

Guidelines for Keeping a Laboratory Notebook

Following an understanding of theoretical material, the scientific method requires quantitative verification via experimental observations and analysis. Effective and complete communication of your results is crucial for your experimental findings to be useful to the scientific community (or to an employer), for your results to be scrutinized (and verified) by others, and for you to receive proper recognition for your work.

In this course, you will be practicing proper scientific communication in the form of laboratory reports. Your reports should be descriptive and self-contained, while avoiding extraneous and irrelevant details. In order to receive full credit, all of your calculations and uncertainty estimates should be clearly, concisely, and accurately described.

Do not be surprised if an unorganized, illegible, non-descriptive report that arrives at a correct result receives a much lower grade than a report that is well written but has a few calculation mistakes.

The grading rubrics accompanying the procedures for every experiment will help guide you in performing the analysis required in each section of your lab reports. You are responsible for covering all of the analysis listed in the grading rubrics as well as all of the details that are listed in these guidelines.

BOOKKEEPING

Always write clearly, legibly, and in pen. If you make a mistake, mark a thin line through it. Do not rip out or add pages. The point is to be accountable for everything you write in the report. Don't fill up a page with messy, unidentifiable calculations that can't be checked for mistakes.

Save the first two pages of your notebook for a brief **table of contents**, and add **page numbers** if your notebook does not have them.

LAB REPORTS

1. OBJECTIVE

Limit this section to one paragraph. Describe **what you are planning to measure or verify** and give a very short and simple summary of the procedure. A solid objective statement is crucial for writing a good conclusion. Some relevant details are the following:

- What **physical parameters** will you be measuring? What are the accepted values that you will compare against?
- What **theoretical models or assumptions** are you using in your analysis? How confident are you in the validity of these theoretical models?
- What **precision goals** do you have (if any) for your experiment?

2. MEASUREMENTS AND OBSERVATIONS

- *Diagram of apparatus:* Draw a simple diagram of the experiment and label all of the components and quantities that you will be measuring.

- *Data/Observations*: Make sure that each measurement is followed by an estimate of its **uncertainty**, a short description of the source of uncertainty, and units. Data should be clearly written and organized. Tables can be useful for organizing your data.

3. GRAPHS

Sometimes your data or results should be represented in a graph. These should be complete with a title, labeled axes, units, error bars, and a brief caption describing your graph. Some relevant details you can address in your caption are the following:

- How **precise** do you think your data is? (including discussion of error bars, if applicable?)
- What trends or curves do you **expect** to see?
- What kind of trends do you **observe**? Does it seem to agree or disagree with your expectations?
- Are there any data points that you think you should discard? Do you have a good reason to discard these points?
- Were there any approximations you made that might affect the accuracy of your results?

4. CALCULATIONS, ERROR ANALYSIS, AND RESULTS

Always label each calculation, properly propagate errors, and show your work. For results calculated using a computer, show a sample calculation. When you finish calculating a value, **box the final answer** (cited with appropriate **significant figures, units, and uncertainty**). Picking out the **dominant source of uncertainty** following each calculation is necessary for properly writing your conclusion.

5. CONCLUSIONS

In this section you will **summarize** the results of your calculations, error analysis, graphs, and any other observations made during the course of your experiment, and use your results to make a judgment about the things you aimed to validate in this experiment.

Keep your conclusions **concise**, while describing the most important results and **dominant sources of uncertainty**. Make judgments about how significantly your measurement uncertainties affect the precision and accuracy of your final answers and the **confidence** you have in your results to conclusively accept or reject the theoretical assumptions used to describe your experiment.

Your conclusions should be a combination of **quantitative** results and a **qualitative** discussion of your results: the physical meaning of all numbers (or statistics) that you state should be described in words, and all statements and judgments that you make should be backed up by your calculations.

In answering the question posed in your objective, some relevant details you can address are the following:

- Are you satisfied with the precision achieved in your experiment? Are your results consistent with each other? Which measurement contributed the dominant source of uncertainty in your experiment?
- Compare what you observed with what you expected to get in both qualitative and quantitative terms. If the calculated uncertainty does not account for the discrepancy between the two, what other sources of error could have contributed?
- Is your experiment precise enough to make a conclusive statement about what you were trying to verify in this experiment? If not, do you think measurement uncertainties or systematic errors were more significant in your lack of confidence of your results?
- How could the measurement have been improved?