

Writing a Formal Lab Report

Note: This handout provides guidelines for writing a *formal*, typed laboratory report for a Biology, Chemistry, Natural Science, or Physics class. Routine lab “write-ups” such as those used in a laboratory notebook may follow a similar format and style, but they are usually written in pen during the lab with no editing afterwards. For more specific guidelines on formatting and recording results in laboratory notebooks, please see your instructor. Students should also remember that each instructor will have slightly different requirements. If an instructor gives guidelines that differ from the ones provided here, please follow them; this handout should be used only as a general reference to help students learn the style of scientific writing.

General Tips

- **Be concise.** In scientific writing, it is very important to say as much as is needed while using as few words as possible. Lab reports should be thorough, but repetition should be avoided. The entire report should be clear and straightforward.
- **Write in the third person.** Avoid using the words “I” or “we” when referring to the experimental procedure. For example, instead of “I boiled 50 mL of water for 10 minutes,” the report should read, “50 mL of water was boiled for 10 minutes.” This can be a bit difficult to get used to, so it is important to pay close attention to the wording in the report.
- **Use correct verb tenses.** Many students become confused when trying to decide whether to use past or present tense in their reports. The general rules for verb tenses are as follows:
 - The experimental procedure has already been conducted, so use the past tense of the verb when referring to it:
Ex: The purpose of the experiment was...
The compound was weighed to 5 g...
 - The report, equipment, and theory still exist, so use the present tense of the verb for them:
Ex: The purpose of this report is... Bunsen burners are used...
- **Be prepared for the lab.** Before coming to the lab session, read the procedure in the lab manual thoroughly. Write down a purpose, hypothesis, and a general plan for the procedure you will follow and bring them to the lab with you. If you understand what you will be doing before beginning, it will be much easier to take relevant notes during the lab and to see what you will need to include in the report afterwards.
- **Take good lab notes.** When conducting the lab, it is important to write down all the results that will be needed for the report as well as all observations, any materials and equipment used, and anything out of the ordinary that may have happened. Notes should be clear enough, so they are easy to review when writing the final report. Tables are useful for

keeping large amounts of experimental data in order, so you may want to include them in your laboratory notebook. Good notes will help you to write an insightful and accurate report.

- **Don't copy the laboratory manual.** If you are working from a lab manual, it can be used as a helpful guideline when explaining the procedure and the purpose of the experiment; however, you should not copy it word for word. By using your own words, you are showing the instructor that you have a good understanding of what is being done and why it is being done.
- **Write about what really happened** in the experiment, not what “should” have happened. Instructors grade lab reports based on understanding of the experiment rather than the results achieved, so if things did not go exactly as planned in the lab, resist the temptation to lie about the results in the report. Instead, try to explain what might have gone wrong and suggest ways the experiment might be improved in the future.
- **Use peer-reviewed sources for research.** If background research is needed for the report, only credible sources should be used. Online scientific and medical journals are good internet sources for this type of report; in contrast, unofficial websites that are not peer-reviewed should be avoided. Textbooks and encyclopedias are also helpful for explaining theories or concepts used in the experiment.
- **Cite your sources.** Always use parenthetical citations within your report to document all sources you have referenced. This includes all ideas that are not your own! For instructions on formatting references in the APA style, see the APA format handout under the English section on the Tutoring Services' web site:
http://www.germannna.edu/tutor/helpful_handouts.asp

Format

Instructors often give their students basic guidelines for format when they assign a formal report. Your instructor's preferred format may not include all of the sections given in this handout, but the content of the report as a whole should be similar. Usually, laboratory reports are not double spaced. Bold-face subheadings for each of the sections described below are usually included, and if references are needed, APA format usually suffices (see our APA format handout for instructions). Always ask instructors if they prefer a specific format; however, they are usually more concerned with the content of each section rather than the page numbering, references, font, etc. Follow the instructor's directions very carefully with respect to the content of the sections of the report; include no more and no less than what is required for each section. The following portion of this handout describes in detail the content of the sections most commonly used in undergraduate lab reports.

1. Title Page

- Number and title of the experiment
 - Ex: Lab #4: Isolation of Caffeine from Tea Leaves
- Names of lab partners
- Date(s) on which the experiment was conducted

2. Abstract

The report abstract is a short summary of the report. It should be no more than one paragraph (100-200 words) and should include about one or two sentences on each of the following main points:

- Purpose of the experiment
- Key results
- Major points of discussion
- Main conclusions

It may help to complete the other sections of the report before writing the abstract, as these four main points can be drawn from them.

3. Introduction

This introduction is also often referred to as the ‘purpose’ or ‘plan’ section. It should include two main categories:

- **Purpose or objective** of the experiment expressed clearly in only one or two sentences, including the main method used to accomplish the purpose.
 - Ex: The purpose of the experiment was to determine the percentage by mass of acetic acid in vinegar using acid/base titration.

The purpose is also sometimes written as a separate section from the introduction.

- **Background and theory** pertaining to the experiment. This can include information from previous research, explanations of theories, methods or equations used, etc.; for the example above, you might want to explain the theory behind acid/base titration and a brief description of the setup and process you will use in the experiment. If research is done for this section, be sure to cite any sources used according to the instructor’s preference. Be careful to include only the information that a reader would need to know in order to understand the purpose and methods; the report should still be as straightforward as possible.

In addition to the purpose and background information, the instructor may also ask students to provide the following items in the introduction section:

- A hypothesis: what is expected to happen in the experiment based on background information.
- Safety information. This is especially useful in chemistry classes, where toxic or flammable chemicals are often used. The best resources for this safety information are Material Safety Data Sheets (MSDS), which can be found in many locations on the internet. One good place to find a wide variety of MSDS is at www.flinnsci.com/search_msds.asp. On this page, you can search for an MSDS by typing the name of the chemical of interest into the search bar and clicking 'search.' The sheet will contain a tremendous amount of information on the physical properties of the substance, first aid measures, and how the substance should be handled. In the report, summarize key safety information from the MSDS in a few sentences if possible.

Regardless of the specific information required from the instructor, the main focus of the introduction should be on helping the reader to understand the purpose, methods, and reasons these particular methods are being used.

4. **Materials and Methods**

This is usually a simple listing of the equipment used in the form of a bulleted list, but it should be complete and accurate. Graphics of more complex setups may also be included if they would be helpful.

5. **Experimental Procedure**

This section includes the process of the experiment exactly as it was done in the laboratory. Usually the procedure is written out in paragraph form, but it may also be written out step-by-step in the form of a numbered list. Some instructors allow a citation to the lab manual for this section (Ex: "The process in the laboratory manual for BIO 102 was used."); however, if the lab manual is cited, any changes made to that procedure should be noted. There should not be any **results** (things that happened when the procedure was being carried out) included in this section; only include the procedures carried out. A good rule of thumb for writing complete but concise experimental procedures is to include enough information so that others who read the report would be able to duplicate the experiment at a later date.

6. Results

This section contains all the results of the experiment, including:

- **Raw data** (weights, temperatures, etc.) organized into graphs or tables. Each graph, table, or figure should be labeled and titled properly. The key to making tables and figures effective is to refer to and explain each one in the body of the paper.
- **Important results** in verbal form. For the main results that will be expanded upon in the discussion section, use complete sentences (i.e. “The percentage of acetic acid in vinegar was calculated to be **4.982 %**”). This will help the key results to stand out from all the calculations, tables, and figures that normally dominate the results section.
- **Calculations.** Usually, only a sample of each calculation is needed. For example, if the percentage of acetic acid in 10 samples of vinegar has to be calculated and then averaged, write out the calculation for only one of them, then mention that the calculation was repeated for 10 samples and give the average of all 10. Correct significant figures should be used in all calculations (see our “Significant Figure Rules” handout for help with significant figures). Make sure units (cm., mL, etc.) are included in all calculations, and that major results of each calculation stand out from the rest of the numbers. This can be accomplished by typing the key numbers in boldface and by including them in a complete sentence as shown above.

7. Discussion

The discussion section is the most important part of the report. This is the section where the results are explained, and a student can show the instructor that he or she has a thorough understanding of the concept of the experiment and the results obtained. The main question to be addressed in this section is “What is the significance of the results?”

Here are some strategies to help focus your discussion:

- **Compare expected results with actual results.** If the experiment did not turn out exactly as expected, think about why the results might have been different and try to explain why you got the results you did.
- **Analyze experimental error.** There is a degree of error in every experiment, so every lab report should mention potential causes of error. Be specific about what caused the error. Was it due to the equipment? Impurity of the sample? Errors in calculations?
- **Explain how the methods could be improved.** Once you have decided what might have caused error, you should explain how the error might have been avoided. How could the setup be made more effective? Should you have been more careful with measurements? How could contamination have been prevented more effectively? Should more precise equipment be used?

- **Explain the results in terms of the purpose.** If the original purpose of the experiment was achieved, explain how the results show that the purpose was accomplished. For example, if the purpose was to determine the percentage of acetic acid in vinegar, you could research the real percentage of acetic acid in most commercial vinegars and compare that to the calculated result from the experiment. A small difference would indicate that the percentage calculated was very close to the actual percentage and the purpose was accomplished. If the purpose was not achieved, prove this by the results in a similar fashion.
- **Relate the results to those of other, similar experiments.** Depending on the nature of the experiment and the instructor's preferences, you may want to compare your results to those of the rest of the class. If your results were similar to the others', this can be an indication that they were reasonably accurate. If they were very different, explain why they may have been different.

8. Conclusion

This section includes only one or two sentences that summarize definitive conclusions from the results. Here is an example of a conclusion for the acetic acid experiment used in earlier examples:

From a comparison of the results of the experimental calculations with the normal value for percent acetic acid in vinegar, it can be concluded that the percentage of acetic acid in the sample used in this experiment was about 4.982%.

Notice how the conclusion relates directly to the main objective of finding the percentage of acetic acid in the given sample of vinegar. The conclusion also justifies itself based on the results; the actual results were comparable to the expected results. The degree of confidence the writer has in the conclusion is also shown; the percentage was an average rather than an exact amount, so the word 'about' was used.

9. References/Appendices

Not every instructor will require these sections, but if outside sources have been cited, a reference list will be needed. If there is a significant amount of extra data or calculations, it may be beneficial to put them into an appendix at the end of the report. As mentioned earlier, instructors will usually tell students how they want references formatted, but if a format is not specified, APA citations should be used. For instructions on formatting references in the APA style, see the APA format handout under the English section on the Tutoring Services' web site: http://www.germannanna.edu/tutor/helpful_handouts.asp