Writing Lab Reports

The following is an outline of the fundamentals of writing a lab report. Please read it carefully. There is also a sample laboratory report with comments for you to read. The grading criteria for your lab reports will refer to the following outline.

Scientists are investigators who "try out" ideas. They conduct experiments in order to test or prove ideas, and they share the results of their experiments in papers and written reports. Reports allow others to learn the results of scientific investigations. Like other scientists, you will be conducting experiments, stating hypotheses, observing processes, recording data, and formulating conclusions. For some of these experiments, you will be asked to write a **lab report** describing the experiment, summarizing your observations, and explaining your conclusions or judgments about the meaning of what you observed.

Audience

Professional scientists 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 lab reports, think of the ***reader*** as an educated person who is interested in learning about your experiment but who knows less about this subject than yourself. You take the role of expert; you are in charge of efficient, accurate communication of facts and ideas.

Evaluation

Lab instructors, of course, will actually be reading your papers, commenting on them, and grading them. Your instructor assumes the role of the reader described above. He or she judges how well you communicate necessary background information as well as the processes and results of the experiment itself. Your instructor also observes how carefully you follow the format for lab reports described in this manual. The grade sheets included in this booklet indicate some of the things looked for by lab instructors. Read them carefully and ask your lab instructor about any remarks or corrections which puzzle you. Make sure you understand what the criteria on the gradesheet mean and what parts of the lab report they apply to.

General Format

Lab reports and papers must be typed or word processed. They should include tables and illustrations where necessary. Lab reports contain the following sections: ***title page***, ***introduction***, ***results***, ***discussion***, ***conclusion***, ***experimental section***, and ***references***.

Title Page

The first page of the report is the title page. Include the title of the report, your name, the course number, your section number, the instructor's name, and the date the report is due.

Put the information in the order just presented. NOTE: The title of the paper can simply be the name of the experiment -- for example:

The Kinetics of Solvolysis of *t*-Butyl Chloride
Jane Doe
Chemistry 101 Laboratory, Section 255
Instructor: Linus Pauling
January 2, 2003

or for a more complex project it can be an overall description, for example:

An Investigation of the Structure and Properties of an Unknown Compound.

Abstract

The abstract gives a condensed version of the whole report. It should give readers an idea of what was done and why, in a few sentences. Typically the abstract should be between 100 and 200 words. In practice, the abstract will be the last thing that you write. When you have everything that you have done organized and explained, it will be easier to write a condensed version.

Introduction

The text of the report begins with an introduction. In this section of the paper, identify the experiment(s). In general terms, tell the reader what you intend to do and why you intend to do it. Include all phases of the experiment(s). Emphasize any unusual or critical conditions.

Point out exactly what ideas or principles you are investigating. Make sure the reader understands the purpose of the experiment(s). What you are attempting to test or prove or investigate should be clear to the reader. If necessary, include general information which explains the importance of the experiment(s) and why you are doing this project. Tie the experiment to your general course of study by explaining how it confirms or fails to support the general laws of chemistry you are exploring and learning.

Even though you are acting as the "expert" for the general reader, you must cite references both to support statements you make about the scientific basis for your investigation and to define sources for specific pieces of data crucial to the experiment. Citations give you credibility: they tell the reader that you have prepared properly for the experiment by providing yourself with a basic background and by "checking out" the accepted authorities. These citations should be numbered consecutively in the text and listed in the References Section (see **References** at the end of this section).

Typical sources for your citations include: your text book, other lab manuals you may have consulted, tables of data such as the CRC handbook, chemical catalogs, and internet resources.

Results

In this section you summarize the outcome of your experiments for your reader. This section will consist primarily of **data** (facts and figures) that you gathered in the course of the experiment. Read the section of the lab manual on reporting numerical results. Data must be presented in such a way that it is easy to read. You must organize or assemble and label the data for the reader. Numerical data or lists of numbers are usually presented in tables. Relationships between sets of data or factors in the experiment are often shown in graphic form. Graphs, drawings, and sketches are called **figures**. Although tables and figures are labeled on the page with descriptive titles, they are identified in the written body of your report by number rather than name. When you discuss tables and figures in the text of this section, you mention Table 1, Table 2, Figure 1, and so on.

Place tables and graphs at appropriate points in the body of your report. This makes it easy for the reader to use and understand the graphs, charts, tables, etc. If you put the data presentation in a separate appendix, the reader will have great difficulty in understanding the results of your experiment. It is permissible to have one large section called Results and Discussion, in which the results are presented in tables, graphs and charts, and then discussed in a block of text immediately following.

Discussion

The discussion section of your report is the most important one for you and your reader. In this section of the report, you interpret the results of your experiment for the reader. You explain what the results mean, and you mention any weaknesses or problems in the plan of the experiment or methods you used. You demonstrate not only how successful your experiment was but also how well you understood the experiment. The discussion section can be difficult to write, but you will learn more about your experiment and yourself as an investigator as you write it.

Before you begin writing this section, complete the ***Introduction, Results,*** and the ***Experimental section***. Put these sections on the desk together with your lab notebook so that you will be able to look at all these sources of information as you write the ***Discussion*** section. Then prepare to write a rough draft of this section. You can make an outline for yourself by taking the following steps.

1. Write out your ideas and goals again. Look over the tables, figures, and general information you compiled for the ***Results*** section. What did your experiments show?

2. Write down the specific data which led you to decide that your hypotheses were correct (or incorrect). List all the data, including actual information you recorded during the experiment.

3. Write down what you know about the principles of chemistry involved in your experiment. How do the results of your investigation fit with accepted laws of chemistry? Identify the sources of your information at this point.

4. List any weaknesses or problems you discovered in your experimental design or procedure. Tell the reader how these problems may have affected the results of your experiment.

5. Review the experiments again. List and discuss any difficulties which arose during the course of the experiment. Be sure to point out to the reader any way in which these problems could have affected the outcome of the experiment.

Using this list as a guide, prepare a comprehensive discussion or explanation of the results of your experiment.

Conclusion

Your overall conclusions about the project have probably already been mentioned several times in the course of your report. You may have predicted some of the outcomes of your experiments in the ***Introduction*** and discussed them again as an empirical conclusion (meaning that it was derived from your experiments and observations) in the ***Results*** section. In the Conclusion section, a brief, single paragraph may be enough to clearly state the outcome of your investigation. The Conclusion Section tells the reader what the results of the experiment mean. In a sense, it is a summary of the ***Results*** and ***Discussion*** sections combined. Make sure your stated conclusions clearly match the actual outcome of your experiment(s).

Experimental Section

In this part of the report, you give the reader a step-by-step account of the actual experiment. Here, you will do more than simply provide greater detail about the experiments than you did in the ***Introduction***. You need to describe your procedures in such a way that others could read your lab report, follow your lab procedure, and successfully duplicate your experiment. Scientific experiments are not considered valid unless they can be repeated by other experimenters working in other laboratories. In one sense, science has no secrets: scientific theories become established only when the experiments that led to them can be repeated or verified by others besides the original investigators. You make this verification possible when you write a complete, accurate description of your experiment. Scientists also use lab reports as a means of learning and sharing techniques. Other investigators may not choose to duplicate your experiment, but they may choose to use your procedure in some similar investigation. The experimental section of your lab report should be usable as a set of directions for other scientists.

a word about style ----

As you are writing, pay close attention to your style. The personalities of you and your lab partners (if you have any) are not important to the report. In scientific papers, facts and interpretation of facts count more than personalities, so the depersonalized writing

known as "scientific" or "academic" is most appropriate to your lab report. What are the common elements of this style?

- **Use the past tense.** You are writing about the experiment you have already completed – not one that you are now doing.

- **Use the third person and passive voice.** In a sense, you are telling a story; in another sense, you are providing directions. Rather than telling a story or writing a recipe, you must describe what you did. At the same time, keep the personal element out of the report. For example:

  write: **The solution was filtered.**
  not: **I (we) filtered the solution.**
  not : **Filter the solution.**

- **Be as accurate and specific as possible.** Successful scientific description requires exact detail.

Note: The style used in scientific reports is quite different from that required for an English paper. It is important that you understand and get used to using different writing styles appropriately.

The experimental section can be placed after the introduction if you wish, however, you will avoid the trap of discussing results if you place it last as it is found in most chemistry journals.

References

The final section of your report tells the reader where to find any of the sources of information you used in your report. In the body of your report (particularly in the ***Discussion*** section), you may have mentioned other texts. Each of these references should be numbered consecutively within the text as superscripts. At the end your report, after the ***Conclusion***, include a complete reference list, in numerical order, of the sources used. The reader can use this list to follow up or check out any source you mentioned or to do additional reading.

The format of the references should follow the American Chemical Society Guidelines, which can be found in the ACS Style guide. For example:

"A similar experiment has been reported by Haight[1], and expanded by Vogel[2]."

1. Haight, G.P. *J. Chem. Educ.* **1965**, *42*, 468.

2. Vogel, A. I. *A Textbook of Qualitative Inorganic Analysis,* Longman: New York, **1979**, p358

In general the format to be used for journals is:
author(last name, initials), *title (in italics)*, **year (bold)**, *volume number (italics)*, starting page number.
For books:
author(last name, initials), *title (in italics)*, publisher: city, year, page number.

For multiple authors, separate the authors by a semi colon, e.g.,

Brown, H.C.; Corey, E. J; Cram, D. J. *J. Irrep Res,* **1990,** *21*, 991

For further information see Dodd, J. S. Ed. *The ACS Style Guide, A Manual for Authors and Editors,* American Chemical Society, Washington DC, 1986.

Internet Resources
If you find a reputable resource on the internet then you may also cite that as a reference. Be careful in the sites that you visit; try to stay with sites hosted by professional societies, the government or other reputable institutions.
When citing an internet site you should give the URL, the host institution, and the date of your visit to the site (since many internet sites are transient)
For example

"SuperChemLab" http://chemed.eng.clemson.edu/SCL/index.html Clemson University (January 1, 2002)
A sample lab report follows this section.

Preliminary Lab Report Guidelines

Most teachers of writing stress the importance of rewriting and editing. In order to give you experience in this area you will probably be asked to write a preliminary lab report. This exercise will give you the chance to write a fairly brief report and get feedback **before** you write the major report on your project. In this way you get to make any mistakes on your preliminary report, rather than the full report.

If you are asked to write a preliminary report, read the report guidelines first and use the same general format. Usually you will not have all your results, and you may not have any conclusions at this stage. However, you can include the other sections, with as much detail as possible.