PHYSICS 132 LABORATORY

The laboratory is an integral part of the Physics 132 course. It is a place to work in groups on the techniques of problem solving, see how the ideas presented in the text and in lecture apply to experimental problems, and learn some basic techniques for making measurements, analysing data and drawing conclusions from your results. Physics is, ultimately, an empirical science. Whatever ideas, principles, theories, and laws appear in the study of physics, they are only valid if they are ultimately consistent with experiment. In this introductory physics laboratory, you will be introduced to some of the ways that theories of physics are tested.

The Experiments

The experiments are designed to reinforce the concepts covered in lecture and to help you learn the material of the course. You must do all the experiments and complete the lab reports to pass the lab - and you must pass lab to pass the course. You should try to complete as much of the analysis as you can during the lab period. If you miss a lab - contact me and plan to make up the lab with another section during the same week.

Lab Notebook

Maintain a laboratory notebook. Collect data and do calculations in your notebook so that everything is together. Graph your data as you collect it (whenever possible) so you can see how the results are coming out. Outline your conclusions and any discussion of your results in your notebook - even though the lab report will be written separately. I may ask to see your notebook.

Lab Reports

Lab reports are due by 4 pm on Friday following the experiment. At least two of the reports must be formal individually written lab reports - and should represent your best work. You may work together on the remaining lab reports as long as all members of the group are more or less equal participants in the analysis and report writing. If you prefer, the remaining reports can also be done individually as “brief” or “informal” reports. But every person must submit at least two individual formal reports. Do not assume that late reports will be graded. If a problem occurs which prevents you from getting a lab report in on time, please contact me so we can talk about what to do.

Quizzing and Testing

The lab may be used for quizzing and testing for this course. Check the schedule (and also the course web page) if you are unsure of whether a quiz or test is scheduled.

Grading in Laboratory

The lab will be graded basically on an S/U (Satisfactory/Unsatisfactory) basis. The grades will be determined by your performance in lab (how well prepared you are and how involved you are in doing the experiments), the lab reports, and any lab quizzes. If this class is typical, most lab grades will be S. S+ and S− grades will be assigned for exceptional or marginal performances in lab. To obtain an S+ in lab, most of the lab reports should be done individually and should be evaluated as S/S+ or better. A U grade is not passing and means either that the experiments were not completed or that the quality of the work was insufficient to assign a passing grade. A missing lab and/or report will automatically lower your grade based on the work you do complete and could result in a U grade if the rest of the work is marginal. Two missing labs/reports will automatically result in a U. An incomplete grade will be assigned only if an acceptable reason prevents you from completing the work. An incomplete in lab will result in an incomplete in the lecture course.
LAB REPORT GUIDELINES

Completing the laboratory experiment and much of the analysis in lab may depend on how well you have prepared for the lab. Spend some time prior to coming to lab reading the lab manual description and any related material in the text. The report itself should be written clearly enough that you could read it five years from now and understand what you did, why you did it, more or less how you collected your data (without going into detail), what that data was and how it was processed. Any graphs should be clearly presented - and obviously related to the data. And you should draw conclusions based on your results - and relate the conclusions to the goals of the experiment. In writing your report you should follow guidelines:

1. The report need not be lengthy, but must be logically complete and consistent. A concise report distills the essential ideas from all the detail. The lab report should be in your own words - reflecting your thoughts.

2. The quality of your writing is important - it will help you present your work clearly and ultimately will help you understand the ideas related to the experiment.

3. The presentation of any measured or calculated information always involves three elements: A value, an associated uncertainty, and the units of the measurement. Write the results of the measurement or calculation in the form \( X \pm \Delta X \text{ units} \) and identify what is being presented.

   When uncertainties are not explicitly displayed, the precision is determined by the number of significant figures used. Be careful about significant figures when quoting measurements and results.

4. Graphs are particularly useful in presenting data and for extracting information from your experiment.
   a. Graphs should be at least half page. The axes should be away from the margins of the paper and should be labeled with the physical quantity being represented on each axis, the corresponding symbol, and its units. A glance at a graph should make it clear what is being presented.
   b. Axis scales should be chosen so that the values are easy to plot and to read. In most circumstances, the origin should be included on the graph.
   c. You should show the data points clearly (with distinct dots or circles, for example). You should include grid lines and scales so that the data can be read directly from the graph.
   d. In most cases, a smooth curve should be drawn through the data - or the “expected” curve should be shown superimposed on the graph (as opposed to a “connecting-the-dots”). If the graph is expected to show a linear relationship (\( y2 \) vs \( x \), for example if you expect that \( y = k \sqrt{x} \)), include a best fit straight line.
   e. The graph should include a descriptive title.
   f. If you use a computer (for example, the CricketGraph software in the lab or Excel) to plot your data, you will need to take particular care to increase the graph size to at least half page, show the appropriate scale and units on each axis and show grid lines on your graph. If what is being plotted can be expected to be linear, then use the features of the software that let you super-impose a least squares straight line fit to your data. If it is not linear - do not try to fit a straight line. The computer graph should not substitute for thoughtful analysis of your experiment.
Your laboratory report should include:

1. Identification

   Name and Lab section  “Group Report”  
   Experiment title and date or  Experiment title and date  
   Names of your lab partners  Names (indicate principle author of report)

   Group reports should be clearly indicated as such. The name of the “principle author” should be indicated, and all members must sign the report following the conclusions. To be a group report, all members of the group must be involved in writing the report.

   Individual reports should be identified as either “Formal report” or “Brief” or “Informal”. Your formal reports should represent your best work in reporting an experiment.

2. Introduction

   A brief description of each part of the experiment including a statement of what you are trying to show or measure and how you intend to do it. This should be in your own words. A figure or two will often help.

3. Data

   This section should be presented well enough that you could clearly tell how the data was obtained. The data should be organized - perhaps in a table. The units of the measurements must appear, and where appropriate, the measurement uncertainties.

4. Analysis

   Include graphs, sample calculations (where appropriate) including the equations used, and the results (which can often be included in the table with your data), and any determination of experimental uncertainty, percentage error from expected results, etc.

5. Results

   Your results should be clearly presented including units and uncertainties. You should compare your results with those of others - including accepted values that have been published.

6. Discussion of Results and Conclusions:

   You should always draw conclusions from your work. The conclusions should be based on the results of your experiment. The experimental results could be restated and comparisons made to what results you expected to see in the experiment. Be explicit in your conclusions - it is not a general statement about the topic of the experiment. This section should tie together the work that you did in lab and the analysis and results with the introduction and stated purpose and the results you expected.

   A finished lab report should meet the following test for clarity of communication: You should be able to read your lab report in a year or two and have a clear understanding of what the experiment was about and why you did it, how you did the experiment, what the results show and what you can conclude from your work. Take pride in your work.