Elements of PHY 252 lab reports

The lab notebook should document what you did on an experiment, how you did the analysis, and what your results and conclusions were. Here are some comments based on the Michelson Interferometer lab.

First of all, the only way to do the lab properly is to be prepared! Read the lab writeup beforehand. Think through what the most important parameters of the measurement are; often your error will be dominated by one parameter and if you can improve its measurements you can greatly improve your results.

Your lab notebook should record the date of the experiment, and the people on the experimental team. You should list the name of the lab and a 1–3 sentence description of your goals in the lab. If your apparatus has a serial number, record that. Make a simple schematic sketch (not an artistic drawing!) of your apparatus, and indicate relevant settings. Note that for the measurement of the refractive index of air in the Michelson Interferometer lab, you have the rare situation of needing to record one environmental parameter: the barometric pressure at the time of your experiment (you can probably get that off of a web site with a listing of the weather at Islip airport).

Describe the procedure of setting up your apparatus. In the case of the Michelson Interferometer, you should add any comments you find useful to the alignment procedure in the lab handout, and make sketches of how the fringe patterns change as you get the system into alignment. As you take data, make a clear table of your results, indicating both the units and the uncertainty in each measurement. If an entire column of measurements has the same uncertainty, you can simply list this for the first value and the same uncertainty is then implicitly applied to all subsequent values.

There are a variety of ways you can improve your experimental procedure. As one example, consider the act of turning a micrometer knob. When you turn it one way, you are causing a lead screw to have threads make contact in one direction and push on the part to be moved; when you are turning it the other way, the threads are making contact on an opposite side and often you are relying on a spring to push the moving part back in contact with the lead screw end. Therefore the best way to adjust a micrometer is to overshoot when unscrewing and then always make your final adjustment in the screwing-in direction, thereby eliminating backlash as a systematic error in your measurements. This is one example; if you think through how your appartus works you are likely to come up with procedures for maximum accuracy.

It is essential that you do a quick analyis of your data during your lab session! This will help you find out if you have forgotten to determine any key parameters, or if you are somehow using erroneous units for some value, or if something has gone wildly wrong on the lab. This need not be exhasutive; for example if you have a long table of points (such as fringe number versus vacuum in the Michelson Interferometer lab when you are measuring the refractive index of air), you might simply do a calculation of the last point of data rather than a careful plot and line fit of all data, though a plot can also tell you if things went haywire. Your T.A. should not sign off on your attendance at lab until you can show that you have reasonable results.

In the aftermath of your experiment, you now want to carry out a more complete analysis of your results. Show all relevant formulae, and show your uncertainty calculations (you don't need to spell out every detail of every repetitive uncertainty calculation; showing the detail for a representative data point is OK). Note that the use of a spreadsheet program such as Microsoft Excel can remove much of the tedium of this work, and it will also give you nice printouts of your analysis tables and graphs. Make note of things you realize about your data, such as pointing out the factors that might dominate the accuracy/systematic error and those that dominate random error in the experiment. Include any relevant plots in your writeup (if you do things like the plotting and analysis on a computer, it's perfectly fine to paste printouts into your lab notebook).

You want to end with a conclusion to your lab. In very brief sentences, describe what you learned, how your measurements worked out, how your results compare with accepted values, and any thoughts you have for how to improve your measurements were you to do the lab again.

It may be the case that your result comes out slightly different than the accepted value, even when your uncertainty is taken into account. If you are off by a factor of 2 or 100 or something large, you had better ask hard questions of yourself because you probably made a serious mistake somewhere (was a calibration knob mis-set?). (But of course this won't happen to you because you have already done a quick analysis of your results in the lab room before leaving). Beyond that, it is important that you report the result you obtained in all honesty even if it's not what you expected. There are at least two reasons for doing so: "fudging" or altering results to get what you expect rather than what you measured constitutes academic fraud, and of course there are numerous examples in the history of science where those who made more careful repeats of experiments obtained significantly different values that stood the test of time.

Above all, realize that this is a lab notebook and not an essay. You don't need to repeat all that is in your lab handout; it is assumed that anyone who repeats the experiment will have access to the same handout. However, waht you do want is make it clear in the end what you determined from your experiment and what your numerical results were.