

San José State University
College of Science, Dept. of Chemistry
Chem 162L, Physical Chemistry Lab, Fall 2019

Course and Contact Information

| | |
|-------------------------|---|
| Instructor: | Nicholas Esker PhD. |
| Office Location: | Duncan Hall 501 |
| Telephone: | (408)-924-4950 |
| Email: | nicholas.esker@sjsu.edu |
| Office Hours: | |
| Class Days/Time: | Tuesdays and Thursdays, 2:30 – 5:20PM |
| Classroom: | Duncan Hall, Room 010 |
| Prerequisites: | CHEM 100W or ENGR 100W; and CHEM 160A or CHEM 161A with concurrent enrollment in either: CHE 158 or CHEM 161B |
| Credit: | 2 units |

Course Web Page

Course materials such as syllabus, handouts, notes, assignment instructions, and any other materials can be found on CANVAS at <http://sjsu.instructure.com/>. You are responsible for regularly checking CANVAS to learn any updates.

Course Description

Physical chemical measurements with data analysis and written reports.

Course Learning Outcomes (CLOs)

Significant emphasis in this course will be placed:

1. Laboratory safety, including the interpretation of material safety data sheets (MSDSs) and safe disposal of chemical waste as appropriate for individual experiments
2. Collection of scientific data, including the use of specialized equipment and a laboratory notebook
3. Advanced methods of data analysis, including least-squares fitting methods and other statistical analyses)
4. Preparation of written laboratory reports, specifically following the format used in American Chemical Society (ACS) publications
5. Presentation of scientific data, including the preparation of publication-quality graphical representations.
6. Error analysis and interpretation.

In addition, the following table indicates the learning objectives for each of the exercises/experiments:

| Exercise / Experiment | Objective |
|--|---|
| Nuclear Chemistry | In this exercise, students will measure the rate of nuclear decay of a short-lived isotope to determine a number of statistical and physical properties. |
| Kinetics of the bromination of acetone | In this experiment, students will measure the rate of reaction for the bromination of acetone in order to determine the rate law for the acid-catalyzed reaction. |
| The Joule-Thomson Effect | In this experiment, students will measure the Joule-Thomson coefficient for selected gasses and relate results to those predicted based on theoretical methods. |
| Heat Capacity Ratio for Gasses | In this experiment, students will determine γ , the ratio of C_p / C_v for several gasses using the speed of sound method. Results will be related to those predicted based on statistical thermodynamics. |
| Enthalpy of Combustion | In this experiment, students will utilize bomb calorimetry to determine the enthalpy of combustion of a hydrocarbon. |
| Electronic Spectrum of I_2 | In this experiment, students will record and analyze an electronic transition of I_2 in order to determine the dissociation energy of the molecule in both ground and excited electronic states. |
| Rotation-Vibration Spectroscopy of HCl and DCl | In this experiment, students will record the 1-0 infrared bands of HCl and DCl and analyze the spectra for structural and energetic data for these molecules. |
| Partial Molal Volumes | In this experiment, students will use the Debye-Huckel Theory to determine partial molal volumes of water and NaCl in solution, from precise density measurements. This laboratory is a great introduction to determining propagation of error. |
| Vibrational Spectroscopy and Greenhouse Warming Potentials of Polyatomic Molecules | In this experiment we will examine the greenhouse warming potential of a variety of polyatomic gasses based on the overlap of their infrared absorption spectra with the earth's infrared emission spectrum. |

Finally, a note about the experiments: This is an advanced laboratory class designed to give you a taste of what it is like to work in a real laboratory. In real life, you will rarely perform experiments that are neatly laid out with step-by-step instructions. Consequently, experiments in this course may require you to 1) come up with your own plan for accomplishing a goal, 2) read and follow instruction manuals for instruments, 3) experiment with different settings on an instrument to optimize performance, 4) familiarize yourself with software that runs an instrument, and/or 5) perform "quick and dirty" preliminary experiments to guide your "real" experiments. In addition, as in "real life," you will almost certainly make a mistake or experience an equipment malfunction and have to repeat some experimental work at some point. Again, this is natural and it is a good opportunity to learn how to deal with such a situation, so you will be prepared when you are on the job.

Program Learning Objectives

This course addresses the following [BS/BA Chemistry Program Learning Objectives](#)

4. Demonstrate understanding of core concepts, methods and limits of scientific investigation to effectively solve problems in physical chemistry.
6. Answer questions regarding safe practices in the laboratory and chemical safety.
7. Demonstrate safe laboratory skills (including proper handling of materials and chemical waste) for particular laboratory experiments.
9. Effectively present a scientific paper orally applying the scientific approach, as at an American Chemical Society symposium.
10. Write a formal scientific laboratory report which applies the scientific approach to address a chemical problem and follows the format and style of an article in a peer-reviewed American Chemical Society journal.

Required Texts

Textbooks

Required: [Physical Chemistry Laboratory Manual](#), by Fleming, Van Wyngarden & Terrill (Fall 2017) – sold by the Chemistry Club (SAACS) in DH 20. Note: Versions from previous years are not acceptable since there have been significant changes.

Optional: [Experiments in Physical Chemistry](#); 7th ed., Shoemaker, Garland and Nibler, McGraw-Hill, New York, (2002), or similar

Materials

Required: Permanently bound laboratory notebook

Emergencies and Building Evacuations

If you hear a continuously sounding alarm, or are told to evacuate the building by an Emergency Coordinator, walk quickly to the nearest exit. Take your personal belongings as you may not be allowed to return. Follow the instructions of the Emergency Coordinators. Be quiet so you can hear instructions. Once outside, move away from the building. Do not return to the building unless the Police or the Emergency Coordinator announces that this is permissible.

Library Liaison

Yen Tran, yen.tran@sjsu.edu

Course Details

Schedule

The semester will be broken up into two-week time slots. An initial three-week period will be spent settling enrollment issues and completing a short set of exercises and lectures designed to introduce distributions of experimentally determined data and uncertainty analysis. During the remaining two-week time periods, each student will complete six laboratory experiments (in addition to the nuclear chem. mini-experiment). Each student will work as part of a group and will rotate through the

experiments. Scheduling of experiment rotation assignments will be done as soon as enrollment issues are settled. See the calendar for further details and due dates.

Attendance

Be considerate to your lab partners by arriving to class on time. You must complete all experiments in order to receive a passing grade in the class. You will not be allowed to make up laboratory time unless you have an excused absence that must be agreed to in advance by the instructor. In the case of unforeseen sickness or other circumstances, a Physician's or Dean's note is required.

Lab Notebook

A laboratory notebook will be required for all students. All primary data must be taken in the notebook in ink. A portion of the grade will be determined from how effectively each student uses the notebook. Notebooks will be graded twice during the semester. The first notebook grading session will be during the peer review for the formal lab report. Additionally, students must turn in their notebook for grading at the time of their final presentation. Each notebook review will be worth 25 points. (In many industry or research situations, the lab notebook can be used as an important legal document. Good notebook habits are essential for success in any branch of science!) Students who are absent from the peer review or fail to turn in papers to participate in the peer review will receive a score of 0/25 in their laboratory notebook in addition to losing the peer review points.

Pre-lab Assignments

Students will complete a two part pre-laboratory assignment (forms available on Canvas) before beginning each experiment. This will include completion of a safety section and a one paragraph summary of the objectives of the experiment. The safety section will require consultation with the Material Safety Data Sheets (MSDSs) contained in the MSDS notebook. The summary will identify the physical properties to be explored in each experiment and give an example of the application of the type of property in a commercial or research setting. Completion of the pre-laboratory assignment is required before a student will be allowed to perform an experiment. Each pre-laboratory assignment will be worth 10 points.

Lab Reports

In addition to the introductory exercises, each student must complete six laboratory experiments. Four of the experiments will be written up as informal lab reports, one will be written up as a formal lab report that will be peer reviewed, and the results of the final experiment will be reported in an oral presentation (during the final exam period). Students will work in small groups to complete lab work, but each student must prepare and submit her or his own laboratory reports. All lab reports will be due at least one week after the lab work is concluded (see schedule for specific due dates). Reports are due in both electronic (via Canvas) and hardcopy forms promptly at the beginning of the laboratory period on the date they are due. Late reports will be marked down 10% for each day or fraction of a day they are late. All laboratory reports will include a set of post-laboratory questions, worth 10 points.

Informal laboratory reports will be worth 50 pts. each and will focus on the analysis of the experimental data and, especially importantly, including uncertainty analysis. These reports should include a one page summary of the experiment, stating the major goals and conclusions (10 pts.), a complete presentation of the data and analysis of the data (20 pts.), and a quantitative uncertainty analysis that produces an estimated uncertainty in the final reported values and identifies the major quantitative source of experimental uncertainty (20 pts.)

The formal lab report will be worth 100 points and will be in a form similar to published papers in the Journal of Physical Chemistry. Major sections of the formal lab report include:

- ABSTRACT (5 pts)
- INTRODUCTION (15 pts) - including the background and theory needed to interpret the data
- EXPERIMENTAL SECTION (25 pts) - including the procedure, the raw data and any graphical representations of raw data
- RESULTS/DISCUSSION (30 pts) - including the analysis of the data, graphical representation of results derived from raw data and an interpretation of the results
- UNCERTAINTY ANALYSIS AND COMPARISON TO LITERATURE (20 pts) - including the derivation of estimated uncertainties in the final reported parameters and an interpretation of the calculation pointing to the major source of uncertainty as supported by the computation
- REFERENCES (5 pts)

Students should consult the discussion in the lab manual to become more familiar with the requirements for both short and formal (long) laboratory reports. Post laboratory questions should be added as an appendix. The formal lab report will be required following the fourth experiment rotation, which will be the HCl/DCI rotation-vibration spectroscopy experiment. Laboratory reports must be submitted in both printed and electronic form. Formats for electronic submission can be .docx, .odf, or .pdf. Electronic submission will be done through Canvas.

Peer Review

The formal laboratory report will be subject to peer review. On the due date for the formal laboratory report, each student must turn in three copies of their report, machine printed and double-spaced (for clarity and to give room for peer comments). Two students will review the papers and the instructor will provide a review of the third copy. Students will then be given an additional week to revise their reports, incorporating the comments as appropriate. Participation in the peer review process is mandatory and will be worth 20 points (10 points for each report reviewed).

Grading

Any assignments that do not fit into the above categories will be included in the evaluation points. Final letter grades will be determined based on performance relative to my expectations rather than relative to a fixed and predetermined set of cutoffs with one exception. A minimum of 50% of the total points will be required to receive a passing grade in the course. All assignments must be submitted, even if they are not complete. I reserve the right to adjust the scale downward if conditions warrant, but will not raise the minimum required for any particular grade. Your performance in the course will be evaluated as follows:

| | | |
|---|---------|----------------|
| Safety Quiz | 1 x 10 | 10 pts. |
| Statistics Quiz | 1 x 50 | 50 pts. |
| Prelab Assignments | 6 x 10 | 60 pts. |
| Notebook Evaluation | 2 x 25 | 100 pts. |
| Nuclear decay mini-lab report | 1 x 40 | 40 pts. |
| Informal reports (4) + final oral presentation (1) | 5 x 50 | 250 pts. |
| Formal report | 1 x 100 | 100 pts. |
| Post-lab questions | 6 x 10 | 60 pts. |
| Peer Review | 2 x 10 | 20 pts. |
| Instructor Evaluation | 1 x 60 | 60 pts. |
| Total | | 700pts. |

Failure to take the final will result in a failing grade (F) for the course. The following scale indicates the letter grade has a function of the percentage of points received per student. I reserve the right to adjust the scale downward if conditions warrant, but will not raise the minimum required for any particular grade. Standard rounding practices apply.

| Grade | Percent (%) |
|--------------|--------------------|
| A | ≥ 90.0 |
| A- | 89.9 – 87.0 |
| B+ | 86.9 - 82.0 |
| B | 81.9 – 77.0 |
| B- | 76.9 – 72.0 |
| C+ | 71.9 – 67.0 |
| C | 66.9 – 62.0 |
| C- | 61.9 – 57.0 |
| D | 56.9 – 50.0 |
| F | < 50 |

Safety

Students will be expected to maintain safe practices in the lab. Food and drink are expressly forbidden in the laboratory. Proper eye protection must be worn whenever any experimental work is in progress in the laboratory. Failure to abide by safe laboratory practices will result in removal from the course with a grade of F. Students must pass a safety quiz (to be given in the second laboratory meeting) with a score of 80% or better to be allowed to begin experiments. The safety quiz may be repeated with a 10% penalty on the score counted toward the grade for each attempt to get 80% of the questions correct.

Emergencies and Building Evacuations

If you hear a continuously sounding alarm, or are told to evacuate the building by an Emergency Coordinator, walk quickly to the nearest exit. Take your personal belongings as you may not be allowed to return. Follow the instructions of the Emergency Coordinators. Be quiet so you can hear instructions. Once outside, move away from the building. Do not return to the building unless the Police or the Emergency Coordinator announces that this is permissible.

University Policies

Per [University Policy S16-9](#), relevant information to all courses, such as academic integrity, accommodations, dropping and adding, consent for recording of class, etc. is available on Office of Graduate and Undergraduate Programs' [Syllabus Information web page](#). Make sure to visit this page, review and be familiar with these university policies and resources.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's [Catalog Policies](#) section. Add/drop deadlines can be found on the current academic year calendars document on the [Academic Calendars webpage](#). The [Late Drop Policy](#) is available at <http://www.sjsu.edu/aars/policies/latedrops/policy/>. Students should be aware of the current deadlines and penalties for dropping classes. Information about the latest changes and news is available at the [Advising Hub](#).

Academic integrity

Your commitment, as a student, to learning is evidenced by your enrollment at San Jose State University. The University [Academic Integrity Policy S15-7](#) requires you to be honest in all your academic course work. Executive order 1098 also outlines student conduct and honesty policies and can be found on the student conduct website. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. Please see the [Student Conduct and Ethical Development website](#) for more information.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. Any text, diagram, chart or data that is not the product of the student author must cite a reference for the source as appropriate. This includes (but is not limited to) material taken from reference books, tables, primary research literature, laboratory manuals and computer programs. Failure to adhere to the principles that protect the academic integrity of this course will be dealt with according to the policies and procedures of the Department of Chemistry, the College of Science and San Jose State University.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. [Presidential Directive 97-03](#) requires that students with disabilities requesting accommodations must register with the [Accessible Education Center \(AEC\)](#) to establish a record of their disability.

SJSU Peer Connections

Peer Connections, a campus-wide resource for mentoring and tutoring, strives to inspire students to develop their potential as independent learners while they learn to successfully navigate through their university experience. You are encouraged to take advantage of their services which include course-content based tutoring, enhanced study and time management skills, enhanced critical thinking strategies, decision making and problem-solving abilities, and campus resource referrals.

In addition to offering small group, individual, and drop-in tutoring for a number of undergraduate courses, consultation with mentors is available on a drop-in or by appointment basis. Workshops are offered on a wide variety of topics including preparing for the Writing Skills Test (WST), improving your learning and memory, alleviating procrastination, surviving your first semester at SJSU, and other related topics. A computer lab and study space are also available for student use in Room 600 of Student Services Center (SSC).

Peer Connections is located in three locations: SSC, Room 600 (10th Street Garage on the corner of 10th and San Fernando Street), at the 1st floor entrance of Clark Hall, and in the Living Learning

Center (LLC) in Campus Village Housing Building B. Visit [Peer Connections website](#) for more information.

Chemical Safety

[CHEM 120S Chemical Safety Seminar](#) is a required course for all chemistry majors and minors. The additional [Safety Training](#) is a requirement/prerequisite for CHEM 180/298, if working in a wet/chemical research lab. Please visit the [Safety Training website](#) to sign up for more information.

Disclaimer

This document is subject to change with fair notice.

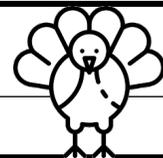
CHEM 160 / Physical Chemistry, Fall 2019, Course Schedule

The following schedule of lecture topics is tentative and subject to change at the instructor's discretion. Readings should be completed **before** the lecture.

| Week | Date | Readings from Atkins and De Paula, Topics for Lectures, Exams |
|------|-------------------------------------|--|
| 1 | Aug 22, Thu. | Lab checkout, Safety Quiz, Hazwaste disposal, |
| 2 | Aug 27, Tue. | Uncertainty Analysis Lecture |
| | Aug 29, Thu. | |
| 3 | Sep 03, Tue.** | Nuclear Lab |
| | Sep 05, Thu. | Statistics and Analysis Quiz |
| 4 | Sep 10, Tue.†† Sep 12, Thu. | Rotation 1, Pre-Lab 1 due Sep 10 |
| 5 | Sep 17, Tue. Sep 19, Thu. | Rotation 1 cont'd, Nuclear lab report due Sep 17 |
| 6 | Sep 24, Tue. Sep 26, Thu. | Rotation 2, Pre-Lab 2 due Sep 24; Lab Report 1 due Sep 26 |
| 7 | Oct 01, Tue. Oct 03, Thu. | Rotation 2 cont'd |
| 8 | Oct 08, Tue. Oct 10, Thu. | Rotation 3, Pre-Lab 3 due Oct 08; Lab Report 2 due Oct 10 |
| 9 | Oct 15, Tue. Oct 17, Thu. | Rotation 3 cont'd |
| 10 | Oct 22, Tue. Oct 24, Thu. | Rotation 4 – HCl and DCl rotational-vibrational spectroscopy, Pre-Lab 4 due Oct 22; Lab Report 3 due Oct 24 |
| 11 | Oct 29, Tue. Oct 31, Thu. | Rotation 4 cont'd |
| 12 | Nov 05, Tue. Nov 07, Thu. | Rotation 5 Pre-Lab 5 due Nov 05; Formal Lab Report 4 due Nov 07 |
| 13 | Nov 12, Tue. Nov 14, Thu. | Rotation 5 cont'd Peer Reviews for Formal Lab Report 4 due back to author Nov 14 |
| 14 | Nov 19, Tue. Nov 21, Thu. | Rotation 6 Pre-Lab 6 due Nov 19, Lab Report 5 due Nov 21 |



| Week | Date | Readings from Atkins and De Paula, Topics for Lectures, Exams |
|------|---------------------|---|
| 15 | Nov 26, Tue. | Rotation 6 cont'd Formal Lab Report 4, REVISED due Nov 26 |
| | Nov 28, Thu.## | <i>Thanksgiving Holiday</i> |
| 16 | Dec 03, Tue. | Lab locker checkout |
| | Dec 05, Thu. | <i>Free day</i> |
| | Dec 11, Wed. | Lab 6 Oral Presentation: 2:45pm – 5:00pm |



Important Dates

- ** Sep 03 Last day to drop without an entry on permanent record ("W")
- †† Sep 10 Last day to add classes and register late
- ## Nov 28, 29 Thanksgiving Holiday, Campus Closed
- Dec 11** Final Examination

