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**Background**

Beginning with the charges which we know are equal to the capacitance times the voltage, and the final charge being a combination of the capacitance from the known and unknown capacitors.

We then can make the comparison that Qi and Qf are equal because there is no more charge added to the system.

Using simple algebra we can set up an equation to calculate the capacitance just from knowing the voltage input and the capacitance of our known capacitor.

**Experimental Procedure**

**Procedure 4.1**

1. Connect signal cable B to the electrometer, and connect the “ground port” of the electrometer to a true electrical ground. Turn the electrometer on, setting voltage range to 10 V.
2. Connect the ends of signal cable B to the two plates of the variable parallel plate capacitor.
3. Connect the “black wire” side of the variable capacitor to ground. Make sure everything is secure.
4. Remove all charge from the variable capacitor by touching both sides with your finger while doing so press the “zero” button.
5. Set the spacing of the variable capacitor’s plates to 1 mm (as narrow as it will go).
6. Make sure that the plates are as parallel as they can be, there are knobs on the back to adjust the angles.
7. Follow the procedure in the Background section to measure the capacitance of the variable capacitor.
8. Remove all charge from the variable capacitor by touching both sides with your finger while doing so press the “zero” button.
9. Repeat this procedure 4 times to get an average.
10. Repeat steps 8-7 with a plate spacing of 2, 3, 5, 10, and 30 mm. Adjust the scale on the voltmeter accordingly.

**Procedure 4.2**

1. Return the plates to 1 mm separation.
2. Briefly touch the terminals of the low-voltage power supply (batteries) to the plates to charge them up to about 18 volts. Measure this voltage with the electrometer.
3. Predict what will happen as you pull the two plates apart along the track prior to doing so and make note.
4. Pull the plates apart gradually and watch what happens to the voltage.
5. Return the plates to 1 mm separation, and re-charge the plates using the batteries.
6. Pull the plates apart to 2 mm separation, and record the voltage.
7. Repeat steps 5 and 6 four times to compute an average for each distance of 3, 5, 10, and 30 mm.

**Procedure 4.3**

1. Use Cable A to connect the Faraday Ice Pail to the electrometer. Make sure the black wire connects to the outer cylinder, the red wire to the inner cylinder.
2. To start, we must measure the capacitance of the pail and electrometer. We can do this by applying a known voltage to our known capacitor and measuring the voltage on our voltmeter when this is touched to the pail.
3. Next, turn on the high-voltage power supply you used in the Coulomb’s Law experiment, set it to 4000 V, and touch it to the conductive ball to charge it.
4. Use the string to touch the ball to the inner surface of the inner cylinder of the Faraday pail, then remove it. Measure the pail’s voltage on the electrometer.
5. Repeat this process a few times in order to get an average.

**Experiment 4.1**

The plot of inverse separation vs. capacitance can be found in the google sheet titled “Experiment 4.1.” The capacitance of our electrometer was 3.04, measured as the intercept. The measured slope of the trendline was . The value of was . While these values are not the same, they are very close to one another. If we were to assume equation 2 to calculate the value of we would get , which is very close to the accepted value of .

**Experiment 4.2**

In all of the experiments for 4.2, the average charge does not remain more or less the same. As we increased our distance, our charge decreased. This could be attributed to the environment, or charge leakage from more time taken to take a measurement. The mean charge was 4.7with a standard deviation of 1.02C. The standard deviation was highly impacted by the decreasing average charge on the capacitor, and it is shown in the value being ~¼ of the mean charge value.

**Experiment 4.3**

The charge on the ball based on the given capacitance was 8.44. The average charge on the pail was found to be 1.07. The average charge on the pail was surprisingly higher than the average charge on the ball. This could be accounted for by equipment not holding the same amount of voltage it claims to hold, as well as the surrounding environment.