Notes on Phys 272 Laboratory Notebooks

Introduction to Modern Physics Laboratory
Dept. Physics & Biophysics
University of San Diego
(Dated: Spring 2023)

I. KEEPING A LAB NOTEBOOK IN PHYS 272L

Obtain a National Brand 43-648, 4x4 grid (rust cover). Your labs will be graded based on the content of this notebook, so it is important that you communicate your work effectively, both to yourself, and to the grader :) Good notebook skills will be essential to you as a practicing scientist, whether in an industrial or academic setting, so it is important that you get in the habit of keeping good records early. We want to establish good habits for doing research. The following requirements are designed to help you practice good scientific record-keeping skills, and to enhance your grade by communicating to the grader what you have done and how you obtained your results.

A. What goes in them, for the purposes of this course:

Students will use their lab notebook to record their thinking and present preliminary results. They will include the following 10 kinds of things (coded using NB#, for a lab notebook item number):

1. Diagrams, sketches of the setup, including apparatus and instruments. See #10. **NB1**
2. All settings on equipment. Not always applicable. **NB2**
3. Location of saved data (directory and filename of files created) **NB3**
4. Tables of hand recorded data with column headings and units. **NB4**
5. Discussion of Modeling, calculations, sketches, and modeling results using Fitteia. Our first laboratory 'experiment' will explore some of its capabilities. For reference, read notes on our public course website, `http://home.sandiego.edu/~severn/p272/making_modelfits_fitteia_p272_sp18.html` **NB5**
6. Estimation of experimental uncertainty. **NB6**
7. Quantitative comparison of uncertainty & discrepancy (iterative modeling steps!). **NB7**
8. Plots, (see notes, `http://home.sandiego.edu/~severn/p272/making_plots_p272_sp18.html`) of data generated while doing the lab, some done by hand directly into the lab notebook, informal, and made to test whether one is on the right track, and others generated by, say, Fitteia[**?**] should be printed and taped into lab notebooks, making certain that model curves and error bars are displayed wherever possible. **NB8**
9. An abstract. **NB9**
10. First of all, record an agenda, plan of attack, questions regarding apparatus and concepts, and so forth. This agenda typically will be part of the pre-class reading quiz questions, and is typically the most important reflection the researcher does before beginning an experiment. Take some time to write this into your lab notebook first, and then input your answer into the pre-lab quiz. However, perspective changes while data taking happens. It is the quality of the diary, the response to the situation, the clarity of the description of what was done, why, and what each result means that makes the record worthwhile. **NB10**

B. Process Notes:

- Prior to the beginning of each lab period, one records an agenda and plan for the day's activities. The agenda (NB10 stuff) includes **a clear statement** of the research question, or, the experimental problem to solve, in ones own words. The student will have read the description of the experiment and will arrive in lab with an idea of how to attack the problem given, but may also have many conceptual and technical questions. These are recorded at the beginning of each day's work, and discussed with the student's lab partner. Be specific and

brief. A piece of a hypothetical example: "In this lab we plan to measure the rates of both charged-current and neutral-current reactions between solar neutrinos and deuterium. If we observe a difference between these two rates, that would be evidence for neutrino oscillations and, hence, a nonzero neutrino mass. We will do the following measurements first...these second...then we will... but I am not sure how to read the data from individual PMT's in the Kamioakande installation, I have to find that out...."

- What goes in an abstract? An abstract quotes principal results, compares uncertainties and discrepancies (if that is possible), uses significant figures appropriately, and captures the essence of the methods used to obtain the results. It is brief. If an item on this list is missing, it is incomplete.
- All entries must be in **ink**. Cross out any mistakes with a ~~single line~~.
- Students will make their records such that their lab notebook may be used to answer questions about data from many weeks prior, once their memory has faded.
- This is your diary. Record your actions and results as they happen. You will record their notes and make plots while 'taking data', solving problems, debugging, modifying their setup, designing, altering, fiddling with apparatus, and so on, not later that evening or during the weekend following. Indeed, the purpose of quadrille paper is to aid in the creation of data tables and plots very simple and direct. Prepare the axes, plot the data as it is 'taken'. Make it nicer later. Analyze what you are doing in real-time.
- The notebook must be interpretable as a whole to another reader, functioning as a guide capable of allowing the reader to reproduce the results claimed in the abstract, found in the graphs, exhibited in the analytic discussions, sketches, and calculations, and so forth.
- Record what you don't know and want or need to find out.
- Use headings in your lab notebook to attempt to be organized, so e.g., headings like:
  - AGENDA, PRELAB NOTES, HOW-TO NOTES
  - APPARATUS AND SETTINGS:
  - PROCEDURES:
  - RAW DATA:
  - MODELING
  - ANALYSIS
  - DISCUSSION:
  - ABSTRACT

  all make sense (colons optional).

II. GRADING RUBRICS SPRING 2023

A couple of notes, to begin with:

1. In the tables below, the evaluative categories are given a bolded symbol so that a very terse, condensed form of the rubrics (Tables I & II) may be used for the grading (and return of feedback) of submissions. See the Table III below.
2. About 'Tables of hand recorded data'; this is not about 'how many' or if 'all' of the tables are present. This is about the formatting that must be true of ANY table that gets recorded in the lab notebook in order to get the point. The same is true for plots and graphs. The formatting requirements must be met for all graphs & plots to get the point. <u>This will be hard at first.</u>
3. About **QR**; I am looking for an overall impression here rather than a very microscopic look at one particular data taking task. Although if an individual data taking task is not recorded proficiently, if its design or the approach is not apparent through sketches and brief statements, if something required for the calculations simply appears there but not recorded elsewhere, etc., etc., ... then it will be hard for the reader to get the impression the whole thing was done proficiently. This comment also extends to the modeling results category, and the all important 'How-to' elements necessary for all lab notebook submissions.

TABLE I. Grading rubric: each evaluative category is graded on a 3 point scale, 3 for proficient, and so on. If a required item is not present, it gets zero pts. And some items are graded only on a 1 pt. scale, meaning that the required element is either there or not there. **NOTE: This is part 1 of a 2 part rubric worth 4pts.**

category of evaluation	'there' (1pt)	'not there' (0pt)
Block diagram of apparatus, settings detail **BD**	there	not there
File names of saved data or analysis files and what's in them **FN**	there	not there
Tables of hand recorded data **T**	for tables, all columns have • descriptors and units, • footnote with a description of how the data were taken • an uncertainty	not all of that is there
Graphs and plots **G**	all graphs have • legible axes labels including appropriate unit • experimental data distinguished from modeling curves • experimental uncertainty of data points observable or discussed	not all of that is there

TABLE II. Grading rubric: each evaluative category is graded on a 3 point scale, 3 for proficient, and so on. If a required item is not present, it gets zero pts. And some items are graded only on a 1 pt. scale, meaning that the required element is either there or not there.**NOTE: This is part 2 of a 2 part rubric worth 12pts.**

category of evaluation	proficient (3pts)	intermediate (2pts)	developing (or 'there') (1pt)	total-whiff (or 'not there') (0pt)
modeling results and intermediate check of results **MR**	includes 1. calculations (exhibited, explicit), 2. modeling sketches, 3. predictions and their 'checks', **both during and after data-taking,** modeling plots, 4. description of **HOW TO (H2) convert a physical model to a numerical or computational one used with Fitteia modeling, including all necessary definitions needed to understand how Fitteia was used to obtain the results; should include an alignment matrix...** 5. estimates of 'goodness of fit', i.e., uncertainty (having to do with Goldilocks plots where appropriate), along with discussion explaining each of these, wherever they appear in the narrative of the lab notebook record. The goal: is holistic: **if the answer to the research question posed is clearly supported by modeling analysis in turn supported by the data taken, that the reasoning is explicit and exhibited, then the lab notebook record has been proficiently and professionally kept.**	one or two of these elements of best practice with respect to modeling work are missing	a few of these elements are missing	not there
uncertainty, discrepancy, and significant figures **U**	includes 1. description of methodology of estimating uncertainty is described, 2. best values and their significant figures are rounded and truncated in light of the uncertainty (only one digit of uncertainty is kept and exhibited) 3. discrepancies are compared with uncertainties wherever possible, and quantitative data driven conclusions are reached in light of these comparisons.	One or two of these best practice elements is missing	a few of these elements are missing	not there
quality of record or diary **QR**	the experimental approach is clearly, usefully explained at the beginning of the entry for the experiment (see NB10), and the research question(s) clearly stated. Beyond this, 1. refinements of the approach may prove necessary once the work is underway. These must be recorded too if necessary. Leave room at the top for these. 2. Procedures followed during the period of the experiment are recorded, both the stuff that proves correct and incorrect. If problems are encountered, if errors are discovered, these are visible in the record. 3. Sketches, block diagrams, including all apparatus and instruments used are present. The goal, a very holistic goal is this: **If all the results can be reproduced and understood from the written record, and the 'know-how' usefully captured, then the notebook has been proficiently and professionally kept. The design or logic of the experimental approach must be made clear.**	One or two of these best practices have not been followed, leading to missing information and a bit of incompleteness.	a few of these items are missing; the lab notebook could not be relied upon to reproduce the results.	not there
abstract **A**	includes 1. quote and interpretation (brief!) of principal results 2. comparison of uncertainties and discrepancies (if that is possible) 3. quotes significant figures appropriately 4. describes the design of the methods and apparatus used in combination to obtain the results, and doesn't assume the reader has read the 'lab manual'. It is brief.	one of these elements is missing	two of these elements are missing	no abstract

TABLE III. Grading rubric: each evaluative category described in detail in tables I and II of the file named Notes on Phys 272 Laboratory Notebooks, found on the lab course public website. Each evaluative category is scored on a 3 point scale, 3 for proficient, and so on. If a required item is not present, it gets zero pts. And some items are graded only on a 1 pt. scale, meaning that the required element is either there or not there.

category of evaluation	proficient (3pts)	intermediate (2pts)	developing (or 'there') (1pt)	total-whiff (or 'not there') (0pt)	score
Block diagram of apparatus, settings detail **BD**					
File names of saved data or analysis files and what's in them **FN**					
Tables of hand recorded data **T**					
Graphs and plots **G**					
modeling results and intermediate check of results **MR+H2**					
uncertainty, discrepancy, and significant figures **U**					
quality of record or diary **QR**					
abstract **A**					
total:16					