

Advanced Laboratory I
CHEM 3860 All sections WAC
Fall 2021 (**Tentative**)

INSTRUCTOR: Dr. Eric W. Findsen
OFFICE: WO 2278 (or BOL185)
Office Hours: Posted on Course Website
Office Phone: 530-1506

Class Lecture:	Sec 001	Tuesdays	1:00 PM - 1:55 PM	BO 2047
	Sec 004	Tuesdays	5:30 PM - 6:25 PM	BO 2049
Class Laboratory:	Sec 002	Tuesdays	2:00 PM - 4:50 PM	BO 2097, 2095
	Sec 005	Tuesdays	6:30 PM - 9:20 PM	BO 2097, 2095
Credit Hours:	2			

Pre-requisites / co-requisites: Chemistry 3730 or 3710, Math 1860, Physics 2140

Course Catalog Description: Laboratory experiments and techniques relating to subjects developed in CHEM 3730 or 3710.

TEXT: "Experiments in Physical Chemistry", Garland, Nibler, and Shoemaker; 6th, 7th, 8th, or 9th edition.

SPECIAL COURSE EXPECTATIONS DURING COVID-19

Maintaining a safe campus during the ongoing COVID-19 pandemic remains a top priority. UToledo continues to follow the guidance of the U.S. Centers for Disease Control and Prevention and Ohio Department of Health to keep our campus safe.

ATTENDANCE

The University of Toledo has a missed class policy. It is important that students and instructors discuss attendance requirements for the course. Before coming to campus each day, students should take their temperature and complete a self-assessment for symptoms of COVID-19, such as cough, chills, fatigue or shortness of breath. Anyone with a temperature at or above 100.0 degrees Fahrenheit or who is experiencing symptoms consistent with COVID-19 should not come to campus and contact their primary care physician or the University Health Center at 419.530.5549. For more information on the symptoms of COVID-19, please go to <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>

COVID-19 testing for sick students is available on both Main Campus and Health Science Campus. Call 419.383.4545 for an appointment. Absences due to COVID-19 quarantine or isolation requirements **are** considered excused absences. Students should notify their instructors and follow the protocols summarized in this document on [Navigating COVID-Related Course Concerns](#).

In the event that you have tested positive for COVID-19 or have been diagnosed as a probable case, please review the [CDC guidance](#) on self-isolation and symptom monitoring, and report the disclosure to the Division of Student Affairs by emailing StudentAffairs@utoledo.edu or by connecting with their on-call representative at 419.343.9946. Disclosure is voluntary and will only be shared on a need to know basis with staff such as in the Office of Student Advocacy and Support, The Office of Residence Life, and/or the Office of Accessibility and Disability Resources to coordinate supportive measures and meet contact tracing requirements.

FACE COVERINGS

Face coverings are required while on campus, except while eating, alone in an enclosed space, or outdoors practicing social distancing. Students will not be permitted in class without a face covering. If you have a medical reason preventing you from wearing a face covering due to a health condition deemed high-risk by the CDC, submit an [online application](#) to request an accommodation through the Office of Accessibility and Disability Resources. Students will need to provide

documentation that verifies their health condition or disability and supports the need for accommodations. Students already affiliated with the Office of Accessibility and Disability Resources who would like to request additional accommodations due to the impact of COVID-19, should contact their accessibility specialist to discuss their specific needs. You may connect with the office by calling 419.530.4981 or sending an email to StudentDisability@utoledo.edu.

VACCINATION

Doctors and other health care professionals agree that the best way to protect ourselves and each other is to get vaccinated. Case data clearly show that vaccines remain highly effective at preventing serious illness from COVID, including the highly contagious delta variant. If you have not yet received your COVID vaccine, the University encourages you do so as soon as possible. No appointment is needed to get the shot at the UTMC Outpatient Pharmacy, University Health Clinic or Main Campus Pharmacy. Once you receive the COVID vaccination, please register on the COVID Vaccine Registry site at: <https://utvaccinereg.utoledo.edu/>.

SPECIAL NOTES

It's important to note, that based on the unpredictability of the COVID-19 virus, things can change at any time. So please be patient and understanding as we move through the semester. I also ask that you keep me informed of concerns you may have about class, completing course work/assignments timely and/or health concerns related to COVID.

University Policies: *Policy Statement on Non-Discrimination on the basis of Disability (ADA) The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance*

The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course please contact the Student Disability Services Office.

Course Objective: The purpose of this laboratory course is to place in a practical light, concepts presented in the physical chemistry lecture series. These principles are fundamental to the understanding and application of chemistry. This is a very demanding course with respect to time and effort. **As with any course, what you learn from this experience is directly related to the effort you put into this course.** The primary job component for a chemist is laboratory work. This course will continue your laboratory training with more rigor and help improve your attention to experimental details.

Technology Requirements: Access to computer with word processing and spreadsheet software, USB Flash drive at least 1 GB capacity. Students are expected to have access to a computer, Microsoft Word, Microsoft Excel, and S Math Studio(Optional). If you do not have access to a word processor you can download a Microsoft compatible freeware word processor and spreadsheet software from Open Office or Office Libre. You have access to online journals through the electronic subscriptions available on campus through Carlson Library. You may occasionally need to use Scifinder software. If you do not know how to access Scifinder or online electronic journals it is your responsibility to ask either a T.A., the instructor, or a member of the library staff for assistance. Note: in general, electronic journal subscriptions must be accessed through the University web servers. S Math Studio is like a math scratch pad and a link to the download site is located on the course website. There are also documents which can help you learn to perform the basic calculations required for this course.

Electronic Media:

This is a Blackboard assisted course. There is a specific Blackboard site for this course containing all documents supplied by the instructor. You are expected to check this site no later than the night before your lab meets for any changes or additional lab related announcements.

Attendance: Attendance is required at all recitation meetings and all lab periods. If work has been completed on the current lab (of two week lab), then analysis of data can be worked on during the lab period.

GRADES: Grades will be based upon;

Technical Reports	(8 x 100 pts. Each)	800 pts.
Prelab Reports	(8 x 20 pts. Each)	160 pts.
Lab technique evaluation		100 pts.
Exercises #1 & 2	(2 x 20 pts. Each)	40 pts.
<u>Final</u>		<u>100 pts.</u>
Total		1150 pts.

Plan on a straight scale i.e. > 90% = A; 87-89 % = A- etc.

Final Exam:

There will be a final exam covering concepts investigated in the laboratory experiments. The exact format of the exam will be provided later in the semester. The final will cover theory and instrumentation used in experiments performed this semester and material in the assigned sections of the text. You are expected to read the assigned sections of your lab text.

Failure to turn in a lab report for every experiment will automatically result in a grade of **F for the course.**

Failure to turn reports in by their respective due dates will result in a severe point penalty of up to 15 points per day unless permission is granted by the instructor.

Plagiarism is partially defined in The University of Toledo's policy on Academic Dishonesty. This definition is extended to include (this list is not inclusive); obtaining past reports and copying the text or information in them, copying and using reports/ information posted on the internet, copying or paraphrasing texts' or articles, any behavior which is deemed by the instructor to fit within the intent of the University of Toledo's policy on Academic Dishonesty.

Plagiarism in any form can result in the award of zero for that specific prelab and the report. After the award of the grade of zero for a prelab or a report, a repeat of the offense will result in the award of a grade of **F for the entire course.**

I am aware of student access to previous student's reports. If I find proof these have been used in the creation of a current students' report, I will assign a grade of **F for the course and note that academic dishonesty was the cause of the grade on your transcript.**

LAB NOTEBOOK: A standard laboratory notebook (with duplicate pages) is required for observations and experimental data. You must turn in legible copies of your notebook pages with your report.

Electronic devices such as tablets, net books and laptops are not acceptable substitutes for a paper laboratory notebook. They are not to be used in the laboratory environment. The risk of chemical contamination is severe. Cell phones are not to be out during lab unless approved by the instructor. Students will have to de-glove, wash hands get the phone, take the photo or go out in the hall and when finished, put the phone away before re-gloving and starting work. .

BEFORE LAB:

Prelabs: Are due the Saturday before the start of the experiment at 8 PM. Resources for Prelabs and Reports:

Text book and documents contained in the experiment folder on the course website. Additional information can be found in the references provided at the end of the experiment in the text or the experiment document in the experiment folder on the course website. You can also look at the lecture text book for information related to many of the experiments.

Reference articles in journals that are hard to access are provided in each experiments' folder. All others are expected to be accessed through the university library's online subscription services.

Instrument operating manuals and supplementary materials for laboratories in this course are available online in the course website. You are expected to read them before operating the instruments or writing your prelab.

Since we have to perform most experiments in a rotation basis, students will most commonly have to prepare, execute, and write up experiments whose topics you haven't addressed in lecture. This is a common problem for physical chemistry labs. When preparing for labs, read the appropriate topic(s) in your lab and lecture texts and other references provided in your texts and on the course website before starting your prelab. If the material still doesn't make sense, ask the instructor.

Also suggested: "Writing the Laboratory Notebook", H.M. Kanare, American Chemical Society.

Prelab Report. (20 pts.) Due by 8:00 PM the Sat. before the experiment is started on the following Tuesday. They will be turned in electronically using the prelab links on the course web page. If the prelab or a student's response to the written and/or oral examination are deemed inadequate the student(s) will not be allowed to start work. **A chemical hazards form must be completed for every chemical used in an experiment. It can be used when answering the safety questions below. Chemicals used in multiple experiments only need be written up once, by saving the form for that chemical, you can simply attach it to the appropriate prelab.**

The purpose of the prelab is to prepare you for the experiment. Also, it will demonstrate that you have read the experiment and any associated literature to show that you have a basic understanding of the principles, procedures, and safety precautions that are involved. **This document (as with all work in this lab) is to be in your own words.**

There will be a brief introduction to the experiment discussing the principle being investigated. This will include a brief synopsis of the theoretical basis for the principle being explored.

A statement of the experimental observable (a.k.a. physical observable) which you will physically measure.

The equation(s) you will use to convert the experimental observable into the value related to the principle being investigated.

The procedure, written out, that you expect to use. Do not "blindly" copy the procedure in the text. It may not be the procedure you are to use or use the same instrumentation. This action makes you appear unprepared and you will be evaluated as such. It also may lead to plagiarism.

The safety portion is crucial. Describe specific safety concerns based upon the procedure to be used, the equipment used, and the chemicals to be used. MSD's are required for all chemicals used in the experiment. Be sure to be able to answer the questions presented below.

By writing this prelab it is expected that you will have thought about the concepts and procedures involved and have an appreciation of the important aspects of the experiment. Instrument operating manuals and supplementary material for laboratories in this course will be available either in the laboratory or on the course website. ***If your effort is deemed inadequate, you and your partner will not be allowed to start working. You will get no extra time to complete the experiment.***

In Lab:

Before you will be allowed to start working you will take a written quiz on the experiment you are performing. You must be prepared to answer the following questions regarding the experiment you are going to work on. Failing the written quiz will result in either a delay in starting the lab or ejection from the laboratory. You may also be quizzed orally during the experiment.

If you cannot answer the following questions orally/written out, you will not be allowed to start work.

- 1) What is the goal of the experiment?
- 2) What is/are the experimental observable(s)?
- 3) How does one get from the experimental observable to the goal of the experiment?
- 4) Put simply, what is the theory behind the experiment ?
- 5) What new techniques are used in the experiment?
- 6) What experimental or environmental factors must be controlled or recorded?
- 7) Safety concerns for the experiment.
 - A) Relative toxicity of reactants, products and solvents.
 - B) Reactivity of reactants, products and solvents
 - C) Routes of exposure.
 - D) Symptoms of exposure.
 - E) Waste disposal.
 - F) Safety with respect to instrumentation or apparatus used in the experiment.

Supplementary Data:

A new policy for supplemental data is in place. With the exception of two experiments; DOG and the High/Low pass filter experiment in the electronics lab, there will be no supplementary data supplied to students except under two specific circumstances;

- 1) an excused absence from lab or 2) failure of instrumentation.

Otherwise students must analyze the data they have. Supplementary data, if supplied, will only be provided by the instructor and must be based on an email request. Each partner is responsible for obtaining their own copy of the supplementary data. You must state in your Report(Post Experiment Analysis) which data was supplied and the potential error between your data and the supplied data discussed. While there is not a great deal of weight(with respect to grades) given to results, it is expected you will have completed the experiment and provide results for all sections.

POST EXPERIMENT ANALYSIS:

The computers in the Physical Chemistry Laboratory will be available for use in analyzing your experimental results. They will be available outside of class by appointment You may also use them during other lab section meeting times but members of the section in session have priority.

Lab Reports: (100 pts.)

Lab Report Submission:

Lab reports are to be turned in electronically using the course website. Reports can be uploaded in sections. Be sure to indicate that a report has been submitted in sections on the first page of the main report body. Be sure to submit the report, copies of lab notebook pages for the experiment, any Excel files or other application data files used in the analysis. Indicate how many files are comprise your report and indicate what software was used to generate a particular data file. I.E. Quattro Pro, Excel, SMath Studio software etc. The body of the report is expected to be submitted as a .pdf file.

The lab report is the finalized document for an experiment. It presents the experimental goal, procedure, results you have obtained, and discusses them (your results) relative to the theory behind them and compares your results to literature if possible. Reports are to be typed and will be 10-14 double spaced (size 12 font) pages in length. Reports must include tables and graphs whenever possible to enhance readability. Computer files that contains your data files and calculations are to be submitted in addition to the report. Reports are turned in through the course website in the folder labeled **Report Submission**.

Report Deadlines:

Post lab documentation will be due one week and two days after the scheduled completion of the lab by the student(on Thursday (at 10:00 PM)). There are very few acceptable reasons for a report to be turned in late.

Late lab documents will not be accepted unless;

- 1) Prior permission is given by the faculty member(Prof. Findsen, not the T.A.) **in writing**. This approval must be attached to,or submitted with, the report.
- 2) Documentation(EWF) is provided that the student was incapacitated according to University of Toledo Criteria. **T.A.'s do not have the authority to grant extensions for report deadlines. If not approved by the instructor, late reports will be subject to a penalty of up 15 pts./day past the due date.**

All lab reports must be turned in by the date specified by the instructor to be eligible to receive a passing grade for the course. **Reports are due one week and two days from date of scheduled completion at 10 PM.** Requests for extensions must be addressed to the faculty member (EWF). Bear in mind that there are very few acceptable justifications for an extension of the due date. Late reports must have documentation submitted with the report to avoid a substantial late penalty of up to 15 pts/day. With possible refusal of acceptance.

Teaching Assistants do not have the authority to allow a report to be turned in late.

Use the document titled **Report Template** on the course website to assist you in writing and organizing your reports.

So you know the procedures the T.A.'s are expected to follow:

Prelabs:

Need to be returned by Monday afternoon. They should be returned with the grade break down and comments. Any significant poor areas, i.e. safety, procedure etc. should be brought to the students attention by email with me cc'd. Students who have not turned in their prelabs by 6 PM Saturday night need an email sent to them with me cc'd. You will apply a 5 point penalty. Students who turn in their prelabs after noon on Sunday (final due date) will receive a penalty of 10 points deducted from their score. For those students who have not turned in their prelab by noon Sunday morning, email me and let me know. They are subject to dismissal from the lab.

Reports:

The same procedures as described for prelabs apply to reports as well. The due dates are 10:00 PM Thursday night the day they are due and Friday noon as the second deadline. Missing the first deadline is an automatic 10 point penalty. If they miss the second deadline the penalty can be as much as 15 pts./ day. The only exception will be reports which have a copy of an email from me granting an extension and for how long and any penalty to be applied. Verify with me as to authenticity. Again, extensive comments are expected. A copy of the grade breakdown is to be included with the returned report. Send the instructor a copy of the graded report.

LECTURE SCHEDULE: (weeks and topics are estimates)

<u>WEEK</u>		<u>TEXT CHAPTER</u>	<u>Exercises due ()</u>
1		Introduction to lab.	
2	I	Introduction	
3	I	Introduction	Chapter III; Prob. 1** Due 2021- 09-16 8:00 PM
4	II	Treatment of Experimental Data	Chapter II; Prob. 1 Due 2021- 09-23 8:00 PM
5	II, and III	Treatment of Experimental Data, Use of Computers	
6	XX (a,b,c,d,e)	Miscellaneous Procedures	
7	XX (a,b,c,d,e) and XXI (a)	Miscellaneous Procedures, Least Squares Fitting Procedures	
8		TBA	
9		No Lecture	
10		TBA	Due 2021- 09-16 8:00 PM
11		TBA	
12		TBA	
13		TBA	
14		TBA	
15		TBA	

** Do not try to plot or use the column partially obscured labeled "ab initio".

You are to read sections 1 and 2 of chapter III on your own and electronically submit problem one during the third week of class.

You will find it helpful to read chapters XVI through XX on your own

SCHEDULE:

Except for the first experiment, experiments will be performed on a rotating group basis. Students will work in pairs, each individual recording results and observations independently. Each person will be responsible for reading the chapters listed under the lecture schedule. These chapters will be discussed in the lecture throughout the semester. These lectures cover topics of direct and indirect consequence to these laboratories. The subjects of these lectures will impact on the skills and knowledge necessary for experimental work and experiment design.

Tuesday Classes Experiment Schedule 3860 Fall 2021 (tentative)

<u>Exp. #</u>	<u>Title</u>	<u>Experiment Number in text and notes</u>
1	Partial Molar Volume	9 Handout + Text(Theory) (Weld type pycnometers)
2	<u>Heats of Combustion (BO2087)</u>	6 (Parr 1341 Bomb Calorimeter / 1108 O ₂ Bomb)
3	Electronics @@	Handout, & Chapter XVII (ref.)
4	Inversion of Sucrose @@	Handout & JCE <u>43</u> , 1966, 34
5	Diffusion of Gases	5 (procedure B**)
<i>**NOTE: The apparatus used is not the same as described in the text.</i>		
6	<u>Intrinsic Viscosity (BO2087)</u>	27 (Ostwald Viscometer)
7	<u>C_p/C_v (BO2087)</u>	3B (using <u>Velocity of Sound Method</u>)
8	Temperature Dependence EMF	18 (we use a DMM instead of a potentiometer)

@@ A USB flash drive will be useful for these experiments.

Handouts are available in the Black board Web site for the course

It is expected that you will investigate the experimental apparatus you will be using in your next experiment before you write the prelab report. Ask your TA or the instructor for assistance.

Attendance is required for all days that your lab meets. If your experiment is complete, you can use the time to analyze your data using the computers in the instrument lab (BO 2095).

	Week	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	31-Aug	Introduction to Laboratory & Literature Resources					
2	7-Sep	1	1	1	1	1	1
3	14-Sep	1	1	1	1	1	1
4	21-Sep	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	4 (1)
5	28-Sep	2	3	6	5	7	6 (4)
6	5-Oct	2	3	6	7 (5)	5 (7)	6 ()
7	12-Oct	3 (2)	6 (3)	5 (6)	8 (7)	2 (5)	5 (6)
8	19-Oct	3	6	7 (5)	4 (8)	2	
9	26-Oct	6 (3)	5 (6)	8 (7)	2 (4)	3 (2)	7 (5)
10	2-Nov	6	7 (5)	4 (8)	2	3	8 (7)
11	9-Nov	5 (6)	8 (7)	2 (4)	3 (2)	6 (3)	3 (8)
12	16-Nov	7 (5)	4 (8)	2	3	6	3 ()
13	23-Nov	8 (7)	2 (4)	3 (2)	6 (3)	4 (6)	2 (3)
14	30-Nov	4 (8)	2	3	6	8 (4)	2 ()
15	7-Dec	(4)	(2)	(3)	(6)	(8)	(2)
		Final Exam: All remaining reports due noon, Dec. 11					
16	14-Dec	Final Exam Week					

In Lab:

I. Data.

The data, and the exact procedure used to acquire it, are the most important written records you will generate. Experimental observations and data must be recorded in your laboratory notebook. **Data pages must be initialed by the T.A. in charge of the lab or the instructor before leaving the laboratory. Failure to have this done will result in a penalty of up to 15 points off the lab report grade. It is important that the copies of the data sheets submitted with the reports be legible.** Data sheets will be perused to check that all pertinent data and conditions were recorded. It is not allowed to remove original data sheets from your notebook. Scan in or photograph your lab notebook pages. Supply them as .PDF files if possible. You must record your work and your experimental conditions in sufficient detail to enable another student to perform the experiment exactly as you did and obtain the same, exact, results as you..

II. Laboratory Technique.

The development of good laboratory technique is important to you and your career. Good laboratory habits are a must for anyone who is going to work in the laboratory or supervise those who are working in the lab. In industry, government, and academics, your laboratory technique has direct influence on your professional reputation, more so than any grade in any course as years go by. Careers and people have been made and destroyed (literally) because of this seemingly "trivial" detail. If you are unsure of how to perform a particular task, ASK! We will be happy to discuss the situation and help you figure out the best approach.

There are six basic areas to laboratory technique:

- A. Safety.
- B. Identifying the proper procedure and then following it.
- C. Careful preparation of reagents and samples and avoiding cross contamination.
- D. Respect for, and knowledge of the proper use of, instrumentation and equipment.
- E. Patience/ attention to detail.
- F. Careful observation/ scientific objectivity.

III. Safety.

The laboratory area is to be treated with the same respect and common sense as any potentially hazardous industrial workplace. Common sense rules such as no smoking, eating, drinking or food in the laboratory are to be obeyed. See the University of Toledo Laboratory Safety (Policies and Procedures) document for details. In this laboratory you are responsible for ensuring that you and your partner and those around you are following these safety practices. **ONE OF THE WORST OFFENSES IN THIS LABORATORY IS THE VIOLATION OF SAFETY RULES. Repeated failure to follow these rules will result in dismissal from the class with a grade of F.**

Safety Goggles and Masks are required to be worn at all times once entering the lab.

Students are required to use supplied cleaning reagents to clean the areas they have used before leaving lab for the day. This includes the cubby used to store your backpack & coat during lab.

You will follow the procedures detailed in the handout for the lab.

IV. Procedure.

The goal of any experiment is repeatable accuracy. This can only happen if a single experimental protocol is followed closely. This is the first step in obtaining repeatable results.

V. Preparation of Reagents.

One must have accurately prepared reagents and clean glassware and apparatus in order to obtain accurate, repeatable results. Reagents must be obtained in a way that prevents cross contamination or changes due to degradation of the reagent.

VI. Instrumentation.

The accuracy of the result of an experiment is directly related to the condition of the instrumentation used in the study. The physical chemistry laboratory is one of the most expensive teaching laboratories to equip. We endeavor to bring research grade instrumentation into the physical chemistry laboratory and we need to take great care to ensure its proper operation. It is good practice to leave an instrument in better condition than you found it. This means taking the time to clean up spills and to pick up the area near the instrumentation. If you find a piece of equipment acting 'funny' report it immediately to the instructor. If in doubt about operating procedures for an instrument, **ASK!** Before coming to class, read and make sure you understand, any supplementary information that is provided for the instrumentation you will be using for the experiment. Your grade will reflect the care you take with the instrumentation. If you feel that a piece of instrumentation might be providing questionable measurements, ask if it is possible to calibrate the instrument. A teaching assistant or the instructor will assist you.

VII. Patient observation/attention to detail.

Science is exacting. Some procedures are very tedious and repetitious. Patience is required to maintain high quality in your work throughout an experiment and to obtain the best data. This does not mean that one cannot work efficiently and relatively quickly as long as quality and accuracy are not sacrificed. Make sure of what you are doing and that you perform a procedure the same way every time. Precision in a series of measurements can be seriously jeopardized by a failure here. While obtaining the literature value for the result of an experiment is not as important as in other laboratories you have attended, a component of your grade will be based upon the accuracy of your determinations.

VIII. Recordkeeping/scientific objectivity.

The laboratory notebook is the official record of observations and data which are pertinent to an experiment or measurement. If one is to err, it is best to record observations in too much detail than too little. Be neat when writing in your notebook. Use pen, and delete suspected bad data by drawing a single thin line through the offending data. Beside the material crossed out you should write a neat, short note as to why the data is suspect. This documentation can be very helpful when trying to determine where an error may have been made and/or where a technique might be improved. When you finish your experiments for the day, as soon as convenient, write any additional notes, observations or comments on the days activities in the notebook. As stated before, you must record your work and your experimental conditions in sufficient detail to enable another student to perform the experiment exactly as you did and they should get the same exact results as you.

Coupled to this is scientists must be very critical of their efforts and results throughout the course of their work. One way to monitor the validity of ones' experimental results and technique is to attempt to calculate, before the experiment is performed, the approximate value of the data to be obtained in one or two key steps. The

comparison of these theoretical results to those obtained experimentally should only be used as a guide. If the data you are obtaining are different, **DO NOT "FUDGE" OR OTHERWISE BIAS YOUR DATA.** This is where your integrity is tested. If your results are different from your estimates, carefully document (write in your notebook) your procedure and the exact experimental conditions. If time permits, repeat the experiment again, carefully noting your procedure as you perform the experiment. Then, if your final results are in disagreement with literature values, you can attempt to reconstruct what might have gone wrong. Experiments rarely come out perfectly. Figuring out what went wrong (where errors occurred) is a valuable skill for you to develop. If your results are suspect, please ask your T.A. or instructor to look over your results. They will be able to provide suggestions concerning the problem. It is important is to find and correct problems in your technique and to expand your laboratory experience. Your notebook must be signed by a T.A. or by the instructor before you leave for the day.

IX. Effort.

The professor will make a judgement as to whether the effort you're making to follow the above criteria is sufficient. The role this assessment will play in your grade will be related to how well your abilities are represented by your lab report and results. For instance, a student who has demonstrated a large improvement in overall performance in the class will benefit (in terms of the lab grade) more than someone who has shown minimal improvement. That is, if the student is borderline between two grades, the student who has demonstrated an improvement would get the higher grade. This course should be challenging, difficult and enjoyable. We realize you are taking other courses concurrently with this one. But with reasonable effort you should gain a substantial amount of scientific acumen.

