Report Format

As stated in the syllabus, the lab reports are meant to follow the format of most professional journal publications. The sections of the report and their contents will be outlined later. The title area and abstract should be centered at the top of the first page, single column, justified to the margins, with the left and right margins equally indented more than the margins of the full page. The body of the report and all other typed material should be in two columns with a relatively thin center spacing, and both columns should be justified. Format the page and body so that ~70 characters fit per line in a single column. The only exception would be for large, detailed images, figures, plots, or tables that simply cannot easily fit into a single column. For these cases the large item should be placed at the top or bottom of a page with the rest of the page back in two column format. Pages should be numbered with numbering on the first page optional.

Clearly label each section of the report with a well-defined heading using your own choice of consistent format throughout the report. You must include the minimum required sections in the report as listed in the syllabus; you could include more if you wanted to, or break one section up into two and rename them as you like, but it should be clear what your intent is so the instructor knows how to grade it. Citations within the body text should be clearly labeled and the label format consistent throughout; the most common formats are numbered superscripts[1] or (author, year). Citation labels must directly correspond with items in the list of references.

The list of references (if titled it is up to you) should immediately follow the 'Discussion of Results' and come before extra stuff like the Calculations, plot data, or raw data. References should follow a standard format (like MLA, APA, etc.) and be consistent. Refer to the document *Experiment Module Authors* to see how to reference the lab modules; these are considered to be works in an anthology, reference, or collection. For more help on citation and reference format you can visit this webpage: http://owl.english.purdue.edu/owl/section/2/

Tables and Figures need to appear professional; they should be easily readable and understandable and readily convey important information to the reader. Tables and Figures should be labeled in numerical order as they appear in the report. Example: Table II, Fig. 2. They must have captions that are not trivial, add value, and clarify details not obvious from the information already present (a graph simply captioned 'velocity vs time' would be a poor choice). Graphs in particular should have data that spans the entire area and is not 'pushed' to one side, x and y axis should be labeled and display the units, the axis scales should be readable and appropriate for the data, and if a line or function has been fit to the data the equation should be displayed. See the document *Excel Graphing & Analysis* for specifics on graph format.

Equations presented in the text should be on their own line, not mixed in the middle of sentences. Equations should be fully formatted by use of an equation editor.

The report should look polished, be clear and concise, well written, and easily convey information to the reader. You can look at the *Example Report* files to directly see how a report should be formatted.

REPORT OUTLINE

Your intended audience is another technically inclined student, though not necessarily someone studying to be a scientist. You should write with enough detail that the reader would understand how to do what you did in lab and be able to follow along with every step of your analysis even if they had never done it before.

**Title* and *Abstract* are single column at the top of the first page; mirrored, indented left and right margins; justified alignment for *Abstract*; centered alignment for *Title*

Title Area

- Name of the experiment
- You (author) name, name of lab partner(s)
- Course number and section number, name of instructor
- Location/Affiliation, i.e. your department and the university and city
- Date

Abstract

Usually a single, short paragraph very dense in specific information with one idea or focus per sentence. Be as to the point as possible. Meant to capture attention.

- What was the main aspect or goal(s) of the experiment?
- What device or experimental method was used?
- What was measured?
- What was the main result(s)? If a specific quantity was measured state your final value along with its error(uncertainty) and give the expected reference value that it was compared to.

*From this point on, starting with the *Background*, everything is in two columns and justified alignment. Format the page and body so that ~70 characters fit per line.

Background

Sets the scene for the reader, gets them ready to read the technical details to follow

- Explain why you did the experiment.
- What was the purpose? What were the goals?
- Briefly give some background context and historical information.
- Explain any deviations from expected procedure, especially parts skipped for reasons like lack of time or equipment malfunction

Theory & Methods

Relatively short, but detailed section covering physical concepts, equations and formula, experimental techniques and procedures used in the experiment. Remember the reader should be able to figure out how to replicate your work.

- State and explain important equations used in your analysis. These are typically the main equations introduced in the lab modules or ones that you are asked to derive. Do not just list equations! Remember citations!

- Describe the variables used in equations, state constants and their values and citations to a reference, highlight necessary conditions for Eq. to work
- If an equation was derived describe what it was derived from and any physics knowledge that was used, such as for simplification purposes
- Briefly explain the main steps of the experimental procedure. Use your own words, don't rewrite the module procedure! The goal is to summarize to the reader how you obtained your data. Point out important precautions and technicalities of equipment or procedure, such as the limits of a given sensor

Results

This will be the most significant part of your report where you show and explain all the hard work you did analyzing your data to get to your final results. It is in this section that your level of intellect and comprehension will come across the most; in most cases how you do in this section will separate the 'A' and 'B' reports.

- Summarize your experimental results, normally the final value you were looking for. This can be done in a sentence or two, or in a table if your results are more complicated and include multiple final values. You should include your experimental value, a theoretical(expected) value from reference, and most likely a percent difference between the two. Order does not matter.

  Example: "From our data taken in lab, we obtained a valve flow rate of 35±5 cm^3/s compared to a manufacturer specified flow rate of 40. cm^3/s $[1]_{*citation}$ for this valve giving us a discrepancy of 13%."
- Your results should be given with the correct significant figures and you should include your error analysis. Show the uncertainty, standard deviation, or propagated error on your experimental values.
- Compare your results to theory and expected values. Discuss any discrepancies if they exist and what might have caused them.
- If approximations or simplifications were made (say in theory like no friction, or small angle) in order to make the analysis easier explain how these might have affected your results.
- Determine at least two possible sources of error(uncertainty); what kind of error is it, what caused it, how large an affect it could have had, if you think it significantly affected your results, if there is any way you could minimize it.
- Be specific! Do not just list things! You need to justify your reasoning with rough quantitative(numerical) and qualitative(logical) arguments.
- Include tables, graphs, and figures when necessary to support your findings. Format these professionally and make them as clear and informative as possible. See the Format section of this document for more.
- Answer all questions asked in the lab module. In the modules these tend to show up as: "question:" or "for your report" or "for your analysis". Do not

answer these in lists or numbered answers, you should be able to work your answers into the overall flow of your discussion.

References

This section is straight forward. You should list the books, modules, websites, papers, articles, databases, etc. that you used information from in order to make your report. Keep in mind that a reference list should only include works that you directly cited from in your report; a bibliography would be the only thing to include other sources you didn't directly quote or cite in your text but used as help.

Calculations

These may be done electronically and properly formatted using an equation editor (there is a built in one in MS Word), or done by hand and must be neat and readable.

- The objective is to show that you know how to do all the math needed
- Include one complete example of every calculation done from start to finish in order to obtain your final results. Approach it like a mathematical cookbook so the reader can follow every step.
- Include units throughout each calculation, not just on the answers
- Significant figures should be correct on all answers, or at the end of a chain of calculations if intermediate answers were not required for analysis
- Make sure to show all error propagation in detail, showing each step
- Make sure to show all derivations asked for, showing each step
- If a calculation was performed many times (like in a spreadsheet) you only need to work it out once, but use your own data values

Plot Data

This section only exists if you included in your report plots or graphs made from your own data or calculated values. You should give data tables, normally 2 column (x, y), properly formatted with clear labels, headings, and captions. Include the units and variable names at the top of the columns, and values should be in correct significant figures. This is a final check to make sure your graphs were made properly, or in case it is too hard to read your graph. These must be typed.

Raw Data

The very last section! This is the data you took in lab during the experiment. It can be saved electronically and printed later, or hand written and signed by the instructor before you leave lab. Whatever you had from lab just attach it to the end of the report, do not feel the need to rewrite it or take hand written stuff and make it typed. It just needs to be present and readable.

You must have raw data attached or your report will not be graded!

Checklist for Writing a Good Report

- Raw data sheet (typed or hand written) is attached to report
- All work is your own original work!
- One column title and abstract at top of first page
- Everything else typed is in two columns (except very large figures or plots)
- All numerical values in report have correct significant figures. This includes within text, in data tables, and calculations. Uncertainties should also have proper significant figures
- All numerical values in report have correct units. This includes within text, in data tables, and calculations
- All measured values include associated uncertainty(error) Ex: 15±2 mm
- All error propagation is done correctly, and if possible all calculated values have associated uncertainties given with them Ex: 9.79±0.03 m/s^2
- Double check that all calculations are done correctly and you have an example calculation for everything done in your analysis
- Double check that all equations and formulas are correct and properly formatted. Formulas should not be in line with text, but on their own line and made with an equation editor (MS Word has a built in equation editor)
- Make sure you are using terms correctly: accuracy vs precision, uncertainty(error) vs discrepancy(deviation), etc.
- Are all graphs formatted properly? Do they look professional, are they numbered, do they have informative captions, are the axes labeled with titles and units, are fit equations displayed, does the data 'fill' the graph? Remember to check the *Excel Graphing & Analysis* document for help.
- Are all figures and tables properly formatted? Are they numbered, do they have informative captions?
- Do you have a citation next to every single thing you used in the text from another source? (quoted text, images, constants, equations from books, website, articles, and lab modules) Are your citations properly formatted?
- Does your reference list include all the sources you used and cited in your report? Are your references properly formatted? Check *Experiment Module Authors* document and here http://owl.english.purdue.edu/owl/section/2/
- Did you discuss at least two possible sources of error?
- Your Plot Data section has a typed table for each graph in your report
- Answer all questions asked in the lab module in your Discussion section
- Review the 'Guidelines' page at the end of the lab module
- Proofread your report! Make sure what you are writing makes sense. ☺