# *Laboratory Notebooks*

> "Everything gets written down, formally, so that you know at all times where you are, where you've been, where you're going, and where you want to get... The real purpose of the scientific method is to make sure Nature hasn't misled you into thinking you know something you don't actually know."
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> R. M. Pirsig, *Zen and the Art of Motorcycle Maintenance*, 1974

> "A good notebook is a diary not a memoir. It reports things as they happen not as they are recalled. It reports what you are thinking in addition to what you are doing. This means writing out an easy-to-read summary of your ideas, why you are planning a particular experiment, what materials and processes you will use, and what you hope to find out... Scientists who learn to regularly summarize their findings in words as well as numbers generally find their notebooks become more useful."
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> D.J. Houser, "Common sense rules for research record keeping," *Wisconsin Week*, December 19, 1990.

Your laboratory notebook must be the original record of your own work, written as you do that work: deciding on purpose and method before beginning, describing clearly but concisely what you see and do, recording primary data and calculated results, drawing conclusions.

*Save a few pages at the beginning of the notebook for a table of contents.* Number all pages so you can find things. If an experiment continues somewhere other than the next page, the page should end with "Continued on page xx." Keep your table of contents current. Quadrille ruled notebooks are recommended for keeping data tables organized.

As in any writing, you should strive for content, organization, and clarity. Aim to provide a record that six months from now would allow you or someone else to repeat the experiment or understand what you planned, found and *thought*, how you did the calculations, and what you concluded. Consider a crime lab chemist taking his lab notebook into a criminal court or an industrial chemist taking her lab notebook into a patent court... it happens every day!

Never erase. Never remove pages. Just cross out neatly anything you think is incorrect; you may have been right the first time and later need to recover what you wrote originally. Similarly, do not write things down on scratch paper since you may lose it, forget to transfer the information to your notebook, or make a mistake when recopying it. Your notebook should be a complete record of what you did and thought, mistakes and all, and be up to the minute of what you are doing. A laboratory notebook is different than the formal reports that scientists use to make it look as if they really did know exactly what they were doing at every step.

A key to good laboratory work is to know ahead of time what each step of a procedure is trying to accomplish. As a scientist, you will either be trying something new and making up your procedure yourself, or you will be trying to repeat something from the literature, perhaps in a better way or for different purposes. The instructor and lab assistant will be happy to help you decide why a particular step is necessary, or what a particular analytical method will tell you.

Your laboratory grade in this course will be based on what you write in a **bound** laboratory notebook. *Each section will be graded separately*.

## Purpose

State the object of the experiment in one sentence. **What** are you trying to do? What are you trying to find out? Be specific enough that you can tell when you are finished. You should formulate a written purpose in your notebook before you come to the laboratory. If an experiment takes more than one period, write a purpose and method for each day's work.

## Method

Summarize the essentials of **how** you plan to achieve the stated purpose. For a synthesis give the chemical equation for the reaction and indicate how you will know if the synthesis is successful. Identify any important variables. Generally this will require you to read and think about the entire procedure before starting. Simply copying the lab manual directions word for word into your notebook or including numbers is too much detail, and providing only a reference citation is too little detail. If you write the method in your notebook before you begin, you will work faster with fewer mistakes.

## Actions and Observations

Record what you **do** and what you **see** and what you **think** *in your own words*. Copy down the labels of the reagent bottles you used. (Is the bottle labeled 1.78 g AgCl/liter really the 0.1 M solution you were supposed to use?) Include all amounts and how you measured them. You need to be able to tell from your notebook when you actually did your work and with whom you worked. *Make your observations part of the record of your actions, not a separate section*. Be sure to record your thoughts and each step of your actions *as you do them*, not as you later recall them.

## Data

*Record all data directly in your notebook and label all entries*. Use a table form for data as much as possible, with plenty of space and room for crossing out entries. Do not write data on anything else for later recopying. This data section should be written during the experiment and not copied later. Adding a table entry every time you do something will keep you from forgetting which steps you have done.

## Calculations and Graphs

Explain or provide an example of *how the data you obtained in lab is used to obtain the final result*. Calculations randomly scattered on the page are not sufficient even if they come out correctly. Show units on all numbers and make sure that units cancel properly in calculations.

Spectra and graphs must have both axes labeled and should be fastened to your notebook with tape or staples. Please fold 8.5x11 pages in half and fasten with the fold to the center of the notebook without covering up anything else.

## Conclusions

*Answer the question posed by the purpose and summarize your results*. What did you learn or measure? Did you make any changes in the procedure? What revisions should be made to improve the experiment? **Answer the concluding questions.**