Physics Exploration Homework Supplement P111-13.pdf

Parallel Plate Capacitor and Capacitance

Go to the Physics Exploration Center. Enter through the resource room in 311/312 Thaw Hall. Go to the setup that has an electrophorus (which consists of a small metal plate with an insulating handle and an insulating surface), a parallel plate capacitor, and a voltage measuring device (kilovolt Meter). Note that one plate of the capacitor has been grounded. You should **only charge the UNGROUNDED side of the parallel plate capacitor** to create a potential difference between the plates. (If you try to charge the grounded side of the capacitor, the charge flows to ground and the potential difference between the plates remains at zero [or its initial value].) The "DIAMETER" of the capacitor plates is 25 cm (you can use this measurement to find the area of the plates, which is useful for calculating capacitance).

Note: The 1 kilovolt meter has a capacitance of approximately 10 pico Farad ($1x\ 10^{-11}$ Farad) and it is connected to the capacitor in parallel. First, find the appropriate equivalent capacitance of the circuit before finding the charge on the parallel plates of the capacitor in the following explorations.

(1) Change the separation between the plates to 1 cm by moving the capacitor plate that is grounded. Calculate the capacitance for this plate separation. Now, rub the large insulating surface of the electrophorus with the provided cloth and then place the electrophorus metal plate on the surface so that a separation of charge occurs. Next, touch the electrophorus's metal plate to create a net charge on it. Finally, lift the charged electrophorus (metal) plate with its insulating handle and touch it to the **UNGROUNDED** plate of the capacitor. This will transfer some charge from the electrophorus plate to the capacitor plate. Measure the potential difference between the plates using the voltmeter provided.

(2) If the potential difference for the 1 cm separation is not .6 kilovolts, adjust the amount of charge on the capacitor plate so that it is approximately .6 kilovolts. This will insure that the voltage readings for the remainder of this exercise will be on scale. [* See the instructions below on how to reduce the charge on the capacitor.] Explain whether the charge should partly be removed from the capacitor plate or added to it if the voltmeter reads a value greater than .6 kV.

* The easiest way to remove excess charge is to use the **small** electrophorus plate. First, discharge the small electrophorus plate by touching it with your hand (or with the ground wire) and then touch the electrophorus plate to the **UNGROUNDED** plate of the capacitor. Some of the charge will transfer from the capacitor plate to the small electrophorus plate. Repeat the above procedure until the potential difference displayed on the voltmeter is about .6kVolt.

(3) Calculate the charge stored on the capacitor plates using the relation between charge, potential difference and capacitance (Don't forget to include the capacitance of the voltmeter in the equivalent capacitance).

(4) Predict if the capacitance, potential difference or both should change if you move the plates of the capacitors out. Without touching the charged plate of the capacitor, change the separation between the plates to 7 cm by moving the grounded plate. What is the new capacitance? Is there an increase or decrease in the potential difference? Using these values of capacitance and potential difference, calculate the charge on the plate.

(5) Predict if the electrical energy stored between the plates of the capacitor is more in (3) or (4) above? Explain your reasoning. Calculate the electrical energy stored between the plates of the capacitor for both cases (3) and (4) and verify your prediction. Explain any discrepancies between the prediction and observation.

(6) Predict whether the capacitance and potential difference between the plates will increase or decrease if a piece of wood is brought in between the plates of the capacitor. Explain your reasoning. Now insert the wood piece, making sure you don't touch the charged metal plate of the capacitor and verify your prediction. Explain any discrepancies in the prediction and observation.