Chemistry Lab Notebook Policy

Instructor: Ken Marr

General Considerations

Maintenance of an acceptable laboratory notebook will be emphasized in this course. Record keeping and data interpretation are skills that you will use throughout your scientific career. The ability to prepare an adequate and reliable record of results is a fundamental requirement for all successful experimental work. Experience shows that most students develop skillful notebook use only through *continued special effort*—it does not come naturally. Some of the main principles of sound notebook use are outlined below.

The most important criterion for an acceptable lab notebook is that the record be complete and neat enough for another person to *easily* follow your experimental work, thus being able to repeat the experiment and to obtain the same results. ***The recording of lab results, data and observations must be written <u>directly</u> into your lab notebook in ink <u>while you do your work in lab</u>.*** Your records should reflect your work so well that any odd or erroneous results can be interpreted later, even if you don't notice the errors at the time. Later, outside of class, you can do the required calculations, interpret the data, etc.

<u>*All entries in the laboratory notebook are to be made in* **ink**</u>. <u>*If errors are made, simply cross them out with a single line*</u>. <u>*Never obliterate entries and never use whiteout*</u>—at a later time you may find that this information is useful! All data and observations are to be entered *directly* into the notebook *in ink,* not on scraps of paper. While you may want to wait to record data until after the lab is over in order to have a neat notebook, it is more important to have a complete, accurate record of all original data and observations, complete with smudges, spills, and cross-outs. Your laboratory notebook should provide a complete record of the work that you have done throughout the year in the laboratory. If it is necessary to omit information on a page in your lab notebook, place a large "X" over the information but never remove the page from the notebook. <u>The original pages should never be removed from a lab notebook</u>—only copies are to be removed to be handed in for grading.

General Guidelines

- **Lab notebook**: *Student Lab Notebook with Spiral Binding: 100 Carbonless Duplicate Sets. Hayden-McNeil publishers* (purchase at the GRCC bookstore!!)
- **Table of Contents**: Before coming to lab enter in the table of contents the title of the experiment to be performed and the starting page of your report.
- **Prelab Assignment**: A pre-lab must be written in your laboratory notebook before you will be allowed to participate in lab. <u>***Carbon copies of the pre-lab are often "stamped" by the instructor before leaving lab***</u>. The pre-lab includes the following components written directly into your lab notebook in ink before coming to lab:

  Title and Date of Experiment, Your Name, Lab Partner(s), Course and Section

  I. Introduction

  II. Materials and Method

  III. Results (Data Table(s) should be prepared before coming to lab and be ready to be filled in during lab!)

Lab Report Format

Unless told otherwise, use the following format when writing up each lab experiment. <u>*Each lab report consists of five* ***clearly labeled and easily identified sections*** *written directly into your lab notebook*</u>. See the next page of a description of what should be included in each of these sections.

I. Introduction
II. Materials/Methods
III. Results
IV. Analysis of Results
V. Conclusion

Title and Date of Experiment, Your Name, Lab Partner(s), Course and Section

I. Introduction

- Describe/summarize *in your own words* (don't plagiarize from the lab handout) the overall goal(s) of the experiment. What is it that you are trying to accomplish/determine with the experiment? This is often called the purpose of the experiment.
- State any hypotheses (if any) that will be tested
- Briefly summarize *in your own words* any relevant background information about the experiment and/or describe the theoretical principles on which the procedure is based, including all *relevant chemical equations* and/or *algebraic equations*.
- Usually the introductory section takes up about half of a page to one full page.

II. Materials and Methods

- The "Materials and Methods" section tells how the work will be done. It's a step-by-step version written ***in your own words*** of what will be done—***excessive detail is not required***. Your procedure should be detailed enough that a competent student could use it to replicate the experiment. Complete sentences are not necessary and diagrams/flowchart/outline can and should be used where appropriate.

A Sample Procedure

1. clean crucible
2. dry to const wt. w/heating
3. add about 5 g unknown
4. heat gently 1st, then strongly for 10-15 min
5. cool-weigh-reheat-cool-weigh-repeat to const wt.

Another Sample Procedure

1. Dry 25 mL an empty pycnometer of known volume & weigh to 0.001 g
2. Fill with ethanol.
3. Dry outside and reweigh
4. Calculate the mass of ethanol in pycnometer
5. Calculate the density of ethanol from its mass and the volume of the pycnometer

III. Results

- Record neatly and directly into a ***ruled* data table *all measurements*** that are made during the lab period—pay particular attention to correct use of units and significant figures. Your data table should be easy to follow and should summarize the results of all major calculations, average result, the theoretical result, percent error, etc. See tables 1 and 2 for examples.
- Your lab notebook is a primary record of *your* lab work and data should not be copied into it from other sources (e.g. from the lab notebook of your partner, other students, lab handouts, the internet, etc.) without *clear acknowledgement of the source*.

Table 1. Density determination of an Unknown Liquid #237

Unknown Liquid used: **#237**	**Trial 1**	**Trial 2**	**Trial 3**
Mass of cylinder & liquid	19.257 g	19.612 g	Should the student have done a 3rd trial? Why is trial 2 so far off? What's the source of error?
Mass of empty cylinder	11.257 g	11.392 g	
Mass of liquid	8.000 g	8.220 g	
Volume of liquid in cylinder	10.0 mL	10.0 mL	
Density of liquid #237	0.800 g/mL	0.822 g/mL	
Average density of liquid #237	**0.811 g/mL**		
Theoretical Density provided by the instructor	0.7915 g/mL		
% Error	2.4637 % = **2.5 %** (using sig figs)		

Table 2. Titration Data for the reaction of 0.100 M NaOH with an unknown acid

	Trial Number		
	1	**2**	**3**
Final Volume 0.100 M NaOH (mL)	35.25 mL	32.65 mL	38.60 mL
Initial Volume 0.100 M NaOH (mL)	5.02 mL	2.25 mL	8.80 mL
Volume 0.100 M NaOH Reacted (mL)	30.23 mL	30.40 mL	29.80 mL
Volume Unknown Acid used (mL)	25.00 mL	25.00 mL	25.00 mL
Calculated Molarity of Unknown Acid	**0.1209 M**	**0.1216 M**	**0.1192 M**
Average Molarity of Unknown Acid	0.1206 M = **0.121 M** (using sig figs)		
Theoretical Molarity provided by the instructor	**0.130 M**		
% Error	[(0.1206 *M* – 0.130 *M*)/ 0.130 *M*]*100 = **-7.2%**		

!! ***Carbon copies of parts I-III, above, are to be "stamped" by the instructor before leaving lab!!***

IV. Analysis of Results

Include in this section all calculations, analysis and discussion of your results.

1. **Calculations**—clearly label what you are calculating!!
   - Show **each** calculation clearly, and with attention to significant figures and units for those experiments that involve calculations.
   - *Before* doing a calculation ***label clearly what you are calculating***—do not leave it to the reader to figure out what is being calculated!! Examples of each calculation should be provided near (preferably on the same page) the table that depicts that result. You need only show one sample calculation if that calculation is used repeatedly in the analysis of the data.
   - If there are questions assigned with the lab activity, answer them clearly, but concisely with full sentences. Number your answers as the questions are numbered and make it clear to *anyone* what the question is that you are answering—i.e. incorporate the question into your answer.
2. **Analyze your results fully by following these general guidelines:**
   - State what conclusions can be drawn from the results and explain how you arrived at these conclusions.
   - Use specific numerical data and/or observations gathered in the experiment to support all conclusions you make
   - Explain why your results might be inconsistent with the predictions you made (what you thought would happen before you did your study, based on a specific hypothesis or other background information)

   Error Analysis. If possible, *always* calculate the percent error:

$$\%\,Error = \left[\frac{X-A}{A}\right]\cdot 100 \qquad X = Experimental\ Value;\ \ A = Accepted\ or\ Theoretical\ Value$$

   - Quoting the %Error, comment on the accuracy of your results and discuss the *specific sources of error that may have caused your results to be too high or too low. Use specific numerical examples to support your response.*
   - Discuss problems that arose in your study and how could they be avoided in the future,
   - If possible, compare your results with those of groups in the class and with the accepted/theoretical results. Cite the references used for comparisons (i.e. names of group members, website, reference book, etc.)
     - Compute the % error for the class data and comment on the accuracy of the class results and discuss specific sources or error that may have caused the results to be too high or too low.
     - Use *Excel* or a calculator to compute the standard deviation for the class results and then comment on the precision of the class results.
   - Explain what you may have done or could have done, if anything, to improve the experiment to get better results

V. Conclusion—Use "*bullets*" to state briefly, concisely and clearly summarize the major conclusions

Use specific data to support your conclusions—that is, quote specific numerical results. It is *not* enough to simply state in the conclusion that you calculated a salt's density or a salt's heat of solution. **Always use specific numerical data to support/substantiate your conclusions!!** Here's a sample conclusion…

- Density of unknown salt #342: 2.030 g/mL (9.82% error and standard deviation of 0.402 g/mL) A likely cause for the higher than expected density and the poor precision was inaccurate high mass determinations due to the fact that the salt is highly hygroscopic
- The class average for the ΔH_{soln} salt #342: -34 kJ/g salt (–7.7 % error and Standard Deviation of 2.5 kJ/g salt). The most likely cause for the lower than expected ΔH_{soln} was heat loss to the surroundings due to the poor insulating properties of the coffee cup calorimeter.
- Our groups average for the ΔH_{soln} of salt #342: -32 kJ/g salt (–13 %). Like the class average, the most likely cause for the lower than expected ΔH_{soln} was heat loss to the surroundings due to the poor insulating properties of the coffee cup calorimeter. Moreover, we used too large of a salt sample and had difficulty getting it all to dissolve, thus contributing to lower than expected results.