

## Physical Chemistry Laboratory 321L/322L (Spring 2024)

**Instructor:** Professor J. W. Petrich; [jwp@iastate.edu](mailto:jwp@iastate.edu); 0773 Gilman; 294-9422; Office hours by appointment.

**Lab Coordinator:** Dr. Feili Qin; [flqin@iastate.edu](mailto:flqin@iastate.edu); 1279 Gilman; 294-3991; Office hours by appointment.

**Head TA:** Iqtidar Hussain

**Teaching Assistants:** Sanduni Devasinghe, Aparna Krishnamurthy, Ethan Leung, Jiashan Mi, Tianyi Zhang

Times for the TAs' office hours will be announced. All TA office hours will be held in the Physical Chemistry Lab, 1656 Gilman.

**If you are suffering from COVID-like symptoms, please DO NOT attend class. These symptoms are: Cough; Fever or chills; Shortness of breath or difficulty breathing; Fatigue; Muscle or body aches; Headache; New loss of taste or smell; Sore throat; Congestion or runny nose; Nausea or vomiting; Diarrhea. If you attend class displaying these symptoms, you will be asked to leave. Failure to comply with such a request will result in dismissal of class. You are encouraged to wear a mask to class and to laboratory and to take advantage of opportunities to be vaccinated against the COVID viruses.**

**Course Materials:** The lab manual and supplementary reading material will be supplied *via* Canvas. You must purchase a laboratory notebook, safety glasses or goggles, and a lab coat.

### SCHEDULE OF LAB LECTURES (venue: Gilman 1104, 2:15 pm)

**Jan. 17 (W)**      **All students.** Error analysis I, analysis required for all experiments (Professor Petrich)

**Jan. 19 (F)**      **All students.** Error analysis II and Quantum Mechanics I, background for experiment 5 (Professor Petrich)

**Jan. 24 (W)**      **All students.** Quantum Mechanics II (Professor Petrich)

**Jan. 26 (F)**      **322L students only. Exp. 1:** Thermodynamic Study of Lysozyme using Differential Scanning Calorimetry (DSC) (Ethan Leung)

**322L students only. Exp. 2:** Heat of Vaporization and the Clausius-Clapeyron Equation (Jiashan Mi)

**Jan. 31 (W)**      **All students. Exp. 3:** Flash Photolysis (Sanduni Devasinghe)

**All students. Exp. 4:** Determination of the Critical Micellar Concentration (CMC) of a Cationic Micelle CTAB using Fluorescence Spectroscopy (Tianyi Zhang)

**Feb. 2 (F)**      **All students. Exp. 5:** Vibrational-Rotational Spectra of HCl (Aparna Krishnamurthy)

**Laboratory Experiments:** 322L students, five experiments are performed; 321L students, three experiments are performed.

**ALL SUBMITTED WORK MUST BE THE WORK OF THE STUDENT WHO SUBMITTED IT. EACH STUDENT MUST SUBMIT AN INDIVIDUAL REPORT. Plagiarism will not be tolerated. Submission of identical laboratory reports or extreme similarity of phraseology of text constitute plagiarism. Students submitting such reports will be disciplined for academic dishonesty and misconduct. See the Academic Dishonesty policy below for more information. (Students working in pairs may submit the same *raw* data. The analysis and graphing of quantities derived from these raw data, however, may not be identical. *E.g.*, in Experiment 5, a pair of students may submit the same FTIR spectrum of HCl. But nothing else in their reports may be duplicated verbatim.)**

Each experiment will be set up by a TA who is in charge of that experiment. This TA will have carried out the experiment completely, including all calculations, and will grade the reports. The TA will also give a lecture on the experiment and will be there when you start the experiment. Seek out the "expert TA" or primary (1°)--the first TA listed for a given experiment--for specific questions regarding the experiment. All TAs will be familiar with all experiments. Experiments 1 and 2 are performed only by 322L students. All experiments are performed in 1656 Gilman.

Exp	Topic	1° TA	2° TA
1	Differential Scanning Calorimetry (322L only):	Ethan	Tianyi
2	Heat of Vaporization (322L only)	Jiashan	Sanduni
3	Flash Photolysis (All)	Sanduni	Jiashan
4	Fluorescence (All)	Tianyi	Ethan
5	Fourier Transform Infra-Red Spectroscopy (All)	Aparna	Iqtidar

## Backup of Laboratory Data and Reports

The laboratory reports for physical chemistry laboratory involve a significant amount of work. Every semester several students lose their flash drives or find that their flash drives become corrupted and unreadable. There is also a possibility that a lab report may be misplaced. For these reasons, be certain to keep multiple backup electronic copies AND hard copies of all your lab reports.

**Failure to show up for scheduled lab: 15-point penalty.**

## Laboratory Reports

All laboratory reports must be written individually and submitted on Canvas. Lab reports are due two weeks after completing the experiment. Please submit lab reports before midnight on the due date. Late reports lose 5 points per day, including weekend days. **No credit will be given for reports turned in more than 20 days after the due date.** The late penalties do not count for Spring break days.

**Make-up Laboratory.** Students are expected to attend all scheduled laboratory sessions and complete the experiments as scheduled. If a student has a valid reason for missing a lab period (e.g., illness, death in family), the student should contact the Head TA and reschedule a time to complete the missed lab(s).

Please follow the Introduction to Physical Chemistry Laboratory Manual for details about how to write a lab report. Also included at the end of each experiment is a detailed rubric for that experiment. A brief description is given below:

## Format of Laboratory Reports

### Part I. General: 10 points

Use proper English grammar and spelling for all Pre-Lab and Final Reports. Use a "scientific writing style" such as that employed in a standard scientific journal, such as *The Journal of the American Chemical Society* or *The Journal of Physical Chemistry*. Reports will also be graded for organization.

### Part II. Pre-lab: 15 points.

***Pre-Lab reports are due at noon the day prior to your scheduled lab period. If you fail to complete the Pre-Lab report, you will not be allowed to perform the experiment on your scheduled day. You will lose 15 points and will have to reschedule the experiment.***

The Pre-lab must contain:

#### Title

**Purpose:** A minimum of two complete sentences.

**Theory:** All necessary equations; explain their significance in the context of the experiment being performed.

**Safety Precautions:** List chemicals; cite special hazards and how you will deal with them.

**Procedure:** Provide a general and condensed outline of the experimental procedure for the laboratory experiment.

**Apparatus and Materials:** List of equipment and instrument used; provide a drawing or reference to a published drawing.

**Pre-Lab questions:** Answer all Pre-Lab questions.

### Part III. Data Analysis and Calculations: 20-37 points.

**Data Analysis and Calculations:** Sample of each calculation INCLUDING an explicit, detailed, written description of the calculation. If calculations were carried out using a spreadsheet, do not simply include the spreadsheet. *You must explicitly demonstrate that you understand how results are obtained.* The spreadsheet, however, if it was used, must be included as part of your report.

**Propagation of Error:** Error analysis of derived results as indicated in individual experiments. Proper error propagation employing calculus is required. Example calculations for error propagation must be written in detail, as indicated in the section above.

**Part IV. Results:** 20-35 points.

**Results:** Results calculated in the **Data Analysis and Calculations** section. This should include a comparison of results with those found in the scientific literature—*i.e.*, journal articles or textbooks.

**Presentation:** Neat presentation of all graphs, figures, *etc.* pertaining to the calculations you have done for the experiment.

**Part V. Discussion & Conclusion:** 15-20 points.

**Discussion:** Purpose of experiment, detailed and critical summary of results, comparison with the literature. Give possible sources of error.

**Conclusion:** Discuss what was determined in the experiment and how well this experiment achieved its stated purpose.

**Post-Lab Questions:** Answer all questions posed in the lab manual or by TA.

**Applications, Implications, Principles Illustrated, Improvements:** Relate what you have learned from the experiment to what you already know about physical or analytical chemistry, engineering, physics, *etc.*

**Problem Set.** The problem set comprises 1/6<sup>th</sup> of the final grade for both 321L and 322L (this is reflected in the weighting in the computation of the grade, given below). It is designed to help you understand error propagation, which is a critical part of each experiment. Read the instructions carefully. You will need your lecture notes to work the problems, and you will also need to study the texts by Bevington and notes, which will be posted.

*Work that contains cross-outs or that is illegible will not be accepted. Papers that bear ratty edges from being torn out of spiral notebooks will not be accepted. The sheets in your assignment should be stapled together. We are not responsible for losing material that has not been securely assembled. If there is any doubt as to the acceptability of a paper, you should contact the instructor for clarification BEFORE SUBMISSION. If you are unable to write neatly, you should obtain a SAAR form requesting an accommodation before the assignment is due or you should use a word processor.*

In each of the problems you will be assigned, unless you are otherwise indicated, *use calculus to derive* the expression for the propagated error; and then provide an answer. Specifically, each problem should begin with stating the functional dependence of the propagated error on the errors of all the quantities used to obtain it. *Do not use standard equations for error propagation that you may have encountered in textbooks from other courses unless you are specifically requested to do so.*

**Grading (weights of assignments):**

322L		321L	
Lab Reports: 5, 100 pts. each	500	Lab Reports: 3, 100 pts. each	300
Homework: 100 pts.	100	Homework: 60 pts.	60
Total	600	Total	360

Plus/minus grading will be used for final grades. *Tentative* letter grade assignments are: “A,” 90-100%; “B,” 75-89%; “C,” 50-74%; “D,” 40-49%; F, 0-40%. **There is no curve for the course.**

Reports will be graded within two weeks after the report is due and submitted on Canvas.

**Regrading Policy.** Any appeal regarding a grade (for *any* assessment instrument) must be made in writing no later than five “school days” after the graded assessment instrument (problem set, lab report, *etc.*) has been made available for review. Any instrument not collected by you after this time will be submitted for recycling. Instruments submitted for appeal may be subject to complete reevaluation.

**Lab Safety:** *Personal Protective Equipment (PPE) such as safety eyewear, gloves, lab coat and fully covered shoes are important components for lab safety. You will not be allowed to do the experiment if you are not in proper attire. You are NOT allowed to wear these PPEs out in the hallway in order to avoid contaminations. Sandals are NOT allowed. Failing to follow these safety rules will also result in the loss of points.*

## Syllabus Statements

- **Free Expression:** Iowa State University supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.
- **Accessibility Statement:** Iowa State University is committed to advancing equity, access, and inclusion for students with disabilities. Promoting these values entails providing reasonable accommodations where barriers exist to students' full participation in higher education. Students in need of accommodations or who experience accessibility-related barriers to learning should work with Student Accessibility Services (SAS) to identify resources and support available to them. Staff at SAS collaborate with students and campus partners to coordinate accommodations and to further the academic excellence of students with disabilities. Information about SAS is available online at [www.sas.dso.iastate.edu](http://www.sas.dso.iastate.edu), by email at [accessibility@iastate.edu](mailto:accessibility@iastate.edu), or by phone at 515-294-7220.
- **Discrimination and Harassment:** Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612, Hotline 515-294-1222, email [eooffice@iastate.edu](mailto:eooffice@iastate.edu)
- **Religious Accommodation:** Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request the reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the Dean of Students Office at 515-294-1020 or the Office of Equal Opportunity at 515-294-7612.
- **Mental Health and Well-Being Resources:** At Iowa State, we're committed to your success and well-being. As a Cyclone, you can access 24/7 resources, services, and people dedicated to helping you achieve your goals and be your best in and out of the classroom. Whether you need academic support or just someone to talk to, we're here for you at Cyclone Support: [cyclonesupport.iastate.edu](http://cyclonesupport.iastate.edu).