Lab 3: Capacitors and Stored Energy

Objective: I will characterize the capacitance of parallel plates with the area and distance between plates by describing the relationships between voltage, charge, capacitance, and potential energy.

In this lab, you will be investigating the capacitance for a parallel plate system. These activities will allow you to gain an understanding of what capacitors are, what they can be used for, and how they are charged. You will be working with 2 simulations:
https://phet.colorado.edu/sims/html/capacitor-lab-basics/latest/capacitor-lab-basics_en.html
https://ophysics.com/em5.html

Pre-lab Questions:

1. How many meters is 1 picometer (pm)?
   1*10^-12

Tasks

Below is a list of tasks that you must accomplish during this lab. Please summarize your results below as indicated.

1. Start on the "Capacitance" tab of the PhET simulation. Determine how the capacitance changes with plate separation and/or plate area by keeping the voltage constant. You can use raw data or graphs to determine these two relationships.

Plate Separation	Plate area	Capacitance
2.0mm	200 mm^2	0.89 pF
3.6mm	200 mm^2	0.49pF
6.0mm	200 mm^2	0.30pF
2.0mm	360 mm^2	1.59pF
3.6mm	360 mm^2	0.89pF
6.0mm	360 mm^2	0.53pF

   Inverse relationship between plate separation and capacitance. Direct relationship between plate area and capacitance.

2. Repeat Task 1, but for determining how the stored energy changes with voltage and capacitance. You can use the voltmeter to get an exact voltage reading. You will need to create both a data table and a graph for this task.

Voltage	Capacitance	Stored Energy
1.5V	0.50 pF	0.56 pJ
1.5V	0.43 pF	0.48 pJ
1.5V	0.37 pF	0.42 pJ
1.5V	0.28 pF	0.31 pJ
0V	Any	0.00pJ
-1.5V	0.43pF	0.48pJ
-1V	0.43pF	0.21pJ
-0.5V	0.43pF	0.05pJ

0.5V	0.43pF	0.05pJ

3. Move to the "Light Bulb" tab. Charge the plates by increasing the voltage of the battery. Then, disconnect the plates from the battery. Connect the voltmeter across the light bulb, and then connect the capacitor to the light bulb. Comment on your observations about how the charge and potential difference change: do they increase or decrease? Is the increase/decrease linear or not? Formulate qualitative observations based on one or two trials.
   Charge and potential difference decreases. They are linear.
4. *Not required*, but if you are curious on exploring Task 3 farther, check out the oPhysics link!

Data

Delete this text and put your data/graphs for Tasks 1 and 2 here

Results and Discussion

Inverse relationship between plate separation and capacitance. Direct relationship between plate area and capacitance. Capacitance and Stored energy directly proportional. As magnitude of voltage increases, the stored energy increases.

Post-lab Questions

1. In your own words, define "capacitance" without using formulas or referencing charge and electric potential/voltage.
   Ability to store energy in an electric field.
2. In the first tab you used for this lab, the capacitor charged instantly. However, for the lightbulb, it discharged over time. Which scenario is feasible in the real world given your hypothesis? What might instantaneous charging/discharging represent about the system?
   Lightbulb is more feasible than the instantaneous charging scenario. Capacitors have a finite amount of charge that they can score, it takes time for the charge to build up or lose. Instantneous charging/discharging would be idealized with no resistance.
3. What might some real-world examples of capacitors be?
   Computers, phones, cars all have capacitors so they can store energy temporarily.