Chemistry 303: Physical Chemistry Laboratory
Department of Chemistry and Biochemistry, Loyola University Chicago
Spring 2019

Instructor:	Dr. Dan Killelea
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Email:	dkillelea@luc.edu
Office Hours:	by appointment (FH 103)
Lab Times:	Mondays, 8:30 am – 12:20 pm; Flanner 315
Teaching Assistant:	Marie Turano
	Tu., 10am – 11 am. FH–019.

Course Description

This course will introduce laboratory techniques and analysis central to physical chemistry. We will pursue the following activities (note these topics are subject to change):

This course covers principles and techniques of experimental physical chemistry including the practice of numerical data analysis, solid-state electronics, and vacuum technology along with their applications to magnetic resonance, high-resolution spectroscopy, and chemical thermodynamics. Students will acquire broad-based knowledge of laboratory skills central to experimental physical chemistry.

Course Prerequisites: A grade of C- or better in Chemistry 301 or co-enrollment in Chem 302. If you have not completed the course prerequisite, you may be administratively dropped from the class. Please discuss this with the instructor immediately!

Course Learning Outcomes

1) Explain the interaction of light and matter through diffraction, adsorption, and photoemission.
2) Measure the rate of diffusion of small molecules through a semipermeable membrane.
3) Learn computer programming by creating electronic circuits and developing devices.
4) Describe the principles of vacuum and how thermal desorption from surfaces occurs.
5) Perform an electrochemistry experiment and analyze the results using electron microscopy.
6) Explain how computational and experimental chemistry work together and compliment each other.

Lab Safety: To enter the lab, protective glasses, long pants/skirt, closed-toe shoes, and tied back hair are required. Loose fitting clothing (that hangs and can get in the way) is strongly discouraged. Please use chairs for your winter attire and do not put clothing on the floor or lab benches. Eating and drinking are strictly forbidden in the lab. Pay attention to what you and others are doing. Improper lab conduct will result in significant penalties.

A bound lab notebook will be provided to you. ALL data, calculations, graphs, and work must be written in the notebook.

You must have safety glasses for the first lab.

Schedule

This is our tentative schedule for the semester. The topics and order may change.

Week	*Date*	*Topics*
1	14 Jan	Introduction and Safety Presentation; quick electronics
	21 Jan	*No class: MLK Day*
2	28 Feb	SEM / electrochemistry / Arduino
3	4 Feb	SEM / electrochemistry / Arduino
4	11 Feb	Light/Matter Lab #1
5	18 Feb	Light/Matter Lab #2
6	25 Feb	Light/Matter Lab #3
	4 Mar	*No class: Spring Break*
7	11 Mar	Computational Lab #1
8	18 Mar	Computational Lab #2
9	25 Mar	Computational Lab #3
10	1 Apr	Diffusion and Dialysis
11	8 Apr	Thermal Desorption in Vacuum
12	15 Apr	Final Oral Exams
	22 Apr	*No class: Easter Break*

Grading:

Grades will be determined out of 600 total points:

Notebook:	200 (collected at final)
Lab Reports:	300
Final Oral Exam	95
Evaluation	5

There are 10 experiments; all will be used for your grade. Each experiment is worth 20 points. Lab reports are worth 100 points each.

The following scale will be used:

>92%: A	88-92%: A–	84-88%: B+	80-84%: B
76-80%: B–	72-76%: C+	68-72%: C	64-68%: C–
60-64%: D	< 60%: F		

Teamwork is integral to lab meetings. Points and grades, however, will be grounded upon individual effort and achievement. P-Chem is neither easy nor quick to learn, but the process is rewarding if good-faith effort is made. Students are urged to consult with the instructors to discuss problems before they become serious.

Course Structure:

- This is a lab course, thus, attendance is ***mandatory*** for all meetings. Labs may not be 'made-up' or otherwise rescheduled. If you miss or will be absent, contact DRK as soon as possible.
- Chem 303 will consist of experiments and lessons in data acquisition, analysis, and reporting.
- You will have a permanent lab partner, and together may work in small groups to conduct the experiments. It is important that each member is an active participant in the lab; contact DRK is there is a problem with this, promptly.
- Before each lab, you **must thoroughly read the provided material and complete the first four sections of the report in your notebook** (as described later in this syllabus). You (and you group) may not begin the experiment until these portions are complete.
- Peer learning. For a few of the labs, groups will cycle, rather than each group doing the same lab in a given week. For these experiments, the group that did the lab the previous week will inform the next group how to properly do the lab. This will be part of the consultation / safety assessment.

Consultation / Safety: Each student will have an informal 'consultation' with the instructors at the end of each lab meeting. We will discuss the day's experiment, the data, and the work-up. We will evaluate each student's knowledge of the fundamental chemical principles the lab covered, their experimental technique, the quality of their observations, and their insight into the significance of their observations. Also, effective communication with other groups in helping them get going on their experiment will be evaluated. The safe conduct of the experiment will also be reviewed; lack of safety equipment (*e.g.* proper attire, eyewear, not following instructions) will result in significant deduction of points. Finally, you must thoroughly clean up and put away equipment after completion of the lab.

Notebook: During consultation, your notebook entries for both the current experiment and the *previous* weeks lab will be examined. Your notebook may be collected near the midterm and in the final week for evaluation as well. The notebooks will be evaluated for *thorough notes* about each experiment and the *completeness* of the work.

Exams: There will be a final oral exam worth 95 points. The instructors will conduct these with each lab pair. We will discuss these in greater detail near the middle of the semester.

Course Evaluation: Successful completion of the course evaluation will merit 5 points. Please email DRK informing me that you have completed the evaluation by 5pm on April 28th to receive credit.

Notebook/report format

Each experiment should be organized as shown below. You ***must*** have the first four sections completed in order to begin the experiment.

1: **Title:** Provide a descriptive title for the experiment.

Example: Effect of Halide Electronegativity on the Band-gap of Makebelieveium Nanoparticles

2: **Objective:** Briefly state the objective of the experiment. What is the hypothesis and what data are you trying to obtain to verify the hypothesis, and how will you know if it is verified or not?

Example: The objective of this experiment is to determine if the electronegativity of the halide in Mb-halide nanoparticles shifts the band gap. We will measure the absorption of 10 nm nanoparticles of makebelievium (Mb) halides using UV/Vis spectroscopy. The energy of the absorption peak corresponds to the band-gap, thus by obtaining spectra of nanoparticles for three different halides will allow us to determine if the different halides alter the spacing between the valence and conduction bands in the nanoparticles. If only a small shift is observed, then the electronegativity of the halide is not an important aspect in the energy of the particles, but the observation of a shift among the three halides suggests the band-gap is not simply the result of electron confinement.

3: **Method:** State how you intend to obtain the desired data. For example, how will the materials be prepared, what instruments will be used, in what order must the steps be taken, etc.

4: **Expected Results:** Briefly state what results you expect to observe and why.

Example: The average diameter of the nanoparticles is 10 nm; using the particle-in-a-box approximation, I expect the band gaps to be on the order of 1 eV (100 kJ mol^{-1}) with only small differences for the three halides, for the confinement of the electron in the particle is much more significant that the bonding among the atoms for electrons in the conduction band.

5: **Data/Calculations/Analysis:** All data must be recorded here, as well as observations and the procedure you followed. All calculations and analysis must also be included. For computational work, provide adequate detail so the computation could be repeated if the file were lost.

6: **Results and Conclusions:** Describe the findings of this study. Were the results what you expected? Why not? What changes did you have to make to the procedure or equipment in order to obtain the data? How should the procedure be improved?

Lab Report Format

Lab reports are typed (Times New Roman, 12 point font, single spaced, 1-inch margins), well written, and free from grammatical errors.

These reports are due on February 18 (SEM/ electrochemistry), March 18 (Light and Matter), April 8 (Computational). You are responsible for doing reports for one of the Light and Matter labs, one of the Computational labs of your choice, and the SEM/electrochemistry labs.

Formatting: typed, Times New Roman, 12 point font, single spaced. Figures should be plotted, not drawn.

Sections: Required sections are abstract, introduction, experimental/method, results and discussion, conclusions, references, and appendix.

1) Title
2) Abstract- Briefly summarize the experiment including what you did and your results. This is a summary of your results. Typically a paragraph.
3) Introduction- What is the background information? What topics did you learn in class that relate to this experiment? Explain any theories that apply to this experiment.
4) Method- State what you did (in past tense). The steps should be descriptive enough that someone else could determine what you did and recreate your experiment.
5) Results- What where the results of the experiment?
6) Discussion- Discuss your results. Where they what you expected? Do your results line up with what is reported in the literature? Explain why or why not? Do your results demonstrate a certain scientific principle that the lab was investigating? Explain why or why not.
7) Conclusion- Summarize your results and conclusions.
8) References- Cite any references. While Wikipedia and the Internet are good for understanding the basics of a topic, please include only primary/secondary sources such as books and articles as references.
9) Appendix- Include all your data in raw form.

These reports will be handed in the week after the lab was performed at the beginning of class (8:30am). 10 points will be deducted for every day they are late. The reports will be graded and handed back the following week.

Academic Integrity

All students in this course are expected to have read and to abide by the demanding standard of personal honesty, drafted by the College of Arts & Sciences, which can be viewed at:

http://www.luc.edu/cas/advising/academicintegritystatement/

> A basic mission of a university is to search for and to communicate the truth as it is honestly perceived. A genuine learning community cannot exist unless this demanding standard is a fundamental tenet of the intellectual life of the community. Students of Loyola University Chicago are expected to know, to respect, and to practice this standard of personal honesty.
>
> Academic dishonesty can take several forms, including, but not limited to cheating, plagiarism, copying another student's work, and submitting false documents.

Any instance of dishonesty (including those detailed on the website provided above or in this syllabus) will result in a ***failing grade for the course*** and will be reported to The Chair of The Department of Chemistry & Biochemistry who will decide what the next steps may be.

Teamwork: I strongly encourage you (the class) to work together to solve assigned and unassigned problems. In order to learn and excel in Physical Chemistry, you should work through problems. The assigned problems are a minimum. Work together with your classmates, if you do not understand something, someone else may. You will also find that explaining a solution to your classmate will cement the information in your mind, and make you a better student.

When working as a group, if each member contributes to the discussion, and you each hand in very similar work, that is perfectly acceptable given the nature of the assignments. On the other hand, if someone simply copies an assignment from someone else, that is plagiarism, and will be

treated as such.

Loyola University Absence Policy for Students in Co-Curricular Activities (inc. ROTC):

Students missing classes while representing Loyola University Chicago in an official capacity (e.g. intercollegiate athletics, debate team, model government organization) shall be allowed by the faculty member of record to make up any assignments and to receive notes or other written information distributed in the missed classes.

Students should discuss with faculty the potential consequences of missing lectures and the ways in which they can be remedied. Students must provide their instructors with proper documentation (develop standard form on web) describing the reason for and date of the absence.

This documentation must be signed by an appropriate faculty or staff member, and it must be provided as far in advance of the absence as possible. It is the responsibility of the student to make up any assignments. If the student misses an examination, the instructor is required to give the student the opportunity to take the examination at another time.

(https://www.luc.edu/athleteadvising/attendance.shtml)

Accommodations for Religious Reasons

If you have observances of religious holidays that will cause you to miss class or otherwise effect your performance in the class you must alert the instructor ***within 10 calendar days of the first class meeting of the semester*** to request special accommodations, which will be handled on a case by case basis.

Student Accommodations

If you have any special needs, please let me know in the first week of classes. The university provides services for students with disabilities. Any student who would like to use any of these university services should contact the Student Accessibility Center (SAC), Sullivan Center, (773) 508-3700. Further information is available at http://www.luc.edu/sac/.

Your well-being

If there are events occurring in your life that cause school to diminish in its priority, please discuss this with me or contact the Wellness Center (http://www.luc.edu/wellness/index.shtml) or the dean of students (http://www.luc.edu/studentlife/dean_of_students_office.shtml) for assistance. These are services that **your** tuition pays for and can be invaluable for your personal health and maintaining progress towards your degree.