General Laboratory Procedure

Course Objectives

The goal of this course is to introduce students to laboratory procedures and learn to keep an accurate record of their experiments and results. Laboratory work is an essential part of science because it is how we test hypotheses and theories to determine which ones best describe observations in the natural world. The more accurate the test, the more confidence we have in its results. Thus, we develop laboratory techniques and skills to perform experiments with the highest degree of accuracy as possible. In many of the experiments you conduct throughout this course, the quality of your results will directly reflect your measurement techniques and ability to follow procedures.

Once we obtain our data, we must analyze to understand its significance and application to the developed hypothesis and theories. A very important part of the analysis is the error estimate of the data. Without any estimate of error, we have no way to gage the value or significance of the results. We also cannot compare the results to those obtained during different experiments. Error analysis is just as important as the values and conclusions you achieve during your experiments.

This laboratory will consist of experiments of differing types and lengths. Some will be highly structured while others will require some genuine experimentation of your own design. The computer will also be used as a tool for acquiring and analyzing data. The structure of this lab is designed to minimize work outside of the scheduled laboratory period. Ideally, no work on laboratory material should be done outside of the scheduled session, other than some advanced review and reading. This is possible, however, only if you make efficient use of both your time in the lab and also of the instructor's assistance during the lab period.

In the case of a laboratory absence, contact the instructor, in advance if possible, to arrange for either an alternate section of attendance or to schedule makeup work. There will also be alloted time toward the end of the semester for students that need to makeup work.

Laboratory Format

The Laboratory Notebook

Your laboratory notebook will be turned in at the end of each lab period. You will choose a partner to work with, and you will work on the experiment together. However, your laboratory notebooks will be completed and individually graded. In other words, while you share your experiment, the notebooks are individual work. Remember that your laboratory notebook is a log of your experiment. It is not meant to be a finished report or paper, but it should contain descriptions and explanations of the experiment such that you can go back at a later date and understand the experiment and your results.A reader should be able to reproduce your experimental results using only the information in your notebook. The following items should be included for each experiment in your laboratory notebook:

a) Purpose or Goal: Make the objective and intended outcome of the experiment clear to the reader.

b) List of Materials: Include the equipment needed to complete the experiment.

c) Diagram of The Experiment: Include a diagram mapping out the set up of the equipment, allowing the reader to recreate the experiment in the laboratory.

d) Experimental Procedure: Include a detailed procedure of the experiment in your notebook, such that every step of the experiment can be repeated by the reader.

e) Answers to Questions: Include answers to all questions ask of the student in the instructions for each particular experiment. These questions will be graded by the instructor as part of your notebook grade for each individual experiment.

f) Data: Include any data taken in your notebook, usually best displayed in a table or chart. This includes any graphs or computer printouts created with the data.

g) Calculations and Analysis: Include any calculations and analysis conducted in the experiment in your notebook in an orderly fashion. This includes percent error calculations, giving a predictable range to your data.

h) Results and Conclusion: Include a final summary of results in your notebook followed by a conclusion. In other words, state if the experiment was successful or not.

i) Error Analysis: Include an error analysis in your notebook, discussing problems with the experiment and possible improvements that could be made.

Your notebook should be clearly legible, neat, and contain all of the relevant information, such as units and equations. Neatness and clarity are two of the most important aspects of your notebook. While you may easily be able to read your own handwriting, someone else who uses your notebook at a later time as a guide may not be able to understand your work if its not neat and well laid out. Also, any graphs or tables you have in your notebook should be properly labeled and have the correct units. A graph for example, should have the $x-$ and $y-$axis clearly labeled with the correct units, a title, and a legend.

Quizzes

A short quiz will be given some weeks at the end of class when you have competed your labwork. The quiz will require you to reproduce a small aspect of the experiment testing what you learned from the current weeks exercises. The quiz should take no more than 10 minutes, and will be graded on the accuracy of your results.

Special Projects

During the last week of the semester, you will conduct an experiment similar to one of the experiments you performed during the semester. The special project is a form of a test intended to measure your ability to conduct an experiment, understand laboratory and data analysis procedures, and reproduce accurate results. During the special project you will conduct the experiment by yourself and only be allowed to use your laboratory notebook in completing the project. Therefore, it is extremely important to keep a very through record of your experiments in your notebook.

Attendance

Attendance is REQUIRED by Lehigh University rules and procedures. If you are absent due to medical reasons, you should obtain an excuse from the Dean of Students. If you are absent due to other conflicts such as athletics, you must contact your lab section instructor in advance, as well as obtain an excuse from the Dean of students. Only then will the instructor work with you in a timely fashion to make up the lab. Failure to follow this protocol for absences will result in a grade of zero for the missed lab.

Classroom Protocol

The physics laboratory is a place for learning. Throughout the semester, you will be working with many expensive pieces of equipment. There is to be NO FOOD OR DRINKS in the laboratory classroom. Not only could spilled drinks or food ruin the equipment, it could be very unhealthy to use the equipment and then touch and ingest food. If you are caught with food or drink in the lab, you will be asked to leave the classroom and either dispose of items or finish with them outside the lab setting.

Grades

A student's grade in the course is determine by the average of the graded lab experiments in the notebooks, the average quiz grade, rand the special project grade. Grading of all materials is the responsibility of the lab instructors, with oversight from the professor in charge of the course. The grades for the course may be curved for each section, and the final letter grade may depend on your relative score as compared to the rest of the students in your section. The breakdown of your grade for the lab is as follows:

Laboratory Notebooks

During the course of the semester, the laboratory instructor will collect the laboratory notebooks after each laboratory session. The instructor will go through the reports and grade them to make sure the work is being completed correctly. The grading will be based on a rubric based on the items described above which are expected to be included in your laboratory notebook. The rubrics for each experiment will be made available to you by the instructor. Comments may or may not be written in your graded notebook, depending on the quality of your work. The graded laboratory notebooks will be worth 60% of your grade in the course. In assigning this 60%, effort and participation in the class will certainly be considered. Remember, that the purpose of the laboratory report is to help the student keep an organized record of the work done in the laboratory. Instructors will look for things including description of the equipment and procedures, accuracy of the results, error analysis, conclusions, neatness, and organization.

Quizzes

Quizzes will be graded soley on the accuracy of your results. The closer your solution is to the actual answer, the higher your grade. These quizzes will be averaged together and make up 20% of your grade in the course.

Special Projects

The special project grade will be based on the accuracy of your answer as well as the presentation and organization of your work. This will be the complete reproduction of a previous experiment, but with a slight difference or twist. The special project will make up the other 20% of your grade in the course.

Final Comment

Your laboratory instructor is there to help you with the laboratory procedures and understand the material. However, they are not there to run the experiment for you, perform your calculations, or draw conclusions from your data. The process of understanding the strengths and weakness of your experiments, data, and relating the results to theory are very important parts of being a successful scientist or student.