DEPARTMENT OF PLANETARY SCIENCES
Lunar and Planetary Laboratory

PTYS 510B | Chemistry of the Solar System

Kuiper 312 | M/W 2:00—3:15
Web: https://d2l.arizona.edu/d2l/home/1480116
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Office Hours: Th 12:00—2:00 and By Appointment

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Introduction

Welcome to Chemistry of the Solar System! The detailed syllabus below contains everything a student might need to know about curriculum, course information, grading, and course policies.

Part 1: Course Overview

1.1 Course Description

Chemistry of the Solar System provides an overview of the gas and ice chemistry in planetary environments including molecular structure, spectroscopy, kinetics. The course describes how these physical processes are manifest in the diverse solar system environments.

1.2 Course Prerequisites

No formal prerequisites are listed for this course. Students are expected to have competencies equivalent to upper-division coursework in calculus, differential equations, and mechanics. Students should be familiar with concepts in general chemistry, thermodynamics, and quantum physics.

1.3 Course Format and Teaching Methods

Chemistry of the Solar System is delivered as a in-person course. Classroom activities will include lecturing and real-time problem solving. Other instructional methods include group-based work, examinations, and professional development activities.

1.4 Course Objectives

Students completing Chemistry of the Solar System will learn advanced concepts in physical chemistry with an emphasis on planetary environments. We will develop models of gas-phase statistical mechanics, as are especially relevant to atmospheres of planets and disks. Concepts in thermodynamics will be used to explain equilibrium properties of chemical systems and kinetic models will be used to explore deviations from thermochemical equilibrium. Quantum physics will be used to explain the spectral signatures of gas-phase atomic and molecular species. Finally, some course materials emphasize growing students as professional scientists.

1.5 Expected Learning Outcomes

- Articulate the physics that describe the chemical behaviors of complex systems, such as planetary atmospheres and protoplanetary disks.
- Analyze the consequences of physio-chemical models for planetary environments.
- Explain the fundamental quantum physics-based origins of atomic and molecular spectroscopy.
- Develop low-complexity models of gas-phase thermodynamics and kinetics.
- Grow skills relevant to working as a professional scientist.

1.6 Required Texts and Materials

The course textbook is Atkins' *Physical Chemistry* (Atkins, de Paula, and Keeler; Oxford University Press). Course sections on spectroscopy will be supplemented with material from *Astronomical Spectroscopy: An Introduction to the Atomic and Molecular Physics of Astronomical Spectra* (J. Tennyson; World Scientific). Finally, a useful explanatory book that covers many elements of chemistry in planetary environments is *Chemistry of the Solar System* (Lodders and Fegley; RSC Publishing).

Part 2: Course Curriculum

2.1 Schedule of Topics and Activities

Week	Dates	Topic
1	Aug 26 / Aug 28	Course Introduction / Physical Chemistry Overview
2	Sep 02 / Sep 04	No Class / Gas Properties
3	Sep 09 / Sep 11	Gas Properties
4	Sep 16 / Sep 18	Thermodynamics
5	Sep 23 / Sep 25	Thermochemistry
6	Sep 30 / Oct 02	Thermochemical Equilibrium
7	Oct 07 / Oct 09	No Class (DPS)
8	Oct 14 / Oct 16	Quantum Physics Overview
9	Oct 21 / Oct 23	No Class (Ty@HWO)
10	Oct 28 / Oct 30	Atomic Structure
11	Nov 04 / Nov 06	Atomic Spectra
12	Nov 11 / Nov 13	Molecular Structure
13	Nov 18 / Nov 20	Molecular Spectroscopy
14	Nov 25 / Nov 27	Student Presentations / No Class
15	Dec 02 / Dec 04	Chemical Kinetics
16	Dec 09 / Dec 11	Chemical Kinetics

Week	Activity or Due
7	Manuscript Peer Review (end of week)
8	Midterm
14	End-Semester Presentation
14	End-Semester Paper (end of week)
16	Final Project (end of week)
16	Final Exam (end of week)

2.2 Assessments

The assessment structure for 510B is designed to provide flexibility to the student in selecting which course elements best-fit the student's learning styles.

Item	Points
Homework Sets (5 x 10 pts)	50
Manuscript Peer Review	10
Midterm	10
End-Semester Presentation	10
End-Semester Paper	10
Final Project	15
Final Exam	15
Total	120

Homework Sets
Homework sets will be assigned every 2–3 weeks. Questions will supplement material learned in the classroom, and some questions may be collaboratively worked through during lecture.

Manuscript Peer Review
Professional scientists are often asked to review manuscripts for journals, but seldom are such scientists taught skills and etiquette relevant to these reviews. Building on brief materials presented in the classroom, this assignment asks students to simulate the process of providing a manuscript review to a journal.

Midterm
Oral examinations are a common assessment technique used when qualifying for a Ph.D., but students are rarely ever given earlier opportunities to experience this examination style. Students in 510B can opt to engage in a low-impact oral midterm examination that aims to provide an opportunity to practice this examination style in a space not occupied by peers and/or committee members. Students will be invited to schedule a 30-minute meeting with the instructor outside of regular class time to take the oral midterm. Exam topics can include any course materials covered prior to the date of the exam and students are permitted to bring (but not project) back-up/note slides (e.g., created in Powerpoint).

End-Semester Presentation
Working in a small group, students select a planetary environment and present an in-class review of the relevant physical-chemical processes that govern this environment. Depending on demand, presentations are expected to span 20–30 minutes.

End-Semester Paper
Working in a small group, students select a planetary environment and develop a written review of the relevant physical-chemical processes that govern this environment. This written review may accompany an associated end-semester presentation. Written reviews are expected to be at least 10 pages (single spaced, not counting figures and references; one-inch margins).

Final Project
Students may elect to engage in a detailed, quantitative final project. Guidance for this final project is intended to be sparse, thus requiring a student to engage in independent problem solving. Results from this work will be submitted as a short manuscript, whose materials include an abstract, an introduction to the problem, a description of the methods (including relevant model/tool validations), presentation of results, a discussion of key findings, and a summary.

Final Examination
A cumulative take-home final examination will be offered.

2.3 Final Examination
The final examination for 510B is optional, take-home, and cumulative. Students are not expected to sit for an exam during the university-provided final examination window.

2.4 Grading Scale and Policies

Letter grades follow:

A: $\geq$ 90 pts
B: $\geq$ 80 pts and $<$ 90 pts
C: $\geq$ 70 pts and $<$ 80 pts
D: $\geq$ 60 pts and $<$ 70 pts
F: $<$ 60 pts

Thus, students can tailor the course assessments to their needs/preferences in a variety of ways that achieve a desired letter grade.

Work Submission Format

Submitted work is expected to be in PDF, Word, or Google Doc format. Hand-written submissions will be returned to the student for typesetting.

Late Submissions

Late submissions are accepted provided the student contacts the professor in advance. Starting one week following the due date, assignments may be marked down 10% per additionally late week.

Group Work Policy

Modern science is collaborative, so training students to be professional scientists should make space for collaboration. Thus, group work is permitted (even encouraged) in 510B for any of: homework sets, end-semester presentation, end-semester paper, final project, and final exam. Any group-submitted work must list the names of all group members and must contain a detailed attribution statement that describes contributions from each group member. The manuscript peer review assignment can be discussed with peers, but each student must submit their own review document. Due to its format, the (oral) midterm cannot be completed as a group.

Part 3: Course Policies

3.1 Safety on Campus and in the Classroom

For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT). University of Arizona affiliates can obtain training resources related to active shooter events through Edge Learning.

3.2 Nondiscrimination and Anti-Harassment Policy

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see University of Arizona's Nondiscrimination and Anti-Harassment Policy website.

3.3 University Policies

University of Arizona's course policies are detailed on the Syllabus Policies website.

3.4 Subject to Change Policy

Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor of this course.

3.5 Graduate Student Resources

Students are encouraged to learn about University of Arizona-provided resources on the ASUA Basics Needs website.