

20.309 Lab Guidelines

Welcome to 20.309 Lab! We're excited to have you join us, and all the teaching staff are very much looking forward to a new semester. Much about 20.309 is new this year, so it's likely that we haven't thought of everything. When something does not make sense, ask!

1 Safety

In any laboratory, there is potential for injury if certain common-sense practices are not followed. In 20.309 this is minimal, but it's still important to follow a few basic rules.

1.1 Electrical Safety

Electrical injuries happen when large amounts of electrical power are dissipated by the body. Most often, this happens in high-current situations, which is why you always hear that "it's not the voltage, it's the current that is dangerous." Strictly speaking, both are dangerous, and it's a good idea to avoid becoming a current path.

In 20.309, we will work with only low-power electronics, and nothing we do is likely to cause injury. However, some common-sense precautions, are in order:

- don't connect supply voltages directly to ground
- don't touch any current-carrying conductor with your bare hands

These simple rules will keep you from injuring yourself and damaging circuit components. Some components will have maximum power ratings that should not be exceeded, so pay attention to these values.

1.2 Laser Safety

We will use three laser systems in this lab that are considered Class III and therefore require vigilance and caution during use. You will receive an introduction to laser safety at the beginning of the lab, and a reminder about proper safety procedures before each of the relevant lab modules.

The three laser types are:

1. 2mW red laser diode with $\lambda=635\text{nm}$ (AFM)

This is a Class IIIa laser, and will only damage your eye if you spend prolonged periods of time (many hours) staring at the beam. We do not require safety eyewear. The beam will be well-contained in the apparatus.

2. 5mW green laser pointer with $\lambda=532\text{nm}$ (fluorescence microscope)

This Class IIIb laser is the most dangerous type we will use, because the beam is unconstrained, and you can aim the pointer anywhere while you are building your fluorescence scope. The beam is strong enough to injure your sight, particularly because the human eye is most sensitive to green light. ***Safety eyewear will be provided to you, and you are required to wear it at all times, while you or anyone else in the lab is building their fluorescence scope.*** In addition, whenever working with these lasers, you must turn on the blinking laser safety sign near the door, to warn others that laser work is going on.

3. 175mW NIR diode lasers with $\lambda=975\text{nm}$ (optical traps)

The hazards of this Class IIIb laser come from its higher power level, and because it is invisible, making it harder to be aware of its location/direction. The beam will be largely constrained in the apparatus, and you will not need to make adjustments that might put you in the beam path. Safety goggles will be available, but not required. Please also switch on the blinking door sign.

In general, other important things to keep in mind:

- Always know the path of the beam, and keep any body parts or reflective items (rings, watches, etc.) out of the beam path.
- Always read the pre-labs and know what special precautions you need to take associated with lasers or optics.
- When in doubt about doing something, don't do it before checking with the lab instructor.
- You will sometimes view scattered light from the AFM laser through a stereo-microscope - this is safe as long as the duration is less than eight hours.

1.3 Chemical Safety & Biosafety

Though there is minimal wet work in 20.309, ***please do not bring food or drink into the lab.*** The electronics will appreciate it, and we will also later be handling some bacteria and fluorescent dyes. When needed, latex gloves will be provided, as well as proper containers for disposing of chemical/biological waste and sharps. Please make sure to wash your hands with soap and water after removing gloves and before leaving the lab. Please report any spills or injuries to the lab instructor immediately.

2 Lab Notebooks

To record the experiments and measurements you carry out, each of you will keep a lab notebook.

A lab notebook is one of the key ways that researchers record, organize, and share the work they do. Lab notebooks in research laboratories are the property of the lab itself, and sometimes can serve as legal documents in intellectual property questions and patent disputes. It's therefore important that a lab notebook be complete, organized, and clear. While there isn't necessarily one "correct" way to keep one's lab notebook, it's important to develop good habits from the start, so below are a few helpful guidelines.

Permanence - Use pen to keep records in your lab notebook. Any photos, print-out graphs, or pages that you add should be taped or stapled in so they don't fall out.

Completeness - One of the main purposes of keeping a lab notebook is so that you, or another researcher in your field, can repeat your experiments. Record your experimental procedures and goals, any special techniques or protocols you develop or use, and conclusions you make from your data. **All** data you collect should be recorded directly into the notebook (NOT copied in later from loose bits of paper). Also, write in any calculations you make or key equations you use or derive. For data collected with and stored on a computer, it's a good idea to make note of file names and experimental conditions.

For 20.309, you do not need to repeat in exhaustive detail the descriptions of lab procedures from the handouts. Paragraphs of description and complete sentences aren't required. Record enough key details and information such that another 20.309 student or instructor can understand what you did. Remember, you're keeping a record for *yourself and peer researchers*.

Clarity and Organization - Always record the date (and time, if necessary) of experiments on every page, clearly label any plots, charts, or data tables you make. Sometimes, you'll need to think ahead to the data you need to collect, so you can write it down neatly and clearly (e.g. creating a data table ahead of time that you will fill in during lab).

3 Lab Report Guidelines

A report will be due at the end of each lab module. Each module will list certain requirements for its write-up, and give an appropriate page estimate for how long it should be. In addition to this, your report should:

- summarize the question(s) you aimed to answer or measurement(s) you made
- summarize what experiments you performed to that end
- detail the collected data and the experimental results
- explain how you interpreted your results, what conclusions you drew and why

A few other things to keep in mind about lab reports:

DO:

1. Follow the Report Requirements section at the end of each lab module.
2. Describe any procedures you followed that were different from what's suggested in the pre-lab handout.
3. Present data concisely and clearly: a series of curves all being compared to each other should all appear on the same graph. A caption or explanation of the graph should make evident the meaning of what's plotted.
4. Use the passive voice — i.e. it is typical to write “the measurement was repeated three times,” rather than “I repeated the measurement three times.” This is a style somewhat unique to scientific writing, and likely to run counter to other types of writing you've been asked to do.

DON'T:

1. ... rehash all the details of the lab procedures if you followed them exactly as described in your pre-lab handout. A short summary is sufficient.
2. ... strive for sheer volume of data. If you're including pages of nearly-identical plots, with little discussion of what they mean, something is wrong. A single figure that's well-thought-out is worth a dozen that aren't.

3.1 Authorship and Collaboration

In 20.309, you will usually work with a partner in the lab. However, every student is responsible for writing and submitting his or her own individual lab report. You should always acknowledge the partner with whom you worked. On occasion, you may need to use data collected by someone else, in which case you must acknowledge that you were not the one to collect it.

3.2 Graphs, Figures and Tables

Always label the axes of all graphs or the columns of all tables with what data it is that's being presented, *and its units*. What you show in a plot isn't always self-evident, even if you followed a procedure suggested in the pre-lab handout. Sometimes, simply making sure you specify the units for something will help you understand the data better.