

**Physical Chemistry I Laboratory
Chemistry 341L, Fall 2019**

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Office Hours: Mon 1-2, Tues 1-2, Wed 11-12, Thu 12-2, Fri 11-12, and by appointment.

Lab Schedule: **Sect. 1:** T 2-5; **Sect. 2:** W 2-5 (all sections meet in SSMB 329)

Textbook and supplies: Handouts outlining the laboratory procedures will be distributed. Although there is not a formal textbook, you are strongly encouraged to consult the textbooks in Addlestone Library, as well as any other suitable texts or online materials that will assist you with the laboratory procedures and reports. *Be sure that you properly cite the references that you use.*

You will need a lab coat, safety goggles, nitrile gloves, a bound notebook, and a pen.

Lab Experiments: You will perform each lab in a group. The course site on OAKS contains a calendar of the weekly lab rotation including the names of the students conducting each lab. Each student should consult this calendar to obtain their schedule.

Attendance Policy: Students are required to attend and complete all laboratory experiments. In case of an unavoidable absence, speak with the instructor promptly. If you do not attend the lab you will receive zero lab conduct and notebook points, and you will not be permitted to turn in a lab report.

Classroom Conduct: In order to foster a cordial and secure learning environment, please be respectful of your instructor and your classmates. Do not obstruct or disrupt the teaching and learning processes by carrying on conversations on your cell phone or with other students in the class, sending text messages, or surfing the web on your laptop while you are conducting the labs. Proper laboratory conduct is important to ensure that the labs are performed correctly, thereby generating accurate experimental results, and, more importantly, to assure lab safety. If you fail to comply with these simple requests you will be asked to leave the lab and if the problems persist you will be referred to the office of Student Affairs for disciplinary action.

Some comments: Physical chemistry sometimes has an intimidating reputation. This is partly because it requires you to think about chemistry in new ways. In organic chemistry you were able to use powerful symbolic ways of thinking about how molecules behave to qualitatively understand molecular behavior in synthetic chemistry. In physical chemistry we use the language of mathematics and physics to quantitatively calibrate the intuition you have developed thus far in your career as a chemist. During this semester we will learn to use the powerful tools of thermodynamics, kinetics, and statistical mechanics to understand in a fundamental way why some molecules exist and others do not and why some molecules react with each other and others do not. As when learning any new language or skill, the key to success in physical chemistry is practice. You can study rules of grammar for years on end, but you will not be able to carry on a conversation unless you actually practice talking to people.

In physical chemistry you can gain general familiarity with physical concepts like energy, entropy, and chemical potential, but *unless you practice working problems you will not be able to use your familiarity with these concepts to your advantage*. The goal of this class is neither to develop vague familiarity with trendy concepts like entropy nor to mindlessly plug numbers into formulas until you get a number that agrees with the answer key. Rather, the goal of this course is to gain a solid knowledge of the physical basis of chemical phenomena and to turn that knowledge into a tool for doing chemistry. In short, you need to attend the lectures, read the book, do the assigned problem sets, and perform all of the laboratory exercises.

Physical Chemistry and the Curriculum: This course should help you meet several of the College's curricular goals. By the time you are finished you should have a better idea of how physical chemistry is different from other areas of chemistry. Physical chemistry operates at the interfaces between chemistry, physics and mathematics. We will use many ideas from physics and mathematics to explore chemical systems so you can see how chemistry is related to other scientific fields. Physical chemistry's role in the chemistry curriculum is to provide you with a strong physical basis for understanding ideas that chemists use every day: energy, enthalpy, equilibrium, and reaction rates. The ideas we look at this semester are the basis for how chemists understand whether or not a reaction will happen (thermodynamics) and how long it will take (kinetics).

CHEM341L Experiments: Throughout this semester you will work in groups to perform the nine experiments listed below. All of the handouts and the experimental rotation are available on the OAKS page for each lab section. With a couple of exceptions, the student groups will not conduct the same experiments each week. You should consult the OAKS site to see when your group is performing each lab.

- 1 Introduction to Error Analysis (1 week)
- 2 Viscosity of Liquids (1 week)
- 3 SDS Micelles (2 weeks)
- 4 Naphthol: Protonation and Deprotonation (2 weeks)
- 5 Surface Tension of Liquids (1 week)
- 6 Solution Calorimetry: Heat of Ionization of Glycine (2 weeks)
- 7 Heat Capacity of Gases: Speed of Sound Method (1 week)

Learning Objectives: Physical chemistry is a laboratory science. The laboratory portion of a physical chemistry course is designed not only to demonstrate experimentally the various laws and theories learned in the lecture portion of the course, but also to help introduce the student to scientific research. Most of the theoretical background for each lab in this course can be found in the lecture course notes and textbook and the laboratory handouts, but library sources also should be used. A wise student will thoroughly study the experiment before coming to the laboratory and should have a good idea as to what he or she is going to do before attempting to perform the experiment. When studying these experiments, do not hesitate to draw on knowledge gained from prerequisite courses or your own independent research, particularly those techniques involving quantitative analysis.

CHEM341L is the laboratory co-requisite of the CHEM341 lecture course focusing on classical and statistical thermodynamics. A course in thermodynamics incorporates the traditional suite of state functions, laws of thermodynamics, ideal and real gases, and chemical and phase equilibria, and chemical kinetics. This semester the subject of chemical kinetics and reaction dynamics will be covered exclusively in CHEM341L using both lectures and laboratory exercises.

Listed below are some of the general learning objectives for Chemistry 341L:

1. Apply the basic concepts of calculus and physics to concepts in chemistry within a laboratory setting.
2. Describe the physical basis for the physicochemical phenomena that you observe in the laboratory exercises.
3. Collect experimental data on the physical properties of chemical systems and synthesize the data to the point that the correct conclusions can be drawn about the measurements you have made.
4. Develop proficiency preparing and interpreting graphs, figures, and tables of experimental data.
5. Write a lab report that clearly summarizes the experiment(s) performed, the data analysis undertaken, the results obtained as described in the handouts.
6. Improve manipulative skills in the laboratory setting and develop your aptitude for carrying out advanced laboratory procedures and data analysis.

Laboratory Preparation: You are expected to arrive in lab on time and prepared to carry out your assigned experiment. Preparation consists of:

1. Reading the assigned materials from the lab handouts and any assigned reserve reading.
2. Performing any required calculations.
3. Preparing in your notebook a *brief* outline of the procedure to be followed.

Any students who have not completed their preparation before coming to lab will be required to complete the preparation before proceeding. ***If this delay results in the students not completing the lab on time the lab reports will be based on the incomplete set of data; thus, the lack of preparation will adversely impact the grade on their lab report.*** You must have your lab notebook initialed by the instructor before you leave at the end of the lab. If you fail to check out with your instructor you will receive a zero for the notebook and conduct points for the experiment.

Laboratory Notebook: One of the most important parts of the laboratory procedure is recording permanently all procedures, observation, and numerical data in a bound notebook. Loose-leaf or spiral-bound notebooks are not acceptable because pages can easily be removed from these types of notebooks. Under no circumstances should pages be removed from a research or laboratory notebook. Pages should be numbered consecutively, leaving two or three blank pages at the beginning for a table of contents. *All entries must be made in permanent ink.* The procedures and observations should be recorded in the notebook at the time the experiment is being performed, not recalled from memory at some later time. While this approach may take extra time and appear to be a nuisance, it is the only acceptable way to keep a research notebook.

Any error made in recording data, procedures, etc., should be crossed out neatly with a single line. Never erase in a laboratory notebook, since, like tearing out pages, it immediately invalidates the notebook. A duplicate of each notebook page is to be attached to each laboratory report. *A good portion of the experiment will be based on how well the notebook is kept.* A good rule to follow is to ask yourself whether you could understand and perform the experiment from just the information given in the laboratory notebook. An experimental setup may be difficult to explain with words, so when appropriate include a figure of your experimental set-up.

Each experiment should be started on a new page. The title, date and lab partners should be recorded at the beginning of the write-up. All data must be recorded in a clear, legible fashion in your lab notebook during the laboratory period. A key skill for any scientist is learning to record data in a clear, organized and complete enough way that someone reading your lab book can understand what it is you have measured without you standing there to tell them. A person should be able to repeat the experiment using your notebook as a guide. As scientists you must present your results in a way which can be understood by others. Otherwise, they are essentially worthless.

The purpose and procedure sections should be written prior to the lab. Any changes in the procedure should be noted in the notebook. Data should be recorded with the appropriate significant figures. You should include clear headings and units to describe the measured quantities. If it is difficult or unfeasible for all the students in the research group to record the data in their notebook while performing the experiment, *each student must record the data into their notebook before leaving the laboratory.* Your notebook must be checked before you leave the lab.

Laboratory Reports: A scientist must be able to convey his or her findings to the outside world. He or she does this by putting his or her experimental data and findings together in the form of a laboratory report. All experiments in Chemistry 341L will be the subject of brief lab reports. These reports will consist of a minimum amount of prose and will focus instead on the quantitative results of the experiments. The content and form for each lab report, e.g., calculations to be performed, graphs to be handed in, questions to be answered, etc., will be outlined in the laboratory handouts. In general, the lab reports will consist of a report sheet, your graphs and tables, answers to the questions included in the lab handout, and copies of your data analysis and error analysis calculations.

Attendance Policy and Classroom Conduct: *Students are required to attend and complete all labs.* In order to foster a cordial and secure learning environment, please be respectful of your instructor and your classmates. Do not obstruct or disrupt the teaching and learning processes by carrying on conversations on your cell phone or with other students in the class, sending text messages, or surfing the web on your laptop while you are conducting the labs. Proper laboratory conduct is important to ensure that the labs are performed correctly, thereby generating accurate experimental results, and, more importantly, to assure lab safety. If you fail to comply with these simple requests you will be asked to leave the lab and if the problems persist you will be referred to the office of Student Affairs for disciplinary action.

Laboratory Safety Guidelines: Safety is an important issue in the Department of Chemistry and Biochemistry, and the department considers safe practice as essential to all activities in the building. The safe use of all equipment, devices, and procedures in this laboratory, as well as your future career, is of the utmost importance. It is the responsibility of ALL of the people in the lab to observe safe practices and to know what to do in the event of an accident. *Failure to conduct yourself in a safe manner may result in your forced departure from a particular laboratory period. You will receive no points for lab, nor will you be allowed to hand in a report*

Listed below are some general safety guidelines:

1. Follow all instructions given by your instructor. Special precautions will be noted by your instructor when necessary.
2. Lab coats, protective eye wear, closed toes shoes, long pants, and long sleeve shirts are required attire. *You will be turned away if you do not show up with the proper attire.*
3. "Horseplay" is strictly forbidden. Enjoy the lab period, but be mature.
4. No smoking, eating, or drinking in the lab.
5. Always wash your hands before leaving the lab.
6. Use good housekeeping practices in the lab, cleaning your individual work station, as well as general work areas.
7. Tightly cap all reagent bottles immediately after use. Do not place tops on benchtop in a manner that they can become contaminated.
8. Never return reagents to stock bottles.
9. Always add acids to water, never water to acids.
10. Dispose of unused or contaminated reagents properly. Consult your instructor before cleaning up a chemical spill.
11. Perform all reactions in a functional hood.
12. Report all mercury spills immediately to your instructor.
13. All broken glassware should be carefully and immediately cleaned up and disposed of in the proper "broken glassware" receptacle.
14. Report all broken or defective laboratory equipment to the instructor.
15. Never leave an experiment unattended.
16. Unauthorized or unsupervised experiments are not permitted.
17. Never take chemicals or other substances out of the lab, unless required to complete an experiment, e.g., performing an NMR scan.
18. Never wear gloves on both hands outside of the lab.
19. Bare feet, open toed shoes, and crocs are not acceptable in the laboratory. Clothes must come at least to the knee, and pants are strongly recommended.
20. Contact lenses are permitted in the lab, but they are not considered to be approved eye protection and, therefore, they do not replace safety goggles.
21. If you have long hair, tie it back.
22. Keep all experimental apparatus as far away from the edge of the benchtop as possible.
23. Report any accident, however minor, to your lab instructor at once.
24. Know how to get help in an emergency. Dial 3-5611 from a campus phone to contact emergency personnel.
25. When in doubt "ask."
26. AT ALL TIMES, THINK ABOUT WHAT YOU ARE DOING!

You should familiarize yourself with the location of the safety equipment in the lab. If there is an accident, knowing the location of the fire extinguisher, fire blanket, shower, and eye wash, and, most importantly, where the exits are, can save lives. You may have to find these things without being able to see them.

Safety information about the chemicals used in this laboratory course is available in the yellow MSDS binders in the lab room and can also be found online on a number of sites, like <http://www.msds.com/>. Other sites for MSDS sheets can be found by searching "MSDS" on Google™.

The Student Code of Conduct and Physical Chemistry: *The Honor Code of the College of Charleston forbids lying, cheating, stealing, plagiarism, and failing to report an Honor Code violation. The Student Code of Conduct can be found in the Student Handbook.*

Science is inherently collaborative. If you go on to work in industrial or academic laboratories you will work with other scientists as a collaborator, as a mentor, and as a student throughout your career. Learning to work effectively with other people is therefore an important part of your undergraduate training. You may choose to work together on the data reduction and analysis with your lab partners, but you should not merely copy out their answers to homework questions. Working together means **working** together. There are two reasons for this. The first is that you will not really understand how to do the problem simply by copying it out, and understanding the problems should be your chief goal. Secondly, your colleagues will get tired of your mooching. If you do work with people on your assignments, please include the name(s) of your partner(s) on your work.

Although you may work together during your data analysis, your report must be in your own words, thereby reflecting your own knowledge and understanding of the experimental theory and purpose, procedures, observations, and results.

Plagiarism involves using another's work without attribution, as if it were one's own original work. The College of Charleston Honor Code forbids plagiarism and the Student Handbook defines plagiarism as follows:

1. The verbatim repetition, without acknowledgement, of the writings of another author. All significant phrases, clauses, or passages, taken directly from source material must be enclosed in quotation marks and acknowledged either in the text itself and/or in footnotes/endnotes.
2. Borrowing without acknowledging the source.
3. Paraphrasing the thoughts of another writer without acknowledgement.
4. Allowing any other person or organization to prepare work which one then submits as his/her own.

Beyond being an Honor Code violation at the College of Charleston, plagiarism is considered a serious ethical offense and can be detrimental to one's academic reputation and integrity. You should begin now, during your undergraduate education, to develop good practices for avoiding plagiarism and to learn how to properly cite and reference resources from which you draw your facts, ideas, and inspiration. If you are in doubt as to whether or not you may be engaging in plagiarism do not hesitate to ask your instructor.

Plagiarism on laboratory reports will not be tolerated.

Because scientific integrity is central to all scientific endeavors, the faculty will vigorously prosecute any student thought to be in violation of scientific ethics at the College's Honor Board. The following acts are examples of scientific misconduct that will not be tolerated:

- Modifying data to conform to an expected outcome
- Copying another student's data into your own notebook or report
- Using another student's interpretation and/or ChemDraw images/schemes or spectra and presenting it as your own
- Using or possessing previously interpreted data or graded reports from this lab course
- Providing your data or graded lab reports to another student who presents it as their own
- Presenting data collected in prior semesters for credit in the present semester

If there is any doubt as to the proper interpretation of what is allowed under this code of scientific integrity, you should consult your instructor before submitting any work for evaluation.

Violations of the Honor Code, when identified, will be investigated. Each instance will be examined to determine the degree of deception involved. Incidents where your instructor believes the student's actions are clearly related more to ignorance, miscommunication, or uncertainty can be addressed by consultation with the student. Cases of intentional and willful academic dishonesty will be reported directly to the Dean of Students for further consideration and, if necessary, disciplinary action.

Grading: Your laboratory grade for this course will be derived from your performance in the lab (preparation and hands-on experience) and written reports based on the experiments. The relative weights for these three basic components are indicated below:

Lab reports	90%
Lab Conduct and Notebooks	10%

At the end of each lab you will be assigned a maximum of 20 points. Ten of these points will be based on your lab conduct and will be a measure of how well you performed the tasks at hand, your mastery of the experimental apparatus and instrumentation, your adherence to safety guidelines, and your general behavior throughout the laboratory period. The other ten points will reflect your ability to keep a laboratory notebook

Your lab reports will be worth 100 points each. Reports are by the end of the lab period one week after completing the experiment, unless otherwise stated by your instructor. There is a 10 point per day penalty for late lab reports (including the weekend). If you e-mail a copy of your lab report to your instructor you must also submit a paper copy of the report.

Letter grades will be assigned based on straight grading scale shown in the table below.

Score/%	Grade
93-100	A
90-92	A-
87-89	B+
83-86	B
80-82	B-
78-79	C+
75-77	C
73-74	C-
72	D+
71	D
70	D-
<70	F

The instructor reserves the right to increase a student's grade if the instructor feels that it is warranted. Periodically you will be made aware of your class standing so that you can assess your progress and to help you avoid any surprises at the end of the semester.

Important Dates:

DATE	DESCRIPTION
Tuesday, August 27	<i>Last Day to Drop/Add Courses</i>
Mon-Tues October 14-15	<i>No class: Fall Break</i>
Wednesday, October 16	<i>Midterm Grades Available</i>
Friday, October 25	<i>Last Day to Withdraw with a Grade of "W"</i>
November 27-29	<i>No class: Thanksgiving Break</i>
Monday, December 2	<i>Last Day of Classes</i>
Friday, December 13	<i>Final Grades Available Online</i>