INTRODUCTION TO EXPERIMENTAL CHEMISTRY
5.35

8th Edition Fall 2012

TABLE OF CONTENTS

1.1 EXECUTIVE SUMMARY

For most of you, 5.35 will be the first formal laboratory course you will take at M.I.T. It is the first part of a modular sequence of increasingly sophisticated (and challenging) laboratory courses required of all Course V majors: 5.35, 5.36, 5.37 and 5.38. The objectives of 5.35 are:

- **To illustrate a number of theoretical concepts** previously encountered in lecture courses via practical examples in the laboratory;
- **To provide experience with a wide range of laboratory techniques and instruments**, ranging from simple gravimetric and volumetric measurementsto optical and nuclear-spin spectroscopy;
- **To develop planning and organizational skills for efficient use of laboratory time**;
- **To learn to rigorously analyze data, including uncertainties** in experimental measurements;
- **To meet the standards expected of scientists in acquiring, interpreting, and reporting data**;
- **To demonstrate the value of teamwork in scientific** investigation;
- **To develop written and oral communication of scientific** results;
- **To learn proper safety practices**, especially the handling and disposal of toxic chemicals;
- **To foster collaborations with Chemistry faculty** and learn about current work being done in their research labs as it relates to your lab work
- To demonstrate **that laboratory work can be both exciting and fun**.

1.2 COURSE POLICIES AND INFORMATION

(1) **THE UNDERGRADUATE LABS OPEN** AT 1:00 p.m. for Chemistry 5.35 students. Students may NOT arrive earlier and may NOT to do any work until his/her TA is in the lab.

(2) **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.

(3) **5.35 students SCHEDULED for MW Labs CANNOT COME INTO THE TR Labs TO WORK AT ANY TIME, AND VICE VERSA**.

(4) SELECT FRIDAYS from 1:00-4:30 p.m. may be scheduled as **"MAKE UP LAB"** days for students who require additional time due to excused absences or experimental misfortune. **Students may NOT come in to work ahead of their scheduled lab work unless they have the explicit approval of the Director of Undergraduate Laboratories.**

Students who need to work on a scheduled Friday afternoon must see the Lab Director by 5:00 p.m. on WEDNESDAY AFTERNOON (for MW labs) and on THURSDAY AFTERNOON (for TR labs).

(5) **ANY absences from lab** due to illness or other unforeseen emergencies or circumstances require a note from S^3 sent to the Lab Director. Absences from lab due to sports or other extracurricular activities need to be discussed with the Lab Director well ahead of time (1 week MINIMUM). If you have any weekly conflicts with your lab schedule, the lab takes priority. No accommodations will be made.

(6) At the end of each laboratory day, glassware and equipment must be cleaned and stored in your desk. Although students do not pay a lab fee, a fee will be charged at the end of the semester for lost, broken or stolen glassware and equipment.

(7) **All requests for an extension of assignment due dates and oral reports** in 5.35 should be directed to the Lab Director. Extensions are only given for excused absences and other crises beyond the reasonable control of students and are solely at the discretion of the Lab Director.

(8) **Please make a special effort to take extremely good care of the balances and other instrumentation so that they will perform well throughout the semester.**

1.3 FIRST AND LAST DAY OF LAB

A. CHECK-IN PROCEDURE

Your desk assignment will be determined at check-in. At your desk you will find the following items:

1. Laboratory desk inventory sheets listing the equipment contained in the desk.
2. EH&S CLEARANCE FORM, which must be **signed and returned to your TA during your first work day in the lab.**
3. 5.35 Laboratory Manual. **Additional copies of the 5.35 Lab Manual may be purchased from the Chemistry Stockroom .**

A key for the lock on your assigned desk will be distributed during the afternoon.

Check the equipment in your desk against the inventory; the items in your desk may not be arranged as outlined on the sheet. For convenience in checking-in and checking-out, arrange your desk equipment conform to the organization of the sheet. Immediately report any discrepancies to your TA, who will give you a replacement slip to be used in obtaining the missing item from the Laboratory Stockroom . When your equipment is in order, sign the check-in sheet and return it to your TA. You will not be registered for the course until the check-in procedure is completed. Once you have checked into the laboratory, you are responsible for the items in your desk, and even if the course is dropped the following day, it is your responsibility to check-out of the laboratory.

B. CHECK-OUT PROCEDURE

Students will check out of the lab on the day designated in the course schedule. **Students who do not check-out as scheduled, will be checked out by the Laboratory Stockroom Personnel. For this service, the charge of $50 will be billed to the student's MIT account. If you DROP the course, you are STILL required to complete the check-out procedure, and you may arrange with your TA to check out at the time when you are leaving the course.**

All glassware and other equipment must be replaced, if necessary, by purchase from the Laboratory Stockroom. Desk items will be checked against the check-in sheet.

C. LABORATORY EQUIPMENT

In addition to the equipment in your desks, other items may be checked out from

the Laboratory Stockroom on presentation of a withdrawal slip.

Returnable equipment

These may be obtained from the Laboratory Stockroom for a limited period of time. Most items are in short supply and must be returned at the end of EACH laboratory period. You will be notified if a returnable item may be stored in your desk for the duration of an experiment. You will be charged only if the equipment is not returned or is damaged. Only those items issued to you will be accepted for credit. Fill out and submit a return slip with each item returned to the Stockroom.

Non-returnable Items

Bring the empty container or worn out item (filter paper box, septa, etc.) to the Laboratory Stockroom for refill or replacement.

D. LABORATORY CHARGES

You will be charged only for your purchase of "breakage," i.e., all returnable items you fail to return to the Laboratory Stockroom and desk items that are replaced during the semester or while checking out. Do not indiscriminately purchase non-returnable items from the Laboratory Stockroom without consulting your TA to determine whether you will need them.

1.4 GRADING

A detailed overview of the URIECA program can be found online from the Dept of Chemistry's web page.

5.35 is composed of three separate lab modules. Each module has similar grading schemes differing principally in the format of the final report (see below). You will receive a distinct letter grade for each module upon completion of the module and after marks have been tabulated. Once you have completed all three modules (not necessarily in the same semester), you will receive an overall letter grade for 5.35 that is based on an equal weighting of your grades for each of the three modules

Module 1 – Grading Scheme

Laboratory Quizzes	10 points
Pre-lab Preparation	10 points
The Factual Record (notebook, data, plots)	20 points
Technique, Safety	10 points
Oral Report (incl submitted data analysis)	50 points
	100 Points Total

Module 2 – Grading Scheme

Laboratory Quizzes	10 points
Pre-lab Preparation	10 points
The Factual Record (notebook, data, plots)	15 points
Technique, Safety	10 points
Waste Inventory	5 points
Written Report + Report Interview	50 points
	100 Points Total

Module 3– Grading Scheme

Laboratory Quizzes	15 points
Pre-lab Preparation	10 points
The Factual Record (notebook, data, plots)	15 points
Technique, Safety	10 points
Written Report	50 points
	100 Points Total

Laboratory Quizzes: 5 minute quizzes will be conducted at the beginning of most lab periods, as determined by the instructor or TA. These quizzes are solely designed to determine if you have read the lab manual and have prepared yourself and understand the experiments you will do that day.

Pre-lab Preparation: IT IS ESSENTIAL for students to read through and beprepared for the experimental work expected for each day. You need to outline a "game plan" prior to each lab session. This outline must be done in the labnotebook before your scheduled lab day. The pre-lab is a brief outline of what they hope to accomplish and in what order. This outline does not need to haveenough detail to replace the lab manual, which you are allowed to bring to lab. The pre-lab should also include preparing clearly labeled tables for data entry
(e.g. reagent weights, absorbance values, chemical shifts, etc.) When applicable, relevant equations that will be needed in lab should also appear in theprelab preparation.

The Factual Record: Data, procedure signed and dated. It is important to develop good habits in keeping a notebook. Students must submit carbon copies of their notebooks to their TAs at the end of each lab period.

Techniques, Safety:

The staff will use the following guidelines for assessing each student's laboratory technique, proper waste disposal, safety, etc.

1. Is the student is able to follow instructions?
2. Does the student wear goggles/gloves and observe lab safety at all times?
3. Does the student arrive in laboratory on time and ready to begin work?
4. Is the student able to complete experimental work and leave the lab on time at 5:00 p.m?
5. Does the student come to the laboratory well prepared, having read theexperiment in the lab manual and prepared a proper pre-lab?
6. Is the student's work in lab well planned and well organized?
7. Does the student work well with his/her lab partner and cooperate with the othersin the lab?
8. Is the student able to work independently?
9. Does the student ask well thought-out and appropriate questions?
10. Does the student handle balances and other instruments with care?
11. Does the student clean-up after him/herself?

Waste Inventory Sheets:

Waste inventory sheets require you to track the chemicals you use in each experiment and their ultimate destination at the experiment's completion. **For labs that include this, you must keep track of your consumption after each lab day.** Waste management is an important aspect of modern chemistry. These will be graded based on the quality of the tracking of chemicals and wastereduction ideas. Ideas will be considered for future incorporation into 5.35.

Notebooks and Reports:

The TA responsible for the experiment will grade the notebooks and reports(see also Section 1.6). Your TA should discuss the comments and evaluations with you. Questions, suggestions, comments, and complaints not being handled by the TA's should be directed to the course faculty or laboratory director.

Each experiment will be graded based on the quality of the laboratory work and the write-up. All of the categories listed below will be considered in grading, but the relative weight will depend on the nature of the experiment (your TA will provide more details and advice). Your final grade for each experiment will be based on:

(1) Results: accuracy, yields, molecular characterization
(2) Data Analysis: correct manipulation of data, error analysis, sample calculations.
(3) Interpretation and Discussion of the data
(4) Technique: efficient use of time, independence, experimental expertise.
(5) Notebook report: organization, comprehension, completeness, lack of extraneous or irrelevant entries.

Laboratory reports and any other written assignments are due on the dates announced in lab . All written reports must be turned in by **the report due date** to obtain a grade in the course.

- **Reports should be dropped into the URIECA WRITTEN REPORT SUBMISSION BOX . Reports must be handed in by 1:10 P.M. on the due date, otherwise they are considered late (for example, a Report turned in at 1:11 P.M. is one day late).**
- **The late penalty is 3*n*-1 grade points where *n* is the number of days late (n counting weekend days).**
- **Reports not submitted after 5 weekdays following the due date (plus any extensions granted) will receive an irreversible mark of ZERO.**

1.5 NOTEBOOKS AND REPORTS

1) Notebook

A. General

Several laboratory notebooks are commercially available at a variety of prices. Acceptable notebooks must have numbered duplicate pages (i.e., each white page is followed by a colored page, perforated for easy removal). Carbonless copy pages are preferable to those requiring carbon paper. Most students will require a notebook with 100 duplicate pairs of pages.

B. Submission for Grading

The colored duplicate copy of the factual record of each day's work must be handed in to your TA after each page has been signed and dated by your TA at the end of each lab day.

C. General Guidelines for Maintaining the Laboratory Notebook

1. Duplicate pages work best with a ball point pen (black or dark blue ink), press hard.
2. Write on one side only.
3. No erasures or whiteout:

   - If you make a mistake, cross it out neatly so it still can be read.
   - Write the correct entry on top or side.
   - If the entire page is incorrect, cross it out with a single diagonal line and state the reason why it is believed incorrect.
   - Under NO circumstances should any original page be removed from a notebook.

4. Record all data and results with **units and experimental error** directly into your notebook:

   - Data may NOT be transferred. Never record anything on scraps of paper, your hand… Plan to have your Notebook with you wherever you will make a measurement of observation.

- If circumstances force you to record data remote from your notebook; date, sign and tape it into your notebook.

5. Start a new page for each experiment and each new major section:
   - Write the title of experiment, date, your name and your TA's name at the top of each page.
   - Indicate if the page is continued from previous page.
   - NEVER skip a space for later additions. Always record data is a serial fashion except when it is appropriate to record it in a table.
6. Be neat! Do not overcrowd a page:
   - If handwriting is large skip a line.
   - Write legibly. If you can't write legibly then 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 **legibility, accuracy and completeness**.

D. The Factual Record: What to Record

1. Title, date, your name and your TA's name on each page.

2. Procedure and observations in the laboratory:
   - Keep a running account of ALL procedures carried out and observations made during experimental work (including for intermediates).
   - Record observations: physical appearance, color, odor, physical properties… ("solution turned blue"; "crystals were small and powdery.")
   - Sketch complex apparatuses; label parts: i.e., vacuum distillation, which can be cited later as "Laboratory notebook 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).

Reagent name	Formula	Source	Grade	Weight	Mol. Wt.

Record all data and results. 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 extremely 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 1.0 moles of a reactant and then to describe only the isolation of 0.13 moles of a product at the end of the reaction is inexcusable. The fate of the remaining 0.87 moles of material should be indicated, even if no additional pure substance can be isolated.

FOR EACH PURE 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.)

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

50 mL beaker & compd.	30.2684 g	(indicate ± uncertainties)
50 mL beaker	<u>20.2221</u> g	
weight of compd.	10.0463 g	

Example: Synthesis and purification by recrystallization (include recrystallizing solvents used):

	wt.	% yield	m.p.*	color	Appearance**
crude product					
recryst. #1					
recryst. #2					

* or other physical properties such as refractive index, optical rotation
** including the crystalline form obtained (e.g., needles, prisms, plates, etc.)

Note: **always** report both the weight and physical constants for the crude and pure products.

Example: Absorbance vs. Concentration

sample #	concentration	absorbance

4. Calculation and graphs.

If you need to use data to calculate some quantity:

- Show formula.

- Show a sample calculation, substituting the number in with appropriate units.
- If the calculation needs be repeated, it may be shown in tabular form.

Graphs:

- Use fine paper graph paper if the rulings in notebook are not sufficient.
- Provide a reference to the data in tabular form, e.g., STC-I-42A.
- Attach the graph to the notebook
- Label axes and title with units.

Spectra:

- Attach the spectra to your laboratory notebook.
- Label axis with units.
- Provide a reference to the spectra in the procedure section of your notebook, e.g., STC-I-42A.

5. Data Analysis and Errors.

- Perform appropriate error analyses
- Examine and discuss the accuracy and precision of data.
- Is the precision of your result reasonable based on the uncertainties of the original measurements?
- Discuss possible systematic and random errors.

6. Discussion, Interpretation and Conclusions.

- Summarize the key results.
- What do you conclude?
- What difficulties did you have, if any?
- What results are poor and why?
- Suggestions for improvement.
- The lab manual includes questions to guide your thinking.
- Look at the grading sheet for each experiment for additional guidance.

2) Written Report

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

(2) **Abstract**. The abstract is a concise statement of the major results obtained and should consist of no more than 2 to 4 complete sentences. It should be prepared after the rest of the report has been completed.

(3) **Introduction**. The second page of the report should begin with the Introduction, which is record of the experiment. The **Introduction** should contain a brief statement of the experiment to be performed with balanced chemical equations where relevant, and a statement about the goal of the experiment. DO NOT just regurgitate the laboratory write up.

(4) **Procedures and Observations**. Refer to the manual for descriptions of experimental procedures, and be sure to record any variation from the suggested procedure. Clearly labeled sketches of experimental setups are preferable to lengthy descriptions. When describing a synthesis, use a style that is similar to what is found in scientific journals (e.g., "...a solution of 10.0 g of reactant A in 50 mL of anhydrous ether was added drop-wise 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, 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 are more quickly and rectified if detected immediately. Graphs should always be done separately on good quality paper referenced in your notebook.

(7) **Analysis of Data and Errors. ALL ANALYSIS OF DATA MUST BE DONE INDIVIDUALLY**. The reproducibility and precision of data should be examined and the major sources of errors identified. Although detailed statistical analyses of error are rarely called for, you should at least 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.
(b) Explain the significance of your findings.
(c) Explain any unusual difficulties or problems that 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 (and not as a series of questions and answers).

(9) **Conclusion**. A very brief (1-3 sentence) statement 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**. Hard copies of computer output (tables, spectra) should be inserted into an Appendix. Each Appendix should have a number and a title and 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, experiment number, name of compound.

3. 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 oral report, you should tell your TA briefly:

- What the experiment was all about;
- Relevant theoretical background;
- What happened in **your** experiment;
- Your results and analysis;

Much of the preparation for your Oral Report will be the same as for a Written Report, described above. 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.

WHAT TO BRING TO THE ORAL REPORT

A. **A 4-6 page written summary** of your experimental results. This should include the key results and conclusions and all appropriate data analysis, error analysis, graphs, and other quantitative materials.
B. Your lab notebook, raw data, analysis, results, plots (computer-generated or hand-written), and any other materials that are appropriate.
C. Notes, books, and pretty much anything (inanimate) which will help you in your discussion. You are, of course, expected **to do your own data analysis and calculations**. You may use any sources of help, including other students, written reports from previous years, textbooks, journal articles, etc. to aid your **understanding** the analysis as well as other aspects of the experiment. All such sources **must be appropriately acknowledged** in your report.

YOUR PRESENTATION

You should plan on discussing your experiment for no more than 15-20 minutes. Be aware that it is impossible to present everything that you know about the experiment. Therefore, you should selectively plan what you have chosen to present. Throughout the time, 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, organize your presentation. You will almost surely 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 surely 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. Some students find it helpful to use a poster format to avoid shuffling papers.

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 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;
- Conclusions;

Ordinarily, you will not turn in your original data. 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 your TA as a guideline for determining your grade.

ORAL REPORT LOGISTICS

The schedule for the oral reports will be posted in advance on the course bulletin board. It is your responsibility to check the day, date, time and topic of your oral report.

It's that simple! The oral should not be a harrowing experience.

1.6 ACADEMIC HONESTY

> *"*Cheating, plagiarism, unauthorized collaboration, deliberate interference with the integrity of the work of others, fabrication or falsification of data, and other forms of academic dishonesty are considered serious offenses for which disciplinary penalties can be imposed*."* (http://web.mit.edu/policies/10.2.html)."

Standards for Academic Honesty:

The expected behavior in the laboratory courses and the consequences of not following these standards.

In order for a society to function, it should be based on trust. Decision making, from seemingly small everyday actions to important political matters, presumes a large component of ethical conduct. Unfortunately, the world is full of examples in which this trust is violated, making it sometimes hard to tell right from wrong. Nevertheless, this trust is sustained by the ethical conduct of each individual.

Every decision has its ethical component. While it may appear that in a laboratory course such as 5.35 it's really not difficult to tell right from wrong, there is always the potential for ambiguity or miscommunication on these issues: hence this perhaps overly long statement. The MIT policy on academic misconduct is very strict. "MIT assumes that all students come to the Institute for a serious purpose and expects them to be responsible individuals who demand of themselves high standards of honesty and personal conduct. Cheating, plagiarism, unauthorized collaboration, deliberate interference with the integrity of the work of others, fabrication or falsification of data, and other forms of academic dishonesty are considered serious offenses for which disciplinary penalties can be imposed."[1]

Where does ethical conduct come into the picture? Experimental scientific work requires, among other things, *background knowledge* (why do we want to do the experiment, what do we want to get out of it), *experimental skills* (how do we do it), *scientific ethics* (what are we going to do with the information we obtain from it, what if the experiment fails, etc.), and a large dose of *motivation* (motivation to study, motivation to learn, motivation to discover, or even motivation to obtain a good grade). Lack of motivation is one of the principal causes of failure in experimental work, especially in a laboratory subject. This

[1] "MIT Policies and Procedures", (http://web.mit.edu/policies)
[2] "On Being a Scientist. Responsible Conduct in Research", 2nd. Edition, Committee on Science, Engineering, and Public Policy, NAS, NAE, IOM, National Academy Press, Washington, D.C., 1995.

lack of motivation is usually accompanied by weak background preparation, lack of experimental techniques and skills, and in several cases, unethical behavior. Motivation is very personal and cannot be provided or taught. On the other hand, the background knowledge you need to perform an experiment is mostly built during your lecture subjects. It is in laboratory subjects such as this one where you learn experimental skills as well as the basis of ethical scientific behavior.

Unethical scientific behavior can take several forms. "Fabrication (making up data or results), falsification (changing or misreporting data or results), and plagiarism (using the ideas or words of another person without giving appropriate credit), all strike at the heart of the values on which science and society are based."[2] These different forms of unethical scientific conduct have a broad range of consequences depending on the seriousness of the offense. For example, copying a lab report from a classmate or cheating in an exam is usually the cause of failing the class. Publishing forged data in a scientific journal can result in the loss of reputation or even ruin the career of a scientist. Hiding vital information can produce large economic damage or even lead to loss of life. (See "www.onlineethics.org" for more information and some important and very interesting case studies.)

Frustration is not a foreign feeling to a student or a scientist. It is not unusual that experiments fail the first time, the second or, sometimes, even third time they are performed[3]. Occasionally the data collected during an experiment are not as easy to interpret as one would expect, or would like; or the compound from a synthesis doesn't look the way it is supposed to look or doesn't have the properties it is supposed to have. What are the acceptable and unacceptable alternatives in cases like these? It certainly seems easier and less time consuming to copy a lab report from previous years instead of spending a whole weekend on it. It could be tempting to forge or make up data or even copy it from a classmate, instead of investing time repeating an experiment that failed or even admitting that the experiment failed. Someone could argue "It's just a lab report." Even apparently "minor" gestures like the one described above undermine the foundations of the academic system and should be taken very seriously.

Good scientific behavior is built throughout the formation of a scientist, a doctor, an engineer, or a business person. "The scientific research enterprise… is built on a foundation of trust. Scientists trust that the results reported by others are valid. Society trusts that the results of research reflect an honest attempt by scientists to describe the world accurately and without bias."[3] The same applies to the field of health-care, business, engineering, and every aspect of life.

---

[3] For examples of experiments which failed on multiple occasions, just recall NASA's 1998 Mars Climate Orbiter and Mars Polar Lander missions. For details, consult the NRC report at www.nap.edu/catalog/9796.html.

Unlike in the lecture subjects, your actions in a laboratory subject can affect, and they usually do affect, the performance of your classmates. Imagine that by accident you contaminate a solution of a reagent that your classmates will use after you. Would you inform your TA at the risk of losing your "technique" points? Or would you keep silent and let your classmates perform the experiment with a contaminated reagent?

In some cases unethical behavior seems to be the easy way out, and some students think they can get away with it. That is certainly not the case, and we will do our best in defending the effort of those students who honestly work toward academic excellence.

Examples of conduct in 5.35 that would fall in the category of academic dishonesty, and would result in severe penalties

- CHEATING on a lab quiz, including having your lab manual or notebook open during a closed book quiz, will result in a grade of zero for that experiment.

- COPYING into your lab report any section of another student's lab report (from the current or a previous year) will result in a grade of zero for that experiment, could result in a grade of F for the course, and could result in the case being referred to the MIT Committee on Discipline.

- MAKING UP and/or ALTERING DATA will result in a grade of zero for that experiment and could result in a grade of F for the course and the case being referred to the MIT Committee on Discipline.

- PLAGIARISM (using material from other sources without giving appropriate credit) will result in a grade of zero for that experiment, could result in a grade of F for the course and could result in the case being referred to the MIT Committee on Discipline.

- Adding a grade sheet or other materials to the written report after submission for grading will be considered academic dishonesty unless the submission date is adjusted and the late report penalty is taken.

1.7 REQUIRED ITEMS

Required Items:

A USB Flash Drive will be needed to collect data files. The U Lab is also outfitted for wireless web/e-mail connectivity for your laptops. However, lab computers are to be solely used for data collection and are not connected to the network.

A laboratory research notebook with numbered duplicate pages (i.e., each white page being followed by a colored page, perforated for easy removal). Carbonless copy pages are preferable to those requiring carbon paper. Most students will require a notebook with 100 duplicate pairs of pages. Notebooks with 50 duplicate pages are available; however, a second notebook may be required to complete the course.

You are allowed to bring your lab manuals for use during the lab period.

5.35 / 5.35U Introduction to Experimental Chemistry
Fall 2012