Syllabus

Course Meeting Times

Lectures: 2 sessions / week, 1 hour / session

Labs: 2 sessions / week, 4 hours / session

Course Overview

5.310 is a 12 unit class which introduces experimental chemistry for students who are not majoring in chemistry. The course covers principles and applications of chemical laboratory techniques, including preparation and analysis of chemical materials, measurement of pH, gas and liquid chromatography, visible-ultraviolet spectrophotometry, infrared spectroscopy, kinetics, data analysis, and elementary synthesis. Enrollment is limited. Students gain experience by completing the five experiments detailed below.

Format

In this course, students are divided into four groups for the laboratory experiments. To accommodate this, there are two concurrent offerings of the course, one that meets on Mondays and Wednesdays and one that meets on Tuesdays and Thursdays. The content for both offerings is the same. Students are potentially prevented from doing some of the experiments if the instructors believe that the students are unprepared because of absence from a lecture pertinent to that experiment.

Experiments

EXPERIMENTS	DESCRIPTION
Unknown Amino Acid	In this experiment, the student is given an "unknown" amino acid and asked to identify it using several procedures. This introduces several basic manipulative techniques of preparative chemistry and quantitative volumetric analysis including preparation and characterization of a derivative, recrystallization, determination of equivalent weight by using titration and determination of melting points.
Ferrocene	This experiment involves the synthesis of ferrocene a relatively simple organometallic compound followed by preparation of a ferrocene derivative. In addition to execution of a reaction under an inert atmosphere, this experiment also introduces thin-layer chromatography as an analytical tool and both column-chromatography and sublimation as means of purification.
Essential Oils	This experiment involves the separation and characterization of the major components found in either caraway oil or spearmint oil. These two oils each contain limonene and carvone, but each oil contains a different isomer of these chiral compounds. During the course of the experiment, the student will be exposed to fractional distillation under vacuum, gas chromatography, refractometry, polarimetry, and IR absorption spectroscopy.
Potentiometric Titration	In this experiment, the student is given a mixture of a strong monoprotic acid and a weak polyprotic acid. A standardized base solution is prepared and then potentiometric titrations are performed. The resulting data are used to determine the molar concentrations of the two acids and the second pKa value for the polyprotic acid.
	This is an integrated experiment comprising topics from inorganic, organic, analytical, physical, and computational

Kinetics	chemistry. It introduces the student to some of the basics of acquiring kinetic data, manipulating the data to extract information such as reaction order and rate constants, and how to assess the catalytic effect of the reaction environment upon rate constants.

General Information

- Organization (PDF)
- Notebooks (PDF)
- Report Format (PDF)
- Grading (PDF)

LABORATORY ORGANIZATION

1. GENERAL INFORMATION

THE UNDERGRADUATE LABS OPEN AT 1:00 p.m. Students should not arrive earlier and expect to do any work until his/her TA is in the lab. TAs will present a pre-lab lecture at the beginning of each afternoon. Drawers will remain closed, except for removal of safety goggles, until after the **pre-lab lecture**.

THE UNDERGRADUATE LABS CLOSE AT 5:00 p.m. TAs must remain in the lab until his/her last student has left for the day.

A student SCHEDULED for MW LABS CANNOT COME INTO THE TR LABS TO WORK AT ANY TIME, AND VICE VERSA.

Selected FRIDAYs from 1:00-4:30 p.m. are "OPEN LAB" time. Students should not come in to work on Friday afternoon to be ahead of their scheduled lab work, but only to "catch up" if he/she is behind in the lab. Students who need to come into the labs to work on Friday afternoon must SIGN-UP AFTER 3:00 pm and BEFORE 5:00 p.m. on WEDNESDAY AFTERNOON (for MW labs) and on THURSDAY AFTERNOON (for TR labs). The sign-up sheet is posted across from the GC Room. Attendance is limited to 15 students from MW lab and 15 students from TR lab.

The Chem 5.32-5.33 Lab is off limits for any work or use of instrumentation by Chem 5.310 students, and Chem 5.32 or 5.33 students should not invade the Chem 5.310 labs.

2. TEACHING ASSISTANTS.

There will generally be four TAs present for each afternoon of lab. One TA will be in the charge of each lab section (A,B,C,D) for a given experiment. Over the course of the semester the **TAs will rotate around the four sections**. Each student will thus have three of the TAs for one lab each and one TA for two labs. This permits each student to get to know and experience the strengths of each TA. Students should feel free to approach any of the TAs for assistance throughout the course.

3. ORGANIZATION

There will be five required experiments in 5.310. Please, review the experiment schedule. Questions regarding experimental procedures, data interpretation, grades, etc., which a TA cannot answer should be directed to a faculty member.

Experiment	**Lab Periods**	**Points**
Exp. #1. Unknown Amino Acid	**5**	**100**
Exp. #2. Synthesis of Ferrocene	**4**	**100**
Exp. #3. Essential Oils	**4**	**100**
Exp. #4. Chemical Kinetics	**3**	**100**
Exp. #5. Potentiometric Titration	**3**	**100**
Total Experiments		**500** (80%)
Lecture Quiz		**100** (16%)
Safety Quiz		**25** (4%)
Total points		**625 points**

- **PLACE: (1) a GRADE SHEET ON THE FRONT OF EACH REPORT and then (2) a DATA SUMMARY Sheet. Reports missing the data summary sheet and/or the cover sheet will be penalized 2 points/missing sheet.**

- **Reports** will be turned in to the **Undergraduate Laboratory** at 1:00 pm on the **due date** indicated on the schedule. A **report collection box** labeled 5.310 will be placed on a table across from the "Prep Room" next to the Stockroom. **Reports not handed in by 1:10 pm on the due date are considered late** (a Report turned in at 1:11 p.m. is one day late)**.** All late written reports must be turned in by final date specified in the laboratory schedule in order to get a grade for the report/course.

- **Late written reports are penalized by loss of 3*n-1 grade points (n is the # of office days late).**

- When graded reports are returned to students, the report will have the TA return date stamped on the cover page. Students have SEVEN CALENDAR DAYS from this date to submit a report for consideration of a re-grade. Re-grade requests must be **in writing**, and must be specific as to the portion or portions of the report which the student wants to have re-evaluated. Students should first present their re-grade request to the TA responsible for grading the report. If a grading question remains after the review by the TA then it may be presented within 7 days of TA review to the faculty teaching the course. The faculty reserve the right to re-grade the entire written report.

- ***ONLY Dr. Gheorghiu may grant an extension of the due date of a report (and only for a VERY GOOD REASON)***

NOTEBOOKS

A. General.

The notebook to be used in the laboratory is the "**LABORATORY RESEARCH NOTEBOOK**," available from Laboratory Supplies . It has 100 pairs of duplicate numbered pages (each white page being followed by a blue page, perforated at the side for easy removal). No carbon paper is necessary. Supplementary material including spectra, graphs, etc. should be assigned a number when they are first produced, referenced in the notebook and submitted with the notebook number, the page number of the first reference and a letter to sequence the references on this page. For example, JD -I-38B identifies the second item on page 38 on Jane Doe's first notebook. Label the item with this number, your name, the date, and other relevant information. **At the end of each laboratory period have the teaching assistant initial, and date your day's entries.**

B. Submission for Grading.

Your T.A. must sign and date your notebook at the end of each day's work.

Laboratory reports are to be submitted in the following manner:

- The colored copy of the of the **pre-lab notes** is to be handed to your TA at the **beginning** of each experiment.
- The colored copy of each **day's work** is to be handed in to your T.A. at the **end** of each lab day.
- Using these data prepare a coherent report using the format described below. Also, refer to the **grade sheets** for each experiment **as guidelines**.
- The report for each experiment will consist of:

  - the grade sheet (as a cover sheet)
  - the data summary sheet (directly below the grade sheet)
  - the written (or oral handouts) report (as described under report format)
  - all leftover unknowns and products (handed directly in to your TA)

C. General Guidelines for Maintaining the Lab Notebook

Manner of use:

1. Duplicate blue pages work best with a ball point pen, press hard.
2. Write on one side only
3. No erasures:
   - If you make a mistake, cross it out neatly so it still can be read, and write the correct entry above or to the side.
   - If entire page is incorrect, cross it out with a single diagonal line and provide the reason it is believed incorrect.
4. Record all data and results with **units** and **experimental error** directly into your notebook:

- Data may not be transferred. Plan to have your Notebook with you wherever you make an observation. If circumstance forces you to record data remote from your notebook, date and sign the record and tape it in your notebook.

5. Start a new page for each experiment and each new major section:
   - Write the title of the experiment, date, your name and name of your TA on top of each page.
   - Indicate if the page continues an experiment from a previous page.
6. Never skip space for later recording. Data should always be recorded in a serial fashion except where it is appropriate to record it in tabular form.
7. Be neat! Do not overcrowd page:
   - If handwriting is large skip a line.
   - Write legibly or print. Illegible notebooks may receive a grade of zero. Other things being equal, **a neat and well organized notebook** is far preferable to a messy or poorly organized one, although, neatness and organization are distinctly secondary to other considerations: **legibility, accuracy and completeness**

D. **Pre-lab: What to record:**

1. **Title, date, your name, name of TA.**
2. **Introduction:** A brief statement of the purpose of the experiment with balanced equations as appropriate.
3. **Safety issues:** A brief outline of the safety issues for the experiment.
4. **Procedure:** From the information provided in the lab manual write out the step-by-step procedure you will follow. Be concise but complete. Do not just copy the lab manual.

NOTE: THE LAB MANUAL MAY NOT BE BROUGHT INTO THE LABORATORY OR CONSULTED DURING THE LABORATORY SESSION.
(Exception: appendices with detailed instruction for running instruments and Excel.)

E. Factual Record: What to Record:

1. Title, date, your name, name of TA.

2. Procedure and observations in the laboratory:
- Record procedure that you carry out in the lab; be concise; **do not copy lab book**
- Record observations: “solution turned blue”; “crystals were small and powdery”
- Sketch complex apparatuses; label parts. If cited later in the report, refer back to i.e., “Fig. 1, p.5”
- In a synthesis, use tabular form to record information about reactants (volume and density of liquid; volume and concentration of solution)

Reaction name	Formula	Source	Grade	Weight	Mol. Wt.

3. **Data.** Use tabular form wherever possible; e.g., weighing:

50 mL beaker & cmpd	30.2684 ± 0.0001 g
50 mL beaker	20.2221 ± 0.0001 g
weight of cmpd.	10.0463 ± 0.0002 g

Examples:

Synthesis and purification by recrystallization

	wt.(g)	% yield	m.p.(°C)	color	appearance
crude product					
recryst. #1					
recryst. #2					

The crude yields of products or product mixtures should always be recorded. If the product is separated into crude acidic, basic, and neutral fractions, the weight of each crude fraction should be recorded. If any of the crude fractions is a solid, its crude melting point should be recorded. It is important to make every effort to account for all of the reactants in the various fractions of crude products. Thus, for a chemist to begin a reaction with 0.1 moles of a reactant and then to describe only the isolation of 0.013 moles of a product at the end of the reaction is inexcusable. The fate of the remaining 0.087 moles of material should be indicated, even if no additional pure substance can be isolated.

The progress of the purification of reaction products should be recorded by noting the weights and the physical constants (melting point or boiling point range, refractive index or optical rotation where appropriate) of the various fractions throughout the purification. One should never report the weight without melting point or other physical constants for a crude product or report only physical constant (s) without weight data for the pure product.

For each pure reaction product, important intermediate, or derivative, record the total yield (both weight and percentage), physical appearance, color, odor, and physical constants (m.p., b.p., etc.). For a solid product, record also the recrystallizing solvent used and the crystalline form obtained (e.g., needles, prisms, plates, etc.).

Distillation as purification

fraction #	b.p. range (°C)	wt..(g)	appearance

Note: It is important to determine the weight of each fraction immediately after distillation to avoid loss due to evaporation.

Absorbance vs. Concentration

sample #	concentration (M)	absorbance

4. **Calculation and graphs.**
- Show any formula used in calculations.
- Show a complete sample calculation substituting the number in with their units.
- If a calculation needs to be repeated several times, show results in a tabular fashion.

Graphs:
- Graph any necessary data and make copies to present with your report.
- Attach in your Notebook and reference to the appropriate table of data in tabular form, e.g., JD -I-38B.
- Label axes and title with units.

Spectra:
- Attach to Notebook and make copies to present with your report.
- Label axis with units.
- Reference to procedure, e.g., JD -I-38B.

5. **Data Analysis and Errors.**
- Perform error analysis.

REPORT FORMAT

Some experiments will have in a written format. Other experiments will have an oral report.

1. WRITTEN REPORT

IT IS TOTALLY FORBIDDEN TO USE PREVIOUS YEARS WRITTEN REPORTS (BIBLES)

Those students, who are proven to be guilty of this offense, will be graded either incomplete (I) or failed (F). See section on Ethics.

The written report, **no longer than 10 pages, spacing 1.5** (without cover sheets and Appendices) should consist of the following elements:

A. Grade sheet
B. Data summary sheet
C. Written report
On the first page print: Title of the experiment
Your Name (Your partner's name for Kinetics)
Your TA name
Section MW or TR
Abstract

(**1) Title**. This should be a brief, clear description of the subject of the report.

(2) **Abstract.** This is a concise statement of the major results obtained. It should consist of *only* 2-4 complete sentences. It is best prepared after the rest of the report has been completed.

(**3) Introduction**. The record of an experiment should begin with a concise statement about the experiment to be performed, with balanced chemical equations where relevant, and a statement about the goal of the experiment. The second page of the written report starts always with the Introduction.

(4) Procedures and Observations. Refer to the manual for descriptions of experimental procedures, but be sure to record any deviation from the suggested procedure. Clearly labeled sketches of experimental setups are usually preferable to lengthy descriptions. Particularly when describing a synthesis, attempt to use a style similar to that commonly employed in describing synthetic procedures in scientific journals (e.g., "...a solution of 10.0 g of reactant A in 50 mL of anhydrous ether was added dropwise and with stirring over a period of 30 minutes, to ..."). For each reactant, the correct name, formula, source, grade or stated purity, weight (or volume and density in case of a pure liquid, or volume

and concentration in case of a solution), should be recorded. Standard data (m.p., b.p., etc., of reagents are not necessary. In addition, the volumes of any reaction solvents used should be specified. These data are very important and should be noted in table form.

(5) Summary of results. All data, yields, calculated results, etc. should be presented, preferably in tables or graphs if applicable.

(6) Calculations and Graphs. A sample calculation should always precede results of calculations based on a formula. Notebook entries in this category should be done in the laboratory. Experience should soon convince you that problems with quality, internal consistency, and data validity, which are detected immediately, are more quickly and efficiently rectified. Graphs should always be done separately on good quality paper referenced in your notebook.

(7) Analysis of Data and Errors. **ALL ANALYSIS OF DATA IS TO BE DONE INDIVIDUALLY,** even for the Kinetics experiment where data is obtained with a partner. The reproducibility and precision of data should always be examined, and the major sources of errors identified. Detailed statistical analyses of error are rarely called for, but when possible, you should attempt to distinguish between systematic and random error.

(**8) Discussion, Interpretation**. The outcome of each experiment should be quantitatively and qualitatively discussed in relation to the goals of the experiment as stated in the introduction. You should:

(a) briefly summarize the key results of each experiment;
(b) explain the significance of your findings;
(c) explain any unusual difficulties or problems which may have led to poor results;
(d) offer suggestions for how the experimental procedure or design could be improved.
(e) answer all questions posed in the laboratory manual as part of the overall discussion-not as a series of questions and answers.

(9) Conclusion. A very brief (1-3 sentence) conclusion to the experiment based on the data collected and analyzed.

(10) References. Present a numbered list of references to texts, monographs, journal article, standard computer programs.

(11) Appendices. This is the place to put hard copies of computer output (tables, spectra). Each Appendix should have a number and a title and be referred to in the body of the report.

(12) **Leftover unknowns and samples of prepared compounds** are turned in to your TA. Solid derivatives should be placed in a small vial and appropriately labeled: Student's name, Exp. No., Name of the compound.

Note: Consult the following paper: Spector Thomas, "Writing a Scientific Manuscript. Highlights for Success," *J. Chem. Educ.* **1994**, *71*, 47-50. Xerox copies are available upon request. The *ACS Style Guide*, Janet S. Dodded, is also a useful reference.

2. ORAL REPORT

After completing the last experiment, you will present your results and analysis to your TA in the form of an **INFORMAL ORAL REPORT**. In this report, you should tell your TA briefly:

- the purpose of experiment;
- relevant theoretical background;
- what happened in **your** experiment;
- present your results and analysis;

Much of the preparation for your Oral Report will be the same as for a Notebook Report such as those you have turned in for earlier experiments. In particular, the data analysis, graphing and plotting, error analysis, etc. should be carried through to completion and the results should be presented in an appropriate form (tables, plots, etc.) for efficient communication. You will bring your lab notebook, raw data, analysis, results, plots, and any other materials that are appropriate, and you will discuss your experiment with your TA. You may bring notes, books, and pretty much anything (inanimate), which will help you in your discussion. You may work with other students; use written reports from earlier years, and in general use any sources you want to prepare for your oral. You are, of course, expected to do your own data analysis and calculations. You may use any sources of help in understanding the analysis as well as any other aspect of the experiment.

You should plan on discussing your experiment for about 10-12 minutes. Be aware that it is impossible to present everything that you know about the experiment. Therefore you should plan very selectively what you choose to present. During the last 8-10 minutes your TA will ask questions pertaining to your experimental work.

The objectives of the oral are to encourage you to learn as much as possible, and to find out how much you know in an efficient manner. In an informal exam of this type there is no substitute for knowing the material.

After analyzing your data and mastering the material, you will want to spend time organizing your presentation. You may want to use some notes, especially to guide you through theoretical discussions. You may use a blackboard if you wish. You may also just show your (neatly written) notes to your TA on occasion, rather than transcribe them onto the board. (This is especially convenient if there are many equations.) Do whatever makes you most comfortable, without wasting time. You will need to show your TA spectra, plots, etc. As always, attention should be paid to the **presentation** of data and results so that they are easily understood. **Write neatly,** label the axes of plots, indicate units, errors, etc.

You should come prepared to "take the initiative" and guide the oral exam. Otherwise your TA will be forced to take the initiative by asking you question after question, likely venturing into territory you may prefer not to explore. Be prepared to give an informal but well organized presentation. Your presentation should include the following elements, in sequence:

- Introduction;
- Background (why you did it);
- Experimental (what you did);
- Results (what happened);
- Discussion (including answers to questions posed in the manual);
- Conclusions.

The oral should not be a harrowing experience. Just tell your TA:

- what the experiment is about (briefly);
- what you know about it;
- what you did (briefly);
- what the results were, and why.

Ordinarily, you will not turn in your data, analysis, results, etc. However, you must do so if your TA so requests after your oral exam.

Your grade will reflect your ability to convince the TA that you understand the most important aspects of the experiment. The experiment grade sheet will be used by TA as guideline for grading you.

Oral schedules will be posted on the 5.310 bulletin board located near the entrance to the GC Room. Check the day, date, time and topic of your oral Report. Plan to come to the Reference Room approximately ten minutes prior to your scheduled Oral Report time. You will be directed to the Section of the Lab where your Report will be heard.

IF THERE IS ANY PROBLEM WITH THE TIMING OF YOUR ORAL REPORT SEE Dr. GHEORGHIU! (OTHERWISE NO CHANGES IN THE SCHEDULE ARE PERMITTED).

GRADING POLICY.

Note: ALL EXPERIMENTS MUST BE SUCCESSFULLY COMPLETED INCLUDING THE WRITTEN OR ORAL REPORT IN ORDER TO RECEIVE A PASSING GRADE IN 5.310.

Each experiment will be graded on the basis of quality of the laboratory work and the write-up. The TA responsible for that experiment will grade experiments. Your TA should discuss the comments and evaluations with you. Questions, suggestions, comments, and complaints not handled by the TA's should be directed to Dr. Gheorghiu and/or Dr. Schrenk.

All experiment reports, which have been graded, are returned to you with a date stamped on the cover sheet. Please take time to check the total score, and to look at the comments made by the TA.

You have SEVEN (7) calendar days from the TA return date stamped on the cover sheet to request any review of the grading of your report. This request should go first to the TA responsible for the grade and then if a question related to grading remains the faculty teaching 5.310 (see details under Laboratory Organization). After seven days from TA return date, no report will be accepted for change of an incorrectly added score or any re-evaluation. If your Report is re-graded, it is your responsibility to check with Dr. Gheorghiu to verify that your grade has been updated on your 5.310 grade record.

IT IS YOUR RESPONSIBILITY TO TAKE THE TIME TO PROMPTLY LOOK OVER EACH REPORT WHEN IT IS RETURNED TO YOU.

Grading policy:

Final Grade = Experiment Grade + Lecture Quiz Grade + Safety Quiz
(max. 625) (max. 500) (max. 100) (max. 25)

A. Experiment Grade (80%):
100 points per experiment

(a) **Lab Quiz** (check the lab schedule; closed book ~15 min.). **15** points
(b) **Pre-lab preparation**. **10** points
It is essential that you have reviewed the experiment and recorded in your lab notebook all the information required to perform the experiment **without** consultation of the Laboratory Manual.
(c) **The factual record**. **20** points

Data, procedure signed and dated. It is important to develop good habits in keeping a notebook.

(d) The Staff's assessment of technique, deportment, safety, etc. **5** points

(e) **Lab Report** (either written or oral) **50** points
This includes points for correct identification of unknowns and data quality

The major part of the grade for the Lab Report is based on the analysis, interpretation and quality of the results, as well as the calculations, graphs, and the discussion sections. The Lab Report should demonstrate what you learned form the experiment and your ability to interpret and explain your experimental results. No grade for an experiment will be given without the laboratory report.

B. Safety Quiz (4%)

There will be a **closed book** quiz on Safety based on the mandatory safety lecture AND required readings (especially the section on safety in this lab manual) on the first day of the first experiment.

C. Lecture Quiz (16%)

There will be a **closed book** Lecture Quiz after the lectures are completed.

D. Grading Scale:

100% - 90%.....A
89% - 80%.....B
79% - 70%.....C
69% - 60%.....D
59% and less.....F

E. Details of the Experiment Grade

Laboratory Quizzes (15 points)

There will be five lab quizzes during the semester. The quizzes will be given in the laboratory on the days indicated in the schedule. Any topic related to the theory, procedure, analysis and safety of the experiment may be fairly probed. The emphasis should be on the lab manual and **application** of information from the morning lectures. More theoretical aspects of the lectures will appear on the final lecture quiz.

IF YOU MISS A LAB QUIZ DUE TO AN **EXCUSED** ABSENCE FROM LAB, SCHEDULE A MAKE-UP QUIZ WITH YOUR TA AS SOON AS POSSIBLE, WITHIN ONE WEEK.

Pre-lab Preparation (10 points)

The quality of the pre-lab preparation is assessed in two ways. The first and more important is your ability to follow your notes within the laboratory. The second is the grade assigned to the quality of the pages you turn in to your TA at the **BEGINNING OF EACH EXPERIMENT.**

> **It is forbidden to use the Lab Manual during your work!**
> **The only sources you are permitted to examine during the time you carry out the experiment are your pre-lab notes. Exception: the Appendices containing detailed information on how to run an instrument or use of Excel may be brought into the lab.**

Laboratory Notebook (20 points)

Your TA, based on the pages you turn in at the END of each day's experimental work, will assess the quality of each day's laboratory record. Organization, comprehension, completeness, lacks of extraneous or irrelevant entries will all be considered. See the section on notebooks for more details. These pages may be read in parallel with the written reports and examined during oral reports.

Staff Evaluation of Laboratory Techniques (5points)

These are guidelines for evaluating laboratory techniques for the students. The TA (along with other staff members as appropriate) will assess and keep a record of the following:

1. The student is able to follow instructions.
2. The student wears goggles and observes lab safety.
3. The student arrives in laboratory on time.
4. The student is able to complete experimental work and leave the lab by 5:00 p.m.
5. The student handles balances and other instruments with care.
6. The student comes to the laboratory well prepared, having read the experiment in the lab manual, and has the pre-lab notes in the lab notebook.
7. Work in lab is planned and well organized.
8. The student works well with the lab partner and is cooperative with others in the lab.
9. The student is able to work independently.
10. The student asks good questions.

Formal Written Report (50 points)

All categories listed below will be considered in grading the written report, but the relative weight will depend on the nature of the experiment. Your final grade for each experiment will be based on:

(1) Results: accuracy, yield, and unknown identification. ***** See individual cover sheets for further information.
(2) Data Analysis: correct manipulation of data, error analysis, and sample calculations.
(3) Technique: Efficient use of time, independence, and experimental expertise.
(4) Organization, comprehension, completeness, lack of extraneous or irrelevant information
(5) Quality of discussion and conclusion
(6) Quality of writing/ ability to communicate scientific ideas-while not a writing class it is expected that the formal report will be a well written document. The ability to communicate one's research is an essential component of scientific research.
(7) The agreement between the factual record and the report. **Please note that if an observation, measurement, procedural step etc. does NOT exist in the factual record, it can <u>NOT</u> exist in the written report!!**

**** For some experiments you will be given the opportunity to identify unknowns during laboratory time and thus receive part of this grade in advance. This will permit the opportunity to collect additional data and re-evaluate unknowns to the extent scheduled time remains for that experiment and thus reclaim <u>SOME</u> of the points lost due to the initial incorrect identification.***

<u>See the report format section for more details on the proper form for the report</u>