CHEM 309A
Physical Chemistry I Laboratory

Coordinator: Dr. Codrina Popescu Office: Pfahler 303D Telephone: x2676;
e-mail: cpopescu@ursinus.edu

Class Schedule: Section A: W 1:30 – 4:20pm; Th 1:30 – 4:20pm in Pfahler 302
Prerequisites: Chemistry 112; Math 112; Physics 112. Co-requisite: CHEM309

Introduction and Goals:
Physical Chemistry unifies physical concepts, mathematical rigor and the close study of chemical processes. The Physical Chemistry lab has the crucial function of placing the abstract concepts encountered in lecture in an experimental context.
The format of this lab will demand you to think and perform experiments independently. Lab skills develop slowly, during a sort of apprenticeship. The goal of this lab is to provide a safe setting for this apprenticeship. Thus, all experiments and apparatuses are described in detail and you receive guidance and advice, as needed. However, you are expected to come prepared to lab. You will make observations, collect data and write them in your notebook. You will interpret these observations and communicate them in your lab reports. Thus, you may think about a lab as a surrogate of a research experience.
Goals of this lab experience are to:

- Demonstrate experimentally established principles in thermodynamics and kinetics (from designing an experiment, to setting up apparatuses);
- Develop research aptitudes by providing experience with diverse types of measurements that can yield new results;

Students will have ample opportunity to:

- Collect, record and report experimental data;
- Do searches and compilations of specific chemical literature;
- Present results in several different report styles.

Structure of the lab:
- You will work in teams of two (maximum three) students. You are free to choose partners. Write teams on board by the end of the first lab session.
- This lab is split in two parts: Part 1, Thermodynamics and Part 2, Kinetics. The Thermo section, containing four experiments forms a cyclic sequence. Groups 1 to 4 will rotate weekly through these four experiments. After that we have the Mid-Term Exam. (see schedule)
- For the Kinetics part, all teams will perform the same experiment, according to the schedule.

Textbooks: A custom-made lab manual compiled with experiments from Halpern, Arthur, *Experimental Physical Chemistry, A Laboratory Manual*, 2nd Ed., 1997, Prentice Hall, and Shoemaker, Garland and Nibler, *Experiments in Physical Chemistry*, 7th Ed., McGraw Hill, 2003. (both required)
Some experiments will send you to the following reference books, available in the library (reserve section):
- *Noggle, Joseph, H.,* ***Physical chemistry,*** *3rd Ed, 1996, Harper Collins.*
- *Engel, Reid:* ***Physical Chemistry****, 2006, Pearson, B. Cummings.*

Recommended Book *The ACS Style Guide: A Manual for Authors and Editors*; 2nd ed. Dodd, Janet S., Ed.; American Chemical *Society: Washington, DC, 1997.*

ASSIGNMENTS AND EXAMINATIONS

Pre-Lab Safety and procedures sheet: Before every session in which you start a new experiment you will write a **Safety and procedures sheet** in your notebook. At the beginning of each lab, you must present your notebook to me, for checking and signing you safety and procedure sheet. You should not start working on your experiment without having the Safety and Procedure checked by me.

Lab Reports: For each experiment you will write either a full lab report or a report sheet, accompanied by one particular section, as required by the schedule. For formal reports, you must present a draft and the calculations one week after you performed the first part of the lab (for one-part labs, one week after finishing). You must follow the guidelines given below in this syllabus. Examples of lab reports are also available.

Examination: There will be two written examinations, one at mid-term (1 and ½ hour) and the final exam (3 hours). If possible, they will be common for both CHEM309L sections.

Grading

Item	Total Points	Percentage
Quizzes	50	5%
Notebook + lab activity	100	10%, checked periodically but the notebook is graded at the end of the semester
Informal, Formal, Oral Reports	Up to 550	Up to 55% 3X 50 +4x100p
2 Examinations	Midterm 100+ Final 200	30% together (People with A in midterm can opt to exclude Part I from Final)
Total	1000 points	100%

Approximate grading guidelines: You will not receive letter grades for individual exams or lab reports. You will receive scores that reflect your performance in each assignment. However, should you wish to discuss your grade at any time in the semester, you are welcome to come to my office. The approximate cut-offs are: > 90%, A; >80%, B; >70% C; >55% D; below 55%, F.

LATE POLICY:

All work should be turned in within the due hours. Work turned in late by students will be returned late to the students.

Penalties are 10% per day.

All work can usually be done within the scheduled lab hours, 1:30pm-4:20pm. However, if you wish to work outside the lab hours, you are free to do that, just announce me when you would like to come. Should you need to make up a lab, continue working after hours or do your work on a different day, ***please contact me in advance (reasonable advance can be just the day before)***.

ATTENDANCE: Attendance is obligatory for all lab sessions. In case of a legitimate reason for missing a lab, notify me immediately. Make-up for missed labs is not permitted, unless the circumstances in which you missed a lab were deemed legitimate and serious.

Inclement Weather: Please notify me if you are a commuter. According to the college's policy, should this class be canceled for reasons of inclement weather, you will be notified. If the dean declares an inclement weather day, commuter students will be excused in case of absence, although class may not be canceled.

Schedule of Lab Experiments

	Wednesday (A), Thursday (B)	NOTES
WK1	AUGUST 29, 30 Introduction: Lab tour and introduction to each Thermodynamics experiment.	*Read for next week: Chapter 1/ SGN and pages 7-34/Halpern;* *Prepare your lab experiment*
WK2	SEPT 5 G1 Critical Point Determination* (SGN) Bring COMPUTER! G2 Vapor Pressure (SGN) – Bring COMPUTER! G3 Heat capacity ratio Cp/Cv (Halpern) G4 Thermochemistry (Halpern)- Bring COMPUTER!	*Prelab: Collecting and analyzing experimental data, reporting errors.)* *The practical instructions for Critical Point Lab will be handed out. **Read the "Discussion" (page 83) in the SGN manual**.
WK3	SEPT 12 Rotation G1 to G4	***Formal report for the calorimetry*** *experiment* (focus on the Results section); Report sheets for the rest.
WK4	SEPT 19 Rotation	
WK5	SEPT 26 Rotation	
WK6	OCT 3 Mid-term Examination: Introductory chapters 1-4 + thermodynamics part (Introductory chapters + first 4 experiments; open notebook)	
WK7	OCT 10, 11 All groups Kinetics: Iodine clock reaction (SGN)*	*Groups use lab manuals indicated in parentheses.
OCT 13-16 MID-SEMESTER Break		
WK8	OCT 17, 18 Continuation of kinetics of Iodine clock. Finalize.	Introduction due + draft of results due in meeting.
WK9	**OCT 24, 25** Kinetics of a homogeneous reaction (Halpern)*	**Final Reports due from Wk 7.**
WK10	**OCT 31, NOV 1** Kinetics of a homogeneous reaction. Finalize	**Full drafts are due. Meetings optional.**
WK11	**NOV 7** **G1** Enzyme kinetics (SGN) **G2** Enzyme kinetics (SGN) **G3** Enzyme kinetics (SGN) **G4** Enzyme kinetics (SGN)	**Final Formal Lab reports are due.**
	NOV 14 **G1, G2:** Enzyme Kinetics (SGN) **G3, G4:** Enzyme Kinetics (SGN)	**Draft of first part of lab report due (with calculations)**
NOV 21 TO 25 THANKSGIVING BREAK: No classes		
WK12	**NOV 28, 29 Finalization of Enzyme Lab Experiments**	**Second draft due (with calculations)**
WK13	**DEC 5, 6 Clean up + Discussions of lab reports**	**Drafts of WHOLE Enzyme Kinetics lab are due** **Final report due on December 12 at 5pm.**
Final Exam:	**A final exam which contains: the introductory chapters + Part I and Part II of the lab experiments; Students with 85% or higher in midterm can opt out of the Part I of the exam.**	**If you ALL prefer a common day of final, please discuss with me before the midterm.**

Safety and courtesy

The safety goggles approved by the Chemistry department should be worn at all times. (You must buy a pair of these goggles from the stockroom before next Tuesday.) You will comply with the departmental policy of safe attire in the lab. (see attached) It is your responsibility to be aware of the hazards of each lab and act accordingly. Be aware of what is going around you. Remember, your lab mates will be working on different experiments.

Dispose of all chemicals in a proper manner and leave each experimental set-up in the same or better ☺ condition than you found it.

Work with me, we do not have TAs. If you don't know something, ASK!

Be polite to other people. Remember that these labs take work, from you and many other people! Your colleagues, instructor, your TAs, and Mr. Robinson deserve your courtesy.

Finally, never work alone in lab.

Experiments

Experiments will be performed with a partner during the scheduled lab period. Arrive on time! You will need to come prepared and work efficiently in order to finish within the allotted amount of time.

In carrying out an experiment, you will make several "runs" (sets of measurements). It is worthwhile to do a practice run, as a warmup test, to make yourself familiar with the instrument. As soon as you understand how to operate, proceed immediately to collecting your data. Do not waste any time!

During an experiment, don't just collect data and plan to think about them later. Make a rough plot to observe possible trends, or to notice possible problems. If you notice that there are problems, troubleshoot the apparatus and repeat the data collection.

Be alert at noises, high pressure, high humidity, local heating, sparks. Notify me immediately if you become suspicious of malfunctions of instruments.

Notebook

The notebook is the crucial connection between what occurs in the lab and the rest of the world. The notebook should contain all the necessary information that would be needed to permit someone else to perform the same experiment in the same way.

You will keep a complete record of your laboratory in a **bound notebook**. If the pages are not numbered, number the entire notebook yourself. (see lower for instructions). The notebooks WILL be reviewed each week by me. If you want to see a model, ask. ☺

It is important to keep your notebook current. Remember that the notebook is an official document, which can be used as proof by you or by your supervisor in a company or any research laboratory. The notebook is to be a complete record of what you have done in lab, so keep it neat and well organized. Ideally, you should be able to find this notebook in ten years and easily repeat all the experiments! Some information should be entered into the notebook before you come into lab, while the rest is recorded while you are in the laboratory.

How do I grade notebooks weekly? I go around the lab, talk to you, ask you what you are doing. Then I take your notebook and look at your procedure notes. At the end of the lab, when you are finished, I may check again your notebook. Your data and observations should be there.

The notebook should include:

- Table of Contents that includes title of experiment, dates experiment performed, and pages on which experiment is recorded.
- In the body of the notebook, begin a new experiment on a new page and write the title of the experiment and the date at the top of the page. If for some reason, there are empty pages between

experiments, draw a line through the entire page. Use a pen, NOT a pencil.

- Objective or Purpose: Write a sentence or two about what you plan to do and how you will accomplish it.
  e.g. I will measure the heat of combustion of naphthalene using bomb calorimetry.
- Procedure and MSDS Info – before lab
  • Before you come to lab, you will write the safety information and a summary of the procedure in your notebook. Moreover, you will sketch the apparatus and make quick notes on how the book indicates you should use it.
  Additionally, reference in your notebook the pages in the manual where you found the procedure, so you can find it later. If there have been any changes to the procedure, note them.
  e.g. The procedure was that on page 165-168 of Shoemaker, Garland, and Nibler. A pressure sensor (include type and maker) was used.

  • While you are in the lab, you should record what you do. e.g. Weighed the pellet and wire using a Mettler analytical balance.

During the lab period: I will explain the operation of your instrument and how you collect data. You are expected to write some quick (but neat) notes about the operation. You may do that after we finish explaining and talking.

- Data: Record all the data neatly. When appropriate, use Excel to create tables and graphs. Write down the parts of even the simplest calculations. If you make a mistake, you will still be able to correct it later.
- Observations: Observations should include appearance or disappearance of droplets, gas formation, color, odor, or anything unusual that happens. This may help elucidate the cause of outlying data.
- Calculation and Results For written reports, your calculation and results will go in the report; in case of informal oral reports, these calculations should go in your notebook. (I will announce, if this is the case.)
- Graphs Any graphs you create from your data should be taped neatly into your notebook. If they are generated as you make the report, you don't need to tear them from the report. You should neatly paste a copy in your notebook.
- Do not tear out your reports in order to put parts of them in your notebook. Print out graphs or tables separately and paste them in your notebook. Keep your reports in a folder for future reference.

Guidelines for Formal Lab Reports (follow these instructions!)

- Learning how to write a good lab report is a crucial part of the training you will get in this class. A good lab report is complete, scientifically correct and written in correct literary English, in a concise and precise scientific style.
- All lab reports in PChem must be typed and all graphs and figures must be generated on a computer. (graphs in EXCEL and figures in PowerPoint). Formal lab reports may be submitted in either paper or *electronic form.*
- Collection of lab reports: Keep all your drafts and final reports in a collection. At the end of the semester you will submit the collection with your notebook. (However, your reports will be graded ONLY at the time of submission.)
- Lab partners may discuss the results and work on calculations together, but each person will write up his or her own report separately.

A) Formal Written Reports. Obligatory sections: *(attached is also a sample grading sheet)*

1. Title, Name, Partner, Date

2. Abstract : maximum half a page. Should be written after you completed the experiment and know most of the results. Should contain only the important goals, methods and conclusions of the experiment.

2.1. Purpose of Abstract

Summarize the principal findings

Give your reader fast access to the nature and scope of your paper (the reader decides whether to read the whole paper)

Allow editor to pinpoint key features for indexing

Often used in Chemical Abstracts

2.2. An abstract should…

Briefly state the problem or purpose of research (80-200 words)

Indicate theoretical/experimental plan used

Summarize the principal findings (include numerical results)

Point out major conclusions

Be self-contained

Be written LAST

2.3. An abstract SHOULD NOT…

Add, evaluate or comment on conclusions in the text

Cite specifics of the paper

Contain equations/structures that take up more than one line

3. Introduction: depending on the experiment's complexity can vary from half a page to two pages.

Clear statement of the problem and why you are studying it. (For a lab report, usually this statement is titled Objective and indicates what property you measured, on what substance, and using what method in two or three sentences.)

An introduction goes from GENERAL to SPECIFIC.

A concise background of the problem and what has been done before, citing relevant references.

Include, where appropriate: - the chemical reaction studied
- formulae and theories used to interpret the data

Significance, scope and limitations of your work:

How does your work contribute?

How is this related to or is different from previous research?

Introductions are in present tense (Theory and background IS)

All equations cited should be on separate line and numbered. (to easily refer to equations)

End with a specific statement regarding the paper, such as "In this study, we report…" Or "This work focuses on the …."

4. Experimental Methods and Materials**:**

In general

Do not give instructions, or copy from the lab textbook.
Provide enough detail for an experienced worker to reproduce your results.
Use tables when appropriate
Subdivide the section if appropriate

Include: 1. Materials
Source
Degree of purity and amount
Chemical Names, formulae
Structures if they are uncommon or if isotopes and specific isomers are used.
Avoid trademarks and brand names

4. 2. Apparatus
Describe/diagram if not commercially available
Otherwise, indicate company and model

4.3. Procedures
Describe unless established. Do not copy from the manual.
Refer to the literature procedures.

4.4. Hazards
e.g. explosive, pyrophoric, toxic
Include precautionary handling instructions in a separate paragraph labeled "Caution!"
Refer to MSDS
Waste disposal
Safety considerations

4. 5. If report is theoretical
Include sufficient mathematical detail so other workers can reproduce derivations and verify your numerical results
Include background data, equations, formulae.

4. Results: This is the most important section of your paper.

Summarize the data collected and the statistical treatment
Include relevant data, give enough detail to justify your conclusions
Use equations, figures and tables if necessary for clarity
Past or present tense

Advice: When you are writing your lab report, you should already have the calculations done. Data should be organized in tables and you should not waste your space with raw data, but show tables of pertinent information. *For instance:* for kinetics experiments, you should first calculate your concentrations and rates for each trial, then make a table in which you put these columns, organized by trial. You should not put volumes or times in the table. Those are intermediary steps, which should show up in your notebook.

Organize the results, include tables in the order that makes more sense for the reader; include units and uncertainties; explain how you obtained these values from your raw data; attempt explanations of your results and observations; the raw data should be included in the Appendices.

Tables, Graphs and Figures: These belong to the results section. Each table, graph or figure should be accompanied by a caption. The caption should NOT say" This figure/table shows the dependence of the velocity of the ship versus the wind velocity".

The correct caption should say: "**Figure 1**. Dependence of the velocity of the ship (m/s) on the wind velocity (m/s)." Note that units have to be included in the caption for graphs. Tables should have either a title or a caption, not both.

It is preferred that you use titles for tables and captions for graphs and figures.

Sample Calculations The use of spreadsheets for repetitive calculations is highly encouraged.

However, include a written-out example of each type of calculation. Show the equation algebraically and then show it with numerical values substituted. Always include your units. Remember to watch your significant figures! **For every sample calculation, also include the sample uncertainty calculation.**

5. Discussion:

Purpose of discussion:

To interpret the results in the light of known theories and previous experiments

To relate the results to the original purpose of the project: have you solved the problem? Have you found other problems?

To compare results with previously published results

Be objective

What exactly have you contributed

State the implications of your results

Point out features and limitations of your work

Suggest further study

Advice: Discuss the results in light of previous results that you find in the papers given at the back of the chapter in the book. For kinetics experiments, you will obtain reaction orders and rate laws. You should discuss what experimental conditions influenced your determination (stirring vs. not stirring, temperature fluctuations, concentration of the indicator, calibration curve with large uncertainty; if you suspect that your molar absorptivity coefficient is incorrect, contact me before you write the report.) Kinetic data are used to propose or disprove mechanisms. This is the moment to learn this skill and use it.
Comment on the technique, errors, on whether your experiment was successful or not and why.

6. Conclusions: A separate section of conclusions is not necessary if conclusions have been stated in the Discusion section.

SHOULD…

Be brief

Restate major findings

Put interpretation into context of original problem

SHOULD NOT

Repeat discussion points

Include irrelevant material

Introduce something new

Include your “feelings” or “hopes” about an experiment.

7. References. References should be grouped in a section at the end of the report.
Properly cite your sources of information, according to the ACS Style Guide. Use the citation format of the Journal of the American Chemical Society.

B) Writing Style: The style should be concise and precise. Always *spell check and proof read your report* before you submit it. Submit a draft if you wish. It will not be graded, but we will suggest modifications. If a sentence is longer that two lines, try to rephrase and shorten it.

Spelling Errors: A report with too many spelling errors will not be graded. Spell-check your document, but watch for inappropriate choices that Word will make and discard them.

Dedicated spelling and notations for chemistry: You are strongly advised to buy and consult the ACS Style Guide for general rules on scientific writing.

Statement of Academic Honesty

Academic Honesty: Plagiarism and cheating: All writing assignments must be prepared individually. Do not copy solutions from the solution manual. Should you include any written material from the World Wide Web, original articles or books in your assignments, exercise particular care in using proper citation and precise references.

Homework policy: You are encouraged to work together on homework assignments. However, the work you submit cannot be copied directly from another student's work and cannot be submitted through e-mail, faxed etc, unless specific emergency procedures have been approved prior to submission. Each assignment must indicate the names of all group members. If identical work is submitted by people who did not belong to the same group, both students will receive no credit for the assignment. All group members must participate in good faith in preparing solutions to the problem sets. It is a serious breach of ethics to include the name of someone who did not contribute.

The college imposes severe penalties on students who cheat. Please read the the following excerpt from the *Student Handbook* on academic honesty, plagiarism, and procedures for suspected academic honesty violations for further details.

Academic Honesty. (from pages 10–11 of the Ursinus College Student Handbook) Ursinus College is a small community, which functions on a social contract among students, faculty, administration, and alumni. In order for the spirit of community to endure and thrive, this agreement, based upon shared values and responsibilities and a sense of mutual respect, trust, and cooperation, must be preserved. Students have an obligation to act ethically concerning academic matters and the faculty has a responsibility to require academic honesty from students and to be vigilant in order to discourage dishonesty. Lying, cheating, stealing, plagiarism, and other forms of academic dishonesty violate this spirit of mutual respect and collaboration and corrode the atmosphere of openness and free inquiry upon which the educational process is based. Such activities are demeaning and potentially damaging to those who undertake them. Moreover, academic dishonesty is damaging to the student body as a whole, in that it cheapens the achievements of the honest majority of students and subverts the integrity and reputation of the institution with which they will be identified for the rest of their lives. Students should be aware that there are many legitimate sources of help available on campus. Several departments, s provide help sessions. There is a writing center run by the Department of English, and the Library provides research help. Tutorial services are coordinated through the Unity House for all disciplines and peer mentoring services are arranged by the Dean's office The student body, faculty, and administration of Ursinus College therefore unanimously condemn academic dishonesty in all its forms and affirm that it is the responsibility of all members of the college community to prevent such activity.

STATEMENT ON PLAGIARISM

Plagiarism is the act of taking the words--written or spoken-- or the ideas of someone else and passing them off as one's own. You are plagiarizing if you copy exactly a statement by another and fail to identify your source. You are plagiarizing if you take notes from a book, an article, or lecture, express those materials in your own words, and present the result as your work without identifying your source. You are plagiarizing if you copy part or all of a paper written by a friend, another student, or a writing service and offer it as your own work. You are plagiarizing if you take material verbatim from a source (even though the source is acknowledged) without identifying it as quoted material by means of quotation marks. Plagiarism is easy to avoid by using common sense and following the advice and directions for acknowledging sources. Such forms and methods are available from professors and style sheets provided by departments as well as by a composition textbook. Never take notes verbatim or in your own words without using appropriate quotation marks and noting exact sources, including page number of the material. It is the policy of Ursinus College to reject and punish the act of plagiarism. The above has been adapted from, and credit is given to Millward, *Handbook for Writers*, pp. 354-355.

For example, you are cheating if you:

1. Copy answers or use information from a fellow student's paper during a quiz, test, or examination.
2. Divulge answers or information, or otherwise give improper aid to another student during a quiz, test, or examination or accept such aid.

3. Relay or receive any improperly obtained or confidential information concerning a quiz, test, or examination. (Example: if one sees the test before it is to be given and transmits information concerning its contents or whereabouts to other students.)
4. Use or refer to any unauthorized notes, books, calculators, problem solving aids such as "cheat sheets" during a quiz, test, or examination.
5. Collaborate improperly with another student on an open-book or take-home quiz, test or examination; or obtain information from an unsuspecting fellow student during such an exercise.
6. As a proctor or student assistant, divulge confidential information or aid any student in an improper manner during a laboratory exercise, quiz, test, or examination.
7. Commit an act of plagiarism in any form.
8. Borrow under false pretenses, steal or otherwise improperly obtain lecture or research notes, laboratory data, or any information gathered by another student and presents it as your own work (examples: term papers; laboratory reports or experimental yields; computer programs or assignments; English composition themes), or knowingly collaborate with another student by making such material available to him/her.
9. Falsify laboratory data, notes, results, or research data of any type in any course and present it as your own work.
10. Steal or intentionally damage or destroy notes, research data, laboratory projects, library materials, computer software (including the intentional passing of a computer virus), or any other work of another student (or faculty member), out of malice, or for the purpose of sabotaging that person's work and thereby gaining an unfair advantage to yourself.
11. Knowingly and willingly violate any special rules concerning research procedures, group assignments, or inter-student collaboration, which may be established by an instructor in any course.
12. Submit the same work including oral presentations for different courses without the permission of the instructors involved. Since it is expected that different courses offer different learning experiences, students are depriving themselves of an educational opportunity by submitting the same or similar work for more than one course. Examples include but are not limited to submitting a partial or complete paper previously handed into another class, superficially reworking one assignment for submissions to another class. (Example: submitting a sociology paper as an English 100 paper.)
13. Misrepresent yourself to an instructor or an administrator for the purpose of gaining special favors or extensions for academic work missed. Examples include but are not limited to lying about your health or the health of a relative, forging doctor's notes.
14. Forge signatures on forms, documents, or letters pertinent to College business. This may include but is not limited to course of study sheets, drop/add forms, or doctor's notes.

You are an accessory to cheating, and penalties may be applied, if you:

1. Witness or have direct knowledge of any of the aforementioned forms of cheating and fail to inform an authorized person (faculty member, administrator, proctor. or student assistant).
2. You bring unauthorized materials into a testing area and fail to or refuse to remove them when instructed to do so.
3. You fail to or refuse to comply with admonitions from a faculty member or authorized proctor to cease any activity, which might aid other students in cheating.

These guidelines apply to your work on any assigned problem, quiz, exam, or in-class exercise. You generally may not collaborate with another student unless specified by me. One exception is on outside class assignments that are not collected. On these assignments I encourage you to work with each other, but I also encourage you to first work on the problems on your own.

By signing this statement, I acknowledge that I have read and consider myself bound by these rules of honor.

Student's Name (please print) _____Signature _____