Appendix A

Report Writing

The primary objective of an engineering report is to transmit technical information to individuals having training comparable to that of the author. The information in the report should be presented as clearly and concisely as possible, but always with sufficient detail that the methods and data can be well understood by the reader.

Imagine that you are writing a report that you would want to read. Imagine that you will have to make an important decision based on the information in the report. This does not mean that the report has to be long or elaborate. It does require you to explain the equipment used, the procedure followed, and to identify and explain the significant results. In addition to presenting essential information, a good report is well organized and uses a conventional style.

In many situations the reader of a report will not have seen the apparatus or performed the experiment. The reader needs a description of the experimental apparatus and the procedure used to make the measurements. The use of line drawings (schematics) is an essential aid to a text description of the apparatus.

While preparing your report, ask these questions:

- Could someone with your education reproduce your results with the same apparatus? In other words, is the description of the apparatus, procedure, and theory complete?
- Could someone with your education make make a judgment on the quality and usefulness of the results without having to reproduce the experiment?

Content

EAS 361 Laboratory reports should consist of the following sections:

1. **Cover page**. The cover page allows quick identification of the report. It should contain the number and title of the experiment, your name and names of lab partners, the date the experiment was performed, and the lab section (identified by day and group).
2. **Introduction**. The introduction is where you explain the purpose of the experiment. Give an overview of the methods used and the expected results. In this class the introduction should be brief. One paragraph should be sufficient.
3. **Apparatus**. Sketch the equipment used in the experiment and describe the key components in words. Use of computer generated drawings are strongly encouraged. All drawings should be labeled according to the "Style Conventions" discussed below. Additional drawings may

be necessary to help explain pieces of the apparatus that are referred to in later sections of the report. Specialized equipment should be identified by brand and model number.

4. **Procedure**. Briefly describe the procedure used in the experiment. Do not copy verbatim from the instruction sheets. Be sure to describe any special steps needed to achieve good results.

5. **Theory**. Provide a concise listing of equations used to obtain your results from the measurements. Equations should appear as in the following page excerpt.

> The line of action of the hydrostatic force is through the center of pressure. For a vertical plate, the the center of pressure is at y_R. The theoretical formula for y_R is
>
> $$y_R = y_c + \frac{I_{xc}}{y_c A} \qquad \text{(A.5)}$$
>
> where y_c is the depth of the centroid of the plate, I_{xc} is the moment of inertia about the horizontal axis through the centroid, and A is the surface area of the plate.

The equation is *centered* between the margins. The equation number (which is (A.5) in this case) is aligned flush with the right margin. These effects can be obtained by placing a centering tab stop in the center of the page, and a right-aligned tab stop on the right margin.

More important than the appearance of the equation is the documentation of the equation content. *Each symbol used in the equation must be defined in the text of the report.* In the preceding excerpt, notice that y_R, y_c, I_{xc}, and A are all identified in the sentences preceding or following the equation. The reader should not be left to guess about the meaning of a symbol. The one exception is that universal mathematical constants like π or functions like $\sin(\theta)$ need not be explained (though θ should be defined).

6. **Results**. The *Results* section should contain the reduced data in either graphical or tabular format. If possible, list known values for comparison. See *Style Conventions* below for a discussion of the proper format for graphs and tables. Raw data should appear as part of the Appendix. The Results section should contain a brief narrative that describes what is contained in each graph and table. A few sentences are usually sufficient. Results sections lacking a narrative will be ignored.

7. **Discussion**. State what has been learned from the test and the significance of the results. Discuss the accuracy of the results. Explain any sources of error. Do the limits of accuracy explain discrepancies in the data, or is there something missing or wrong with the experiment? If possible give alternate procedures to obtain the same or better results. Answer any questions given on instruction sheets. Did the experiment achieve its objective?

8. **References**. Always give complete citations for material on other sources. A proper reference involves two components: the citation in the text and the complete bibliographic entry in the *References* section. Consider the following excerpt.

> The viscosity of water at 22 °C is 9.61×10^{-4} kg/m/s. This value was obtained by linear interpolation of the data in Table B.2 in the book by Munson et. al [2].
>
> ⋮
>
> **References**
>
> 1. Department of Mechanical Engineering, Portland State University, *Laboratory Manual for EAS 361 Engineering Fluid Mechanics: Fall 2002*, Portland, OR.
> 2. Munson, B.R., Young, D.F., and Okiishi, T.H., *Fundamentals of Fluid Mechanics*, 4th ed., Wiley, New York, 2002.

Notice that the citation in the text uses a number [2] in square brackets. This tells the reader to look at the second entry in the reference section for the complete bibliographic citation.

When in doubt, emulate publications that you have. For example, look at the way citations are made in your course textbooks. Refer to the ASME style guide at `http://www.asme.org/pubs/MS4.html` for additional examples.

9. **Appendices**.

   A. **Sample Calculation**. Give an example of how the reduced data was obtained from the raw data.

   B. **Raw Data**. All the data collected during the experiment should be presented in a neat and clearly readable format.

   C. **Additional calculations** or information supporting arguments made in the report. Occasionally it is necessary to make a lengthy justification or mathematical proof of an argument made in the body of the report. For example, you may want to show that the variation of fluid viscosity with temperature could not account for the scatter in the data. That conclusion could be stated in the body of the report, while the quantitative justification, especially if it involves detailed calculations, should be in the appendix. In general, for this class, if the "proof" takes more than half a page of algebra or computations, it should be relegated to the appendix.

Style Conventions

Engineering technical reports are structured documents with the contents described in the preceding section. The style of the lab report should conform to standards for professional communications, and good usage of the English language. The visual appearance should be clean and rather plain. Do not distract the reader with fancy fonts, borders, and cute graphics.

For information on the style suitable for ASME journal publications, see `http://www.asme.org/pubs/MS4.html`. For questions on usage of English consult a style manual such as Strunk, W., Jr., and White, E.B., *The Elements of Style*, 3rd ed., Macmillan, New York, 1979.

Format

The report should be typed. Use of a word-processor is preferred. All text, Figures and Tables should appear on only one side of each sheet of paper. All pages other than the cover sheet should have page numbers that begin with “1” on the first page after the title page, and should continue through the last page of the Appendix.

Handwritten reports, or reports that contain pages of scrap paper or notebook pages with ragged edges are unacceptable, and will be returned without grading.

Text

The text of the report should be written in complete sentences. The style should be formal. This does not mean that you should use vocabulary words that are not part of your speaking vocabulary. Rather, formal style means to avoid slang, cliches, abbreviations that are common in spoken English or advertising copy. In short, imitate a engineering textbook, not the writing that appears in popular magazines.

It is convention that formal reports are written in the third person.

First Person:	“We repeated the test five times and computed an average from this data.”
Third Person:	“The test was repeated five times and an average was computed from this data.”

Use clear, exact prose. Be specific.

Bad:	“The numbers were close enough considering all the data.”
Good:	“The viscosity values were within 15 percent of the published values listed in Table 3.”

Clear thinking and understanding of the material is a necessary but not sufficient condition for good report writing. Consider the quality of your report as evidence that you understood the experiment.

Figures and Tables

A *Figure* is any drawing, photograph, or data plot. All Figures and Tables should have a *number and a caption.* When your laboratory reports are graded, Figures and Tables without captions will be ignored. All Figures and Tables should lie within the margins of the text of the report.

Table A.1 is an example of a properly formatted table. The caption includes the number of the table, i.e., “A.1”, and a brief caption identifying the contents of the table. Units of data in the table are usually be placed in the column headings. The exception is when an individual column contains quantities with different dimensions. Never put dimensional data in a table without somehow indicating the units. Of course, “percent” is dimensionless.

Computer-generated graphs are suggested, but not required. Hand drawn graphs should be on graph paper, and to scale. Graphical display of quantitative data must be precise. Never use freehand sketches to present quantitative data. Axes should be labelled with a symbol or word, and the units of the scale. Multiple curves should be identified with a legend. If colors are used to represent different data on a graph, make sure that the final printout is in color. Figure A.1 is an example of a properly formatted graph.

Table A.1: Summary of viscosity measurements at $20°C$. Percent deviation is relative to the published values.

Fluid	Test Ball	Viscosity values, kg/m·s Experimental	Published	Percent Deviation
Glycerin	small metal	1.85	1.50	+23
Glycerin	large metal	1.72	1.50	+15
Water	large metal	0.75×10^{-3}	1.00×10^{-3}	−25
Water	glass	1.13×10^{-3}	1.00×10^{-3}	+13

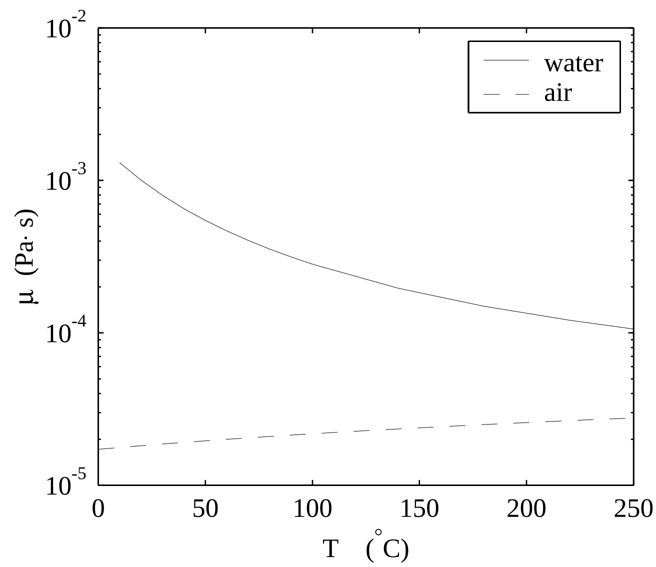

Figure A.1: Variation of the dynamic viscosity of air and water with temperature.

Word-Processing

The purpose of using a word processor is to increase your productivity, not to produce elaborate reports. Properly used a word processor allows you to (1) type your rough draft directly into the computer, (2) easily make editorial revisions, (3) present your report in a neat, easily readable format and (4) check your spelling. In short, a word-processor should help you write better reports. A word processor should not be used to (1) copy the report of another student, (2) waste time playing with multiple fonts and formats, (3) waste paper by printing your report after making small changes, (4) write poorly. The GIGO phenomenon, "Garbage In, Garbage Out" is as common with the use of word-processors as any computer tool.

Free Advice

Writing well has nothing to do with word processors, fancy font selection, or plastic report covers. Writing well is hard work. It is about clear communication with a reader who is not able to directly ask you for clarification.

In order to write well you will need to revise your manuscript. In other words, do not simply type out a report and print it. Rather, sit down with the printed draft and mark it up with a pencil. After you have edited the draft, go back and revise the document in your word processor. Repeat this write-edit-revise loop at least twice.

There are many paths to a completed manuscript. It is usually a *bad idea* to start by writing at the beginning of the report. Instead, you might want to try the following procedure

1. Complete the data reduction. Perform all necessary computations and make all plots and tables of final results. This information forms the core of your *Results* section.

2. Write the text of the *Results* section. Explain the content of each plot and table in words. Guide the readers attention to the most important information. Explain any unexpected results. Use equations to support quantitative arguments.

3. Write the *Theory* section. Include all of the equations necessary to convert your raw data to the reduced data in the *Results* section. Because you wrote the *Results* section first, you will know exactly what equations are necessary. Include any additional background equations that help to explain the results.

4. Write the *Apparatus* and *Procedure* sections. Be sure to include diagrams of the equipment that are useful in explaining the results. Close up diagrams or alternative views of the equipment may be necessary.

5. Write the *Introduction* section. Because you have already completed the *Results*, *Theory*, and *Apparatus* sections, you should have a clear idea of the entire experiment. Now you are in a position to prepare the reader for what is to follow in the report.

6. Write the *Conclusion* section.

7. Write the *Abstract* (if required).

Policy on Collaboration

Writing a laboratory report is an educational experience. Copying the lab report of another student means loosing out on that experience. It also constitutes a misrepresentation of your achievements.

Students working in laboratory groups are expected to communicate with each other about performing the experiments and analyzing the results. Students are expected to turn in reports that are substantially their own, independent work.

- **It is unacceptable to turn in photocopies of any part of another student's work.**

- **It is unacceptable to exchange any part of word-processing documents used for lab reports.**

- **It is unacceptable to exchange spreadsheets or computer programs used to analyze data or prepare graphs for any part of a lab report.**

Visual similarity of the final report constitutes proof of unacceptable collaboration. Other evidence such as duplicate files on computer disks also constitute proof of unacceptable collaboration. Since it is usually impossible to determine who is the source and who is the recipient of such unacceptable copying, grades of zero will be given for lab reports for any and all students who turn in duplicated work.