Today we will be exploring the behavior of capacitors with and without dielectrics. You will complete the virtual lab using the Capacitor Lab from Phet, data analysis software (Logger Pro or Excel) and this document. Each member of the lab group must complete and submit a copy of the assignment.

***Pre-Lab Questions***

1. Draw a diagram of a simple capacitor in a circuit with one battery (1.5 V).
2. What is a dielectric?
3. What does a capacitor store?

***Basic Characteristics of a Capacitor***

Open the [Capacitor Lab](https://phet.colorado.edu/en/simulation/capacitor-lab) (https://phet.colorado.edu/en/simulation/capacitor-lab)

Set the plates to the minimum area (100.0 mm2), maximum separation (10.0 mm) and maximum positive battery voltage (1.5 V) to begin.

Using the provided meters in the simulation complete the following data table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Trial | Separation (mm) | Plate Area (mm2) | Capacitance (μF) | Stored Energy  (J) | Plate Charge (C) | Electric Field between plates (V/m) |
| 1 | 10 | 300 |  |  |  |  |
| 2 | 9 | 300 |  |  |  |  |
| 3 | 8 | 300 |  |  |  |  |
| 4 | 7 | 300 |  |  |  |  |
| 5 | 6 | 300 |  |  |  |  |
| 6 | 5 | 400 |  |  |  |  |
| 7 | 5 | 350 |  |  |  |  |
| 8 | 5 | 300 |  |  |  |  |
| 9 | 5 | 250 |  |  |  |  |
| 10 | 5 | 200 |  |  |  |  |

Analyze the data above and answer the following questions. You may want to create graphs to better explain relationships between variables. Attach any graphs or figures you create with the data to explain your responses.

1. Which variables increase as the plates are moved further apart? What is the pattern of increase?
2. As the plate separation decreases which variables increase? What is the pattern of increase?
3. Which variables increase as the plate area is decreased? What is the pattern of increase?
4. As the plate area increases which variables increase? What is the pattern of increase?

***Dielectrics***

Click on the “Dielectrics” tab in the [Capacitor Lab](https://phet.colorado.edu/en/simulation/capacitor-lab).

Set the plates to the area (200.0 mm2), separation (8.0 mm), maximum positive battery voltage (1.5 V) and minimum dielectric constant (1) with zero offset to begin.

Using the provided meters in the simulation complete the following data table (keep the plate separation and area constant through all trials):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Trial | Dielectric Constant | Capacitance (μF) | Stored Energy  (J) | Plate Charge (C) | Sum Electric Field between (V/m) | Electric Field in Dielectric (V/m) | Electric Field between the plates (V/m) |
| 1 | 1 |  |  |  |  |  |  |
| 2 | 1.5 |  |  |  |  |  |  |
| 3 | 2 |  |  |  |  |  |  |
| 4 | 2.5 |  |  |  |  |  |  |
| 5 | 3 |  |  |  |  |  |  |
| 6 | 3.5 |  |  |  |  |  |  |
| 7 | 4 |  |  |  |  |  |  |
| 8 | 4.5 |  |  |  |  |  |  |
| 9 | 5 |  |  |  |  |  |  |

Analyze the data above and answer the following questions. You may want to create graphs to better explain relationships between variables. Attach any graphs or figures you create with the data to explain your responses.

1. How does the dielectric constant affect capacitance?
2. As the dielectric constant increases how does the total stored energy change?
3. Does the dielectric constant affect the amount of charge stored on the plate? If so, what is the relationship?
4. Based on the data from your two experiments and any further experimentation you wish to carry out, what do you think the dielectric constant of air (which is what separates the plates in the first experiment) would be?

***Conclusion***

Explain how you would construct the ideal capacitor. In your explanation include the basic physical dimensions as well as any specific materials you feel would work. While you might not be able to give specific numbers, you should be able to relate general trends and magnitudes of the figures.