"Back Bench" Capacitor Labs

Exercise 1: "Look before you Leap"

You'll be working with a variable air capacitor, of the sort shown in Fig. P26.6 on page 746 of your text. Therefore:

a) …some members of your group should work problem # 26.6,

b) …while other members try to obtain approximate values for the plate radius, R, and plate spacing, d, for the particular type of variable air capacitor sitting at your lab table. [Note: When you remove screws from *anything*, you need a place to keep them, such as a jar or a lid. When possible, put the screws back where they belong *immediately*, so that you don't lose track of them! Also, there is no need to tighten these screws very much: *over*-tightening does damage!]
Take great care to ensure that your actions to not result in *bending* the "plates" of the capacitor. [Don't set the capacitor down on its plates! Don't contaminate plates.]

c) Using the results above, you should be able to **record** an estimate of the numerical value for the maximum capacitance:

Lab 1: Capacitance vs. Effective Plate Area

In the first part of this lab, you will measure the capacitance how capacitance scales with plate area (*i.e.*, you will really measure C as a function of the angle of rotation, θ).

It is *essential* that you

ALWAYS discharge the capacitor *before* connecting it to the capacitance meter

by plugging the capacitor into "Position 1" on your "breadboard."
(Failure to do so will destroy the meter.)

a) Move the capacitor from "Position 1" (where it is discharged by a jumper cable) to "Position 2" (where it is connected to a capacitance meter). Use the screwdriver supplied to adjust the angle of rotation, θ, while the capacitor is connected to the meter. – The fine wires entering the meter make only tenuous contact, so you may have to gently "fiddle" with them if you to not find a C_{max} of roughly the value you expect.

b) Tabulate your measurements of C as a function of the angle of rotation, θ, and plot (and fit) your results.

Lab 2: "Static" Measurement of Capacitance

In Physics 105, you measured the stiffness of a spring in two ways: one method involved an examination of the dynamics of a mass suspended by the spring, while the other involved measurements of the equilibrium response of the spring to various different masses. There is a direct analogy that can be made here: the capacitance meter that you used in the work outlined above looks at the time scale involved in dynamics of an electrical circuit that includes your capacitor. Next, we will examine the equilibrium response of your capacitor to various different *low-level* voltages.

a) While your capacitor is still connected to the capacitance meter, adjust the angle of rotation until you get a reading of around 100 pF. After this, you will *not* be using the capacitance meter anymore, but will have to measure charge directly, using the electrometer. You will also no longer be adjusting the angle of rotation.

b) Start up *DataStudio* and configure the software so that it recognizes that a voltage probe is connected. (Follow the wires and find what the voltage probe is connected to.)

c) Move the capacitor to "Position 3," where it is connected to the power supply. Record the voltage difference applied across the terminals of the capacitor.

d) *Rapidly*, start a *DataStudio* data collection "Run," *release* the zero check on the electrometer, *and* move the capacitor to "Position 4," where the capacitor is discharged through the electrometer, which measures the charge that had been on the plates.

e) Stop your *DataStudio* "Run" and examine a graph of your data, recording the results along with a numerical estimate of how confident your are in the numbers you record. (You may wish to read the brief notes in the electrometer manual on measuring charge.)

f) Push the zero check button on the electrometer back into place.

g) Repeat steps (c) through (f) for a variety of voltages. Tabulate your measurements of the accumulated charge, Q, as a function of the applied voltage, ΔV, and plot (and fit) your results