Undergraduate Research
Chemistry 292-294
Preparing Your Laboratory Report

(*The following is based, in part, on:* Cooper, M. **Cooperative Chemistry,** McGraw-Hill, N. Y. 1969)

To the Student:

Reports serve the purpose of allowing others to learn the results of your investigations. As with other laboratory workers, you will be conducting experiments, stating hypotheses, observing processes, recording data, and formulating conclusions. At the end of the term or before you will be expected to write a report, describing the work you have done, summarizing your observations, and explaining your conclusions or judgments about the meaning of what you have observed.

Your **GRADE** will depend largely on the quality of this laboratory report. While it may be that you haven't accomplished your research goals, the lab report provides a means of evaluating what you have done and how seriously you have approached scientific research. Let the report reflect your best effort, even if your progress in the laboratory has not met with your expectations. Your advisor will be looking for elements of style and clarity that demonstrate progress towards a professional level of report writing.

Professionals write papers and reports for their own use, for their colleagues, and for the public. When they write, they choose the language, style and format best suited for communication with their readers. In preparing your report(s) think of your reader as an educated person who is interested in learning about your experiment but who knows less about it than you do. It should be clear that your research advisor will assume the role described but that other faculty, at Temple University and elsewhere, may also receive copies of what you write. Therefore, the critique offered by your advisor, which may result in revision and resubmission of your report should be taken constructively.

Your report must be typewritten (usually word-processed) and will necessarily include tables, illustrations, graphics, etc. Each **MUST** contain the following sections…

title page, introduction, results, discussion, conclusion, experimental section, and references .

(Some words about style… As you write, please pay close attention to the style…
(a) Use past tense when you are writing about work that has been done.
(b) Use the third person and passive voice. You are telling a story and providing directions. So, write : "The solution was filtered."
NOT ; "I (we) filtered the solution."
NOT: "Filter the solution."

(c) Be as specific and accurate as possible. Weigh materials and measure volumes to appropriate quantities, *i.e.*, use g (and/or mg) and L (and or mL) as appropriate.

Title Page

The first page of the report is the title page. Include the title of the report, your name, the course number, your faculty mentor's name and the date. For example…

An Investigation on the Structure, Properties and Synthesis of Timeothialin

Yura Fast Learner
Chemistry 291
Professor Help M. Out
January 1, 3000

Introduction

The text of the report begins with an introduction.

In this section of the paper, tell the reader (in general terms) what you intended to do and why you intended to do it. To the best of your ability (your mentor is likely to correct some of this) point out exactly what ideas or principles you are investigating so that it is clear to the reader how what you did or attempted to do or to prove fits into a larger context. If possible, include some general information, which explains the importance of what you did. In a general way, tie the work that you did to work that others in your laboratory or elsewhere did before you began or while you were doing it. A more detailed discussion of this should appear in the **Discussion** section (see below).

Results

In this section you summarize the outcome of your experiments for your reader.

This section will consist primarily of **data** (facts, figures, schemes, *etc*) that you gathered in the course of the experiments. **Figures** and **Tables** should have captions and legends with axes appropriately labeled if present. Graphs, drawing and sketches (of reaction **Schemes**) are called **Figures** and should be consecutively labeled if there is more than one. Place the material in the appropriate place in the section so that the reader does not need to flip back-and-forth and can look at the figure in close proximity to the material discussed and to which it relates.

General guidelines are as follows:

- A clear summary (preferably in tabular form) of your results must be given, together with the established errors and all appropriate units. It is important to write clearly in complete sentences indicating where the results are presented (e.g. Table I, Figure 2, Graph 1, Appendix I etc.). Important intermediate results should also be given (for example, if you use averages of several experimental runs as the starting point of your calculations, or derive your data from chart recordings). Whenever appropriate (for example when the same experimental measurement is repeated at different temperatures or concentrations), you must also include graphs showing the data. While comparison of your results with theoretical predictions or with literature values is made in the Discussion section of the report, it is often convenient to show them all together in the same table or graph; however when you do this (a recommended practice), you must allow the reader to understand clearly which are your own results and which are the theoretical predictions or the literature values.
- Errors: An error analysis should be included in your results section. The error estimates on the final results may require that you use the propagation of errors technique. Whenever appropriate, perform a suitable statistical analysis of your results. If you question the validity of one or more experimental data points and wish to discard them, you will have to provide a reasonable (quantitative, if possible) justification. The extent of the error analysis required will vary greatly depending on the experiment.
- Theoretical model calculations: This will be appropriate only for some experiments and should be skipped entirely for others. State briefly the basic premises and results of the model. Then use the model to obtain a theoretical estimate of only those quantities derived from your experimental data.

Discussion

The **Discussion** is where you interpret your **Results** for the reader**.** In this section, you explain what the results mean and criticize what you did by suggesting what you might have done differently to get better (different?) results. Here, you demonstrate how successful you were and how well you understood what you did.

This is also the section to compare your results with those in the Literature. How came you frame your results, and what was learned, in the context of what was already known? How has your work advanced the field? Is your work an extension of knowledge, or a real breakthrough? This is your opportunity to read deeply and widely into your research problem, and to help others understand the context and the significance of your work.

It is usually very difficult to write this section!!. Occasionally, the **Results** and **Discussion** sections can be combined. However, it is usually useful to reexamine the **Introduction**, the **Results**, and the **Experimental** sections while writing the **Discussion.**

So, you might consider writing the goals and introduction again, writing down the specific data, some of the general principles surrounding the work you have done,

difficulties that arose during the experiments, *etc.* You should be as comprehensive as possible!

Conclusion

Your overall conclusions about what you have accomplished as a result of the work you did should be reported here. In a sense, this is a summary of the **Results** and **Discussion** sections. **It is important that your conclusions are supported by your data and accurately reflect the outcome of your experiments.**

Experimental Section

In this part of the report you give the reader a step-by-step description of what you did (as found in your laboratory notebook). You **MUST** report your work in sufficient detail so that it can be replicated by those who follow you in the laboratory. Thus, while your interpretation may be subjective, this portion of your report should be as objective as possible and should serve as a set of directions for others.

References

Even though you are the "expert" for the general reader, you **must** cite references (see that section at the end of these directions) to support your statements and to define sources for data that you may be using. These citations serve also the purpose of letting the reader know that you prepared yourself with a basic background before you went into the laboratory to build on the work of others. Frequently, these citations will be materials your mentor has suggested you read before you begin.

The citations should be numbered consecutively in the text and listed in the **References** section at the end of the report using accepted American Chemical Society style, which can be found in the American Chemical Society Guidelines (see the link: *http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=education%5Ccpt%5Cts_rrguide.html*).

Using superscripts in the text and sequentially numbering the references[1,2]

for journals…author (last name, initials), *title (in italics*), **year (bold),** *volume number (in italics)* and starting page number

1. Smith, A.B.; Jones, M.T. *J. Am. Chem. Soc.* **2004**, *128*, 45778.

for books

author (last name, initials),), *title (in italics*), publisher:city, **year (bold)**, page number.

2. Vogel, A. I. *A Textbook of Qualitative Inorganic Analysis*, Longman: New York, **1979**, 358.

Supplemental Material

Copies of spectra, output from recorders, and other materials not easily inserted into the text should be placed here. It should be ordered so that if held separately while reading the report, the sequence of materials (as referred to in the report) can readily be followed.

Other Guidelines

1. Graphs **must** be computer generated with the axes clearly labeled, including units. Try to scale graphs so that data or curves occupy a significant fraction of the page, i.e., do not bunch all of the information in one corner of the page. Label each data set clearly, using different symbols or colors. Each graph should have a brief **title or caption** that describes what kind of information is shown. Whenever appropriate, error bars should be shown for your experimental data points.
2. Tables **must** include titles or captions
3. In several reports you will refer to theoretical and/or literature information. Each time you do this you must give a complete reference.
4. Write in third person; do not use "I", "we".
5. Do not wait until the last minute to prepare your report. You may run into unexpected trouble - and help may not be available then.