

Students with Disabilities/Special Needs: If you have a documented physical or learning disability for which you require special accommodations, please contact John Hennessey, Assistant Director for the Institute for Academic excellence, hennesj@thomasmore.edu, mezzanine level above the cafeteria, (859) 344-3507. **Free tutoring** and academic coaching is also available.

Sections of a Lab Report: Third person only!

- Title
- Purpose: usually a single sentence **in your own words**
- Chemical Equations:
 - there is no reaction equation for the first several labs
 - No mathematical equations here
- Equipment & Materials used: Be complete!
- Procedure: summary/bullet points, not complete sentences **Left side only**
- Observations: **Right side of Procedure written as you do the lab**
- Data: in tables as much as possible
- Calculations: show all work here!
- Results Summary: no sentences, just a table listing your **final results**
- Conclusions/Discussion: the most important section of a lab report!
 - **HERE IS WHERE STUDENTS MUST CRITICALLY THINK!**
 - **Comparisons:**
 - Discuss *each* set of data or result (compare to known/expected results).
 - Explain accuracy vs precision when dealing with numbers.
 - **Sources of error:**
 - Explain what part of the actual procedure (doing the lab) caused error.
 - Be very specific!
 - Explain how this error effected your results.
- Post-Lab Questions: many are challenging; so you should ask for help when needed!

Guidelines and Suggestions for the Formal Laboratory Report CHE 111L

Thursday, June 14 – Formal Laboratory Report Due by 3:00pm

Writing a Formal Laboratory Report

A formal laboratory report is likely very different than most other papers you have written either at TMC or in high school. First, scientific reports should always be written in the third person, past tense. In other words, statements such as “I heated the reactants over a hot plate...” or “Heat the reactants over a hot plate...” should be replaced with “The reactants were heated over a hot plate...”. Second, you should never begin a sentence with a numerical value; statements such as “0.345 g of the sample was reacted...” should be rewritten. Finally, the proper laboratory report should include the following sections in this order: Title, Abstract, Introduction, Experimental, Data / Results, Calculations, Discussion / Conclusions, and References. To clarify what should or should not be included in each section, please see the paragraphs below:

Overall Format

- Your report should be typewritten, double-spaced, with 1” margins on 8½ x 11” paper.

Title and Title Page

The title should be relatively short and represent the ‘essence’ of the report. This should give the readers a clear indication as to the major direction or focus of the study. Additionally, the title should be no more than two sentences long and does not have to be a complete sentence. On your title page, you should include the following:

- Title of the Report
- Name
- Course Number and Title
- Date of Submission

Abstract

The abstract is a short (typically ca. 300 word) summary of the major points of the study. This should give the reader a clear indication of (a) the problem or problems under investigation, (b) the theory behind the experiment, (c) the methods and strategies used to study the problem, and (d) the important findings of the study (this may include determined quantities, % error, and other calculated values). Ultimately, a good abstract should give the reader sufficient information that helps them determine if they would like to read the rest of the paper for more details.

Introduction

In the introduction of the experiment, you should attempt to lay the groundwork for your experiment. When writing an introduction, I have found it helpful to try to address the following questions:

- What previous work has laid the foundation for this study? (In this part, include a short discussion about any important theories or previous work from the scientific literature.)
- What problems or limitations were present in the previous work (in other words, why are we performing this study)?

Specifically for the aspirin experiment, you should be prepared to discuss the following topics:

- Discuss the synthesis of aspirin and show the equation for the chemical reaction
- Discuss the type of information that can be obtained with a melting point measurement
- Discuss infrared spectroscopy and/or the interaction of a molecule with infrared light

While the lab manual is a good reference for some of this material, you should consult outside sources as well (other than your textbook). Be sure to reference those sources in the Reference section of your report. Conclude the introduction section with a brief statement as to what will be done in this experiment. It may be helpful to mention the major objectives of the experiment and any hypotheses you might have about the experiment. Concluding the introduction section in this manner usually provides a nice, logical transition into the experimental section.

Experimental

The experimental section should describe in detail the experimental procedure that was followed and is always written in the third-person past tense. Any special equipment should be described (type of instrument, model, manufacturer, etc.) and chemicals should be identified. In addition to writing a complete experimental procedure for what you have done, you should also stress all modifications or deviations you made. Cite appropriate references, and do not recopy the lab manual. Be sure to put what you did in your own words!

Ultimately, the goal of the experimental section is to provide sufficient detail to the reader such that they are able to reproduce the results of your experiment.

Data and Results

In your data section, you should include any data that you obtained during your experiment, in either tabular or graphical form. Specific comments on Tables and Figures are shown below.

- Tables: All tables in the document should be sequentially numbered and be given a short descriptive title, both of which are placed at the top of the table. Tables should contain data with the appropriate number of significant figures, and units for each measurement should be included in the column/row label and not alongside the data.

- **Figures:** Figures should also be sequentially numbered and have a short description. Instead of placing a title on the figure, however, the figure number and a caption should be included below the figure. Be sure to include appropriate labels (with units!) on both axes. Also include regression equations and R^2 values, where appropriate.

For the aspirin report, you should be sure to include the following:

- Table of melting points for known and experimental compounds
- Table of infrared data (i.e. significant absorption bands (in wavenumbers) observed in known and experimental compounds, identity of the bond (see p. 19) that accounts for these absorption processes)
- Percent yield
- Infrared spectrum of aspirin (with caption)

You should also include a short paragraph on the major findings of your report. Clearly state the results obtained (what you found, measured, and determined) and briefly discuss the precision and accuracy of the results.

Calculations

Recalculate your results for this section of your report. As with the written lab reports, a sample calculation with defined variables should be listed first and immediately followed by one worked, example calculation with appropriate units. (Repeat calculations do not need to be shown.) If you wish to type your mathematical equations, Microsoft Equation Editor has the capability of generating very nice mathematical and chemical equations. If you do not wish to use this program, however, you can neatly write the equations in ink in an Appendix for your report.

Discussion / Conclusions

For your discussion, you should talk about the results that you presented in the data section. As you discuss each set of data, mention table or figure numbers (i.e. ...as Figure 2 illustrates...) when you talk about specific values. In this section, your goal is to critically evaluate the data you have collected and discuss the significance of these results. You should include both 'positive' and 'negative' results and mention any sources of error that were problematic. The discussion section is an excellent place to include observations as well.

For the aspirin report, you should include the following:

- Interpret your results (similar to the questions at the end of the experiments)
- Explain the significance of your results
- Comparison of melting points and spectra of known and unknown compounds
- Possible sources of error (only systematic and random error – human error can be eliminated by repeating the experiment)
- Effect of error sources on your measurement (i.e. higher or lower values?)
- Potential modifications / improvements to the experiment

References

You should include at least two additional references (other than your Lab Manual and Chang) for your report. *Your additional references should be from primary literature (other textbooks, books, journal articles, etc.) that has been checked for accuracy (peer-reviewed). Wikipedia is not an acceptable reference.* Sources are numbered as they appear in the body of the report. Once a source has been assigned a number, the number is used in the text wherever the source is cited again. Reference numbers are listed in the text as a superscript numeral at the end of the block of information obtained from the source.¹ All references are then compiled in a list at the end of the report.

Books are to be cited in the following manner:

- (2) Broekaert, J.A.C. Analytical Atomic Spectrometry with Flames and Plasmas. Weinheim: Wiley-VCH, 2005.

Journals should be cited as follows:

- (3) Kirchhoff, G.R.; Bunsen, R. *Philos. Mag.*, **1860**, 20, 89-109.

Additional suggestions as you begin to write your report

I have found that beginning to write any document is often the most challenging part. To help you get started, I would suggest that you try the following:

1. Compile all data tables (with titles), figures (with captions), and observations.
2. Write down the main points of discussion and important conclusions you want to relate about your experiment.
3. Write the six main sections of the report on a page and begin placing your data, figures, observations, discussion points, etc. into each of those sections.
4. Organize the components of the six sections such that they flow logically.
5. Using the outline you have made, begin writing your report.
6. As you write the text of your report, have your outline close by so you can add more details. (I have found that as I begin to write, I often think of other discussion points and ideas that would be good to include.)
7. Once you have a draft of your report, proofread for spelling / grammatical errors.
8. Proofread again!
9. **Do not put this assignment off to the last minute!**