AP Physics - Lab Reports

Labs are a very important part of this course. In the labs you will be exploring the laws of physics and finding out, for yourself, whether they work as they are supposed to. As you know, good scientists are skeptical about things - they don't want to be taking anyone's word for nothing. Better by far to find out for oneself. That is what experiments are all about.

You are probably used to labs where you have a lab book or a handout that tells you precisely what to do. They typically have some background information, you know, specific step-by-step instructions, places where you fill in numbers, directions for some simple calculations, questions that you are required to answer, etc. The lab is more or less laid out for you, sort of like a recipe. This will not always be the case. Here you will be required to figure out how to do the lab and how to write it up.

You will be provided with equipment, and materials. Occasionally you will be given basic instructions to do the lab, occasionally you will have to make up your own instructions. In fact, you will have to make up your own lab. You will be expected to figure out how to do the lab, what data needs to be obtained, how to display the data, what to do with the data, and, finally and most importantly, what it all means.

Lab reports are formal documents. They should be typed or ***very neatly printed*** in ***ink***. If the Teacher cannot read your lab, he will deduct valuable points. Lab reports require your ***best*** writing skills and will be assessed on spelling, punctuation, clarity, logical organization, voice, &tc. They should not be messy. Do not include scrap paper or your lab notes. Use new, clean, standard 8 ½ by 11 sheets of paper. The paper should be the same for each page of the report.

Lab Format: All lab reports should include each of the following sections.

Title
Background
Objective
Procedure
Data
Calculations
Conclusions

Below is a brief description of each section:

Title: The title should be a short descriptive name for the lab of your own devising.

Background: A short paragraph with information and details on the topic of the experiment.

Objective: A short paragraph which, in your own words, describes what it is you are to explore/discover/experience/wonder at in the experiment. It is why you are doing the experiment.

Procedure: A brief but complete description of what you did and how you did it. It needn't be ridiculously detailed, but it should include all major steps and provide enough information so that a second party could reproduce the lab by following the steps you listed. Use of drawings to show the basic lab setup are very useful.

Data: What you actually measured. These are the raw, unprocessed measurements you made. These could be length measurements, times, velocities, voltage, current, &tc.

- The data should always be organized in a logical, sensible, readable manner. There is no single right or wrong way to do this. Any method that displays the data in an intelligible way is acceptable.
- Include units.
- Your measurements determine the number of significant figures which your results will have, so make sure your measurements reflect their proper level of precision.
- Do not present calculated values in the data section. For example you might measure the mass of an object and then calculate its weight. The weight is not data, it is a calculated value. Only the mass should be in the data section. The weight should be displayed in the calculations section of the lab report.

Calculations: This is what you did with the data after you got it; how you used it.

- Use the problem solving format.
- When multiple, repetitive calculations have to be made, it is sufficient to show one set of calculation steps and indicate that all subsequent calculations were made in the same way.
- Your calculations must be clear and legible.
- If many calculations are to be made, you may want to display the results in some sort of table.
- Often the data will be displayed in a graph. The graph should be part of your calculations.
- Graphs should have a title. Each axis must be labled and the unit indicated. An appropriate scale must be used. Graphs should be large. The x axis should take up most of the width of the page. The data displayed on the lab should take up most of the x and y scales.

Conclusions: Here you present your proud results***. This should be the most extensive section of the lab report.*** You should be expansive about the lab and your thoughts. The following is what the Teacher will want to see:

1. Report the results

2. Discuss whether your results are reasonable. If they aren't, comment on what may have happened to cause any inaccuracies.
3. Explain the basic physics concepts that took place in the lab.
4. Comment on whether you met the objective for the lab.
5. Discuss any problems you encountered.
6. Include your experimental error if appropriate (see below for particulars).
7. Discuss what you ***learned and the meaning of this knowledge***. Try to be eloquent. Creativity is nice too.

The conclusion section is very important. It will require a substantial amount of writing and thought. Two or three sentences on the order of, "We had a lot of fun doing this lab and learned a lot. We learned that velocity and acceleration are very important in our daily lives. It was very interesting." Simply will not do. They don't ***say*** anything.

Use common sense and ask yourself if your results are logical. If you say your results were good and they weren't, that would be bad. If you say your results were poor but they really weren't, that too is bad. It means you aren't thinking (or paying attention). The whole idea of the labs is to get you to think. The Teacher wants you to think and then formalize those thoughts into a well-written paper.

The Teacher wants you to tell her what happened and why. She wants you to explain in your own words the way the laws of physics worked during the experiment. There is no right or wrong way to do this, so long as you give it a serious attempt.

Further Guidance: Always use your actual data, even if you suspect it will yield poor results. Don't try to fudge the numbers to get a good answer. That is one of the worst things a scientist can do. In fact it is considered to be a very vile form of dishonesty. It is unethical and thoroughly improper. You will not lose major points for data errors that give you bad results so long as your recognize the situation and have a sensible, logical reason or reasons to explain the thing away. Of course, if the bad data is the result of a poorly conceived data collection plan, you will suffer a loss of points. Points will also be lost if the data and the results don't add up or if its obvious there has been some manipulations going on.

Some labs will ask you to make predictions and explain the how and why of the thing. You will not lose any points if your prediction is incorrect, just so long as you have a reasonable explanation for why you made it. Physics can be tricky - there are lots of logical little traps that will fool you. Things are often not what they seem. This is one of the joys of physics. So don’t worry if your common sense lets you down.

The use of graphics - images, drawings, photos, &tc. is strongly encouraged. The Teacher is a sucker for stuff like that.

Experimental error: Experimental error is found by comparing the results you obtained in your experiment with what you know is the accepted value. Experimental error is expressed as a per cent, and is sometimes called percent error.

$$Experimental\,Error = \left(\frac{Accepted\ \ Value - Experimental\ Value}{Accepted\ \ Value} \right) 100\%$$

You can see that if your experimental value is equal to the actual value, your experimental error is zero. Of course, to get an experimental error, you must have an accepted value to compare your results with. This does not always happen. For example, a lab may task you with determining your average speed over a 50.0 m course using a stopwatch and a tape measure. Clearly, you don't know what your actual speed was, only the one you calculated, so in this instance you would not need a percent error in your lab report.

On the other hand, you might do a lab where you obtain an experimental value for *g*, the acceleration of gravity on earth. The accepted value that we will use is 9.8 m/s^2. For example, let us assume you obtain a value of 10.3 m/s^2. Here's how you calculate the experimental error:

$$Experimental\,Error = \left(\frac{Accepted\ \ Value - Experimental\ Value}{Accepted\ \ Value} \right) 100\%$$

$$Experimental\ Error = \left(\frac{9.8\,\frac{\cancel{m}}{\cancel{s}^2} - 10.3\,\frac{\cancel{m}}{\cancel{s}^2}}{9.8\,\frac{\cancel{m}}{\cancel{s}^2}} \right) 100\%$$

The units all cancel and you are left with a percent, in this case, the experimental value turns out to be:

Experimental Error = -5.1 %

It would be nice if you got perfect results for every lab, but that is not easy to do. Generally, you will have only a few trials for any one lab and often the instruments and measurements will be quite crude. You may well find that your experimental errors are between 10 % and 25 %. Such errors are perfectly fine for the type of labs that we will be doing.