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## The Role of the Laboratory Notebook

The laboratory notebook is a complete record of what was done in the laboratory. In a real life research situation, someone may have to reproduce the work several years after the original experiment was performed and the only record they will have to rely on will be what was written in the notebook.

## Laboratory Notebook Specifications

1. The notebook should be bound, with numbered pages and removable carbon copies. National<sup>®</sup> Brand No. 43-649 is recommended. The essential features of a notebook are (1) the pages are bound, (2) the pages are numbered and (3) the material (paper) does not deteriorate or does not make the writing deteriorate over time. The Chemistry Department Stores sell a decent notebook published by Hayden McNeil. Strictly speaking the spiral binding is not acceptable for permanent records as it is relatively easy to disassemble the book and reinsert new numbered pages at a later date. The spiral binding is great for other reason though; the book lays always flat.

If you have a notebook from a previous course with enough pages to last for this semester, you may use it.

2. The first three pages of your laboratory notebook should be reserved for a table of contents, which must be kept up to date.
3. Each experiment should begin on a new page. Never put information from more than one experiment on a page. Include the following items on EVERY page:
  - The title of the experiment ("continued..." if applicable)
  - Your name
  - The date
  - Name of the laboratory partner(s) – if any

**Every** experiment should also include, if applicable:

- A primary literature reference (or reference to your lab manual).
- Purpose of the experiment.
- Balanced equations for all reactions performed or studied.
- Formula weight, mass and number of moles of each reactant.
- Percent yields (in grams and percent).
- ALL observations (color changes...or lack thereof).

- Sources of the chemicals used (manufacturer, or if a solution was prepared by the TA, the TA's name).
  - Instrumentation or equipment used (manufacturer and model, NIU inventory number to distinguish between instruments).
  - ALL data collected. If a spectrum is obtained, summarize the peak positions and intensities.
  - If the raw data are in computer files, indicate the location, name, subdirectory of the files. Leave a copy of the file on the laboratory computer, but make your own copy as well. You should keep these files as long as you keep your notebook.
  - All calculations.
  - Your conclusions and interpretation of the data.
4. Do not skip pages in your laboratory notebook to allow space for the completion of an incomplete experiment. The situation can be handled adequately through the table of contents and by making references on the pages involved such as "continued from page 7" or "continued on page 9".
  5. All entries should be made in blue or black ink. These entries should be made during the regular laboratory period while the experimental work is in progress (except for instances indicated below).
  6. **NEVER** use intermediate scratch sheets. All data and descriptions should be entered directly into your laboratory notebook. Students found using scratch sheets will have points deducted from their notebook score and may also receive a penalty for poor technique.
  7. Mistakes are to be clearly crossed out but left in a legible manner (to avoid giving the impression of trying to conceal something). The reason for any correction should be noted.
  8. Your notebook should be neat, orderly and complete. Another chemist, chemical engineer, or chemical patent lawyer should be able to take your notebook either now or months later and be able to read it and to understand what you did and the results you obtained. Note: The carbonless copies, when exposed to organic solvents, will turn blue.
  9. Research notebooks are kept indefinitely and are the property of the company of the university. The teaching laboratory notebook is yours to keep. You may retain it indefinitely, but at least for a semester after you finished your work.

## Daily Procedure

**Before** you come to lab, review the experiment and make any necessary calculations in your notebook. You will finish your work much quicker if you come prepared and understand the work you will be performing. You will also get more value from your experiments that way.

**During** each laboratory period, enter data and comments in your book according to the guidelines given below. Do not forget to bring your laboratory notebook. If you forget, you will have to buy a new one in the Departmental Stores.

**At the end** of the laboratory period, clean up your lab area and equipment, making sure to leave common equipment in equal or better condition than you found it. If something is broken, let your instructor know. Give your notebook to your instructor to inspect and initial. If everything is in order, the instructor will initial and date your book. If it is not in order, you will be asked to remedy the deficiencies.

If you perform calculations outside the laboratory, be sure to enter these in your notebook and turn in the duplicate pages during your next laboratory period. Such pages must be turned in before your laboratory report!!

## Guidelines for Notebook Entries

Most laboratory time should be devoted to experimental work rather than to writing. However, it is useless to do the work unless it is properly recorded for later use, recollection and reflection. Not only should essential measurements and precise procedures be recorded, but also all conceivably pertinent observations. A slight change in procedure, a seemingly insignificant observation, *etc.* is often a crucial matter in the final analysis.

A number by itself is meaningless; therefore, the units, corrections, and information that make its interpretation meaningful should be carefully noted. There should be sufficient information about conditions, reagents, and equipment that the experiment can be repeated to give essentially the same results.

### Preliminary

Before coming to the laboratory, write a short paragraph stating the property or properties that are to be measured, the results that are to be calculated, and how these are to be done. For example one might measure the distance a cannon ball falls during each of five different periods. The acceleration of gravity might then be calculated from a plot of distance versus time squared.

### Experimental

All numerical data must go into the notebook as soon as they are determined, with no intervening scraps of paper! The following information should **always** be included.

The specific system you are studying (although you may not know its identity until after the experiment).

Procedure: This should be written as each portion of the experiment is performed. The procedure should be as short as possible and still contain enough of the detail that another chemist could repeat your work.

Data: All the numbers must be written and their units indicated-even an initial burette reading of 0.00 ml. There should be some explanation or heading for every set of numbers. The uncertainty for each type of measurement should be indicated. You should do short calculations, such as subtraction of weighings, additions, etc., right on the data page before you turn it in and leave the room.

Comments: Put down anything that might be pertinent or helpful. It is better to write down things that you may not need than to inadvertently leave out something significant. The comments may be in "note" form as long as they are complete enough to be intelligible to others.

Comments, Data and Procedure belong together. They should not be separated under three different headings.

Equipment and Chemicals: It is not necessary to describe standard or "everyday" glassware, hardware or procedure that might be used in any experiment. This can be described as procedure done *lege artis*. However, seemingly trivial issue, e.g., change in the source of the distilled water should be noted. Larger or special equipment and instruments should be described:

Name of the item (or description) and size if applicable

Manufacturer and model number or catalog number. If several identical instrument are in use, not also the NIU inventory number.

Specially constructed glassware or other equipment (such as the Kodaly-Blagojevic Freezing Point Apparatus) should be described either by a labeled sketch or a complete reference to the detailed description in the literature. Chemicals should be described by the name and formula. Manufacturer, grade, and lot number should be given where possible.

Evaluation

Before evaluating your experiment, you should be familiar with generally used methods of treating experimental data. Under the heading you should describe your results and

the method you used to obtain these results. This should include a discussion of the significance and reliability of the results with sufficient discussion to justify the use of your procedures. Entries in your notebook should follow the general pattern described below.

Calculations should be performed in the notebook. However, for highly repetitive calculations you can do one representative calculation and simply tabulate your answers. Do not forget the units and do all calculations using the metric system.

Propagation of errors: Use standard propagation of error methods to assign uncertainties to all your results. If you are reporting an experimental value, it must have an error stated.

Results: Collect your results and organize them so that they can be easily assimilated and compared. Tables and graphs should be titled and completely labeled. You may want to plot several pieces of similar information on the same graph for easy comparison. Computer plots using Origin, TableCurve or SigmaPlot are best.

Programs: If you develop a computer script for analyzing your data, the print-out from the program must be neatly affixed to your notebook. Stapling is fine in the teaching laboratory setting. In real research situation permanent adhesive tape (archival quality Filmoplast P is excellent) should be used. Also include a listing of the program. Make sure to include a hand written sample calculation as outlined above. Acknowledge any help in programming from outside sources, including help from your fellow students.

Literature Comparison: Whenever possible your experimental result should be compared with accepted or typical literature values. Record the source in your notebook for use in your report. Comparisons should include notations of significantly different experimental conditions or procedures. Both absolute and relative differences should be included after the data have been adjusted to the same temperature, pressure, etc.

Commentary: Briefly and quantitatively assess the accuracy and precision of your work in light of the uncertainty in the measurements that you have made. If there is a circumstance (duly noted as a comment in your notebook) which would explain good or bad results, describe it and give an estimate of its magnitude and effect.

If you have suggestions for improvements in the design or recommended experimental procedures, make them here. Be concise in this section as well as all other parts of your write-up.

**Remember:** It is better to put in **too much** data than too little!

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Material used here is in large part from the Laboratory Notebook Policy, Department of Chemistry, University of Kentucky  
(<http://www.chem.uky.edu/courses/common/notebook.html>)

7 January 2009 - Petr Vanýsek