Colorado State University
Spring Session 2020

CHEM 475
Physical Chemistry Laboratory - 1
Course Syllabus

Laboratory Location: Yates 503

Instructor: Dr. Joseph DiVerdi
Email Address: joseph.diverdi@colostate.edu
Office Location: Yates 504A
Office Phone: 970.980.5868
Office Hours: MTWRF 11:00 AM – 12:00 PM
Office Hour Location: Yates 501, 502, 503, 504A

Graduate Instructor: Ian Anderson
Email Address: ian.anderson@colostate.edu
Office Hours: MTW 1:00 PM – 2:00 PM
Office Hour Location: Yates 503

Section #: L01 **Laboratory Hours**: R: 3:00 PM - 6:00 PM

Course Objectives: The objectives of this laboratory course are: (1) To provide the student with practical experience in the techniques of experimental physical chemistry. (2) To deepen the student's understanding of the principles of spectroscopy, thermodynamics and kinetics through experimentation. (3) To develop more sophisticated chemical laboratory skills in the student. (4) To increase the student's ability to communicate effectively and professionally both in writing and in speech. (5) To develop the student's ability to read, interpret and understand modern professional chemical literature. (6) To foster, encourage and develop critical thinking and higher-order creative thinking in the student.

Course Topics: The experimental measurement of thermodynamic properties of matter, the design of experiments, the application of experimental physical chemistry methods, the development of instrumental methods and the application of advanced mathematics to problems in physical chemistry.

Prerequisites: CHEM 334 - Quantitative Analysis Laboratory.

Textbook: No textbook is required for this laboratory course. *Garland et. al.* (see below) will be used as a source for many of the experiments to be carried out in this course. Textbooks that should be on the bookshelves of professional chemists at this stage in their development: (1) *Experiments in Physical Chemistry*, Carl Garland, Joseph Nibler and David Shoemaker, ISBN 9780072828429 (2) *An Introduction to Error Analysis*, John Taylor, ISBN 9780935702750.

Academic Policies & Integrity: The University's policies on Students' Responsibilities and Rights including Personal Integrity, Academic Integrity and related areas are presented at http://catalog.colostate.edu/, especially as described in Section 1.6 on "Policies and Guiding Principles". These policies will be followed in this course. The short of it is compactly contained in the Honor Pledge:

"*I will not give, receive or use any unauthorized assistance.*"

Assistance from colleagues, experts and other sources is authorized but a threshold exists above which the assistance must be cited. This will be discussed (at some length) in the laboratory sessions.

Additional information on University policies on course registration, add/drop, withdraw and incomplete grades can be found at http://www.catalog.colostate.edu/, especially as described in Section 1.7 on "Advising and Registration". These policies will be followed in this course also.

Web-based Course Tools: http/:canvas.colostate.edu/. As a registrant of this course, the student can access its site and must do so to view announcements, receive grades and submit laboratory report and presentation files. Experimental descriptions are available at http://www.chem.colostate.edu/diverdi/.

Course Plan & Organization: This laboratory course will be conducted as a "local" course in contrast to a "distance" course. As such, the student is expected to attend each laboratory session from beginning to end of each session, not arrive late and not plan to leave early. Each student is required to submit Laboratory Reports individually although the experimental data used in the creation of these may be collected as a group.

Laboratory Notebook: Each student will create and maintain a Laboratory Notebook throughout this Laboratory course and is required to obtain a bound book for this purpose. It is best used as both a journal (or laboratory diary, if you will) and a workbook. This Laboratory Notebook will be reviewed and a grade applied to it based on the customary requirements for a laboratory notebook.

Experimental Protocol & Description: This document describes a particular experiment with a brief and succinct background explanation, experimental description and resulting data analysis description. An instance of this document exists for every experiment that will be performed in this course. All of these documents will be available in electronic form on Canvas. Obtain and study each one of these documents prior to arriving at the laboratory for the corresponding experiment. Understand the theoretical chemistry that you will be applying before you arrive at the laboratory using your personal library (you are developing your own library of important chemistry texts, aren't you?) or various web-based resources (beware of bogus resources - seek out reputable sources and don't accept everything that is "published"). You are not required to create hardcopy for this course but you may wish to do so for your own benefit; there are computers in the laboratory that can be used for viewing these documents (but not for the first time, of course). Do not use the laboratory printer for creating hardcopy of these documents.

Laboratory Experiments: There are a number of experiments that can be performed in this course; examples are provided below. Each student will perform four experiments. For some experiments, students will work individually and for others, in groups. Each student will not necessarily perform every experiment. Each experiment will occupy three weeks of laboratory time and a Laboratory Report will be submitted individually by each student and for each experiment.

Laboratory Report: A Laboratory Report is the final product of a Laboratory Experiment. Laboratory Reports will follow the standard Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References (Appendices as needed and outside of the page limit) format found in professional journals. (Look up the *Journal of Physical Chemistry* if you're not already familiar with it.) Each Report will be no more than eight (8) pages in length, with a separate title page and in single column format. The Laboratory Report will be submitted both (1) in hardcopy form and (2) coincidently as a single PDF file (no other format is acceptable and **a zero grade will be issued if either is not submitted**) at the beginning of the laboratory period one week after the corresponding experiment commenced. No late submissions will be accepted. (Don't Even Ask.) No "re-grades" will be performed. Plan your work accordingly. Make requests for help to the GTAs and Laboratory Instructor in a timely manner. Print your hardcopy version from the PDF version so that they are identical.

A professional style for the names of files submitted is required. Use lower case exclusively. Use the following format for Laboratory Reports and for Oral Presentations submitted in this course, respectively:

"*475_last_name_report_#1.pdf*"
"*475_last_name_oral_presentation.pdf*"

Oral Presentation/Examination: Each student will make a formal oral presentation of one of the Laboratory Experiments and Laboratory Reports and be questioned about it. The choice of the Experiment to be used in the Oral Presentation will be made by the student in consultation with and with the approval of the Laboratory Instructor. A projector and companion computer will be set up in a classroom for presentations and a laser pointer will be provided. Students will bring their presentations on their own USB disks in **PDF format only** (no other format will be accepted). Students will make a presentation in their regularly scheduled section. Each student will be allocated fifteen (15) minutes in which to make a presentation and answer questions. The presentation order will be reverse alphabetical (using the last name) and all students are expected to be present for all presentations. Students will be expected to make a serious oral presentation at an upper division university level on a topic of chemistry and to demonstrate an understanding of the material by responding to questions from the audience.

Laboratory Grades: Each student's final course grade will be based on (1) the scores earned on the four Laboratory Reports (each worth 100 points), (2) the score earned on the Oral Presentation (worth 100 points) and (3) the score earned on the Laboratory Notebook (worth 100 points). The final course grade will be based on the number of points earned out of a possible 600 points. The final letter grade issued will be based on breakpoints set by the Laboratory Instructor in the final earned point distribution.

The Oral Presentation must be made and the slides must be submitted (as a PDF file) coincident with the delivery of the presentation. Failure to complete both of these tasks at the appointed time will result in a failing course grade, that is, "F."

If a student fails to submit one of the four Laboratory Reports, the Oral Presentation score will be substituted for the missing Laboratory Report score as well as being counted as the Oral Presentation score.

If a student submits all four Laboratory Reports and the Oral Presentation score is higher than the lowest of the four Laboratory Report scores, the Oral Presentation score will be substituted for the lowest of the Laboratory Report scores as well as being counted as the Oral Presentation score.

No extra credit or alternate grading schemes will be offered or issued. Final course grades will be issued from the following list: A, B, C, D or F. No "plus" or "minus" values for the final course grade will be issued. There will be no written examinations, including a final examination, in this laboratory course.

Laboratory Experiments: The following is a list of short descriptions of experiments that will be performed in this laboratory course. The order in which these experiments are performed will vary among the student groups. The exact schedule will be clearly communicated during the semester.

A. Quantum Mechanical Computation - potential energy of diatomic molecules
B. Normal Modes - infrared spectroscopy of halogenated hydrocarbons
C. Rotational-Vibrational Spectroscopy - infrared spectroscopy of hydrogen chloride isomers
D. Nanoparticle Growth Kinetics - near ultraviolet spectroscopy of zinc oxide colloid
E. Rotational Potential Energy Barrier - NMR examination of a chemically exchanging system
F. Steady-State Fluorescence - fluorescence of aqueous quinine and quenching by halide ions
G. Time-Domain Fluorescence - nanosecond fluorescence spectroscopy of aqueous quinine

Laboratory Safety: The physical safety in the laboratory of all personnel including students, GTAs and faculty is of paramount importance. Proper laboratory dress and conduct are required at all times. Students are required to secure and use their own approved (!) protective eyewear. There are no "loaners" available in the laboratory. Additionally, students are required to be suitably attired in the laboratory according to the clearly and previously identified in the lower division laboratory courses at all times. Lastly, professional and courteous conduct is required at all time. Students failing to abide by any of these requirements will be summarily ejected from the laboratory without provision for making up any experimental work missed and without any special consideration in the evaluation and grading of the corresponding submitted materials.

University Activity Conflicts: Any student having a conflict with the Schedule described in this syllabus as the result of scheduled University Activities must to inform the Instructor via e-mail during the first week of the semester. The options will be reviewed at that time and accommodations will be made, both as provided for by University Policy. Otherwise, students are expected to be executing according to the Schedule presented in this Syllabus.

Laboratory Topic Schedule:

Laboratory Schedule		
Week Beginning	Topic	Notes
20 Jan	Course Introduction Experiment #1	
27 Jan	Experiment #1	
3 Feb	Experiment #1	
10 Feb	Experiment #2	Experiment #1 Report Due
17 Feb	Experiment #2	
24 Feb	Experiment #2	
2 Mar	Experiment #3	Experiment #2 Report Due
9 Mar	Experiment #3	
16 Mar	University Holiday	
23 Mar	Experiment #3	
30 Mar	Experiment #4	Experiment #3 Report Due
6 Apr	Experiment #4	
13 Apr	Experiment #4	
20 Apr	Presentation on Presentations Laboratory Notebook Evaluation	Experiment #4 Report Due
27 Apr	Draft Oral Presentation Review	Draft Oral Presentation Slides Due (hardcopy only)
4 May	Oral Presentation/Examination Student Course Survey	Oral Presentation Slides File Due (electronic only)
11 May	Final Examination Week	No final examination

Topics of Great Practical Importance: The following items represent various methods and techniques that are central to the ways of Physical Chemistry.

1. How to prevent the contamination of solid and liquid reagents.
2. How to properly handle and use a high-pressure gas cylinder.
3. How to perform high-quality, well-controlled physical chemistry experiments.
4. How to read analog and digital instruments
5. How to create high-quality graphs and how to embed them in a document.
6. How to create high-quality laboratory reports modeled on high-quality journal articles.
7. How to create robust and portable documents and presentations.
8. How to wrangle experimental data from some sophisticated scientific instruments.
9. How to understand macroscopic chemical systems at a molecular level using spectroscopic principles, that is, through the skillful use of the interaction of electromagnetic radiation and matter.

Homework: There is no specifically assigned or named "homework" for this upper-division university course. Student responsibilities outside of the laboratory are: (1) to prepare for each particular experiment by obtaining the appropriate Laboratory Description prior to the time when the actual experimental work is begun and (2) to create an upper-division university quality Laboratory Report. Within these short descriptions the student responsible for seeking out the information necessary for completing these tasks. As in other upper-division university courses it is considered customary to spend a serious three times the actual contact time on these "homework" activities. Three hours of scheduled laboratory time each week translates into nine hours of out of laboratory work. Your mileage may vary.