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

Instructor:	Marie Turano
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Office Hours:	Monday 2:30 pm – 3:30 pm and by appointment (FH 019)
Lab Times:	M, 8:30 am – 12:20 pm; Flanner 315
Teaching Assistant:	Brona O'Sullivan
Office Hours	Friday 10:00 am – 12:00 pm; FH–420

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 302 or co-enrollment in Chem 302.

Course Learning Outcomes

1) Explain the interaction of light and matter through diffraction, adsorption, and photoelectric emission.
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. 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 is *required*. We will provide a lab notebook for you. ALL data, calculations, graphs, and work must be written in the notebook.

You must have such a notebook and 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	26 Aug	Introduction and Safety Presentation
	2 Sept	*No class: Labor Day*
2	9 Sept	Light/Matter Lab #1
3	16 Sept	Light/Matter Lab #2
4	23 Sept	Light/Matter Lab #3
5	30 Sept	Dialysis and Diffusion
	7 Oct	*No class: Fall Break*
6	14 Oct	Information
7	21 Oct	Information
8	28 Oct	SEM / electrochemistry / Arduino
9	4 Nov	SEM / electrochemistry / Arduino
10	11 Nov	Computational Lab
11	18 Nov	Thermal Desorption in Vacuum
	25 Nov	*No class: Thanksgiving Break*
12	2 Dec	Final Oral Exams

Grading:

Grades will be determined out of 500 total points:

Notebook:	200 (collected at final)
Lab Reports:	200
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–
64-60%: 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 MET informing me that you have completed the evaluation by 5pm on December 15th 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 notebooks should be completed soon after the lab. Observations and any changes to the method should be noted ***during*** the lab. Calculations/analysis/results/ conclusions should be completed soon after the lab while the lab is fresh in your mind. Lab notebooks will be collected at the end of the semester (after the final exam.) If you do not hand in your notebook at the time of the final exam, you will lose 10 points for every day it is late.

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 October 14 (Light and Matter lab report), November 18 (SEM/ electrochemistry lab report).

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- Provide an overview of the experiment including what you did, your results (include specific results), and any relevant scientific principles that applied to the lab. 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. Are there any real world applications? Explanations should be detailed enough that a non pchem student will understand the background and how it applies to the lab.
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 without having the procedure to follow.
5) Results- What where the results of the experiment? Include any plots of your data that you collected here. They should be labeled (Figure # 1, #2, etc. and have a brief description of what the figure is/shows.)
6) Discussion- Discuss your results. Where they what you expected? Why or why not. 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. Evaluate your data. What worked in the lab? What didn't? Were there any sources of error?

How could the error have been avoided? How accurate was the experiment?

7) Conclusion- Summarize your results (once again be specific when you mention your results) and draw conclusions. Show all explanations- compare and contrast your data.
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. Should be cited using ACS format.
9) Appendix- Include all your data in raw form.

Your labs will be graded according to the above 9 sections as well as spelling, grammar, units, and readability.

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 in a timely manner.

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 University, can be viewed at:

https://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.
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> Plagiarism is a serious form of violation of the standards of academic dishonesty. Plagiarism is the appropriation of ideas, language, work, or intellectual property of another, either by intent or by negligence, without sufficient public acknowledgement and appropriate citation that the material is not one's own. It is true that every thought probably has been influenced to some degree by the thoughts and actions of others. Such influences can be thought of as affecting the ways we see things and express all thoughts. Plagiarism, however, involves the taking and use of specific words and ideas of others without proper acknowledgement of the sources.

I have no tolerance whatsoever for cheating or plagiarism. ***Any*** *instance of dishonesty (including those detailed on the website provided above or in this syllabus) during a quiz, test, or exam will result in a* ***failing grade*** *for the course*. The Dean of Arts & Sciences and The Chair of The Department of Chemistry & Biochemistry will also be notified. I truly hope to never have to invoke these processes. Please be honest with your work.

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.

Students with Disabilities

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.