

Physics 360

Biophysics Laboratory

The teaching staff wants all of you to learn about how experimental physicists overcome research problems and obtain important results by doing three relatively sophisticated experiments during the course of the semester. These experiments are not canned experiments written up in cook-book fashion which work properly each time they are set up. In these experiments important biophysical principles are explored. Their successful completion depends upon proper selection of equipment, the solution to immediate unexpected problems, and careful data collection, much the way research proceeds. Final reports can outline new experiment designs, equipment modification and fresh new ideas about how to make the measurements better. These are precisely the type of problems and/or opportunities facing scientists in the real research world. Students should feel free to discuss opportunities for change and/or improvements as the experiment proceeds, integrating these into your written and oral presentations.

I. Lab Participation

Each student will receive a grade for class preparation, attendance and for their demonstration of independence and ingenuity in their work carried out in the laboratory. Students who need to miss a class period for interviews, etc., need to let both the instructor and their lab partner know at least one week ahead of time.

II. Data Notebooks

Data notebooks are diaries of the work done in the lab. They should contain a record of the experimental setup, all equipment settings used, and all numerical data taken or graphs thereof. Since they are the only source of original data, all notebooks should be neat and contain sufficient information that a similarly qualified researcher can reproduce the results from the notebook alone and arrive at similar conclusions. One notebook will be kept and turned in per group per experiment.

III. Oral Presentations

An important part of scientific research is communicating your results to the scientific community. Often the first method of reporting important new scientific findings is in oral presentations at scientific conferences. The oral presentations in Physics 360 are meant to simulate a scientific presentation at a conference. They are to be brief (~15 minutes), concise and informative. In Physics 360 these will differ from conference presentations in that they will be: (1) a learning experience in the sense that both staff and other students can make suggestions they feel would improve your presentation; (2) each presentation will be divided into two parts (the theory and description of apparatus will be presented by one student and the results and interpretation will be presented by the other. Oral presentations should make use of Power Point presentations for clarity and efficiency of presentation.

Grading will be determined by:

- a) staying within the 15 minute time limit
- b) organization of talk
- c) clarity of speaking and quality of slides
- d) level of understanding of content and subject
- e) quality of discussion of results and conclusions

IV. Research Papers

The final result of physics research is publication in an appropriate journal. In Physics 360 you are asked to prepare a document following the general format of a *Physical Review*, *Science*, *Review of Scientific Instruments* or other similar publication. This document uses your data notebook as the only source of raw data. Information included in referenced articles may supply supporting information and theoretical models. Research papers should be prepared on word processors with references, figures and tables included as appropriate. As in scientific publications, all experimental data should be carefully analyzed and thoroughly checked. All experimental uncertainties, both systematic and random, must be included in the results with the expected precision reflected in the number of significant digits shown. You should properly propagate errors through all stages of computation. See *Theory of Error Propagation* handout for details.

In the final section of the paper, point out problem areas and make recommendations for improving the experiment.

In addition to handing in a paper copy of your publication, a PDF copy of your publication must be emailed to physics360@physics.wustl.edu. If you have trouble making a PDF copy of your publication, ask the TA or instructor for help.

V. Grades

The final grade will be based on lab performance (10%), the lab notebooks (10%), the oral presentations (40%) and the publication (40%). The following section explicitly states what is expected of the student. The staff will attempt to provide constructive feedback during and after the oral presentations.

VI. Grading Rubric

1) *Lab Participation (individual grades)*

1. *Preparation for experiment 30pts*
Read the lab write-up and literature documents **before** starting the experiment
2. *Quality, ingenuity and independence of the work carried out in the lab 30pts*
3. *Presence in the lab during class time 30pts*
 - a) Class is from 1:10-5:00 pm Tuesday and Thursday
 - b) If you have to miss a class period, you must notify your lab instructor and partner
 - c) You must make up the time missed outside of class time
4. *The experimental workspace must be left in a tidy state 10pts*

2) *Lab Book (combined grades)*

1. *Evidence of critical analysis 25pts*
This includes relevant notes during the experiment and brief analysis of results at the end of each day.
2. *Is Procedure Reproducible? 25pts*
You should keep your notebook in the form of a journal, with an entry for each day you are in the lab, even if not much happened. You should write your notes assuming that someone is going to repeat your work with the same apparatus. Be sure to note everything that could have affected your results or caused problems.
3. *Is documentation concise? 10pts*
You don't need to write too much background or details that may not be needed. Write down everything relevant that happens each day, using clear language.
4. *Proper presentation of data 15pts*
This includes clear presentation of tables, as well as reporting units and error estimates on all data. If you are calculating a quantity or converting measured values to something else, show an example of the full calculation once.
5. *Error Analysis 20pts*
This includes both physical estimates and quantitative results when applicable. Some experiments will require a propagation of error calculation, and some will rely on physical estimates such as averaging or noting the spread in measurements. If a propagation calculation is needed, you should show the calculation.
6. *Clarity of work 5pts*
Your work should be legible and well organized. Always use a pen. Never completely eradicate a mistake. Just cross it out so that it is still legible. It may be useful to see what the mistake was, or it may not be a mistake after all.

3) Presentation (individual grades)

1. *Total time limit 15 minutes 10pts*
Practice talks...make sure you have enough time for results
2. *Organization 25pts*
3. *Clarity 25pts*
 - a) Speaking
 - b) Slides
4. *Content/Subject Knowledge 25pts*
5. *Good discussion of Results and Conclusions 15pts*

4) Publication (combined grades)

1. *Title, Author List and Affiliation*
2. *Abstract 5pts*
3. *Introduction 15pts*
 - a) Objective/Goal
 - b) Theory/Review
4. *Methods/Procedures 15pts*
 - a) Outline of procedure/Specific measurement details
 - b) Apparatus figures/diagrams
5. *Results 30pts*
 - a) Analysis
 - b) Tables/Graphs
 - c) Uncertainties
6. *Discussion 30pts*
 - a) Comparison of experimental results to predicted results
 - b) What went wrong?
 - c) How to improve?
7. *References 5pts*
Cited in the text, numbered in order of appearance in text