Your AP Physics Lab Book

Introduction:

As an AP Physics student, you are asked to use a quadrile-ruled, bound lab book. "Real" scientists and engineers typically keep a complete and careful record of their work in such a book. A lab book can provide a permanent record of a scientist's work, and can even be used as legal evidence in priority disputes. Learning to use a lab book correctly may well be one of the most valuable skills you take away from AP Physics. Many unfortunate young scientists and engineers find out "the hard way" that people judge the quality of their work from the quality of their communication. Learning to clearly communicate now is easier!

Preliminaries:

Before you do anything else:

1. Write your name in permanent ink on the cover of your lab book.
2. Number every page (front and back) of the book in ink in the upper, outer corners of the page.
3. Go back to page 1, and title it 'Table of Contents."

The General Idea:

A scientifically-literate person who is perhaps not entirely familiar with the particular area of physics in question, should be able to replicate your experimental setup and procedures (perhaps benefiting from your hints and suggestions), obtain similar data, and follow the logic of your calculations and conclusions based only on what you have written in your lab book. They should be able to tell exactly what you did, why you did it, when, and with whom.

Your lab book is a complete, permanent, as-it-happens record of your laboratory work. It does not contain "lab reports" - that is, it is not something that you write out at home, later that evening, based on your notes and recollections. You do not "copy things into it later so it will be neat". The lab book is not meant to be a finely-honed jewel of English prose.

General Lab Book Rules:

1. Use permanent ink only - no pencil.
2. Write legibly.
3. Never remove pages from a lab book.
4. Never erase anything in a lab book, or "color" over anything so that it cannot be read. If there is an error, "X" it out, and indicate briefly why you did so.
5. Write original data directly into your lab book. Do not recopy it "to make it neater".
6. Computer-generated data tables, graphs, and diagrams must be permanently fixed inside your lab book. Absolutely no loose papers, ever. Best way: a thin bead of glue. Not the best, but sometimes all that's available: tape (it deteriorates rapidly), staples (cause bulges)
7. It is best if papers permanently inserted into your lab book are trimmed to fit the pages. If that can't be done, they need to be folded to fit inside the lab book. Nothing should be "hanging out" of your lab book.
8. Be sure that the instructor inspects and signs your lab book before you leave the laboratory for the day. (No, "real" scientists don't have to do this..)
9. While a great deal of discussion and collaboration is expected in the physics laboratory, your lab book should be your own work. After you discuss the lab with your colleagues, write your analysis in your own words. Do not copy from your lab partners.

Specifics:

What goes in the lab book?

Preliminaries:

At the top of a new page, write the title of the lab, the date, and the name(s) of your lab partner(s). On the index page, write the title of the lab and its page number.

A full lab record will generally contain the following sections:

- Abstract
- Introduction/Purpose/Background
- Equipment and Materials
- Experimental Procedure
- Raw Data
- Results
- Conclusion

Details follow:

Abstract:

The abstract is a concise, one-paragraph (100-200 words) summary of the purpose, methods, and significant results of the experiment. It is a "lab report in miniature". This means that you really can't write the abstract until the experiment is over, so you need to leave enough room in your lab book so that you can come back "after the smoke clears" and write the abstract.

Introduction/Purpose/Background:

The introduction or purpose section introduces the question to be answered by the experiment. It also gives any necessary theoretical background. You don't need to repeat material that would be available in a standard textbook. This section can be (and probably should be) written before the lab period begins.

Equipment and Materials:

This section lists all equipment (including any model or serial numbers, if known) and materials used in the experiment. It also includes a diagram of any experimental setups, and notes on setting up the equipment, if appropriate. This section can be (and probably should be) written before the lab period begins. Any needed additions or corrections can be made "on the fly".

Experimental Procedure:

This section needs to be descriptive and precise, giving all of the experimental steps you actually performed (in the order in which you actually performed them) and reporting all of the data you actually obtained in an organized data table. You should indicate and justify all uncertainty estimates.

Some notes on data tables:

1. Always put large (or even reasonably-sized) amounts of data in a data table.
2. Each column should be labeled with the quantity, symbol, and units of the data it contains. (Example: Time (t) in seconds")
3. Write neatly.
4. Avoid clutter as much as possible. Put units in the column heading if all of the data have the same units. Same for uncertainties.

Raw Data:

This section needs to contain clearly organized tables recording measured data. Column headings should describe the measured quantity, units of measure and uncertainty in the measurement. Raw data does not include any quantity that has be gained through a calculation or the result of a formula. Raw data is gathered in real time during the actual experiment. For Example:

Trail #	Vertical Position (cm) +/- 0.05	Mass (g) +/- 0.01	# of Cats (cats) +/- 0
1	24.65	344.56	12
2	36.50	456.31	16

Results:

The results section needs to contain a sample of each calculation that you perform on your data, including error propagation. The results of the experiment need to be neatly and clearly presented in tabular or graphical form (or more often, both).

Some notes on graphs:

1. Use graph paper. The quadrille-ruled pages of your lab book are meant to make it easier to construct neat lists and data tables, not graphs. The lab-book page would be suitable for the sketch of a graph, or for graphing rough data.
2. All graphs have a descriptive title.
3. Choose the largest convenient scale for the graph. A graph should fill a page, as nearly as possible.
4. Each axis must be labeled with the quantity, symbol, and units plotted on it. (Example: "Time (t) in seconds")
5. Number the scales neatly and clearly.
6. Use an "x" or "+" to indicate data points - not a big blob.
7. Draw error bars on your data points where appropriate.
8. Remember that a bunch of points is not a graph. Draw the "best smooth curve" - usually a straight line - through your data points.

Conclusions:

Here is where you answer the question that the experiment was designed to answer, to the extent that you are able. You also analyze the factors that influenced your results. This is the "meat" of the lab, and it is the section that your instructor will spend the most time reading. Here are some things to avoid - things that will definitely "cost you" in terms of your grade:

1. You will loose points if your conclusions do not follow logically from your results. Do not say something just because that is what the textbook says.
2. You will loose points if you do not remark about remarkable results, and attempt to analyze their cause. For instance, if your lab record says "We measured the free-fall acceleration, g, in the classroom to be 468 m/s^2." without any further comment, you are "toast".
3. You will lose points if you use the word "prove" or "disprove" in any of its forms. Proof is a mathematical notion, and you haven't done it. There is no absolute truth in science. Your results may "support" or "not support", some hypothesis, theory, or law, but you did not "prove" it. The words "verify" and "confirm" seem a little strong to me, but they are OK.
4. You will lose points if you merely speculate about sources of experimental error. Statements like "Friction may have caused a discrepancy in the results" need to be supported with data, or at least some plausible theoretical mechanism.
5. You will SO lose points if you use the words "human error". Your instructor will read this phrase as "I don't care enough about this experiment to actually think about what is going on in it, so please butcher my lab grade." You will SO lose points if you say something like "there may have been a calculation error". Your instructor will read this phrase as "I really don't care enough about this experiment to go back and check my work, so please butcher my lab grade."