Lab Reports

Introduction

Your grade in PHY122/132 is determined mainly on the basis of your lab reports. They are graded both for content and format. In this document, we outline how to properly format your reports. A well-written report conveys the essence of an experiment in complete but concise terms. It should be written with proper formatting and structured redundancy such that "results" can be easily found and understood.

An experienced technical reader should be able to explore your report at increasing level of detail, by examining in order: title, abstract, figures & tables and lastly, body text.

Basic Outline

Your report should be organized as follows:

1. Cover page: title, abstract, your name (prominent), partners, TA and section time, date.
2. Introduction: purpose and background, including theory.
3. Equipment: table of equipment used.
4. Procedure: overview only, avoid excessive detail.
5. Results: built around figures and tables.
6. Discussion: interpretation/clarification of results, espec. errors.
7. Conclusion: short summary of *important* results.
8. Appendices: raw data (signed by TA), equation sheets, large tables.

Abstract

The abstract deserves special mention. It is the most important part of a research paper. It should state what you did, how it was done, and the main result, all in concise terms. Usually 3-4 well-chosen sentences will suffice. An example follows:

> *We have measured the distance dependence of the Coulomb force between conducting ping-pong balls of radius R by balancing gravity*

against electrostatic repulsion on a simple pendulum. We find that the force follows Coulomb's law $F(r) = Cr^{-2}$ except for small separations $r < 4R$ where the force is systematically too small. This effect is attributed to a rearrangement of charges on the balls, leading to a non-spherical charge distribution. Assuming Coulomb's law at large separation, the charge on the balls was found to be $Q = 53 \pm 2$ nC.

Length and style

The total narrative (without charts, tables) should be 500-1000 words (2-3 pages). Anything longer is not well thought out. Make a first draft of your report; delete words or sentences that are unnecessary. Avoid subjective, ambiguous, unclear or undefined terms.

Word Processing Tips

1. Format your major results so they stand out, using blank lines, bold, indent, boxes, etc.
2. Set up "hot keys" for Greek letters, (±) symbol and super/sub scripts.
3. Learn the table feature of WORD. Tables of calculations might be done in EXCEL, but do not simply paste these into your document, since the formatting will rarely be adequate. You can paste special (formatted text) into WORD then edit further, using super/sub scripts, ± symbols, etc.
4. Use an equation editor for anything but the simplest equations. Some might be copied from the handouts. Difficult or numerous equations are best done by hand and attached as appendices.

Units

On September 30, 1999, the Mars Climate Orbiter accidentally plunged into the Martian atmosphere and was vaporized, costing NASA (and a skeptical public taxpayer) $125 million. This happened because two engineering teams mixed metric vs. English units for rocket thrust, and radioed the wrong numbers to the obedient spacecraft. This major embarrassment provides a real life enduring lesson for beginning scientists and engineers everywhere:

> *Any time you write a physical quantity in your notebook or report, you must include the units!*

Failure to do so will cost you serious grade points now, but we hope will prevent the loss of spacecraft, automobiles and airplanes in the future.

Summary Table

One goal in designing and/or evaluating an experiment is to identify the limiting factors in terms of accuracy. That is, identify the major source of error and perhaps suggest how to make improvements. A common student faux pas is to diligently list out all as many sources of error as possible in vague qualitative terms with accompanying useless comments, such as "the meters were noisy", "the beam was fuzzy", and of course the classic "..there was a lot of human error...".

> *Such statements are worse than useless. They prominently reveal that the student has learned nothing at all from this course, and they will not be tolerated.*

Instead one should present a summary table such as table X shown below. Every report should contain such a table, showing all measured parameters and all important derived parameters, with units and errors. Brief comments can be included in the table or elaborated below using footnotes. All error values should be explained clearly elsewhere in the report. For example, "Mass was determined from 3 independent trials" (show these values and errors).

Table X. Summary of results.

name	value	(%)	Comment
Measured parameters			
m	3.0 ± 0.1 gm	3.3%	Mass of pp balls
L	97 ± 2 cm	2.1%	Length of pendulum
$2R_0$	37 ± 1 mm	2.7%	Diameter of pp balls
Derived parameters			
α	$2.52 \pm 0.2 \times 10^{-5}$ Nm^2	7.9%	slope of Force vs. (r^{-2}). Figure 1.
Q	$52 \pm 2 \times 10^{-9}$ C	3.9%	Charge on one ball(1)

1. See error prop. calculation in appendix 1.

Plots

Attributes of a typical good plot:

1. Large size (at least fill the width of the page) with large fonts. Legend and other info might fit inside the box, leaving more room for the data itself.
2. Descriptive title.
3. Axis labels with units.
4. Sensible sub-divisions on axes, to facilitate interpolation by humans.
5. Data points with error bars and NO CONNECTING LINE.

6. Fit line for theory (connecting line, not points).

An example of a properly formatted plot is shown below in figure 1. Do not be afraid to add informative information by hand. Plots may be pasted into your document, but be careful not to shrink them too much. Full page plots can be attached at the end of the report, and numbered for referral in text..

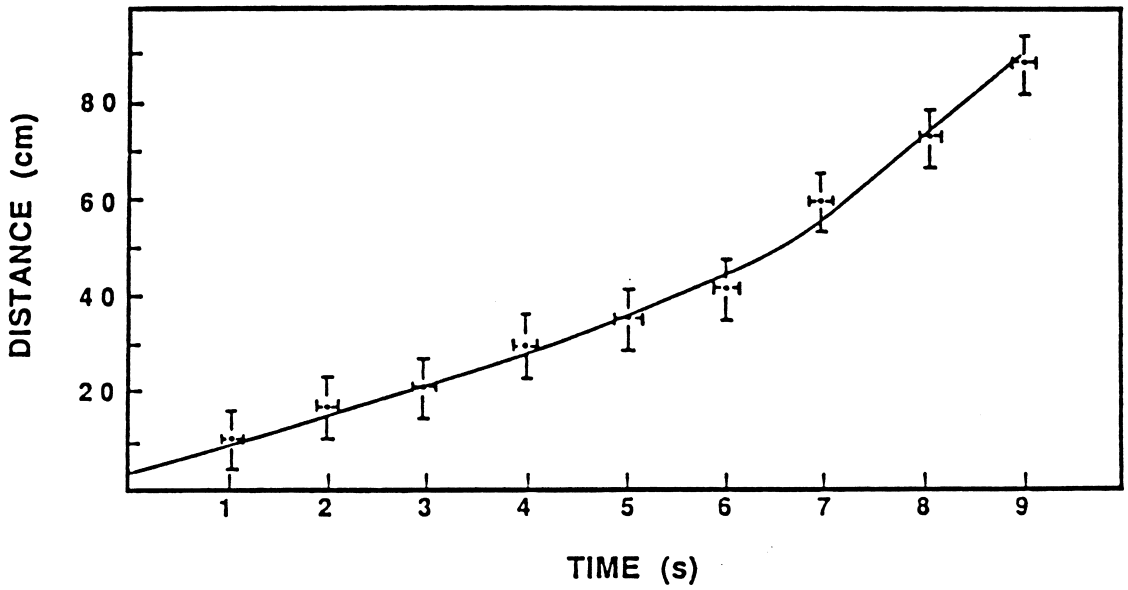

Figure 1. Distance vs. time for an object under constant acceleration.

Grading:

Your TA will provide timely and specific feedback to help you improve your reports. They should provide an itemized list of points allocated for at least the following:

1. Proper use of significant figures, units, errors everywhere.
2. Use of tables for multiple values (anything more than 1).
3. Clearly formatted statements of single results, as "We found ....".
4. Proper formatting of plots, including assignment of X or Y axes.
5. Correct answers to all direct questions in the handout.
6. Suitable narrative in the body of the report.
7. Overall quality of procedure and results.