

Instructions for Laboratory Notebooks and Reports in Organic Chemistry

Your lab reports will constitute a significant portion of your overall laboratory grade. It is important that your reports be of the highest possible quality and follow the correct format so that you may earn the maximum possible points on the assignment. Each experiment will be graded on the following:

- experimental results
- responses to post-lab questions
- pre-lab preparation
- format of the report
- writing quality.

These are listed in the *usual* order of importance, but priorities may vary from experiment to experiment. Notice that I do grade you on writing quality; this is a college-level course, and I expect college-level writing from you. You will rarely be asked to turn in a report without at least a week to write it up, so I do not think it is unreasonable to require that you provide a quality product which represents the best of your abilities.

Fortunately, Rio Hondo College provides on-campus resources which may assist you in your writing tasks, so if you are at all worried about your writing, please seek them out for help. The standards for the “Observations” section of the report will be much more relaxed, since you will be filling this information in rapidly, while the experiment is in progress, and you will not have the opportunity later to tidy this up—in fact, it is *forbidden* and *unethical* to do so! In these cases, write as neatly and as best as you can under the circumstances. All work completed in your laboratory notebook must be written entirely in black (preferably) or blue ball-point or gel pen! Do not use felt-tip, as it will not penetrate to the second page. You may not erase, scribble over, or white-out any entries. Simply draw a single straight line through any entries you wish to be ignored (~~like this~~). This way, the writing is still legible should you later decide that you needed that information.

Prelaboratory Assignment

For each experiment, you are expected to prepare a preliminary assignment in your laboratory notebook. All prelab assignments should include the following labeled sections in the order below:

1. A title (you may use the title in the textbook)
2. An “Experimental Objectives” section, which is a list of brief statements (1 to 2 sentences each) which summarize the purpose of the experiment. Here are some examples:
 - To synthesize malathion, an important insecticide
 - To characterize the Infrared and NMR spectra of a series of insecticides
3. A balanced equation (only if the experiment involves a reaction)
4. A “Table of Reagents”

5. Pre-lab questions (only if specifically assigned)
6. A separation and purification scheme/flowchart (only if your experiment contains washing and/or extractions)
7. A "Procedures and Observations" section
8. Calculations (some may need to be completed before performing the experiment, while others can only be completed after it is complete)

There is not a standard method of writing up lab reports that all chemistry instructors follow, although most of us generally require the same information with only minor alterations. The format I am providing you with here may not be exactly the same as that which you will encounter in later classes, so please be flexible in the future.

Note the following important requirements for your laboratory notebook:

- The top of every page in your lab notebook should contain: your name, the title and number of the experiment being performed, and the date the experiment was begun. You need not include the name of the course or the section number.
- Many, but not all, experiments require a separation scheme. Review to the Extraction section in your techniques manual for a typical example.
- If the experiment involves using an unknown compound, draw a box around the unknown number to call attention to it.
- You should also draw a box around any of the following information to draw attention to it: experimentally determined melting points, boiling points, and percentage yield.
- Any assigned pre-lab questions must be completed before beginning the experiment. They should be written in the lab notebook.
- Your "Table of Chemical Reagents" should look something like this:

Chemical Name/ Formula	Molar Mass (in g/mol)	Chemical Quantities				density (g/mL)	melting pt or boiling pt (°C)
		amount anticipated	amount actually used	moles anticipated	moles used		
salicylic acid	138.1	2.0 g		0.014		--	mp: 158-161
acetic anhydride	102.1	5.0 mL		0.053		1.08	bp: 140
sulfuric acid, conc.	98.08	5 drops		catalytic	--	1.84	--
ethanol	(solvent)	15.0 mL		--	--	0.8	bp: 78

Note the following:

- Blank boxes will be filled in during the lab period.
- Include the boiling points of liquid reagents and solvents. Also include the density (only for liquids) where possible.
- Include the melting points of solid reagents.

- The only compounds which must be listed on this table are those *involved in the reaction itself, including the solvent*. Drying agents and solutions used in later steps for washing/extraction may be omitted.
- Many important chemical properties (densities, mp, bp, and others) can be found on the web at www.sigmaaldrich.com. You should explore this web site at your leisure.
- If any special equipment is used, they should be listed below the table (including IR spectrophotometers, Gas Chromatographs, TLC plates, etc.)

The Procedures and Observations Sections

The *Procedures* section usually makes up the bulk of the prelab assignment. It includes specific directions on how to perform the experiment as described in the laboratory text. Basically, this section is no more than a numbered list of activities to be completed. When first preparing this section, many students tend to include too many steps, making the section longer than it should be. In writing up this section, use this rule of thumb and you should never go wrong:

The procedures section should be written so that you (or any other reader) could successfully complete the experiment by using only what you have written in your notebook, and without referring to the textbook.

Here is an example of a procedure section, with observations filled in as they would be during the laboratory period:

Procedures	Observations
1. Obtain approx. 0.4 g of fluorene.	Amount used: 0.455 g
2. Dissolve the fluorene in just enough ethyl alcohol as is needed to completely dissolve it. Use a beaker for this.	This required about 5 mL of alcohol. The solution was clear and colorless.
3. Heat the solution until it just begins to boil.	The solution turned pale yellow in color after 5 minutes.
etc.	etc.

The Observations section should remain blank until you begin to perform the experiment. You should take notes in this section as the experiment proceeds, including any measured

quantities, simple calculations, color changes, temperature readings, drawings of TLC plates, and anything else you deem to be important.

Almost all calculations should be documented in the "Calculations" section immediately following the "Procedures and Observations" section. Only the most brief and simple calculations should be omitted.

Laboratory Reports

Unless otherwise announced, all laboratory experiments (beginning with #7) will require *typed* laboratory reports. Please use standard fonts and double-space your text. The laboratory report will consist of each of the following labeled sections, in the order listed here:

1. Cover Page (see example on last page)
2. Title of Experiment
3. Chemical Equations (hand-written or produced using chemical drawing software) Alternatively, these may be presented in the Introduction section.
4. Reaction Mechanisms (only if the reaction is one we have studied in lecture)
5. An Introduction section—generally one paragraph long, discussing what this experiment will attempt to show and summarizing the experimental objectives.
Example:

The synthesis of insecticides has historically been an area of significant focus in synthetic organic chemistry. Through many diverse methods, these compounds significantly reduce the threat posed by insects to crops, and help to curb the spread of diseases. Unfortunately, many of these chemicals, DDT most notably, persist in the environments in which they are used and wreck ecological havoc on the species which live there. Carbamazol, a molecule which is highly effective in sterilizing female mosquitoes without damaging the ecosystem in which it is used, has enjoyed considerable popularity in both the agricultural and chemical communities in recent years. This report documents the synthesis, purification, and analysis of Carbamazol, and compares its efficacy with other popular insecticides through tests on live mosquito populations.

6. A Discussion and Results Section. In this section you will both summarize the procedure and offer important comments and observations based on your experience in the laboratory as well as your insights developed in reviewing your work. In this section you should also especially emphasize

any interesting, and perhaps unexpected, observations, important chemical quantities, especially percent yield, sources of error in your experiment, and how they could have been prevented

7. Spectrum Analysis. Many experiments require you to analyze IR spectra. Each spectra should be briefly discussed (usually in a paragraph or less). Your

- explanation should especially focus on whether or not the spectrum confirms the identity of your compound and how you arrived at this conclusion (usually by documenting the important peaks in the spectra and the bonds they stand for.) If possible, use your spectra to assess the purity of your final product. You will also occasionally be given ^1H and/or ^{13}C NMR spectra to discuss. I must emphasize that a *discussion* of the spectra involves more work than simply listing peak positions; be thorough, yet concise, in your discussion.
- References. Cite the references (in proper format) used in writing the lab report. These will virtually always include your laboratory notebook (yes, you have to cite it as a source!), the laboratory textbook, and sometimes the lecture textbook.
 - Post-lab questions. These questions may be typed or carried out by hand at your option. If one of the questions asks you to analyze the IR spectrum and you have already done so earlier in the report, then just state "See Spectrum Analysis Section"
 - Laboratory Notebook pages. Always attach your laboratory notebook pages at the end of the experiment.

Although you are allowed to draw any chemical structures in your laboratory report by hand, I recommend that you use free software to make these drawings whenever possible. Please visit the website below to download the outstanding ACDLabs ChemsSketch program which I myself use to draw structures:

<http://www.acdlabs.com/download/chemsk.html>

Please come see me if you should need any help in putting together your first lab reports.

Multi-Step Synthesis of Carbamazol

John C. Student
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Chemistry 230