PHY 202/182 Lab Instructor notes
Lab 1: Electric Field and ϵ_0
Spring 2004

General comments

- The rules for the lab report is like last term: one report for each group with separate conclusions.
- The policy for late lab reports and missed labs is up to the instructor.
- As with last year, the lab manual will be handed out during the semester.
- Be sure to tell me of any mistakes or points of confusion in the lab manual.

Electric field plotting

Instructions for the students:

- Black DMM lead clips to the negative bolt terminal.
- Hold the probe vertically.
- Draw a coordinate system on the graph paper under the tray. Then you can, specify points by their coordinates: x is 1.5 inches, y is -2.0 inches ...

For the instructor:

- You need to have a qualitative discussion of $\mathbf{E} = -\nabla V$. Generally, students have not had V introduced in lecture.
- The multimeters should be set up with one alligator clip and one regular probe.
- You only want a small amount of water in the trays. If there is too much, students will have trouble with parallax error.
- The DMM's live on a regular supply of batteries. You can find replacement batteries in the tub where they the multimeters are stored.
- One weakness in this lab is that there is no discussion of symmetries. I would like to see a lab where students are given various two-dimensional geometries (such as two concentric rings, two parallel plates, or a quadrapole) and they have to identify the symmetries and relate that to symmetries of the electric field.

ϵ_0 Measurement

Here are some instructions for the students:

- Increase voltage *slowly* when making a measurement.
- The power supply uses vacuum tubes, which must warm up. Use the standby switch, not the power switch, to turn off the voltage for adjustment.
- 400 V hurts! Keep hands away from the terminal on the board.
- Make sure the upper plate is as parallel as possible to the lower plate. You can position a larger mass (2 g or so) on the upper plate to adjust this.
- Adjust spacing, 3–4 mm, and horizontal position with the rod clamp.
- Read the voltage on the DMM. When the plates come together, read the DMM. The short-circuiting of the plates will not affect the DMM reading: the supply is regulated and there is a 22 MΩ resistor in series with the lower plate.
- When performing the analysis, enter the exponent as 0.666666....
- In your analysis, you will have to estimate errors for various quantities. If you don't know any better, use ± 1 in the last digit. Also, the error in area is not the length error squared.

For the instructor:

- It seems that the springs "stretch out" slightly right after they are set up. Maybe set up the springs several hours before the first lab?
- A good value of the slope for the $V^{2/3}$ vs. m curve is something like -10^5, check that students get something reasonable. Common errors are to switch axes or improper units.
- Students should figure out the correct units for the slope.
- We need to order more small masses: 10 mg, 29 mg, 100 mg, etc.
- We need to grind down the screws so that they do not protrude from the plate.
- The analysis of this experiment is too complicated. Would a torsion beam experiment work better?