

Lab Notebooks

Communication skills are important in science, engineering, and medicine. Although your laboratory records are primarily your personal observations, your records are also a means of communication. You should maintain your records so that any reasonably intelligent reader (e.g., your laboratory instructor) can understand and evaluate what you have done in the laboratory, without an oral explanation from you. Neatness is helpful and nearly as important as good planning and organization.

Until recently, the notebook was the only type of laboratory record. It is still the principle record, but modern researchers must file photographs, computer programs, and actual recordings obtained from instruments. Many chemical industries require employees to maintain detailed notebooks, with bound and sewn edges. Pages are generally initialed by supervisors and/or witnesses, to protect the interests of the company and the researchers in patent litigation. Madame Curie's lab notebooks are still available, and filled with valuable data (they are, however, stored in a lead vault since they are dangerously radioactive). You must record your laboratory data directly in your notebook. "Double-entry" systems or disorganized notes on scraps of paper or towels are not acceptable at any level of science.

When working in your lab book, always work carefully and neatly, and in pen, not pencil. You are not allowed to remove pages or use white-out to hide mistakes. In the event that you make an error that you do not wish to have graded, simply draw a single, solid line through it. The following elements are required in your lab report. Each section should be marked with its name (Title, Date, Purpose, etc.,) as a header on the left edge of the page. Remember that you must always use complete sentences as well as correct spelling, punctuation and grammar. Please avoid the use of terms such as "it", "stuff", and "thing." If I cannot read your handwriting, I will not be able to grade your lab.

Front Cover

Each lab book should be labeled with your name and your contact information. That way, it can be returned to you if it is lost.

Table of Contents

Set the first few pages of your lab book aside to serve as a table of contents. You should leave enough space so that you can list the content, date, and page number of each entry.

Title & Date

The title should be descriptive. "Experiment 3" is not a descriptive title. "Determination of the Molecular Weight of Oxygen from the Decomposition of Potassium Chlorate" is a descriptive title.

The experiment should be labeled with the date (or dates) that you performed the experiment.

Purpose

A brief statement of what you are attempting to do.

Introduction

In the introduction, I'm looking for background. What chemistry do I need to know in order to understand the results of this lab? What calculations am I likely to need? You never use past tense here, since it is introducing or leading up to the lab. You might also discuss the relevance or the importance of doing the lab in this section. Discuss what you are supposed to learn by doing the lab and why you should care about doing the lab. I grade this section pretty carefully, so treat it as a very important part of your write-up.

Experimental Set-up

Describe the details of your set-up. You need to include details about your starting materials, processing conditions, equipment used, times, temperatures, etc. Provide enough detail so that one of your classmates could reproduce your experiment.

Procedure & Observations

The procedure should be a list of what you did in the lab. Not what the procedure said to do, but what you did. It should be thorough and complete. I should be able to pick up your procedure and follow it like a recipe and get the same results you got in the lab. The first time you do a technique, you might include in the procedure section a description of how to assemble the apparatus and how to conduct the distillation. In later experiments, it will be sufficient to state only that the liquid was distilled.

A source of help for writing lab reports can be found by exploring the website: <http://www.ncsu.edu/labwrite/>

Your observations of the experiment as it progresses are important. This is where you record any data collected and new pieces of information. They will be both qualitative and quantitative. Write these observations (color changes, appearance of crystals, formation of an emulsion, boiling temperatures, test results, masses, etc.) in your notebook as you do the experiment.

I recommend you set up a two-column table, so that an observation can be placed directly to the right of the corresponding step in the procedure. Below is an example, just picture it written rather than typed.

<i>Procedure</i>	<i>Data/Observations</i>
1) <i>Mix salicylic acid and acetic anhydride in a 125 ml Erlenmeyer flask, add 5 drops of H₂SO₄.</i>	1) <i>On mixing, it took a few minutes for everything to go into solution. The addition of sulfuric acid caused some fizzing.</i>
2) <i>Heat on steam bath for 10 minutes, then cool.</i>	2) <i>Heated for about 15 minutes instead of the planned for 10 minutes.</i>
3) <i>Add 50 ml of water and cool on ice.</i>	3) <i>After adding the water and cooling, no crystals appeared. On the suggestion of my teacher, I scratched the flask with a glass rod, chilled it on ice for 10 more minutes and finally a lot of tan crystals appeared.</i>
4) <i>Collect product by vacuum filtration.</i>	4) <i>Quite a lot of solid, lightly tan, was collected on the filter paper.</i>
5) <i>Air dry the crude product crystals and determine a crude yield.</i>	5) <i>Let dry for 10 minutes – crude product + watch glass weighed 32.02 grams</i>
6) <i>Purify as in the flow chart below on page ...</i>	6) <i>When I followed the scheme in the flow chart for purification of the crude product, I noticed that when I added the sodium hydrogen carbonate, the product turned yellow. I suspected a contaminated (dirty) beaker. So, I treated the mixture with Norite pellets. A clear solution resulted. The purification scheme was followed without mishap through the recrystallization from ethyl acetate.</i> <i>Crude product + watch glass: 31.80 g</i> <i>Watch glass: 30.10 g</i> <i>Crude product: 1.70 g</i> <i>yield of product: 1.70 g/2.52 g = 67%</i>

Data

You wrote your raw data in the observations, but here we need to sort it and organize it. Data should be in tables whenever possible; use the data sheet in the lab write-up as a guide but do not write the data in the write-up as this is not your lab notebook, and you want all of your raw data in your notebook.

Safety Concerns

You will look up the Material Safety Data Sheets on each of the chemicals used in the lab and include as part of your write-up a summary of the Health Hazards section. You may copy this word for word if you'd like, but you can't just make a photo copy and paste it into your notebook. You only need to include the hazards for a chemical once in your notebook. If we use the same chemical in another lab, just refer back to the lab where you previously recorded the hazards.

Calculations and Graphs

You should show how calculations are carried out. Give the equation used and show how your values are substituted into it. Give the calculated values, with correct units. If graphs are included, make the graphs an appropriate size. Label all axes and give each graph a title. Graph paper may be stapled in your lab book, if used. I am not responsible for the loss of any materials that are turned in “loose” in your lab book. If experiments are not quantitative, this section may be omitted.

Discussions & Conclusions

In this section, you should discuss your findings, conclusions, and thoughts on the experiment. This section of your notebook is THE MOST IMPORTANT section. I will grade these discussions very carefully. I expect you to put the ANAL in ANALYSIS. You should reflect back on every step in the lab and discuss your results and the importance of your results for that step. These are not easy to write, and will push you to really think about why we did the lab and how it connects to the material covered in class. It should address these ideas:

- *explains how the findings link to the context of the lab*
- *addresses questions and issues related to lab and discusses answers to these questions*
- *sufficiently issues pertinent to lab*
- *present the conclusions you draw from the results.*
- *convincingly describes what has been learned by doing the lab*

Refer back to the purpose and the introduction of the lab to write this section.

Experimental Sources of Error

What are some specific sources of error, and how do they influence the data? Do they make the values obtained larger or smaller than they should be? Which measurement was the least precise? Instrumental error and human error exist in all experiments and should not be mentioned as a source of error unless they cause a significant fault. Significant digits and mistakes in calculations are NOT a valid source of error.

In writing this section, it is sometimes helpful to ask yourself what you would do differently if you were to repeat the experiment and wanted to obtain better precision. If you can calculate a percent error or percent deviation, do so and include it in this section. Let me reiterate - sources of experimental error are just that: Experimental.

Not....Calculations

Not....Something unspecific such as “human error” or “the scale was off”

Questions

Answer any questions included in the lab directions.

Do's and Do not's of Laboratory Notebooks

DO write the page number on top of EACH page

DO include a table of contents on the first page or two of the notebook and keep it current

DO write in ink not pencil

DO write only on the right side of the page; this saves the left side for scratch paper in case you need to perform a calculation during the experiment

DO cross out any errors with a single line, keeping it legible, then date and initial near the cross-out

DO NOT tear ANY of the original pages out...only the copies

DO NOT write in pencil or erasable ink

DO NOT write ANYTHING outside of the notebook; write everything directly into the notebook