Welcome to The Physical Perspective

This is the manual for the laboratory section of PHYSICS 1314 *The Physical Perspective*. The laboratory sessions are primarily intended to provide with an opportunity to test the theories and principles discussed in lecture and to learn some basic skills of scientific investigation: use of simple laboratory apparatus, data collection and analysis, and simple error analysis. These activities are interrelated. Your conclusions depend on your analysis and the quality of the data you collect, which will, in turn, depend on the care taken in performing the experiment.

Course Requirements:

1. You are required to complete all the experiments listed on the Physics 1314 syllabus. This manual contains the instructions for all of the laboratory sessions this semester. To make your learning efficient as you should read and try to understand the theory portion of each experiment *before* you arrive in lab.

2. Please use the associated lab form. It will guide your thinking and provide adequate space for the collection of data, your mathematical analysis, conclusions and error analysis. The entire experiment can be performed in the two-hour lab period. Turn in your complete report at the end of the lab period. Although experiments and data collection will be done in pairs or small groups, all analysis, conclusions, and error analysis must be done individually. If you have a problem understanding a result or coming to a conclusion, see me and/or the Teaching Assistant.

3. Grades: Grades on lab reports will be assigned along the following basis:

40% Data Collection/ Analysis
40% Conclusions
20% Error Analysis

4. Make-Up Policy: The last lab session of the semester is devoted to make-up labs. To use this time, you need to convince me there was a good reason you missed a lab during its regularly scheduled time. I am reasonable but not necessarily “easy”. Requests are handled on an individual basis. Experience shows that students tend to learn less when they do the labs out of sequence with the lectures.

How to read this manual:

Each experiment contains several important terms with which you will need to be familiar with before starting the experiment. These important terms will appear in **boldface** (e.g., **electric field** or **resistance**) upon their first mention in the text..

Numbers will always be cited with units included. There are several types of quantities involved in these experiments. **Scalar** quantities will be written either as numbers (e.g., 9.81 m/s^2) or by a symbol. Symbols for scalar quantities will appear in italics. Here are a few examples:

n = index of refraction

F = the magnitude of the force vector

V = electrical potential

Vector quantities will either appear as an arrow in a diagram, or more frequently by their appropriate symbol. Symbols for vector quantities will appear in **boldface**. Following are a few examples of vectors and their symbols:

F = force vector

E = electric field vector

v = velocity

Parts of a Typical Lab Report:

Abstract: Write a summary of the objective of the experiment, the procedure used, and the conclusion reached. The abstract should be very brief and typically contain no more than three or four sentences. Abstracts permit me to see if you understand the physic purpose of the experiment.

Data Collection: This part contains the actual results of measurements and observations. Usually, this means numbers. It is necessary that you always report the units along with the data (i.e. meters, grams, ohms, etc...). In addition, try to maintain an accuracy of <u>three significant digits</u>[*] ("sig-figs") whenever possible (e.g. <u>9.81</u> m /s^2) in

[*] See Appendix A for an explanation of significant digits.

collected and calculated/extended data. In some cases, you may have reason to include four or more significant digits.

Analysis: The *theory* applied to the *data*. This usually means math and number crunching, but not always. Graphs are also included in the analysis part of an experiment. See Appendix B for an explanation of graphing techniques. Graphs should be neat and well labeled with appropriate units.

For repeated calculations of the same type, you will only need to show *all the steps* for one example unless you are concerned about partial credit. Units should be included in your calculations. If your result is in ohms, for example, and your data consists of measurements of volts and amps, your calculations should show how your final result is expressed in ohms. A result without units is a result without meaning.

Conclusion: The conclusion section is one of the most important parts of your report. In writing your conclusion, you will draw on everything you have done up to that point, your study of the theory, your set-up of the experiment and data collection, as well as your analysis of the data. The main question you should consider when writing a conclusion is, "What did I learn from this experiment, from *my* data, and from *my* analysis”? Your job is to verify whether or not the theory you used is consistent with the data collected from your experiment. Most of the time there will be some discrepancy. If your data does not support the theory, does it have a unique pattern of its own, or does it appear random? In the conclusion, you are expected to answer these questions as well as explain your reasons for making claims that the data supports the theory.

In addition to writing the summary above, you will be required to answer several specific questions about the experiment. It is a good idea to study these questions before arriving in lab.

Error Analysis: This is an important part of both your analysis and conclusion. In this part, you will attempt to explain why your experimental results were not exactly what you expected. State where the numerical error was introduced in the experiment. Did it come from the equipment? How? From the user of the equipment? How? Does the error seems to have a pattern, such as always being less than expected? You may be asked to numerically estimate the percent or actual error of the numbers you record. Instructions on how to estimate error are included in Appendix A.