

Everything you've ever wanted to know about the Lab... but were afraid to ask

These labs are different from what you might be used to.

If you have done science labs before, you were probably told exactly what to do. But that's not the way we really do science. In this lab you have an opportunity to develop your skills as an experimental scientist.

What's different?

- 1. You design your own experiment to answer a question.**
We give you a question; you and your team think about how you can make a measurement to answer the question. And you will need to consider how the design of the experiment affects how sure you are of your result.
- 2. Sometimes the lab comes before lecture.**
In real life, you often have to explore a phenomenon experimentally first. Some of these labs you do with the idea that you determine the answer experimentally – not by looking it up somewhere – just like in real science.
- 3. It's not only your result that matters; it's how good it is – quantitatively.**
No experiment gives an exact result or the same result every time it is repeated. What your result tells someone is, "If you repeat my experiment you should get this answer." A better way to say this is, "If you repeat my experiment, I would give 2 to 1 odds that your result will fall within this range of answers." (The "2:1 odds" is a good range to use as a standard.)
- 4. Your team presents your results to the rest of the class.**
Real science is a community process. Every experiment is considered by others and often challenged. The process of many people thinking about everyone's work helps find the real answer and purge the "wishful thinking" we are prone to.
- 5. These labs are not meant to demonstrate some idealized theory.**
Most of the rules you learn in physics are idealizations. They only work if certain assumptions are true (for example, there is no friction). When those assumptions are not true, we ask the question: are the results "almost true"? Can we correct them, either by changing our experiment or adding more to our theory?
- 6. These labs are not meant to teach you some particular concepts in support of what you are learning in lecture.** You are likely to have to use the concepts and equations you learn in lecture so it might help, but that is not their main point.

The Experiments

Before you come to lab

Designing, carrying out, and presenting your results can be time consuming, so you will have two weeks to do some of the labs. Even with 4 hours, there is still a lot to do.

- *Read over the lab before you come in.*
- *Spend some time thinking about how you might do the experiment.*

While you are in lab:

Since there is a lot to do, it is very important to keep to a schedule. The lab handouts suggest a time plan.

- *Focus on your goals and tasks in the lab. Don't waste time.*
- *If you take a lot of time on irrelevancies, you may have trouble finishing.*

Document what you are doing in a lab writeup created as you go. Each team member has a role – and three of the roles write up parts of the report.

When you leave the lab:

- *At the end of week one of a two-week lab, be sure each team member has a copy of the data.*

You don't want to arrive in the second week and find the only person with your data has dropped the course (or is sick, or is away at a sports event, or forgot it, or ...).

- *At the end of a one-week lab or the second week of a two-week lab, hand in your finished lab writeup before you leave.*

There is no out-of-class lab work permitted after the end of the lab.

Grading

The lab grade makes up part of your total course grade. This grade will be based on your team's lab writeups and your individual participation in the class discussion.

Lab Writeups

At the end of the experiment, your team will hand in a complete lab writeup – a persuasive log of what you have done in lab meant to convince a reader who did not see you do the experiment that you have done it carefully and correctly. A one-week-lab writeup is worth a maximum of 10 points. A two-week-lab writeup is worth a maximum of 20 points.

The writeups must include three components:

- *A Journal*: Discuss what you did, how you designed your experiment, and what results you got, written so that an absent student could understand and repeat your experiment.

If you followed false trails that you gave up you should explain them here with your reasons for giving them up.

- ***Data and Interpretation:*** Present your data, in a form easy for an absent student to understand. Discuss what your data means, conclusions you've drawn, and make a persuasive *case* to convince your reader that your conclusion is valid.
- ***Evaluation:*** After you've had a chance to see what data and conclusions other groups have gotten, go back and reconsider what you've done. Discuss how you could improve on your experiment in light of what you learned during lab and the class presentations.

Roles

In order to facilitate the preparation of the lab report, you will be working in groups of *four*. The division of labor will be as follows:

1. ***The Journalist:*** This person is responsible for taking notes of everything that happens during the experiment, and writing up the "Journal" section of the lab report.
2. ***The Data Interpreter:*** This person deals with tabulating and displaying the data, operating the computer, and writing up the "Data and Interpretation" section of the lab report.
3. ***The Critic:*** This person is responsible for taking notes during the class presentations and discussions, and for writing the "Evaluation" section of the lab report.
4. ***The Checker:*** This person is responsible for checking all sections of the lab report before it is turned in, reading the comments made by the grader on past lab reports, and suggesting ways to improve.

You must rotate roles every week so that each person gets a chance to do every task at least twice. While the lab report is a group grade, it is necessary that you show that you are pulling your own weight in the group work. But working on lab reports is *group* work. Part of the goal is to give you practice working together in a group. Not every group works smoothly together at all times. Part of your task is to find ways to cooperate to cover difficulties. For example, if one person is having trouble with their particular task in a given week, the checker should serve as a support person and collaborator to help out.

Because of the structure of writing the lab report, you must work in a group of 4 or 3. If there are only 3 in your group, share the role of checker.

Participation in Class Discussion

Writing the evaluation can be hard! It's difficult to see how you could improve your experiment. If you could do that, you would have done it better in the first place! That's why we have the class discussion – to help you think about your experiment again and write your evaluation.

Your contribution to the end-of-lab discussion is worth 5 points (as an individual). You will be evaluated in part on your participation in your own group's presentation (0-2 points), and in part on your participation in other groups' presentations (0-3 points). In the latter, we are looking for you to make significant contributions to other groups' understanding of their lab, not just raising your hand and asking "why didn't you take more data?"

The grading for each lab is as follows.

<i>Criterion: Lab Writeup (as a team)</i>	<i>Points for a 1 week lab</i>	<i>Points for a 2 week lab</i>
<u>Design and thoughtfulness.</u> Did your team do a careful and thoughtful job in creating your experiment, and was this thought reflected in the journal?	2.5	5
<u>Clarity and completeness.</u> Did your team explain your experiment so that someone could reproduce it?	2.5	5
<u>Persuasiveness.</u> What conclusions did your team draw from your data, and were you able to back up these conclusions with this data, in a convincing way?	2.5	5
<u>Evaluation.</u> After observing the experiments of other groups, were you able to critique your own lab, propose constructive changes, or explain why your experiment was better than those of your classmates? (The question you are answering in your evaluation is, "If I got to re-do this experiment next week, how would I do it differently?")	2.5	5
<i>Criterion: Participation (as an individual)</i>		
<u>Contribution to team presentation:</u> Did you actively participate in both the preparation of the presentation and its delivery?	2	2
<u>Contribution of other teams' presentations:</u> Did you ask useful questions or make comments that were valuable to the other teams' writeups of their evaluations?	3	3

Your grade will not depend on whether or not your numerical results agree with some accepted standard but on how well you conceived and carried out the experiment.

Attendance

Attendance at every lab is required. If you anticipate missing a lab, or have missed a lab, contact your TA or the lab instructor immediately. Only those with a VALID WRITTEN EXCUSE for missing a lab will be allowed to do a makeup activity that will take at least two hours and may involve doing another lab or evaluating one. If you do not have a valid written excuse, you will get a zero for the week that you missed. If you miss more than one week, you may receive an incomplete or a failing grade for the entire class.