Massachusetts Institute of Technology *Spring Term 2005*

8.02X Electricity and Magnetism

Questions for EF experiment write-up (20 points)

Due Date: Check-off by March 11 in lab 4-355. The lab is located in 4-355. The lab hours are Mon 3-5, Tues 7:30-9:30 pm, Wed 7:30-9:30 pm, Thur 3-5, Fri 12-3.

You will be graded according to the following criteria:

1. Your Experiment: Electrostatic Force apparatus works (you will need to demonstrate a trial run during the check-off).
2. Your understanding of the underlining physical principles involved in the experiment. You may be asked a question during the check-off.
3. The results of your data analysis. You may also be asked how you arrived at your result for the value of the permittivity of free space ε_0

Problem One (10 points)

1. Place a piece of aluminum foil, about 1 cm x 1 cm, on the bottom washer. Put the top washer in place and turn up the HVPS all the way. Slowly raise the voltage and read the value of the voltage on your voltmeter when the foil lifts off. Turn down the voltage and repeat. Repeat 5 times.

2. Prepare double and triple thickness foils (again about 1 cm x 1 cm from pieces 2 cm x 1 cm and 3 cm x 1 cm, folded and squeezed flat, and repeat the above procedure.

3. ***Analysis***: Average the voltages for a given foil thickness. You then have 3 numbers: the voltages required to lift 1, 2, and 3 thicknesses of foil. **Use a table like this to enter your Experiment EF data**

Number of foils	Voltage Trial 1	Voltage Trial 2	Voltage Trial 3	Voltage Trial 4	Voltage Trial 5	Average Voltage
1						
2						
3						

4. Plot the voltage <u>squared</u> V^2 vs. n, the number of thicknesses of foil. Is the origin a data point? (Zero voltage will not lift zero folds of foil). **Include your graph**.

5. Your graph of the experimental values of V^2 *vs.* n should be a straight line with the slope being the factor in parentheses. **Find the slope of the best-fit line.**

6. Calculate the free permittivity of space ε_0, from your experimental value for the slope using the result that

$$V^2 = \frac{\rho t g 2 d^2}{\varepsilon_0} n$$

where:

- thickness of perf-board + tape, $d = 1.7 \times 10^{-3} m$;
- thickness of Aluminum foil, $t = 6.7 \times 10^{-6} m$;
- density of Aluminum foil, $\rho = 2.7 \times 10^{3} kg/m^{3}$;
- acceleration due to gravity, $g = 9.8\, m/s^{2}$.

Problem 2 (10 points)

a) Using Gauss' Law, find an expression for the electric field between two discs of radius R that are separated by a distance d. The discs have opposite charges that are equal in magnitude placed on them. You may neglect edge effects. Make a sketch of the electric filed lines when you include edge effects.

b) Suppose a voltage difference ΔV is applied across the two discs. Show that the charge on the positive plate is given by the expression, $Q = \frac{\varepsilon_o \pi R^2 \Delta V}{d}$ when you ignore edge effects.