

Instructor: Kara Beauchamp, West Science 108, x4515

Office Hours: I will be in the labs during lab hours, and I will be available by appointment M & W between 11 and 12N, and T,F between 3 and 4 pm, or another time by appointment.

Class Hours: Labs will generally run from 9am-11am and 1pm-3pm. Occasionally, you may have to start earlier or work longer to finish a lab or take a quiz.

Course Materials: You need to have a dedicated, spiral bound lab notebook to record your experimental process. Your laptop computer and a scientific calculator will also be useful.

Course Objectives:

Experimental physics is inherently a problem solving exercise. There are many questions that must be answered to do experiments:

What question am I trying to answer?

What measurements do I need to make to answer the question?

How can I make those measurements?

How can I interpret the results that I get from my measurements?

With what certainty can I answer my question, based on the results of my measurements?

In this class, you will get practice answering all of these questions for situations involving different physical principles that you learned about in your introductory physics courses and for some topics that are new.

Specifically, by doing the work in this class, I expect that you will:

Learn and appreciate the techniques and difficulties of the experimental process

Understand and treat error and uncertainty in experimentation

Learn to use computers for data acquisition and analysis

Understand the assumptions made in physical theories and the limitations thereof

Improve your understanding of physical concepts learned in earlier courses

Apply theoretical principles to open-ended, real-world problems

This course supports the Educational Priorities and Outcomes of Cornell College with emphases on *inquiry*: you will confront the complexities of developing an understanding of our physical world through experimental techniques using research skills, creative thinking, and analysis; *reasoning*: you will evaluate evidence; interpret data; and use logical, mathematical, and statistical problem-solving tools; *communication*: you will practice informal communication through group work and formal communication through written reports and oral presentations.

Attendance: Attendance is required for the course. An absence will be excused only if you obtain my *permission* before the absence, if you are too sick to come to class, or you experience a serious emergency. In the case of a serious illness or emergency, you must notify me by phone or e-mail as soon as possible and the emergency must be verified by some kind of evidence. You may make up work from an excused absence. Absence for any other reason and excessive tardiness (more than 15 minutes late) are both considered unexcused absences. You may make up work from a single unexcused absence.

Lab Instructions: Lab instructions will be available on Moodle

Coursework: The total number of points available for the course is 600.

Labs: You will carry out one or two labs per day. This is the most important part of the class, and your attendance is required. Labs will be classified as Type A, Type B, Type C, or Type D, depending on the assignments you are required to complete for the lab.

Lab Guidelines: General instructions for error analysis and graphing will be provided and you should bring these instructions to the lab every day. Information for each experiment will be available prior to the lab session. Lab work will generally be done with partners or groups, which will be assigned by the instructor.

The Lab Notebook: [5 pts for each of 15 lab days] (**Collected on Fridays for grading.**)

Scientists need to keep clear, detailed records of their experimental work, and you should strive to do the same. Some of your lab records can be stored electronically (in a spreadsheet or a Word document). But for each day's lab, you should record information in your physical spiral bound notebook. The information should include the equipment you used, the lab procedure you used, the names and locations of the files in which you recorded data or other information, and any other written work associated with the experiment.

Pre-Lab Assignments: Pre-Lab assignments must be completed and correct before you begin each lab. I will check your pre-lab assignments before you begin the lab. If you haven't completed your pre-lab assignment by the time it is due, your lab partner will have to wait for you. Not all labs have pre-lab assignments.

Post-Lab Assignments: Different labs will have different post-lab assignments, depending on their Type (A, B, C, or D). Post-Lab assignments include a Check-out Interview (A), a Calculation Write-up (B), a Results Write-up (C) or a Full Lab Report (D).

Checkout Interview: [5 pts each for 15 lab days] All labs types require a check-out interview, which you must complete with me before you leave for the day. In the interview, you will explain the measurements you made, show me the results of the experiment, and explain your interpretation of the results. I will examine your lab notebook to make sure you have recorded the required information. Sometimes I will ask you to share your results with the class. I may ask you to repeat or improve your work before I confirm that you have completed the lab. Labs of Type A require only a checkout interview for credit.

Calculation Write-up: [10 pts each for 3 lab days] Labs of Type B require a calculation write-up in addition to the checkout interview. The calculation write-up should include a brief description of the measurements you made and should clearly present the quantities you measured and their uncertainties. It should describe the method you used to calculate important quantities in the lab, including uncertainties. You should make sure to include the values (and uncertainties) of all of the quantities that were necessary to carry out the calculations. Any numerical result you present should have units and an uncertainty associated with it, and should be stated with an appropriate number of significant figures. The write-up should make a clear presentation of the *results* of the calculations that you made for the important quantities in the lab as well their uncertainties. Also write a few sentences to explain the physical phenomenon involved in the lab and what your results showed about that phenomenon. You may write this document by hand or type it. The calculation write-up must be your own work (independent of your lab partners). Include your partners' names on the document.

Results Write-up: [15 pts each for 6 lab days] Labs of Type C require a results write-up in addition to the checkout interview. For labs requiring a results write-up, you should write a report in paragraph

form which includes a brief description of the measurements you made and explains and interprets the results of the lab. The results write-up must be your own work (independent of your lab partner), and it is due at 9 am two days after you do the lab. Include your partners' names on the document.

Content: There are two main things I want to know in this results write-up.

(1) I want to know that you get the *concept* of the physics involved in the experiment, so you need to explain the concept to me in your own words (what was the experiment about?)

(2) I want to know how the data you took addresses the concept and intent of the lab.

(a) This portion of the write-up should give the “result” of the lab, which may be a single numerical result with associated uncertainties, a table of numerical results, or a graph of your data. Any numerical result you present should have units and an uncertainty associated with it, and should be stated with an appropriate number of significant figures. If you fit a curve to your data, show the curve on the graph and report the fitting parameters. You should also include all of the measured values that I would need to recalculate your result. Your “raw” (pre-analyzed) data should be recorded in your lab notebook or in a data file saved in an identified location and must be available for me to examine, in case I have any questions.

(b) Your write-up should also include a description of the graph or result, and the conclusions that you can draw from your data.

Submission: The results write-ups should be typed, double-spaced, spell-checked, grammatically correct, and printed. You may make your graphs available to me electronically to save paper, and I encourage you to print your report double-sided.

Full Lab Report: [2 reports, 60 pts each] There are two lab sets of Type D. For these labs, each lab group will complete a different experiment. You will write a full lab report for both labs of Type D that you complete. The full lab report must be your own work (independent of your lab partner). I will provide more information on the requirements for these lab reports. Late submissions lose 10% of the possible points every 12 hours beyond the due date. You will have the opportunity to revise the first full lab report one time to receive half of the points that you missed on the first submission. Revision is due on Wed, Nov 13 at 5 pm.

Submitting Revisions: You should submit your revision by e-mail. You must also submit the original printed, graded version of your report to me. When you turn in your revised report, you must include with the new version a written explanation of the changes that you made to the report and a description of the reasons that you made the changes. For instance, if you made grammatical corrections, you should not tell me each correction that you made, but you should tell me the types of corrections you made, like “I corrected several run-on sentences, making each sentence a complete, distinct sentence.” If you added content, or details, tell me what kind of content or details you added. So, don't tell me each word, sentence, or paragraph you changed, but do tell me about all of the types of changes you made.

Lab Presentation: [2 presentations, 30 pts each] For each lab of Type D that you complete, you will make a group presentation to the class. I will provide more information on the criteria for the presentation.

Lab Presentation Quiz: [1 quiz, 30 pts] For the first lab of Type D, there will be a quiz covering the topics of all three labs. You will be required to learn the lab concepts for the quiz from your classmates' presentations.

Article Response Papers: [2 papers, 30 pts each] I will assign two articles on recent physics experiments that the whole class will read and discuss. You will write a response paper for each article. Late submissions lose 10% of the possible points every 12 hours beyond the due date. You will have an

opportunity to revise the first response paper one time to receive half of the points that you missed on the first submission. Revision is due on Wed, Nov 14 at 5 pm.

Lab Topics Quizzes: [2 quizzes, 30 pts each, each with 2 questions] The quiz topics are uncertainty analysis and graphical analysis. These quizzes will be closed notes and closed book. To pass a quiz question, you must get the answers to the question substantially to completely correct, in which case, you will receive 100%. You may take a quiz on a topic multiple times, but your grade will be reduced by 10 % each time you take it. Quiz retakes must be arranged outside of normal class hours. If you don't pass the quiz question, you will get 0. Only one quiz on each topic may be taken in one day.

Academic Honesty:

Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgement of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Catalogue, under the heading "Academic Honesty."

Students with disabilities:

Cornell College makes reasonable accommodations for persons with disabilities. Students should notify the Coordinator of Academic Support and Advising and their course instructor of any disability related accommodations within the first three days of the term for which the accommodations are required, due to the fast pace of the block format. For more information on the documentation required to establish the need for accommodations and the process of requesting the accommodations, see <http://www.cornellcollege.edu/academic-support-and-advising/disabilities/index.shtml>.