

Experimental Physical Chemistry

Laboratory Notebook

This laboratory will not require submission of a formal report. Your work will be submitted via a hyper-complete laboratory record in the form of a self-contained research notebook. Each notebook will contain all preliminary planning and analysis including theory and development, all raw laboratory data, all preliminary calculations and complete analysis along with error analysis and critical evaluation and conclusions along with suggestions for further work or improvements.

Philosophy and Design of the Notebook:

The notebook is NOT a formal lab report, please keep this in mind. In an industrial professional R&D laboratory, often records of daily activity and laboratory measurements are kept in an “ELN” or electronic laboratory notebook. Far from being a formal report, an ELN is a chronological record of the project from its inception, to its design and following through to its execution and conclusions. Any subsequent formal presentation utilizes the complete information in this record. It also provides a record for the purposes of review, and in some occasions, evidence for legal hearings and the establishment of awards.

You will keep your notebook as an electronic document using the online service “LabArchives”. Any and all work and changes will be kept there.

Prior to beginning a lab project:

Once you have decided on which lab project you wish to complete, I will meet with your group to discuss the project and brief discussion of the theory and task assignments. Coming away from this, you will then complete a preparatory discussion in your ELN including a brief discussion of the objectives, theory and of the experimental method and working equations. A description of the experimental design and methodology must be included. Reference any materials you use to develop your lab including the laboratory textbook and any external sources. **All preparatory work must be submitted by the end of the day, Saturday, prior to execution of the lab to give me time to review and comment. All corrections made by me need to be completed prior to beginning the lab. If it is not submitted for review by the end of the day on Saturday, or if the corrections have not been made by lab time, then you will not be allowed to begin the laboratory.**

Once the project is initiated:

Once you have begun the project, every step and measurement you take must be recorded as a chronological record in the ELN **as you work through the project**. Include graphics or photos of the laboratory setup. Keep in mind that another individual should be able to reproduce your work using only your lab record. Once you have completed the work for the day and entered the information, you will prepare a summary of the work and any conclusions up to that point along with a set of objectives for the next step in the project. As before, **this must be completed by the end of the day, Saturday for review. If it is not completed, you will not be allowed to continue the project the following lab period.**

At this time, you will also select the next lab experiment you plan to execute. This is so that I can gather the written and lab materials in order for you to begin to prepare.

Upon completion of the project:

Once you have completed taking the data for the lab, you will complete all relevant computations and prepare all data tables and figures and write a summary discussion and conclusion. You will also be required to **critically** evaluate your results. This is a most challenging task and will likely require as much information, including external sources as is possible. Critical evaluation will also include, when possible, statistical evaluation. **The completed work is due 10 days or midnight the Saturday after the week in which the project is completed.**

When you are completing a project, I will gather with your group to discuss the next project. This will allow you to also begin preparation for the next laboratory project.

Laboratory Notebook Checklist:

As noted above, the notebook is a compendium of all the knowledge and information gathered and utilized in the laboratory project including the research prior to the work, the development of the problem, planning, execution and analysis including raw data, data manipulation and conceptual summary. To guide you, I've developed a checklist of items that form some structure to what I seek out when evaluating your notebooks. It is not all inclusive, but forms the skeletal structure of a complete work. Rarely is there too much detail. The hardest thing to do is to recognize what you know and what you have to explain. Try to include enough to enable a peer to pick up and evaluate or reproduce your work, including an understanding of the concepts.

Comments on Notebook and Structure:

LabArchives gives you a file system. Within this file system, add a folder for each lab project. Within that folder, add subfolders containing relevant sections such as the Introduction, experimental design, etc. Include, by upload, all support files such as Excel or MCAD or spectra graphics. In your folder, create as many sub-folders as needed to keep all the files for a given experiment in an organized fashion. Be sure you have virus protection installed on your computer and I recommend malware protection as well such as the program Malwarebytes.

Bear in mind that this is not a formal lab report. It is complete but intended for the inclusion of all the items that you might not include in a paper submitted for publication: items such as observations and commentary, discussion of experimental revisions and problems encountered, lab conditions that may affect the results such as temperature, pressure, humidity, etc.

This notebook is a compilation of your work including background theory, experimental planning and experimental execution (yes, these are different and will require different contextual writing) but it is critical that you write what you understand in your own discussion in a manner that you or another reader would be able to follow. **Do NOT write a narrative that is a paraphrased discussion from your text or other sources! Read your sources, learn and understand what is being presented and write in your notebook a complete discussion as you understand it.** For areas you do not understand, I can help. For some expressions that will be used in the lab and its calculations, you need not always derive them from first principles. You are free to reference the sources in a manner that the text author does. However, you should have at least a qualitative understanding of how they came about. Some expressions can be developed from foundations that you know from lecture. Here you should carry out brief derivations and a discussion of what you understand about it.

Laboratory Notebook Pre-Submission Checklist

Investigators:

Coding Key:

X = Not Applicable \surd = Present **O** = Substantially Missing
δ = Partially present or fulfilled **!** = Exceptionally well done.

Introduction and Literature Review:

- Information and background to the system under investigation along with current knowledge on the topic and results of previous studies as available.
- Complete statement of intent and purpose of the current investigation along with the methods to be employed.
- Complete set of authoritative references cited correctly.

Theory development:

- Theory and development of the methodologies that will be used in order to calculate the quantities of interest.
- Working equations that will be used with your laboratory data in order to produce the results of interest.

Experimental Plan:

- A list of equipment including sizes or quantities. Include manufacturer and model if appropriate for instrumentation.
- A list of materials or chemicals used including amounts.
- Safety precautions of execution and of materials.
- Laboratory setup including sketch of apparatus setup.
- A detailed step-by-step procedure indicating quantities of materials, equipment to be used and what measurements will be taken along with precision.

Overall: (1 = Poor, 5 = Excellent)

_____ Ease of reading, neatness, appearance.

_____ Grammar, spelling and organization.

_____ Well delineated regions of theory, calculations, data, errors with reference to numbered equations, pages, references, etc.

Laboratory Notebook Checklist

Investigators:

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Notebook and Laboratory Execution

Original Written Material

- Chronological record, follow along notes and comments on experimental execution and observations.
- Raw data taken to the correct precision from laboratory measurements.
- Errors and commentary on raw data collection and preliminary analysis.
- Preliminary data analysis to insure equipment is working and lab is progressing properly.
- Raw data analysis. (May include graphs, but not necessary)
 - Calculations using theory outlined initially.
 - Averages of Redundant Data
 - Standard Deviations or Statistical evaluation of Data.
 - Propagation of error analysis or regression error analysis if suitable.
- Repetition of necessary measurements using corrections noted above, if needed.

Final Data Processing and Analysis

- Complete data processing and analysis using the working equations developed in the theory section.
- Inclusion of all supplemental material used for data, calculation and analysis. (Spectra, MCAD, etc.)
- All supplemental material provided referenced from within the notebook.
- Critical** evaluation of results citing specific errors and results of such errors on final results.
 - Error analysis as appropriate to analyze internal consistency.
 - Comparison to available literature as possible.
 - Evaluation of results as being of appropriate magnitude and consistent with expected results.
 - Reasoned and well-argued discussion explaining any error in the results including magnitude and any direction.
- Evaluation of procedure employed and notes for corrections.
- Summary and conclusions of the measurement and results of the physical system.

Overall: (1 = Poor, 5 = Excellent)

_____ Ease of reading, neatness, appearance.

_____ Grammar, spelling and organization.

_____ Well delineated regions of theory, calculations, data, errors with reference to numbered equations, pages, references, etc.

_____ External data or calculations well organized, logically numbered or named and referenced in the main journal.

_____ Consolidated tabulation or graphical representation of all sources; lab, theoretical and literature.

_____ Well-argued points of discussion and evaluation of quality of results, random, systematic and random statistical errors, concordance with theory and satisfaction of initial objectives.

_____ Critical thinking in evaluation of results and achievement of objectives.

_____ Quality of laboratory execution and data collection