Introduction, Policies and Procedures

LAB ENROLLMENT

You must be officially registered through the Registrar's Office for the Physics lab section you attend; *otherwise you may not receive credit for the entire Physics course.* It is your responsibility to make certain you are properly enrolled for the lab you are attending.

During the registration Course Add period at the beginning of the semester, if you need to change your lab section enrollment, you may do so via the web or through the Department Main Office in Phillips 278. All lab section changes must be made before the end of the Course Add period.

LAB ATTENDANCE AND MISSED LABS

You are expected to attend all scheduled labs that correspond to your physics course. If you are unable to attend a lab, contact your lab instructor or consult the schedule of available lab sections (via the University's Directory of Classes) as soon as possible to arrange to attend another lab section in which you can perform the missed experiment. Before attending a lab section other than the one in which you are officially enrolled, you must first get permission from the TA for that section since space for additional students is often limited. After receiving permission and attending another lab section, submit your lab assignment to your regular lab instructor via WebAssign. If attendance in another lab section is not possible due to circumstances *beyond your control*, you may seek an excused absence from the Lab Manager or Lab Director in order to have that lab score dropped. A missed lab will be dropped as an excused absence only in cases where a student has no other alternatives and the absence is well justified and verifiable; otherwise a zero will be recorded for the missed lab. *A maximum of one lab score may be dropped as an excused absence during a single term; any additional missed labs will receive a zero regardless of the reason for the absence. Note: The Lab Exam is required for all students. Excused absences will not be granted to those who miss it.*

GOALS OF THE INTRODUCTORY PHYSICS LABS AT UNC-CH

(based on the 1997 policy statement from the American Association of Physics Teachers)

The Art of Experimentation: The introductory laboratory should engage each student in significant experiences with experimental processes and design. Physical principles are explored through hypothesis development based on empirical observations (inductive reasoning) and testing of theories (deductive reasoning).

Experimental and Analytical Skills: The laboratory should facilitate development of a broad array of basic skills and tools of experimental physics and data analysis, which students can utilize in a variety of career fields.

Conceptual Learning: Labs should enhance student understanding of basic physics concepts through direct observation of empirical evidence and hands-on learning.

Understanding the Basis of Knowledge in Physics: The laboratory should help students understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.

Appreciation for Scientific Inquiry: Labs should instill interest in how the physical world works and inspire students to creatively explore hypotheses through experimentation.

Communication: The laboratory should facilitate students' ability to communicate their findings through written reports.

Collaborative Learning Skills: The laboratory should help students develop collaborative learning skills that are vital to success in many lifelong endeavors

PREPARATION FOR LAB AND PRE-LAB ASSIGNMENTS

Study the experiment you will be performing before you come to lab. (Note: The official **lab schedule** is listed outside the lab rooms, and on the physics lab website). As you prepare for each lab, you should predict the results you expect from the experiment and carefully consider what factors will most significantly affect these results and how you can best control for systematic and random errors. Your lab instructor will generally assign several of the prelab questions and exercises for you to answer before coming to lab, but you should think about the answers to all of these questions that are designed to help prepare you for the experiment. Most labs also require a data table, which you should create on your data sheet or on an electronic spreadsheet that you can bring to lab on your laptop computer.

WHAT TO BRING TO LAB

- Lab manual
- Laboratory data sheets
- Pre-lab assignment
- Scientific calculator (preferably with statistical functions)
- A pen
- Blank data table(s) and pre-lab notes (as needed)
- Laptop computer with spreadsheet and data analysis software (as needed)

LABORATORY WORK

At the beginning of each lab, your instructor will spend 15 to 20 minutes giving an overview of the experiment you will perform. Once you are told to begin work, *approach the experiment with an attitude of curiosity and exploration.* Ask questions of your lab partner, neighbors, and instructor. Most experiments require the full lab period; so do not sit passively waiting for help.

Use a pen to record your data on the data sheets. Cross out with a single line any erroneous entries. Be thoughtful as you take data: Are the readings consistent? Are you investigating the widest possible range of values? What uncertainties are associated with each measurement? It is always best to plot your observations as you record them so that you can better observe

patterns in the data and identify any trials that produced erroneous results. A computer with data and graphical analysis software is provided in each lab room for this purpose, but if you have your own laptop computer, you should bring it with you so that you can enter and analyze data while you perform the experiment (this procedure can yield better results and save time). Measurements that are not consistent with your predictions may indicate incorrect assumptions about the physical model, systematic errors that should be addressed, or possibly a procedural mistake that requires correction. These corrections cannot be made unless you critically evaluate the data as you take measurements. You may discover as you analyze your data that some of it is incomplete or questionable; it is best to learn this while you are still in the lab and can make additional measurements if necessary. Be sure to record all relevant observations and adjustments that you make during your experiment on your data sheets.

Before you leave the laboratory, *return all equipment to its proper place and condition so that your work area is neatly organized and ready for use by the next laboratory section.* Once this is done, both you and your instructor will initial your data sheet. After your TA has initialed your data sheet, **do not make any alterations or additions to your copy of the data sheet. Changes made to your data sheet after you leave lab may be considered a violation of the Honor Code (see below).** *Leave the yellow copy of your data sheet with your instructor.*

LAB REPORTS

Lab reports must be typed or printed clearly in ink. Each report must include a cover page, an abstract, a summary of your experimental results (including your original data sheet and any additional notes, tables, or graphs), and a discussion of your findings. See the descriptions below for what should be included in each section. A detailed grading rubric and sample lab report can be found on the labs website: http://www.physics.unc.edu/labs[1].

: Cover page must include:

- Title of experiment
- Lab section and TA
- Date the experiment was performed
- Your name
- Your partner's name (identified as such)
- Honor pledge and your signature

: Abstract

The abstract is a concise summary of the lab report. A good abstract should state the purpose, procedure, principal results, conclusion, and implications of the lab in a single paragraph that is generally 100 to 200 words in length (use your word processor's *word count tool* to check length). For many scientists, the abstract is the most important part of a journal article, so learning to write a good abstract is an important skill for publishing scientific findings.

: Introduction (optional)

[1] http://www.physics.unc.edu/labs

A complete scientific lab report has an introduction that gives the context for the experiment, the background theory, and a description of the experimental procedure and equipment used. For simplicity and brevity, you are not required to include this section, but you may do so if you like. In cases where a particular lab does not have a prescribed procedure, or if you used a procedure that was significantly different than the one described in the lab manual, you should clearly explain what you actually did either in the introduction or discussion sections.

: Data and Results

The results of your experiment must be well organized and easy to read. Use tables and graphs as appropriate. Graphs must be properly constructed (with a computer or by hand, as directed) with descriptive titles, labeled axes with relevant units, and calculated parameters properly interpreted (e.g. What do the slope and intercept represent?). All measured values must have four critical parts:

1 A **label** (word or symbol) that clearly identifies the measured value

2 The numerical **value** for the measurement (appropriately rounded to be consistent with the uncertainty)

3 A reasonable estimate of the **uncertainty** associated with the measurement

4 An appropriate **unit** of measure (SI units are generally preferred)

Sample calculations, including an analysis of the experimental uncertainties, should be shown for any derived or calculated values as appropriate. Your original, *unaltered* data sheet must be included either in the data section or as an appendix.

: Discussion

In the discussion section, summarize the results you obtained, and then discuss any discrepancies between your results and what was expected according to the given theoretical predictions or your own hypotheses. Did the experimental results agree with your predictions or the findings from other lab groups? If not, what is the most likely reason for the discrepancy? Remember to consider the uncertainty of your results when determining agreement. Try to identify the primary source of error in your results and justify your answer based on your uncertainty estimates. (*Note: General statements without justification and explanation are not acceptable. "Human error" is not an acceptable source of error!*) How could you improve the quality of your measurements with the available equipment? What did you learn or discover from this lab? The discussion section for most labs should be about one to two pages in length. Remember that your discussion will be graded on the *quality* of your explanations, not the quantity.

LAB REPORT SUBMISSION AND DEADLINES

Lab reports are generally due at the next lab period after the experiment is performed; however your lab instructor may be able to give more immediate feedback if you submit your report before your next lab session (this is particularly encouraged for the first lab report). Your lab instructor may deduct points or not accept lab reports that are submitted after the date they are due.

LAB REPORT GRADING

Reports are graded on a 100-point scale as follows:

Section of Write-up	Percentage of Grade
Pre-lab assignment	15%
Cover page	5%
Abstract	10%
Data and results	40%
Discussion	30%

Your graded lab report should be returned to you at the next lab session. In addition to receiving a numerical score on your report, your instructor should also report the class average, standard deviation, and range of scores on that particular lab. *Note: Lab scores usually start low at the beginning of the semester and steadily improve as students understand what is expected. Typical lab scores for the introductory physics labs range from 65% to 95% with an average around 80%. Lab scores are not automatically normalized at the end of the semester, but the Lab Director may adjust the final scores for a section that has an average that is significantly higher or lower than other lab sections.*

LAB GRADES

Lab scores are reported to your physics course instructor, who counts it as part (usually 25%) of your overall course grade. Your score for the lab portion of this physics course is computed from your lab report scores (80%), and the lab exam (20%). Your lab instructor also has the option of assigning a participation score based on your active participation and intellectual engagement in the laboratory activities. Note that an overall lab score of at least 60% is required to pass the course.

LAB EXAM

A physics laboratory practicum is administered near the end of the semester and counts as 20% of your final lab average. This lab exam is designed to assess each student's ability to make accurate measurements with typical physics lab instruments, analyze and interpret empirical data, apply fundamental physics principles, design simple experiments, evaluate results, analyze measurement errors, and communicate findings clearly and concisely. In completing the exercises in this hands-on exam, you are permitted to use your lab manual, notes, textbook, calculator, and any other resources (except other students or your instructor). Since this is an individual lab exam, each student should make a concerted effort to master the experimental physics techniques in all lab experiments performed throughout the semester. A sample lab exam with answers is provided on the lab website for each introductory physics course. You are encouraged to review the sample lab exam that corresponds to your course and practice making measurements with the equipment that is provided for this purpose.

LABORATORY AND THE HONOR CODE

The Department of Physics and Astronomy fully supports the Code of Student Conduct, as expressed in the document "The Instrument of Student Judicial Governance for the University of

North Carolina at Chapel Hill" (1991). It is the student's responsibility to be aware of, and abide by, the Honor Code, and to pledge all written work, including lab reports.

During this course, you will be working with one or more partners with whom you may discuss any points concerning laboratory work. *However, you must perform your own data analysis and write your own conclusions.* Scientists often draw very different conclusions from the same set of data, so it is important to think independently as you collaborate. Analyzing your results independently and then discussing the differences with your lab partner is an important learning opportunity. *Lab reports that contain identical language, formatted data, or results are not acceptable.*

Once your TA has initialed your data sheet, do not make any alterations to your copy. If there is a problem with your data, include an explanation in your report. Recognition of a mistake and a wellreasoned explanation is more important than having high-quality data and will be rewarded accordingly by your instructor. A lab report containing data that is inconsistent with the original data sheet will be considered a violation of the Honor Code.

Falsification of data or plagiarism of a report will result in prosecution of the offender(s) under the University Honor Code.

On your first lab report you must write out the entire honor pledge: "The work presented in this report is my own, and the data were obtained by my lab partner and myself during the lab period."

On future reports you may simply write "Laboratory Honor Pledge" and sign your name.

SAFETY

Always keep safety in mind when working in a laboratory situation. Open-toed shoes are not permitted. Loose apparel and long hair should be held in place to avoid being caught in a rotating apparatus. Consult with your instructor before attempting any unauthorized experiment. Report any broken equipment or hazardous conditions to your instructor. Give special consideration to any specific warnings included in the lab manual or given by your instructor.

No food or drinks may be consumed in the laboratory.

