
**DUKE
PHYSICS
LABS
PHY 41/42**

- **What to expect**
- **What to do in order to succeed**

1. What is the purpose of the labs?

Rote learning does not alone constitute knowledge. Real knowledge begins when you are able to confidently use what you know in a flexible way. Knowledge in this sense can be built when concepts and skills are practiced several times, under changing and novel conditions.

Physics labs are intended to provide hands-on experiences with concepts that you have learned. Firsthand experience – the ability to interact with something and explore it – is one of the most effective ways of building knowledge.

Often, a lab will occur one week after you've had the relevant recitation or lecture. This is not an accident. Even as you move on to further topics in your course, it is important to have a fresh look at concepts you have already covered. It is particularly important to see how the behavior of real things corresponds to what you have learned "on paper".

The knowledge and skills built studying physics are broadly applicable. Physics is the study of how the world around us behaves. This is practical knowledge and so fundamental that every professional field makes use of it in some way. In addition, *doing* physics involves practicing important problem-solving and analytical skills. Physics courses therefore serve a dual purpose, because they teach the skills of **systematic inquiry** that form the basis of the scientific method. The labs in this course are designed to utilize and augment these practical skills.

2. What to expect in the labs

In the labs, you will be presented with a variety of situations that are meant to help you explore physics concepts in depth. Labs are completed in groups of 2 or 4; each member of your group is expected to contribute equally. Your goal will be to explore and examine your own understanding of the material through the lab activities.

You will be expected to practice critical thinking skills. To answer many questions, you will be expected to undertake your own investigations. **Draw well-founded conclusions from what you observe in your experiments, then clearly explain your reasoning, and you will do well.**

Lab activities may contain *pre-lab* or *warm-up* questions. These should be answered prior to lab. *Predictions* also must be completed before you attend. While these are not graded for correctness, they are graded on the depth of thought they contain, as well as completeness. We expect that you will sometimes devote a considerable amount of effort to these.

Labs are designed around group discussions of physics topics. They are intended to create an opportunity to re-examine your physics knowledge. We expect that you will discuss your predictions and conclusions with your group members. You are encouraged to discuss your thoughts with other groups as well. You are also encouraged to revise your predictions or your conclusions based upon your discussions. **However, copying of any kind for any reason is never permissible** and may result in expulsion from this course.

Your lab reports are expected to incorporate principles of good scientific communication. You will be expected to generate well scaled, well labeled and readable plots, diagrams, and explanations, as well as answers to all questions in complete sentences. Pages attached to the end of your lab writeup should be referred-to, and all pages numbered. Your answers may often include mathematical statements of how a system should behave, but they should also include an examination, in plain English, of what that statement *means* in the context of a lab activity.

One week prior to lab, a handout detailing the upcoming activity will be posted at:

<http://www.duke.edu/web/physics/PHY41/labs.html>

You will be expected to read this and the relevant sections of your textbook in order to arrive fully prepared for lab.

Workshop Activities

Some of the labs you will encounter this semester contain “workshop” activities within them – that is, you will be asked to design and build your own experiment meant to answer some physics questions given to you. You will be expected to create a measurement protocol as well as a method to analyze your data and extract useful conclusions – in addition to analyzing the uncertainties in your measurements. Four labs during the course of the semester are listed in the course schedule as fully “workshop”-based, while the rest of the labs typically contain a shorter activity which at minimum will require substantial independent application of your experimental skills.

You will be expected to come to lab prepared with a preliminary design for your experiment, as well as information necessary to conduct your data analysis. Your group will be supplied with certain parts, sensors and equipment. Your lab instructor will be there to guide you as you construct the experiment.

Your group will be expected to keep a **laboratory notebook** for these activities. Its usage is explained in the guidelines below.

Thinking About Thinking

Part of the process of critical thinking must include examining your own reasoning. During your lab activities, ask:

- “What (exactly) am I trying to do?”
- “Why am I doing it this way?”
- “Is this consistent with what we know?”
- “What do I expect to observe when I try this?”

Questions such as these, posed to yourself and your group members, can be very helpful.

3. Some guidelines for success

A. Prepare for lab ahead of time.

- a. The lab schedule is posted on the **course website**.
- b. Read lab documents thoroughly ahead of time, and study your textbook.
- c. Lab documents will be available on the course website and at this address:
<http://www.duke.edu/web/physics/PHY41/labs.html>

Lab documents are accessed on the classroom computers. We do not expect that you will necessarily need a paper copy of the lab document, since it can be opened online. If you want a paper copy, you must print it prior to attending lab.

- d. If you have questions concerning the upcoming lab, Email your TA.
- e. If a lab activity has pre-lab questions or predictions, we expect you to finish these before attending lab.

B. Attendance

- a. Lab attendance is a requirement of this course.
- b. If you are unable to attend your regular lab for any reason, you should contact your lab instructor immediately.
- c. You are expected to normally attend the section for which you have registered. Attending a different section without permission can result in points deducted.

C. The classroom is not a public computer lab, and printers are not for general purposes.

D. Group Work

- a. Debate is healthy, but please be **respectful** in your interactions with others.
- b. Be certain you have contact information for all of your group members!
- c. Divide your workload evenly; rotate roles regularly.
- d. Discussing your thoughts, predictions and conclusions about the lab can be very productive. We strongly encourage you to do so with your group members and with other groups.
- e. Good experimental techniques take some practice and cooperation. At times, you may need to re-take measurements to obtain a useful dataset.

- E. Your group will be required to keep a **lab notebook** to be used during the workshop activities. In the lab notebook, you should record your designs, theory, notes, derivations, thoughts, predictions, data, preliminary graphs, and anything else relevant to your experiment.
- F. Report what you have done
- Classroom printers are **only** for printing your data and/or graphs.
 - During lab, take notes as you do the activities.

We expect you will need to devote time outside of class to writing your report.

- Format

Labs designated “workshop” activities in the course schedule will require you to write up your report as a full paper including an *abstract, introduction (containing background and theory), experiment, analysis, results, and conclusion.*

The remaining labs should abide by the following guidelines:

- All questions posed in the lab must be answered in the report.
- Reports must be typewritten in complete sentences.
- Please include the actual question as well as your answer to it.
- As with all scientific communication, answers and results should be presented **clearly** and **concisely**.
- Questions requiring pictures or sketches may be answered by hand.
- Equations may be handwritten legibly.
- Lab reports are due in the proper gradebox slot **on Friday at 4 pm** the same week as lab occurred.
- Your TA will give you a rubric detailing how reports will be graded.

G. Please clean up after you finish – at minimum, leave your lab station just as you found it.

H. Re-examine graded lab reports.

- Review graded lab reports; understand your TA’s comments.
- Ask for more feedback if needed.