LABORATORY EXERCISES

FOR

GENERAL PHYSICS II
(PHYS 150)
&
UNIVERSITY PHYSICS II
(PHYS 250)

PHYS 150L

SPRING 2003

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This packet contains the following materials:

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   3. Schedules
   4. Fitting Data

II. Laboratory Exercises
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    2. Error (Uncertainty)
    3. Capacitors
    4. E/M Electron Charge to Mass Ratio
    5. Oscilloscope
    6. Reflection and Refraction
    7. Thin Lens
    8. Superconductivity and Interference
    9. Independent Experiment (Resistance)
   10. Radioactive Half Life

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1. These labs were written by the faculty of the JMU physics department and updated by Dr. Giovanetti.
LAB VOUCHERS ARE REQUIRED FOR ALL PHYSICS 150 LABS.

VOUCHERS CAN BE PURCHASED AT THE BOOKSTORE.

STUDENTS WHO DO NOT PURCHASE VOUCHERS WILL BE DROPPED FROM THE COURSE.
**Laboratory Goals**

This laboratory course will focus on two areas:

1. CONCEPTS: General physics, experimental data analysis, uncertainty.
2. PROCESS: How one performs an experiment, use of instrumentation.

In exploring these points the student should realize that a laboratory offers unique opportunities for the development of skills. These skills are valuable because they can be applied in many situations beyond the lab. Our goal is to challenge students by confronting them with situations that strengthen and develop sound approaches for solving the problems that one encounters in the lab. Examples of these skills are:

1. Keeping a notebook,
2. Reading and interpreting manuals and procedures,
3. Evaluating the process by questioning results,
4. Developing problem-solving skills,
5. Using data analysis tools,
6. Understanding and using error analysis,
7. Plotting data and results.

Students will need to learn to confront experimental procedures and results. Despite the level of sophistication reached by today’s instrumentation, absurd results can easily be obtained in a measurement. Good experimentalists are always asking themselves at every step if the results make sense. Most of the time, methods for probing a measurement are basic common sense methods. Students sometimes believe that good science is only done by brilliant scientists asking profound questions. However, to the contrary, applying basic care and straightforward analysis to problems has made many solid contributions. The starting point is ensuring that the simple aspects of an idea or experiment are sound. Strive to identify ways to eliminate simple mistakes and to probe results.

A very effective tool for probing your experiments and ideas is to establish an uncertainty. There are different approaches for establishing uncertainty but in this lab the focus will be on common sense rather than rigorous mathematical analysis. It will be important to understand what is an acceptable difference between two results. How much does one allow results to differ before the experiment is judged to have a serious flaw? At each step the experimenter should try to develop this insight, when comparing two consecutive measurements, when comparing results with the theory, and when comparing two independent experiments. Experimenters know that an uncertainty is a safety net. Your results cover a range of possible values. Large uncertainties make an experiment very defensible. The result cannot be called into question if the uncertainty is so large that all reasonable results are included. On the other hand, an extremely small uncertainty is a sign of a high quality experiment, the smaller the uncertainty the better the experiment. This means that the optimal uncertainty has to balance these two opposing goals. The uncertainty should not be so small as to guarantee failure, nor so large that the experiment has no merit.

Students must learn to record progress and knowledge for use in future experiments. For most people taking notes is a good method to increase learning and retain information. As you record information you reevaluate so that you can write clear sensible statements. When trying to summarize a point you may realize that your understanding is not complete. As the semester
progresses we expect to build on previous experience. Record in your own words how to manipulate data, how to understand the equipment and any details that you feel might be useful. Diagrams and pictures are extremely effective ways to record information.

For some of the labs the manual will be very specific and will provide step by step explicit instructions. Other labs will be more open-ended. Students will be required to design the procedure, refer to general instruction manuals and use their notes from previous experiments. For some labs the equipment will be ready to use. For other labs the students will be required to figure out how to assemble the equipment.

Your instructor will try to alert you to the goals of each lab. Based on these goals students will need to adjust their approach. When the focus is on a concept the student can legitimately bypass details on how the data was recorded and focus on how the results clarify a concept. When dealing with the process the student may find the system under study fairly straightforward and the problems associated with the measurement will be the predominant interest.

In summary:
• Be ready to think and question the steps, methods and results.
• Take notes.
• Be prepared to assemble equipment and design experiments.

**Laboratory Policies for Physics 150L**  
**General Guidelines**  
The laboratory experiments and exercises performed by students as part of this independent introductory laboratory course are designed to provide the following:

1. A reinforcement of concepts presented in introductory physics courses.
2. An introduction to experimental procedure, which includes an exposure to problems that accompany physical measurements and an appreciation for the difference between experiment and theory.
3. Some experience with the operation of laboratory equipment.

There will be 10 laboratories performed during the semester. The students are expected to read the material in this manual pertaining to the week’s work, review relevant material in the text book and complete any preliminary exercises (available through the campus network) before coming to the lab.

**All preliminary exercises but must be finished before your lab period.** The course relies on the JMU computer network for prelab preparation and quizzes. This is an attempt to provide better resources for the student and to provide an efficient method for completing the prelab quiz. To view materials for the lab start at location [http://csm.jmu.edu/physics/html/courses.htm](http://csm.jmu.edu/physics/html/courses.htm) or choose the Course page link on the physics department's home page. Your instructor will discuss this in more detail during the first lab period. Be sure that you are clear on the ground rules for submitting your prelab materials. Also be sure to inform instructors of problems or concerns so that the best use of these facilities is realized.
For most of the labs and exercises a lengthy in-depth write-up of each experiment is not required. The student is expected to produce straightforward summary sheets for tabulated data, analysis results, calculations, graphs and answers to questions using an excel spread sheet. Usually the material will be examined and graded by the instructor during the lab period or, if necessary, reports can be handed in the following week. The instructor will decide. Often particular aspects of the experiment will highlighted and the required experiment summary will reflect these aspects.

One lab during the semester will require a complete laboratory report. Each student should prepare a separate report. The earlier labs will serve as a preparation for performing this lab. The student will be given equipment and some general ideas, which will serve as a starting point. Each group will be expected to develop a lab that explores the problem posed. The details of how to prepare this report are given in the lab instructions for that lab in this manual.

Most of the labs will use a computer to assist the student in recording and analyzing data. There are a few common sense practices that should help make the computers easy to use and reduce computer problems.

**Record your work and data to disk.** At any point in the lab data can be transferred to a disk. The lab computers are reset every Monday so anything saved on the local machine will be lost. There is a network disk Phystu on Csmres. This area is accessible from computers that are logged into the physics lab account (not just the lab computer). Backing up your work provides the fastest recovery time if data should be lost due to a computer failure or if data is accidentally corrupted during analysis. If you have questions on how to complete a lab or questions on your lab grade your instructor will need to be able to examine your work. You or your lab partner should therefore keep a copy of your work until your lab is graded.

**Keep notes.** As you progress through the semester you should become increasingly more competent using the computer. As you are learning how to use computer tools you should make notes in your laboratory manual, especially for the analysis program which will be used frequently.

**Take turns.** You learn much faster by doing. Each person should be able use the equipment introduced in the lab. It is therefore a good idea for each group to take turns and not rely on one person.

In general we expect a mature approach to the labs. Although the labs will not be intentionally misleading or incorrect, the student is expected to pay careful attention to the instructor and be able to make changes when necessary. If significant changes are made to the lab these changes should be documented in the report.
Grade

The lab grade will be based on the following scheme:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
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<tbody>
<tr>
<td>50%</td>
<td>Lab grades assigned before the end of each lab period by the instructor (9 labs) based on completion of assignments and quality of the work.</td>
</tr>
<tr>
<td>10%</td>
<td>Pre lab quizzes (9) completed before the lab. (No quiz for first lab)</td>
</tr>
<tr>
<td>40%</td>
<td>Independent lab, one report for each student</td>
</tr>
<tr>
<td>100%</td>
<td>TOTAL GRADE</td>
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Missed Labs

Attendance for all labs is required. There is a make-up lab scheduled. This is only for students with a legitimate need to miss a regular lab. In the event of a conflict or problem with a scheduled lab the student must make prior arrangements with the instructor, otherwise a documented medical excuse is required.

Etiquette and Computer Problems

You should try to leave the computer and set-up in a working state for the next group. We expect that occasionally students may inadvertently create problems. Deliberate attempts to sabotage a computer or equipment will be considered an honor violation.

Computer System

Each lab station is equipped with a computer running Microsoft Windows 98. These systems will be rebuilt on Mondays. Unaltered copies of all lab data and setup files are available on the lab system server. There should be folder on the desktop that points to this directory. When in doubt, students can obtain new copies of materials for the lab. Your blue binder contains additional information on computer use.

Additional material can be found under the Physics 150L course heading on the Course link under the physics department home page (http://csm.jmu.edu/physics/html/courses.htm).
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other schedule on this page