms and Review for the Exam (Engel & Reid, 18.7-8, 18.10)
Final Exam: Tuesday, December 10	FINAL EXAM, 1:00 – 3:00 pm, Flanner Hall, Room 105

Information from other chapters may be introduced by the instructor as appropriate to specific topics.

Academic Integrity

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 be reported to The Chair of The Department of Chemistry & Biochemistry who will decide what the next steps may be.

Anything you submit that is incorporated as part of your grade in this course (e.g., quiz, examination, homework, paper, presentation) must represent your own work. Any student found to have cheated on, plagiarized, fabricated, or falsified any portion of a test or assignment will receive a zero on that test or assignment and this grade cannot be dropped. The student has the right to appeal the instructor's decision. If the student does so, the Academic Grievance Procedure described at https://www.luc.edu/academics/catalog/undergrad/reg_academicgrievance.shtml will be followed. If a student is found to have cheated on, plagiarized, fabricated, or falsified any portion of a test or assignment for a second time in this class, they will receive an F for the class. Depending on the seriousness of the incident, additional sanctions may be imposed.

Student Accommodations

If you have any special needs, please let me know in the first week of classes. The university provides services for students needing accommodations. Any student who would like to use any of these university services should contact the Student Accessibility Center (SAC, Sullivan Center, (773) 508-3700). Further information is available at <http://www.luc.edu/sac/>.

Loyola University Absence Policy for Students in Co-Curricular Activities:

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

You should discuss with me the potential consequences of missing lectures and the ways in which they can be remedied. You must provide me with proper documentation 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 your responsibility to make up any assignments and work done in class. If you miss an examination, I will make arrangement with you to give you the opportunity to take the examination at another time.

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

Your Well-being

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) for assistance. These are services that your tuition pays for and can be invaluable for your personal health and maintaining progress towards your degree.