

# GENERAL NOTES

## Objectives

The main objective of this laboratory is to teach you the practical techniques and procedures of experimental organic chemistry. A further objective is to enhance your understanding of the facts and theories of organic chemistry by having you consider them in a laboratory setting. It is hoped that at the end of the course you will understand the physical and/or chemical consequences of each step of a procedure as you carry it out and that you will be able to troubleshoot small experimental errors and salvage experiments. The spring semester course is designed to extend these original goals and to have you begin to work like real chemists in that you will be utilizing more library resources and working more creatively and independently.

Organic chemistry is a creative science in which the synthesis of complex and previously unknown molecules plays an important role. The first semester laboratory course will build the foundation for more complex synthesis in the spring. In the first semester, you will learn how to purify molecules, how to identify molecules and how to synthesize simple, relatively well known molecules.

Many of you who carry out chemical, biological, or medical research in the future will use the training you receive in this laboratory directly in that research. All of you, I hope, will use the mental development, organizational skills and manual dexterity gained by this course in many facets of your life. Hopefully, you will be excited by what you learn, but you will also realize how little we really know, how much more there is to learn. There is an infinite amount of studying to be done and discoveries to be made!! One's understanding can always be enhanced!!

"I am the wisest man alive, for I know one thing, and that is that I know nothing."

Socrates

## Texts

If you ever find you need more background on any subject covered in this virtual manual, please just refer back to the schedule - the first webbook page of this manual. It is very important that you be very focused in on the schedule page of the virtual lab manual. It is the source of information (including this!!!). There, you will find links to the labs, links to very helpful YouTubes (we hope). There are YouTubes on nearly every subject, please make use of them. Seeing the technique done in our lab is a great advantage before coming. References to these YouTubes will be highlighted. Also, you should refer to your lecture text book when it is referred to in the lab manual and in general, to connect the theory of organic chemistry to the practice of organic chemistry

## Notebook and Lab Reports

The required notebook for this course, is the "Laboratory Research Notebook", which is available from the College Book Store. It is fine to substitute another notebook, as long as it has alternating pages (each pair having the same page number) with which you can make a carbonless copy of all your work. Your notebook is to be a **complete (and immediate)** record of every record you gather and every observation you make in this laboratory. This aspect of the lab will be greatly emphasized in that copies of all notebook pages for each lab will be collected at the end of each lab and returned to you within a few days with a grade. We have found that this process greatly improves every aspect of the lab, besides being standard practice in a laboratory.

Unlike your general chemistry experience, you are expected to prepare your lab notebook the way a scientist would before lab. We want you to switch from thinking of the lab notebook as a place where you complete your lab write-up (though you can do this), to a place where you prepare for lab and record data and observations. The notebook before lab should have an introduction (a very brief statement about the purpose of the lab). The net reaction if the lab involves a reaction and the mechanism if the involves a reaction. The procedure for the day should be written out in a way that is abbreviated and assists you in carrying out the lab. You should also include a reference to where you obtained the procedure. The procedure should be written in a way that enhances your ability to function in the lab, e.g., a flow chart or useful notes on each step. You should review all relevant YouTubes and any notes you have on repeating procedures (you can put these notes in your lab notebook). You should draw a diagram for any apparatus you have to build. Before coming to lab, you should try to visualize what you will do in lab. You will find this enables you to work much more independently and shifts your focus from the building and carrying out of procedure to what the lab is about. Also, your knowledge will build with each lab and you will start to feel much more confident and competent. Most importantly, your notebook is where you record all observations (and observations should be detailed and continuous) and raw data. We don't care if the notebook is neat, it just has to be a place that you document all information in a meticulous manner. We have an acronym to help you remember what to write each week. The acronym is IMMPPD (I Make Molecules Productively During Daytime = Introduction, Main Reaction, Mechanism, Procedure with reference, Diagrams of apparatus, Data and Observations). You should use this for each new procedure. Please see the Rubric below. Points will be deducted from your lab manual grade if you are not prepared, even if your notebook is prepared. Keep in mind, however, that the primary purpose of the notebook is for you to write down what you did and observed in the lab for future reference. You should not devote the entire lab to creating a perfect notebook. I think it is important to realize that organization in the lab is very much related to your organization. You have to have studied and thought about the lab enough so you have an idea about what you are doing and do not need constant guidance. Some labs will be more than a week long and for those labs, you are just recording observations and data on the second and perhaps third weeks. I hope this makes sense. There is guidance in the cover pages about what you need to do each week. You will find when you get to the spring and are doing a seven week lab, that keeping a notebook in this fashion is essential.

### Rubric for Laboratory Notebook

- Introduction (statement of purpose, big picture ) 10 points
- \* Main reaction 10 points (only for synthetic labs)
- \* Mechanism 20 points (only for synthetic labs)
- Procedure from literature, or lab manual with scaling, give reference for source of procedure 20 points
- Diagrams of apparatus (optional)
- Data and Observations from the days lab (20 points)

General Preparedness (notebook ready, on –time and clean up from lab) 20 Points

\*Some labs are not synthetic and will not include these sections.

Also, some weeks, you are simply recording data and most sections are not included and in investigative experiments, you will not record a main reaction or mechanism. **You must use common sense on these weeks.**

At the end of each laboratory period, the yellow copies of the pages you have used in that period should be removed neatly from your laboratory notebook, stapled together, and handed in to your Teaching Assistant. This protects you from suffering a disaster if your laboratory notebook is misplaced, lost, or accidentally destroyed. It also allows regular evaluation of your preparation. Please do not fuss excessively about these pages. Not everyone will have the same observations and may not be in the same place. The TAs are aware of this, but also if they do constructively criticize what your notebook, please implement the changes in the next notebook entries.

Your lab report itself may be written on separate pages in your notebook or can be written using a computer, but the raw data must be in your notebook. These sheets will be collected each week. DO not keep your laboratory data on loose pieces of paper, your hand, etc. This is very bad lab practice. You should feel uncomfortable in the lab if you do not have your lab goggles on or if you do not have your lab notebook nearby.

Except for some modifications described in individual experiments (e.g. the first few labs and the form write-ups), you are to follow the detailed instructions given for each write-up in the lab manual. Reserve the first three pages of your notebook for an index, and keep this current each week. Note that part of the write-up for a given experiment is to be completed **before** you come to lab.

Most labs, with the exceptions as noted in the laboratory, follow the following general format. Most are Investigative experiments in the first semester.

**Investigative experiments** are designed to answer a question or determine a property of a substance (and of course often to teach a technique). For these types of experiments you should use the rather flexible format described below with the specific modifications given in each lab.

**The first half of the course is in this investigative format, though some labs are designed to lead you through the format without you being totally aware of it, so you will get used to what to include. Also, there are several labs that have forms to facilitate writing. Generally all labs are completed individually, except the spectroscopy lab which is completed in groups of two or three. Though we do a few synthetically oriented labs this semester, these will either have forms or will be written in a more or less investigative format. We will not use the preparative format until next semester, though the sample preparative lab given below is very instructive in regard to what information is needed to do synthetic work.**

## General Investigative Format

### I. Answers to Pre-lab Exercises

These exercises are assigned in this lab manual. The answers should be written in your notebook or stored on your computer. A copy of this assignment is turned in upon entering the lab to do the corresponding experiment.

### II. Introduction

This section should consist of a paragraph or two describing the purpose of the experiment. Not only should the immediate purpose be stated, but the "big picture" goals should be defined. The big picture goal might be ... "This lab trains the student in an important technique used to separate organic compounds". You should also give a reference for the procedure to be followed, e.g., *Lab Manual*, p. ## or the literature reference. You will have a few procedures you look up yourself this semester, in the Spring, most of the procedures come from the literature. This section must be completed before coming to lab. This should be a slight elaboration of what you wrote in your notebook.

### III. Experiments and Results

This section is really a big, flexible data table. For each major part of the experiment, a descriptive heading is written and a space beneath is left blank for recording data and observations associated with that part of the experiment. Processed data also belongs in this section, e.g. graphs, calculations, etc. The setup of the data tables should be completed before lab, raw data is recorded directly into the notebook during lab and calculations are completed during or after lab. The yellow sheets corresponding to this data must be turned in at the end of lab. This is the organization and consolidation of all you data and processed data that was originally in the notebook in raw form.

### IV. Discussion

In this section, draw any reasonable conclusions from the data and state whether or not the goals of the experiment were achieved. Carry out a thorough error analysis and state any improvements that could be made in your procedure to get better results. This section is completed after lab in lab after lab in your notebook or on your computer.

### V. Answers to Exercises

The exercises are assigned in this manual. They should be completed in your lab notebook after carrying out the experiment.

Very few labs this semester, have the sole goal of making organic compounds for the sake of making them and demonstrating chemistry as you learned it, however, when you do you may write a **preparative report**. The report can follow this format or some variation of this format. Please pay attention to the instructions you are given with each lab – there will be two labs that follow this format in the fall. Please study this format because it gives you some important information about the sort of information needed for synthesis, the way one calculates percent yield, the idea of side reactions and the importance of mechanisms. Please review this through the course as it will become more and more relevant as we proceed.

**Preparative experiments** involve the organic synthesis of molecules or molecules. For **preparative experiments** you should use the format outlined below. In this format, Sections I through VI constitute the pre-lab write-up that must be completed **before** you come to lab.

Section VII should include all of the notes that you make while the experiment is in progress. Section IX should contain any conclusions that are called for in the instructions, along with detailed error analysis and suggestions for improvement if the experiment did not proceed as well as it might have. A sample lab report follows the format below with the exception of raw data observations (must be in notebook) or on your computer. You might also pay attention to this format as it shows how to write introductions, main reactions and mechanisms, which are needed for reactions in your notebook.

**Once again: You are also responsible for keeping a notebook. Keeping your notebook is a separate and distinct exercise from writing your report. Some people write their reports in their notebooks, but this should be done on separate pages. You can also write the report on your computer, but the notebook is your daily record of what you plan to do and what you actually do and it is extremely important. So much so that we will collect these pages every week. The components for the notebook are listed repetitively on the main page of the on-line notebook. Don't forget observations! Note: what you do depends on what you are doing. The guidelines for the notebook are based on synthesis, some of these components are not included on a given week if you are doing an investigative report or just collecting data for a multi week procedure.**

FORMAT FOR PREPARATIVE EXPERIMENT LAB REPORTS

Experiment #:

NAME:

Date:

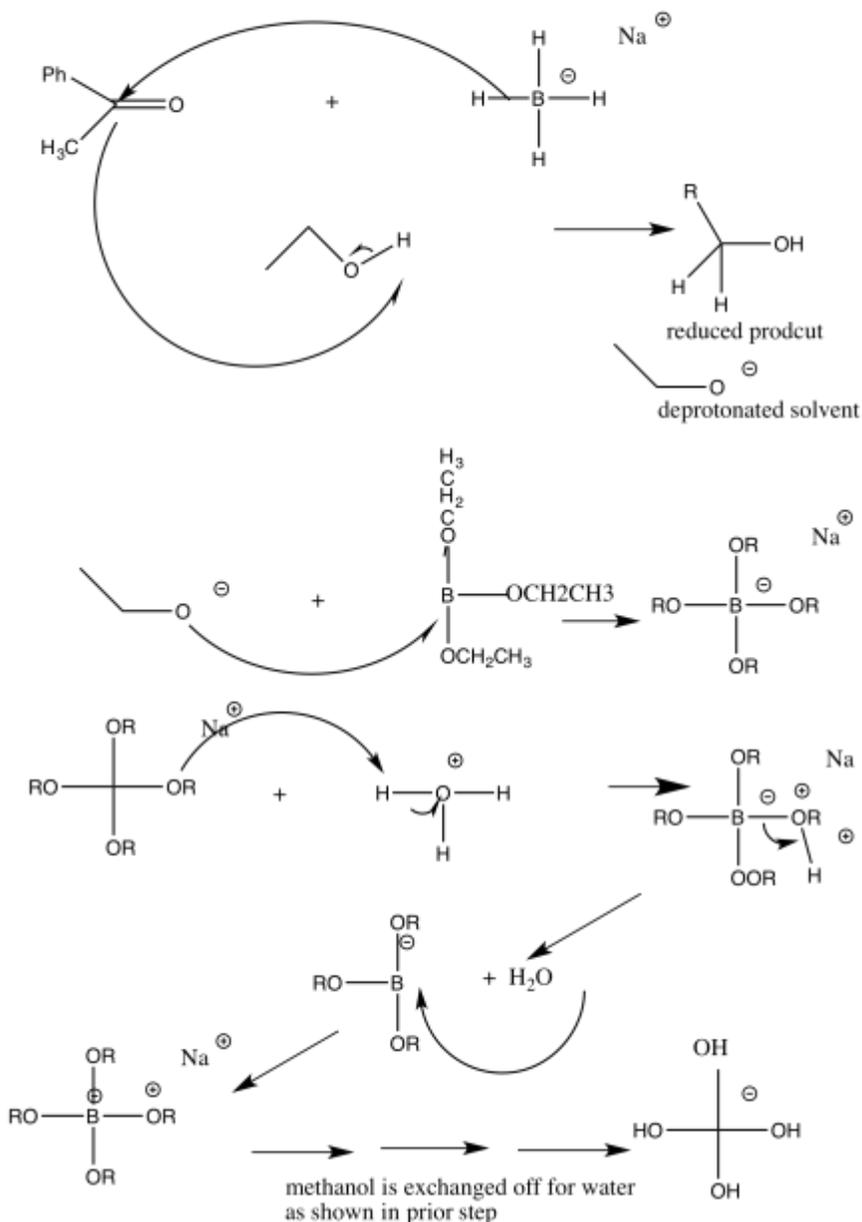
TA:

Title:

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- I. Introduction - In a few words, describe the reaction to be carried out, and give a summary of how the products are to be analyzed. State the "big picture" goal (described earlier). Give a reference to the procedure (either this manual or literature reference) along with any modifications that you have been instructed to follow. **Do not write out the procedure in the write-up).**
- II. Main reaction and mechanism - write the reaction you are going to carry out and its mechanism using the arrow formalism (in your notebook or a computer).

### Mechanism for Sodium Borohydride Reduction



- III. Potential side reactions and how the procedure is designed to minimize them. Mechanisms are not required here. These will be explained in more detail when we carry out the first preparative lab.
- IV. Purification - a verbal description of how the main product is separated from the side products, un-reacted reagents, catalysts, and solvents. Begin by naming or drawing the structures of all the substances (including possible side products) present in the reaction mixture when the reaction is complete. Describe how each is removed. This can be done in a tabular form. This will be explained in more detail when we carry out the first preparative lab.
- V. Table of reagents (This will explained further on future date.)

<u>Compound</u>	<u>Mol. Wt.</u>	<u>Amount used:</u>		<u>MP</u>	<u>BP</u>	<u>Density</u>
		<u>Grams</u>	<u>Moles</u>			

(Give the BP and density for liquids, but only the MP for solids. List **only** reagents, not solvents or catalysts.)

VI. Table of products (This will explained further on future date.)

<u>Compound</u>	<u>Mol. Wt.</u>	<u>Amount used:</u>		<u>MP</u>	<u>BP</u>	<u>Density</u>
		<u>Grams</u>	<u>Moles</u>			

(This much constitutes the material to be written out before coming to lab in notebook or word processor.)

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VII. Observations and data - record significant observations, color changes, etc., and any data collected. (record in notebook during lab)

VIII. Results (record in notebook during lab)

Yield (grams, moles, %):

Properties of product:

Physical state, appearance, MP or BP:

Results of chemical and solubility tests (if any):

Results of GC or IR (if done, normally attached):

Analysis of spectra (if assigned):

IX. Discussion - whether the objective of the experiment was achieved (in most cases whether the desired compound was obtained reasonably pure and in good yield, and if any questions were answered by the experiment), and a summary of the evidence that supports that conclusion. The discussion should include an error analysis, i.e., reasons for low yield, possible contaminants and it should include a summary of evidence supporting the identity of product. (in notebook or computer)

X. Answers to assigned problems (in notebook or computer).

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## Some Suggestions for Writing Lab Reports

My expectation is that the students in this course will do their best to develop their analytical capabilities, this is why I try not to spoon feed you the answers. I want you to get more out of this course than just a head jumbled with organic reactions. I want you to learn how to think, i.e., to develop your problem solving capabilities so that you can use your experiences from this course in non-chemistry situations. It is not my expectation, however, that you will spend inordinate amounts of time writing lab reports. Ten to fifteen hours a week on lab report is too much and it really worries me that some students use so much time. Five to seven hours is a healthier time frame. I appreciate perfectionism, but at some point you have to stop working and turn in your work. Our game plan is that though we will not start writing in third, person, passive voice and perfect journal format, we will move toward this over the year so that your project in the spring will be written in this format.

To keep things reasonable, you have to decide that you are going to develop priorities in using your five to seven hours of work time. You should decide to put most of your time into the assigned readings, preparing your lab and thinking about it (even visualizing it) thinking about your data and the solutions to the assigned problems. You should minimize the time you spend actually writing the report. Choose not to write the entire report on scrap paper and copy it over. Write your work directly into the notebook or on your computer. No one will get annoyed if you cross something out as long as the answer is legible. Alternatively, you can word process your report as long as you record raw data in your notebook. Though I don't recommend this because I know that most students get carried away while word processing. Be as concise as possible in answering questions. Lengthy essays are not required. Answer in a word, phrase or equation if possible. Minimize the amount of time you spend doing things that are not very beneficial to your mental development. For example, try not to become obsessed with finding a particular piece of data, although we have magnificent data bases available on this webpage (see virtual library) and (mnerzsto@brynmawr.edu), write a note, or just bring your problem to lab. I have always been and will always be flexible about pre-labs. When you write answers, keep them short. If an equation or mechanism can be used, use this in lieu of words (this is our true chemical language at this point). You can write lists instead of paragraphs. Use phrases instead of sentences. This sort of language is actually closer to the concise wording used in a chemistry paper. This is all good as long as when you are done writing you have answered the question or described the phenomenon at a molecular level and have fully explained it. We are looking for succinct, deep answers, not wordy vague answers.

Now, how about approaching novel problems? The solutions to these problems are not exotic. They are based on fundamental information that is given in the lab manual, readings or lectures. It is just a matter of gaining enough confidence in yourself to put basic ideas together in a new way. Generally, it is very important to realize that I am most concerned with your mental development. I would rather that you thought for 10 minutes or so and try **your** best to answer the question than scurry around the building for an hour trying to find someone who can give you the best answer. I really feel that the worst mistake you can make in this course (and it is frequently made) is to put all your time and emphasis on finding the absolute answer rather than thinking on your own feet. There is so much to be gained by thinking even if you do get some answers wrong. Side reactions always give students some trouble so I will use them as an example.

This will be more applicable later in the course, but side reactions are anything that lowers the yield of a reaction chemically. Answering the following questions should lead you to the relevant side reactions. You might refer back to this later in the course.

- 1 Does the reaction have another possible regiochemistry (e.g., anti-Markovnikov vs. Markovnikov addition) or stereochemistry (e.g., endo vs. exo)? Any product derived from the less desired route is considered a side reaction.

2. Does the reaction produce an intermediate that rearranges? If rearrangement is possible, any products derived from undesired rearrangements are side reactions.
3. Are any of the reagents or products sensitive to the laboratory atmosphere? For example, does anything react with water or gases in the air? If so, other side products will form because one can't completely eliminate the atmosphere under our crude lab conditions.
4. Are there functional groups in the reagents that are not necessarily involved in the desired chemistry, but are sensitive to the conditions of the reaction? For example, a double bond and a hydroxyl group can react with aqueous acid. Here and everywhere, you are not expected to come up with reactions that have not yet been covered.
5. Finally, is the reaction such that a component involved in the reaction might undergo the same type of reaction with itself.

In any event, you will get stuck every once in a while. If you do, don't beat your head against the wall! Come to office hours, write a note, call, e-mail or just bring the problem to lab! Please bother me!

Science is built of facts the way a house is built of bricks; but an accumulation of facts is no more science than a pile of bricks is a house.

Henri Poincare, *La Science et l'hypothese* (1902)

## HONOR CODE

Lab reports are to be written **independently**. While it is reasonable to ask the instructor/T.A. for guidance, it is not acceptable to ask fellow students for the specific answers to questions or to compare answers to questions. It is also not permissible to consult graded lab reports or exams (unless provided by the instructor) from the prior academic year or to work in groups while writing individual lab reports. Obviously, group work is encouraged on group reports (more prevalent in the second semester). You are encouraged, however, to discuss general concepts with one another. For example, it is perfectly acceptable to discuss the assigned readings and lecture notes with a classmate. It is also permissible to hash through the procedures together to make sure you understand them. I urge you to work in groups under the described circumstances and especially when you are studying for exams!

### A Little about Grading

Lab reports are graded by Teaching Assistants (except one or two) the first semester. The TAS are provided with grading keys and the grading is monitored by the lab instructor. The instructor is responsible for all other grading. In the second semester the TAs grade three of four lab reports and the instructor is responsible for everything else.

#### Lab Grade for First Semester Lab Fall 2017:

Lab Reports (all considered equally)	64%
Lab Notebooks (all considered equally)	18%
Lab Quizzes (Best one of two is grade, but get bonus 3 percent on grade if you take second quizzes and perform competently on both).	8%
Lab technique	10%

The total of 100 percent or 100 points is scaled to 30 points and added to your lecture grade which is scaled to 70 points. Most people in lab have a lab grade in the range 25-28 out of 30.

It should be noted that the TAs are responsible for a bit more than 20 percent of your total fall organic chemistry grade and less than fifteen percent of your spring grade. I can also state after 30 years of teaching, the lab averages among sections are very consistent. If there is a significant difference, the grades from section to section are normalized. This is done when necessary, but happens rarely.

## GRADING

Though each lab has specific instructions and as discussed earlier, the following are typical rubrics for organic chemistry labs. The material in sections can vary a bit and the point breakdown and total will vary from experiment to experiment. This is written to give you a general idea.

### Investigative experiments:

Pre-lab exercises	20 points
Introduction	10 points
Experiments and Results	40 points
Discussion	30 points
Answers to exercises	20 points
Quality of results	<u>20 points</u>
Total	140 points *

### Preparative experiments:

Pre-lab exercises	20 points
Pre-lab write-up (Sections I-VI)	60 points
Completed lab report (Sections VII-IX)	50 points
Answers to questions (Section X)	20 points
Product (yield, purity, appearance)	<u>20 points</u>
TOTAL	170 points*

\* All reports have equal weight. Each experiment, regardless of the rubric is scaled to 100 points.

Your grade for the laboratory portions of Chemistry 211 and 212 is mostly based on your understanding of the experiment and associated theory as reflected in the grades on each of your individual laboratory reports and your scores on the laboratory exams. The quality of your results is worth 20 points on most labs. You can have terrible results and score well on lab reports. Therefore, it is always worthwhile to turn in a report. It should also be mentioned at this point that **the instructor does not require students to start over when an error is made. In fact, it is discouraged!** There is very little to be gained from repeating the procedure. It is wasteful and students seldom learn much from the experience. Whenever you make an error, talk to your instructor. The experiment can usually be salvaged and you will learn more. It is important to realize early on that you are in lab to **learn** and not to perform. You simply can't always perform like an expert when you are a novice.

**Please note that Prelab Exercises must be turned in at the beginning of lab.** Turn your Prelab in to your TA at the beginning of lab lecture. If you cannot do this for some reason, you must talk to your instructor or use the free extension form (there is one, no questions asked, free extension form in the laboratory manual on page on page G-15).

Completed laboratory reports are due by 2:00 PM ONE WEEK AFTER THE DAY THE EXPERIMENT IS SCHEDULED TO BE COMPLETED. Teaching Assistants cannot grant extensions. One "free, no questions asked" extension will be allowed for each student during each semester. To obtain this extension, you must fill out the form on page G-15 of this manual and staple it to the late lab report. The extension is for one week and is not transferable to the next semester. The extension must be requested in this way, so that your instructor can keep an accurate record. Your first extension must be taken this way. You can't save the form for a rainier day. Any extensions beyond this "free" extension must be granted jointly by your dean and your instructor. Your dean's approval must be secured first. Any reports turned in late without an extension or reasonable situation will be automatically graded down according to the following schedule.

<b>Lateness</b>	<b>Penalty (% of grade earned)</b>
1-7 days	-5%
1-2 weeks	-10%
2-3 weeks	-15%
3-4 weeks	-20%
4-5 weeks	-30%
Over 5 weeks	-40%

Graded reports will be returned to you in lab the following week. Please let your instructor know if your labs are not returned in a timely fashion.

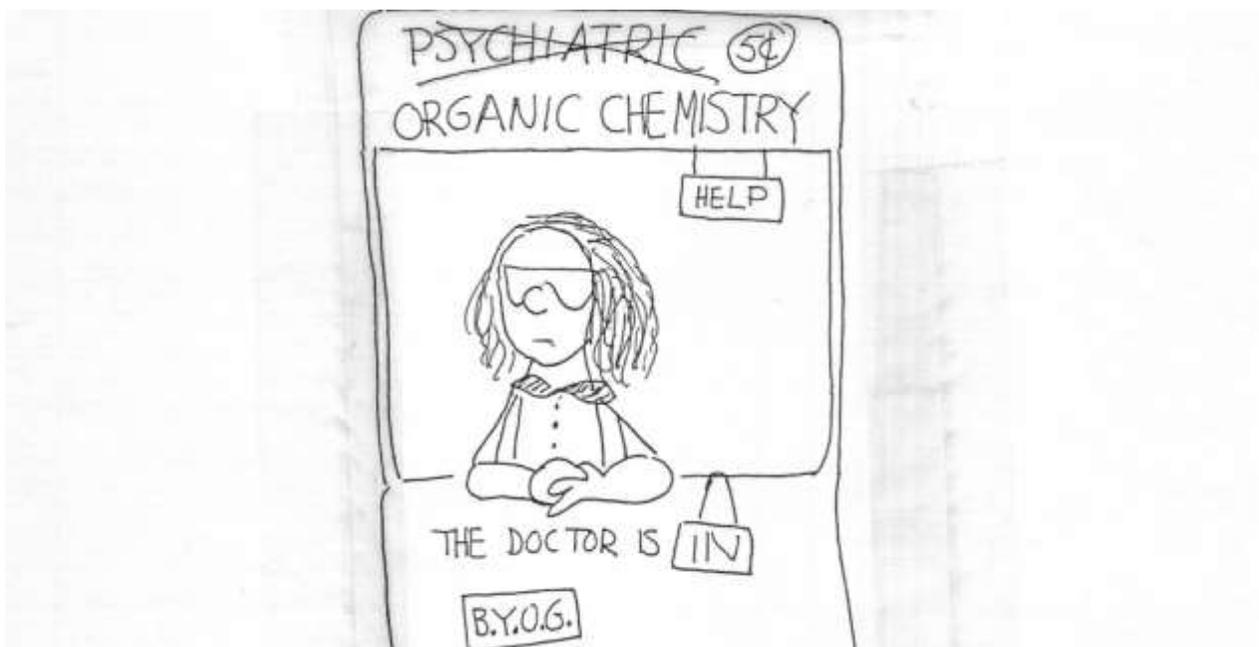
In Semester I, the absolute deadline for all written work, including reports for any experiments carried out during the final make-up session, is **5 PM of the last day of classes in December.**

### **Hours and Attendance**

You will be permitted to work in the laboratory **only** during the hours and on the particular day of the week that your laboratory section is scheduled, **except** that you may weigh solid products and determine their melting points during any time the lab is open. The lab will be generally open from 10-5:30 each day, Monday-Thursday. **At the discretion of the instructor of the course, the lab can be opened at other times.** When the lab is not in session and no arrangement has been made with the lab instructor, you may not do any work.

If you are unable to attend **one** of your scheduled laboratory periods for a legitimate reason you will, in most instances, be allowed to make up that missed laboratory work during another section's scheduled period **provided** you obtain explicit permission from the instructor **in advance.** Otherwise, you may be scheduled, once again with the instructor's permission **in advance,** to make up a missed laboratory period on one of the several afternoons during each semester that have been designated specifically as make-up sessions. In so far as possible, please give advance notice of any expected absences. One make-up lab per semester per student is quite acceptable. The view by the student that the lab and the instructor are totally flexible is unreasonable. Remember often times there are 150 students in the course. There may not be room at your bench on another lab day. Sometimes your make-up lab is chemically or physically incompatible with the one scheduled to be carried out.

A fifty minute lab lecture will be given on Friday Afternoons (classroom and time TBA). The theory behind each lab will be covered in this lecture. The main purpose of these shorter lectures is to go over the experimental procedures for the lab. Please make every effort to attend. Attendance is taken at these sessions. Though they may be taped using the Tegrity lecture capturing program, this is not guaranteed and it is most important that you attend lecture. People who attend lecture are better prepared. This is a fact. Please make every effort to attend lab lecture.



\* Bring Your Own Goggles By Se Young Um

## FREE EXTENSION FORM

**This is only for one lab report; it is not for the lab notebook.**

Name: \_\_\_\_\_

T.A.: \_\_\_\_\_

Section: \_\_\_\_\_

Name and number of lab to be submitted: \_\_\_\_\_

Date lab was carried out: \_\_\_\_\_

DATE LAB REPORT WILL BE SUBMITTED: \_\_\_\_\_

**(this date can't be more than a week beyond official due date)**

Signature: \_\_\_\_\_

Staple this form to the front of late report when you are turning it in. Form is not transferable to another student or another semester. If you have a late prelab only, please see your instructor.

# SAFETY

Please view the safety videos linked into the virtual schedule/lab manual entry associated with this lab.

1. You **must** wear the required safety goggles **at all times** while you are in the laboratory. There will be **no exceptions**. If a TA or an instructor finds you without goggles on, you will be reminded of the rule; after the first such reminder on a given afternoon the second instance of non-compliance with the rule on your part will lead to a reduction in your grade of **10 points** for that experiment. Subsequent violations may result in your **having to leave lab for the day**.
2. Contact lenses can be worn in organic chemistry laboratory, but if you wear them you absolutely must have your goggles on at every minute because of the potential hazard of getting chemicals trapped under the lens. If you tend to take your goggles off, you might consider replacing the lenses with glasses while in lab. The required goggles are large enough to fit over regular glasses.
3. You are required to wear nitrile gloves and aprons (both provided in lab) for all lab work.
4. **Closed shoes (no flipflops) must be worn at all times in the laboratory. Sandals, flipflops and bare feet are prohibited. It is very dangerous to wear open shoes as spilled chemicals tend to fall on your feet.**
5. Avoid wearing shorts and new clothing in the lab.
6. Long hair should be tied back while carrying out experiments.
7. **Smoking, eating, or drinking in the laboratory will not be permitted. You cannot bring water bottles or coffee into the lab. This is VERY IMPORTANT!!!!!! You can leave them in the hall.**
8. **No unauthorized preparations or experiments may be attempted at any time.**
9. **No unsupervised lab work is permitted.**
10. **All lab work should be carried out in your assigned fume hood with the hood door down as far as possible.**
11. Avoid unstable assemblies of apparatus consisting of books, pencils, matchboxes, etc.
12. When inserting glass tubing in a stopper, use a small amount of vacuum grease as a lubricant and wrap both the stopper **and** the glass in a towel. Hold the glass tubing close to the point of entry into the stopper.
13. Do not use cracked or chipped glassware; replace it.
14. Never heat a closed system of any kind.
15. NEVER EVAPORATE ETHER ON A HOT PLATE; use a hot water bath.
16. **Do not place highly volatile solvents in a beaker**, even for short periods of time; use an Erlenmeyer flask with a cork. Beakers should be used only for solids and aqueous solutions. Do not use beakers for recrystallizations, use Erlenmeyers.
17. Wear goggles, gloves and aprons while washing glassware. Never wash glassware with hot water.
18. Many organic substances are toxic or corrosive. Avoid inhalation of organic vapors or skin contact by organic substances.
19. Keep the laboratory floors free of jackets, books, spilled ice, dropped stirring rods, stoppers, and pencils, and any other hazards that might cause someone to trip or slip.
20. Keep your lab bench neat and orderly; a cluttered laboratory is a dangerous place in which to work.

21. Advise your instructor of any health problems you have that may be aggravated by working in the organic lab, e.g., migraine headaches, allergies, etc.
22. **(WASHING GLASSWARE)** Allow glassware to cool completely, then rinse it several times in the cup sink in the fume hood. Proceed to the normal sink. Wash (wearing gloves) with cold water and soap. Gradually increase the temperature of the rinse water. Rinse with acetone, then distilled water.

## IN CASE OF ACCIDENT

The occurrence of an accident of **any kind** in the laboratory should be reported promptly to the instructor.

### ***FIRE***

Your first consideration is to remove yourself from any danger, not to extinguish the fire.

If your clothing is on fire, DO NOT RUN; rapid movement will only fan the flames. Roll on the floor to smother the fire and to help keep the flames away from your head. Your neighbors can help to extinguish the flames by using fire blankets, laboratory coats or other items that are immediately available. Do not hesitate to provide this aid if your neighbor is involved in such an emergency, since a few seconds delay may result in serious injury.

A laboratory safety shower can be used to extinguish burning clothing.

If burns are minor, immerse the affected area in ice water for a period of time. In case of serious burns, professional help should be sought at once. Report all accidents to your instructor.

### ***CHEMICAL BURNS***

Areas of the skin with which corrosive chemicals have come in contact should be washed immediately and thoroughly with water (fifteen minutes with cool water). This means that one should rinse the area involved for at least fifteen minutes with cool water. All injuries must be reported to the instructor. Be prepared to see a physician if you are instructed to do so.

Bromine burns can be particularly serious. These burns should first be washed with soap and water and then thoroughly soaked with saturated sodium thiosulfate solution for three hours. Be prepared to see a physician if you are instructed to do so. In the current course, we are not using bromine.

If chemicals, particularly corrosive or hot reagents, come in contact with the eyes, hold eyes open and immediately flood with water from the specially designed eyewash fountain that is available in the laboratory. Do not touch the eye. Point the eyewash hose upward and turn it on gently so as to produce a soft arc of water. Your contaminated eye should be placed in the arc so that a soft flow of water crosses your eye. The eyelid as well as the eyeball should be washed with water in this manner for **15 or more minutes**. Be prepared to see a physician if you are instructed to do so.

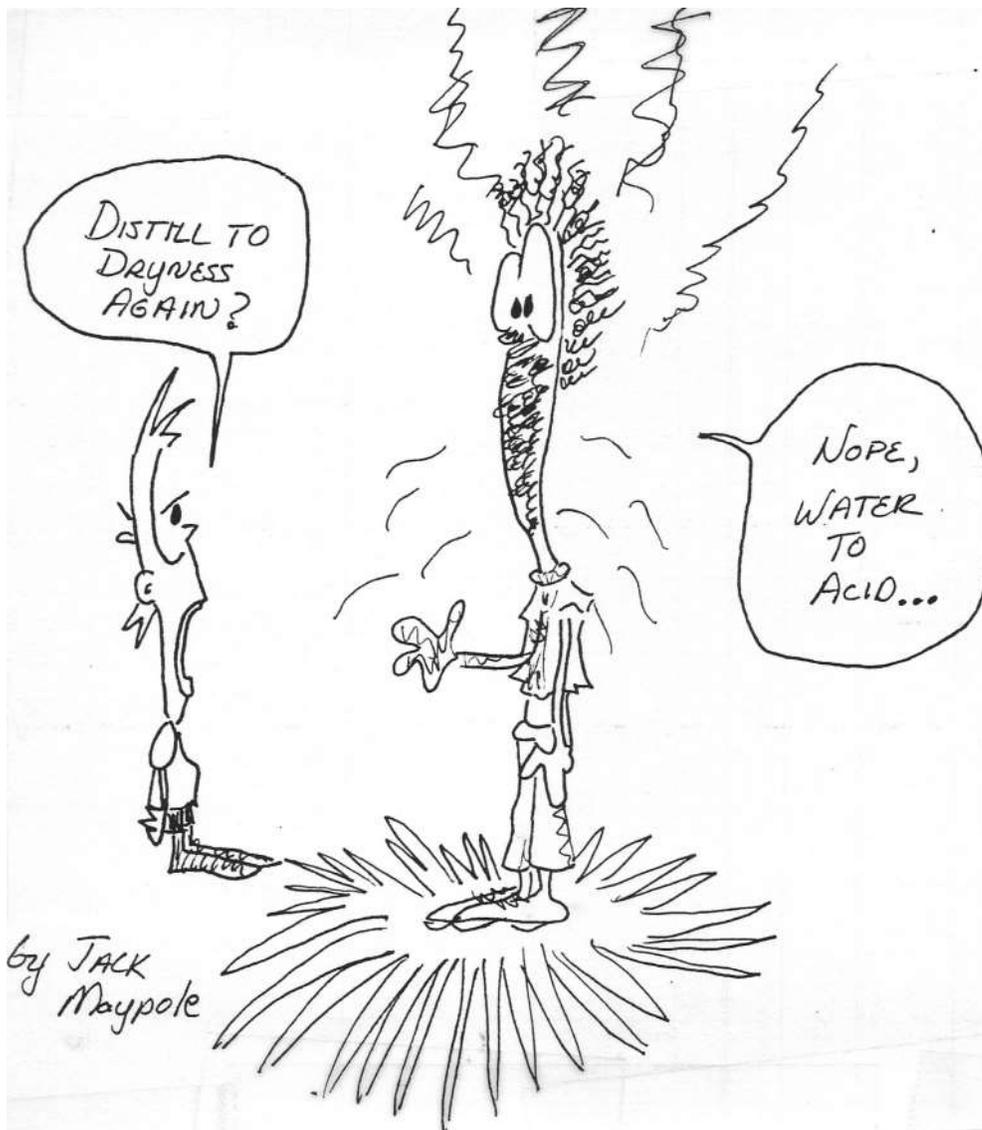
Most of the organic chemicals you will encounter in this laboratory are not seriously corrosive, but many are at least mildly toxic. In the event you inadvertently get an organic chemical on your skin, it should be removed promptly by washing thoroughly with copious amounts of warm water and soap. The area should be rinsed for at least ten minutes with cold water. Do **not** use an organic solvent such as acetone or ethanol to remove chemicals from your skin.

## CUTS

Minor cuts may be treated by first-aid procedures; seek professional medical attention for serious cuts. If severe bleeding indicates that an artery has been severed, attempt to stop the bleeding with compresses and pressure. Arrange for emergency room treatment at once.

Persons who are injured severely enough to require a doctor's treatment should be accompanied to the infirmary, even if they protest that they are all right and can make it on their own. Persons in shock, particularly after suffering burns, are often more seriously injured than they appear to be.

## IN CASE OF EMERGENCY CALL SECURITY AT 911



# PROCEDURES

1. It is critical for your success and your safety in carrying out the experiments in this course that you prepare yourself for each laboratory period by acquiring **in advance** a thorough understanding of the work to be undertaken in that period. When you walk into the laboratory, you should have a clear idea about what you are going to do and why you are doing it. If you have any questions, ask your TA or instructor at the beginning of the period, during or after the pre-lab lecture. Without detailed advance planning, you may find yourself working too inefficiently to complete some of the more demanding experiments within the scheduled periods, and you may make mistakes that could lead to injuries to yourself or others in the laboratory. **Be sure to check the marker board** as soon as you come into the laboratory for last-minute instructions and/or helpful hints. This can happen and it should not be alarming. In addition to being very prepared, having a plan and having VISUALIZED the experiment, you should also be ready for change. In research, we are constantly learning and this is research. When we learn we implement what we learned right away.
2. There are many laboratory operations that require considerable time but little attention (e.g., refluxing a reaction mixture, allowing a sample to crystallize by cooling, allowing solvent to evaporate from a re-crystallized sample, etc.). You should plan your work so that you use that slack time during these operations as effectively as possible by preparing for a subsequent step, taking a melting point from a previous experiment, making a label (perhaps with some blanks remaining to be filled in) for a sample to be submitted later, etc.
3. All reagents needed for your experiments are in the dispensing areas in the laboratory. Liquids will be found in the two dispensing hoods and solids will be found near the balances. After you have used a reagent, return it to its proper place. **DO NOT TAKE BOTTLES TO YOUR WORK AREA.** Reagents with irritating vapors will be dispensed in a hood, and must be taken to your work area in a **stoppered** container.
4. Liquids will generally be dispensed from bottles. **READ LABELS.** This is one of the most important aspects of working in lab. I also feel it is good life training. Do not grab a bottle and use it simply because you saw a peer doing it. Read the label yourself. When dispensing a liquid from a small bottle with a penny head stopper, remove the stopper from the bottle by gripping the penny head between your index finger and middle finger. While gripping the stopper in this way, lift the bottle using the same hand and pour. When dispensing liquids from a large bottle, unscrew the top and lay it on its back on the bench. Approximate the quantity of liquid needed by measuring it into a beaker. Then dispense the liquid from the beaker into a graduated cylinder. Can you guess the reasoning behind these procedures? We will also dispense liquids from specially designed squeeze bottles with graduated spouts and using pumps out of large reagent bottles. It is extremely important to not cross contaminate. Do not put pipets in bottles. Do not pour excess liquids back in bottles.
5. Do not weigh samples directly on a balance pan; instead, use a tared piece of paper, a watch glass, a weighing boat, or a beaker as a container for the sample while it is being weighed. Again **READ LABELS** before measuring out solids.
6. **Clean up spilled chemicals immediately.** Consult your TA if necessary.
7. Do not throw waste or excess organic chemicals into a sink. Waste solvent containers will be provided. **Always** consult your T.A. or instructor before disposing of wastes!
8. Do not put insoluble materials (including boiling stones, paper, and broken glass) in the sinks.
9. **Washing glassware. It is rarely desirable to wash glassware at the beginning of lab.** In many experiments, you will work with water sensitive reagents. Very often that little bit of "crud" at the bottom of a flask is less harmful to a reaction than the water introduced by washing. **Sometimes water is your enemy (meaning, some reagents react with water and can become inactivated by tiny bits of water).** When you do

need to clean glassware, **always wear gloves, goggles and an apron.** A regular good general procedure for washing involves wiping all grease off with a paper towel and then washing the glassware using a brush/ soap and cool water (why cool?). After washing, the glassware can be rinsed with a **small** amount of acetone, followed by a rinse with distilled water. The glassware can be dried by baking it in the drying oven under your hood (watch out for plastic in the ovens - it melts). While this is a good general procedure, **often times glassware does not require much attention.** For example, If the only material coming in contact with the glassware is an organic solvent such as hexane, it is usually adequate to simply wipe the grease off and allow the glassware to air dry. If you are ever in doubt as to what to do, ask your TA or instructor. Believe it or not, unnecessary washing can cost you thirty to sixty minutes each lab period. Never wash hot glassware. If chemicals are particularly noxious or corrosive, rinse them several times in the cup sink in the hood with cold water.

10. Before you leave the laboratory at the end of an afternoon, thoroughly clean your bench top with a sponge, and make sure that all of your vacuum, gas, and water connections are turned off and that all electrical equipment (hot plates, stir plates and power mites) are turned off, unplugged, and put away. Return all borrowed equipment. Put all equipment back where you found it.

**Please leave the lab as you found it at the beginning of the lab period.**

### ***Working Greener***

1. Use two sided copying to print out this manual.
2. Try to print out, lab manual pages , spectra and data off the web only once.
3. Recycle unused paper yourself or in appropriate containers.
4. Only take the amount of reagent you require for a reaction.
5. Do not repeat seemingly failed reactions, consult your instructor and salvage the reaction.
6. We do not start over unless there is no other way. SERIOUSLY!!!
7. Dispose of and recycle chemicals as directed (ask if you don't know)
8. Use traps as directed.
9. Do not allow the water to run continuously while washing.
10. Reuse acetone when cleaning glassware.
11. Unplug equipment. Close you hood at end of the day or if you are not using it.
12. Turn off your oven at the end of lab
13. Turn off the melting point machines when you are finished and all the individual lights in your area.

## SUBMISSION OF SAMPLES

Compounds are submitted and stored in vials. We are very strict about the labeling of samples. It is extremely important for vials to be labeled. WHY? You should use the tape provided in the lab to label your samples. We use the following acronym for labels. The label should include (legibly written) The Name of the Compound, Your name, Your TAs name, the date, This I have to look up. NMR tubes too.

+++++

...Every chemistry student, faced by almost any treatise, should be aware that on one of those pages, perhaps in a single line, formula, or word, his future is written in indecipherable characters, which, however, will become clear "afterward": after success, error, or guilt, victory or defeat...

So it happens, therefore, that every element says something to someone (something different to each) like the mountain valleys or beaches visited in youth. One must perhaps make an exception for carbon, because it says everything to everyone, that is, it is not specific, in the same way that Adam is not specific as an ancestor.

-- Primo Levi, *The Periodic Table*

## CHECK-IN AND ORIENTATION

1. Before coming to the laboratory, study all the pages preceding this one, paying particularly close attention to the material on safety.
2. Meet your laboratory instructor and teaching assistants, and ask any questions you have about the course. Find your assigned locker.
3. Using the locker lists and accompanying pictures given in the pages that follow, check-in your equipment. Consult your TA or instructor if you need help in identifying any items or if any of the equipment is missing or damaged and therefore needs replacing. If any of your equipment is dirty, clean it with soap and water.
4. Become familiar with the location of hardware, reagent shelves, hoods, distilled water, balances, melting point apparatus, gas chromatographs, infrared spectrometers, etc.
5. Complete the following two forms, tear them out of your lab notebook and give them to your TA:
  - acknowledgment of receipt of equipment and understanding of safety rules
  - student information sheet

# Organic Chemistry Lab

## ***Acknowledgment***

1. I acknowledge that all of the equipment listed in the Locker List, Category A (see lab manual), is in my locker, and I agree to leave it in clean condition and to pay for the replacement of any items broken or lost.
2. I have read and understand the Safety Rules and accident procedures given in the safety lecture and laboratory manual, and I agree to abide by them.

Signature: \_\_\_\_\_

Name (printed): \_\_\_\_\_

Section (day and time): \_\_\_\_\_

Teaching Assistant's name: \_\_\_\_\_

Locker Number: \_\_\_\_\_

Date: \_\_\_\_\_

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## Student Information Sheet

### Chem 211/212

Name: \_\_\_\_\_ Chem 211/212 Lab Day: \_\_\_\_\_

School (BMC, Haverford, Swarthmore, etc.): \_\_\_\_\_

Class ( 17', 18', .....PB ..... ) or other: \_\_\_\_\_

Where and when two semesters of General Chemistry were successfully completed:

Health conditions that may be an issue in lab. Submitting this information is optional and if preferred, you can talk to your instructor directly. Realize we may be able to improve conditions for you to accommodate any need you might have. \_\_\_\_\_

Telephone numbers at school and at home:

\_\_\_\_\_

Email address:

\_\_\_\_\_

## LOCKER LIST

**Note: You do not have to pay for glassware. The prices (which are only about half the real price) are there to give you an idea about the value of the equipment. Please treat the equipment with respect.**

### CATEGORY A (LOCKER DRAWER)

---

Beaker, 50 mL	1.50
Beaker, 100 mL	1.40
Beaker, 250 mL	1.30
Beaker, 400 mL	1.60
Beaker, 600 mL or 800 mL	2.00
Cylinder, graduated, 10 mL	2.10
Cylinder, graduated, 100 mL, with bumper	2.90
Flask (2), Erlenmeyer, 25 mL	1.60 ea.
Flasks (2), Erlenmeyer, 50 mL	1.60 ea.
Flasks (3), Erlenmeyer, 125 mL	1.60 ea.
Flasks (2), Erlenmeyer, 250 mL	2.00 ea.
Flask, filter, 125 mL	6.40
Flask, filter, 250 mL or 500 mL	6.40
Flask, round-bottomed, 24/40, 50 mL (optional)	7.00
Flask, round-bottomed, 24/40, 100 mL (optional)	7.00
Funnel, 5.1 cm, Buchner OR 7.8 cm Hirsh	6.50
Funnel, 8.5 cm, Buchner	13.40
Funnel, separatory, with stopper, 125 mL	18.00 (28.00 with stopcock)
Funnel, separatory, with stopper, 250 mL	21.50 (33.00 with stopcock)
Funnel, stemless, 5 cm	1.00
Funnel, stemless, 7 cm	1.50
Micro Distillation Kit** (see below)	400.00 To be checked out as needed
Micro Vacuum kit *** (see below)	60.00 To be checked out as needed
Pan, enamel <b>OR</b> plastic	2.03
Spatula, nickel	3.00
Stirring rod, glass, 20 cm.	3.00
Vials, 4 dram (6), with caps	0.20 ea.
Watch glasses (2)	1.00 ea.

#### **Microdistillation Kit**

\*\*25mL round bottom flask  
50 mL round bottom flask  
100mL round bottom flask  
100 mm West condenser  
vacuum adapter  
three yellow Keck clips  
still head  
2 septum caps

Claisen adapter  
dropping funnel

**Microvacuum apparatus**

\*\*\* micro Hirsh funnel  
25 mL vacuum flask  
Micro neoprene adapter

## CATEGORY B (LOCKER DRAWER)

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Adapter, filter, Neoprene, No. 2 or 3  
Adapter, filter, black Neoprene, No. 4  
Adapter, thermometer, red Neoprene  
Boiling stones, 1 vial  
Filter paper, 4.25 cm, No. 1, 1 pack  
Filter paper, 7 cm, 1 pack  
Filter paper, 12.5 cm, No. 4  
Rubber policeman

pH paper (1 vial)  
Pipettes (6), Pasteur  
Rubber bulb, 2 mL  
Test tube holder  
Weighing dishes (2)

## **CATEGORY C (GREEN CABINET)**

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Hot plate  
Stirplate

## **CATEGORY D (LARGE BUCKET UNDER SINK)**

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Clamps 2 prong with holders (2)  
Clamp 3 prong with holder (1)  
Heating mantle (100 mL)  
Heating mantle support  
Iron Rings (1 large and 1 small)  
Rubber tubing, black (2 pieces)  
Rubber tubing, red (3 pieces)

## **CATEGORY E (SMALL BIN, CRATES, RACKS ON BENCH)**

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Copper Wire  
Grease  
Rubber bands  
Thermometers  
Miniclamps and Medium sized clamps (please be neat with these)

## **CATEGORY F (CABINET UNDER SINK)**

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Acetone bottle  
Soap bottle  
Acetone Waste Bottle

Wire brushes (1 large and 1 small)

PLEASE MAINTAIN YOUR AREA AS DESCRIBED ABOVE!

# BREAKAGE AND LOSS

## DO NOT REMOVE EQUIPMENT/GLASSWARE FROM OTHER DRAWERS

The glassware and equipment used in the is course is extremely expensive. The prices list on page G-27 are a fraction of the real cost. Please treat the glassware/equipment with **Respect**. Students are not charged for breakage in this course, but you should handle the equipment like you own it.

The equipment in Categories A and B should be stored in your locker and will only be used by you. The equipment in Category C will be stored in the cabinet under you hood and be shared by all those who work at your lab station. The equipment in category D will be stored in the "F" drawer at each stations and will be shared by all who work at your lab station. The equipment in Category E will be stored in special bins on the lab bench and the equipment in Category F will be stored in special crates under your sink and will be shared by all who use your sink. Realize that you will be sharing the sink and hood with someone else during your lab period. Because of this you will notice that the Category C and D equipment is duplicated in the oven cabinet and "F" drawer. One set is for you and the other for your neighbor. It is very important to return equipment to its proper location at the close of lab. Do not lock common equipment in your locker.

## HONOR CODE – A BIT MORE

We have some key issues due to the age of the lockers. Please be respectful of neighbor's lockers. Realize that almost all lockers are assigned in the course and if you reach into another locker during lab and take something, you are taking another student's equipment. If you put common equipment in the drawer, we have to find it.

"He says, you have to study and learn so that you can make up your own mind about history and everything else but you can't make up an empty mind. Stock your mind, stock your mind. You might be poor, your shoes might be broken, but your mind is a palace."

— Frank McCourt (*Angela's Ashes*)

"It's lovely to know that the world can't interfere with the inside of your head."

— Frank McCourt (*Angela's Ashes*)