University of Southern Maine — Department of Physics

Physics 116
Syllabus

Instructor

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Course Description: This section of Physics 116 is a 1 credit introductory lab course open only to students who have taken or are currently taking in physics 123. The goals of this lab are to learn the process of doing science, to leann about physics through hands-on experience, and to learn the principles of the error analysis and to become familiar with the scientific writing genre.

Lab Schedule

Week starting	Experiment	Points
14 May	Intro/Data Analysis	10
21 May	Equipotential & field plotting	10
28 May	Electric Circuits - Part 1: Resistance & Ohm's law	10
28 May	Electric Circuits - Part 2: Series & Parallel Resistors	10
04 Jun	The Current Balance	20
11 Jun	Reflection/Refraction of light	10
18 Jun	Lenses	10
25 Jun	The Interference of Light	10

Assessment: Your grade for this lab course will be determined on a point basis. In the lab schedule above, you will find 10 or 20 points associated with each lab session, depending on whether I expect a formal or informal lab report or some assigned exercises related to data analysis. If you miss a lab, you may (at the discretion of the lab instructor) attend another lab section. All labs are due at the beginning of the next lab meeting after performing the experiment. For both formal and informal reports, I will give you specific guidelines before you begin the laboratory experiment.

Formal vs Informal Laboratory reports: Most of the reports you will turn in are of the *informal* type where you will have to (a) answer questions posed in the lab, (b) turn in neatly composed data tables, calculations, and labelled plots, and (c) brief conclusions; in any case, I will give you a checklist of elements for these informal reports.

Formal reports must follow the guidelines for a formal report (attached). Such reports should read like a formal journal article, and will involve significantly more work to receive a good score.

A note on Error Analysis: Since this is a lab course, I will be a total stickler for the inclusion of uncertainties on every measured and calculated quantity. Expect to lose points if you omit uncertainties on measurements or calculations. Why am I so strict about inclusion of uncertainties? The answer has to do with the fact that science is the pursuit of truth and is most valuable when its practitioners are totally honest about their data (if a few practitioners are not, eventually others will find out). To express how accurately you conducted your experiments, you have to therefore include how accurate each measurement was, and this depends on the quality of the instruments you used. This also applies to any quantities you calculate from these raw measurements. So, data table values should have uncertainties, graphs should have error bars, and results should include uncertainties. If you find yourself reporting a result and there is no uncertainty, that's a problem you should fix.

Elements of a Formal Lab Report

A lab report should be a well-written model of scientific integrity and should include several elements:

(1) **Title, Author(s) and Abstract**
The goal of an abstract is to set down clearly and *concisely* what experiment was performed and the basic results obtained. The goal of an abstract is to provide the reader with a quick summary of what you did so that they can tell whether the rest of your report is relevant to what the research they are doing. If the point of the experiment was to measure a particular physical quantity, then a good abstract will mention the measured value of that quantity with its associated uncertainty, along with a comparison to a theoretical or expected value.

(2) **Introduction**
The introduction should introduce the basic ideas behind the lab, and explain them clearly and concisely. What's the point of the experiment? This is the section where you introduce the theoretical background to the experiment and discuss what your hypothesis is and what you predict as an outcome. How will you test your hypothesis and what will determine success or failure of you your hypothesis?

(3) **Procedure**
The procedure section should include a detailed *narrative* description of how you conducted the experiment. That is, I do not want to see a numerical list of steps, and I do not want you to write the procedure section as a set of instructions to another student—just describe clearly and specifically what **you** did. Feel free to use the pronouns *I* (if you worked alone) or *we* (if you worked in a group). In the course of this description, the materials used in the experiment should naturally be mentioned and you should make sure to include sketches (or photos; but be careful—sometimes schematic diagrams are far more clear than a photograph) of the experimental setup. The reader should be able to reconstruct your experiment from your description.

(4) **Data and Analysis**
The data you recorded for the experiment should be presented in a neat fashion, *preferably in tabular form*. The important point is that the data should be understandable. Make sure you include units and uncertainties for each measured quantity! Also, record the conditions under which the measurement was made where appropriate. Show one sample calculation for each unique type of calculation needed to complete your data table. At the end of the lab report, please attach the actual raw data (no matter how messy!). Generally speaking, your analysis of the experiment will involve a discussion of the data, and this discussion will likely include one or several graphs together with your interpretation of the information contained with each graph.

(5) **Conclusions**
What conclusion do you draw from your experiment? What have you learned? What (if any) problems remain unanswered as a result of your work? If the point of the lab was to measure one or more quantities, you should give your final (best) values for these quantities along with their uncertainties.

Other Suggestions

- Write your lab report so that you would be able to look at it five years from now and understand what you did. Consider your audience to be students at another university taking a similar course.

- Be concise. Write well and use proper english! Vary the style of each sentence so that the report flows. Avoid writing a series of short sentences or long ones for that matter! Variety! A good rule of thumb is to read your lab aloud to yourself (or a friend) to see hear whether it flows and whether what you wrote makes sense.

- Take measurements as accurately as the equipment allows.

- Try to develop the habit of asking questions, doing measurements or calculations that allow you to check whether your data is understandable. **B**e skeptical!

- Make sure your graphs are clearly labeled! This includes axes labels (with units) and a descriptive title. A good graph will also show any appropriate fits and will label important features of the graph. Don't forget to use error bars where appropriate. When you draw a graph, there is typically some information that can be gleaned from it! Never draw a graph that goes uncommented in the text of the lab report.

- An outstanding lab will pose "what if questions" and gather, analyze and interpret data in attempt to answer the questions. Such reports go beyond the original scope of the lab.

Example of a Title Page with an Abstract

Determination of g via free fall

Joe Q. Student
University of Southern Maine
September 10, 2001

*W*e determined the acceleration due to gravity by using a Pasco Scientific free fall apparatus. A steel ball bearing was dropped repeatedly from different heights and the fall times were recorded to the the nearest 0.001 second. We used the fall heights and times to graphically determine g to be 9.79 $\pm$0.09 m/s^2. This is consistent with the known value of g at our location in Portland, ME.

Checklist

1. Name(s) on report; indicate who wrote what sections.
2. Uncertainties on ALL measured quantities.
3. Neat data tables with units and uncertainties.
4. Axes labels and units on plots.
5. If you made a plot, you should show error bars (they may be small) and your best fit curve—in this class, it's likely to be a line.
6. Make sure to show the high and low slope lines and the uncertainty in the slope for any straight line fits. Do you have units for your slope?
7. **Nowhere** should you ever use "*human error*" as the sole explanation of why something didn't come out right. Human error with regard measurement of some quantity, for example can induce random error or systematic error—but if this is the case, random error should show up in uncertainty calculations and you should quantitatively estimate the effect of any systematic errors. If you are using *Human Error* as an explanation in some generic unspecified way, that is a non-explanation with no merit. You will very likely lose points if you use this in your conclusion.