Laboratory Notebook Policy

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A. Introduction

This policy governs **all** undergraduate laboratory courses taught in the Department of Chemistry at the University of Kentucky. While some of these rules may seem arcane or tedious to you at first glance, in practice you will find that they make your laboratory work more enjoyable, enable you to complete most of your experiments in the allotted time and make it easier to write your laboratory reports.

If you have questions about any aspect of this policy, please do not hesitate to ask your instructor for clarification.

B. The Role of the Laboratory Notebook

The laboratory notebook is a complete record of what you have done in the laboratory. In a "real life" research situation, someone may have to reproduce your work several years after you have left the laboratory and the only record they will have to rely on will be what you wrote in your notebook.

In both academic and industrial settings, the notebook is a legal document that records your original work. United States patents are granted on a "first to invent" basis, so it is not surprising that laboratory notebooks are occasionally subpoenaed. For example, in 1995 Exxon and Dow Chemical became embroiled in a patent dispute that arose when both companies claimed to have invented a catalyst within two weeks of each other. That dispute involves a product line worth hundreds of millions of dollars per

year and has yet to be resolved. Both companies are building their cases around laboratory records and employee depositions. It is therefore not surprising that corporations not only require that their employees keep thorough records, but that they are signed and witnessed each week!

We hold you to the same standards that you will encounter when you begin your career in chemistry. In industry, a patent would be invalidated if it was found that the supporting information in the patent was fraudulent or missing. Likewise, if we should discover that your laboratory report contains information not found in your notebook, it will be considered a violation of the University's Academic Integrity Policy.

C. Laboratory Notebook Specifications

1. The notebook should be bound, with numbered pages and removable carbon copies. National No. 43- 649 is recommended.

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

4. **Every** experiment should also include:

   A primary literature reference (or one 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).

   Instrumentation or equipment used (manufacturer and model).

ALL data collected. If a spectrum is obtained, summarize the peak positions and intensities.

All calculations.

Your conclusions and interpretation of the data.

5. 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".

6. 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).

7. **NEVER** use intermediate scratch sheets. All data and descriptions should be entered directly into your lab notebook. Students found using scratch sheets will have points deducted from their notebook score and may also receive a penalty for poor lab technique.

8. 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.

9. As note above, 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.

For your convenience, a list of items to include is given below.

D. Daily Procedure

Before you come to lab, review the experiment and make any necessary calculations in your notebook. You will get out of lab MUCH faster if you are prepared ahead of time and understand the experiment you are about to perform.

During each laboratory period, enter data and comments in your book according to the guidelines given below.

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. 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 instructed to remedy the deficiencies. Turn in your duplicate (yellow or blue) sheets with the day's data before you leave. At the discretion of the instructor, there may be a penalty for turning in yellow sheets late.

If you perform calculations outside the lab or work up data, 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!!

E. Guidelines for Notebook Entries

Most lab time should be devoted to experimental work rather than writing. However, it is useless to do the work unless it is properly recorded for later use 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 which 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 which are to be measured, the results which 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.

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

2. **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.

3. **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 lab.

4. **Comments:** Put down anything that might be pertinent or helpful. It is better to write down things which 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.

5. **Equipment and Chemicals:** It is not necessary to describe standard or "everyday" glassware or hardware which might be used in any experiment. Larger or special equipment and instruments should be described:

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

   (b) Manufacturer and model number or catalog number

   Specially constructed glassware or other equipment (such as the Choppin-Cottrel Boiling 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.1 Under the heading you should describe your results and your method for

obtaining 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.

1. **Sample calculations:** Illustrate all computations by writing the appropriate formula or equation, substituting a sample set of data (with units) and listing the answer, e.g.

   P = nRT/V

   P = ((3.00 moles)(0.0821 L atm/mol K)(373 K)/(0.211 L)) = 435 atm

   Calculations should be performed in the notebook. However, for highly repetitive calculations you can do one representative calculation and simply tabulate your answers. Don't forget your units!!!

2. **Propagation of Errors:** Use standard propagation of error methods to assign uncertainties to all your results. If you are reporting a number, it MUST have an error!!

3. **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 TableCurve or SigmaPlot are best.

4. **Programs:** If you develop a computer program for analyzing your data, the print out from the program must be neatly stapled into your notebook. Also include a listing of the program, which should be neatly stapled into your notebook. Make sure to include a hand written sample calculation as outlined in 1. above. Acknowledge any help in programming from outside sources, including help from your fellow students.

5. **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 lab 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.

6. **Commentary:** Briefly and quantitatively assess the accuracy and precision of your work in light of the uncertainty in the measurements which 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!