

PHYSICS 2150

LABORATORY

Prof. Eric D. Zimmerman

TA: Geruo A

Lab Coordinator: Jerry Leigh

Lecture 1
August 29, 2006

SCOPE OF THE COURSE

- This is your experimental introduction to modern physics!
- “Modern” in this case means roughly the 20th Century
- Your goals:
 - Learn how to take data efficiently and precisely
 - Learn proper use of uncertainties/error analysis
 - Learn how to present your results in writing and graphic form

INSTRUCTOR CONTACT INFORMATION

- Instructor
 - **Prof. Eric D. Zimmerman** (edz@colorado.edu)
 - Office: Duane F-435, x5-5338
 - Office hours: Mondays, 9:30-11:30
- Teaching Assistant
 - **Geruo A** (geruo.a@colorado.edu)
 - Office: Duane C123
 - Office hours:
- Lab coordinator:
 - **Jerry Leigh**
 - Office: Duane G2B78A, x2-7368

REQUIREMENTS

- PRE/CO-REQUISITES
 - Have completed PHYS 1140
 - Are taking / have taken PHYS 2170 or 2130
 - Familiarity with numerical calculation program (Mathcad, etc.)
- SUPPLIES
 - Syllabus (handout; on WWW)
 - Lab manual (handout)
 - Lab notebook with carbon duplicate pages (1 per student supplied)
 - Error analysis pamphlet (handout)
 - Radioactive material handling training
 - Textbook: Taylor, "An Introduction to Error Analysis" (required)

COURSE SCHEDULE: LECTURES

- Lectures are Tuesdays, 4:00-4:50, through October 3.
 - There will be no lecture on September 5.
- PLEASE READ THE APPROPRIATE CHAPTERS IN TAYLOR BEFORE EACH LECTURE!
- Lecture 1 (August 29):
 - Review of syllabus
 - Tour of lab room
 - Error introduction
- Lecture 2 (September 12): read Taylor Chapter 5
 - Statistical and systematic uncertainty
 - Gaussian distributions, mean, standard deviation

COURSE SCHEDULE: LECTURES / HOMEWORK

- Lecture 3 (September 19): read Taylor Chapters 6, 7
 - Rejection of data
 - Weighted averages
- Lecture 4 (September 26): read Taylor Chapter 8
 - Least squares analysis
- Lecture 5 (October 4): read Taylor Chapters 9, 11
 - Correlation analysis
 - Poisson statistics
- Homework: One assignment, worth about 0.5 labs (assigned after lectures)

COURSE SCHEDULE: LABS

- Signup:
 - Sign up for experiments on the door pages in the lab.
 - Sign up one week in advance; don't sign up for the whole semester at once.
- You must do six labs; at least 2 “advanced” (see syllabus)
- Lab partners:
 - You may work alone or with one partner
 - You may not have the same partner for more than two labs.
- Most labs are 2 weeks; turn in the lab report at the end of your section on the second week.

LAB RULES AND PROCEDURE

- You will be issued a lab notebook, with duplicate pages.
- Everything must be recorded in your lab book!
 - Record in ink; do not erase. Correct mistakes by crossing out items, leaving them legible.
 - Use the carbon paper to produce a copy onto the yellow pages, which you will hand in.
 - Do not remove the white pages.

LAB SAFETY

- Some experiments use radioactive materials. You must complete the on-line radioactive handling course.
- The biggest hazards in the lab are high voltage (enough current capacity for an unpleasant shock!) and trips/falls. Never touch energized electrical components, and always look out where you are going!
- Treat the equipment with care. The modern equipment is expensive (and parts can have a long delivery time). Some of the classic instruments cannot be replaced.

GRADING

- Grades will be based mostly on the lab reports, with the homework assignment worth about 1/2 of a lab report.
- Lab report deadlines are listed in the syllabus
- There are penalties for late reports. Read the syllabus!

YOUR LAB REPORT

- You may use the yellow pages from your lab notebook as your lab report. Add any computer-generated work (Mathcad output, etc.) separately. You may write text on a computer as well, if you choose.
- Number and date all pages in your book, and be sure they show up on the yellow page

YOUR LAB REPORT: FORMAT

- Experiment title
- Objective: 1-2 sentence description of scientific goal (not “to learn about....”)
- Idea: Paragraph or two giving background and physics to be tested.
- Apparatus: Explanation of equipment. Diagrams strongly encouraged!

YOUR LAB REPORT: FORMAT

- Procedure:
 - Summary of process, including unexpected occurrences. What did YOU do?
 - Discuss problems and how they were resolved
 - Include details! Should be sufficient for someone else to do the experiment
- Data:
 - Include the complete data set, either printout or raw data tables from your notebook

YOUR LAB REPORT: FORMAT

- Data Analysis:
 - Analysis of data and results.
 - Include sample calculations
 - Tables are a great way to organize information
 - Make data plots, including axis labels and error bars
 - Estimate all uncertainties — statistical, systematic

YOUR LAB REPORT: FORMAT

- Conclusions
 - Short discussion summarizing results
 - Further comment on uncertainties: explain basis of assigning them, possible hidden errors, etc.
 - Compare results to accepted value: what is level of agreement based on your error estimate?
 - Stick to scientific conclusions! No opinions, no personal comments.
- **READ THE SYLLABUS FOR DOS/DON'TS ON YOUR LAB REPORT!**

UNCERTAINTY

- As used by physicists, “error” is a synonym of “uncertainty.” It is distinct from “discrepancy” or “mistake.”
- A result is meaningless without an uncertainty. ALL results should be quoted with an error!
- The uncertainty can result from inaccurate equipment, limited statistics, or other factors beyond your control
- Uncertainties should have 1-2 significant digits. The measurement result (“central value”) should have the same final digit as the uncertainty:

GOOD	BAD
1.41 ± 0.07	1.408 ± 0.07
6.7 ± 1.3	6.7 ± 1
0.1006 ± 0.0022	0.1006 ± 0.00225