Title

Experiment 3: Capacitance

Aim

The purpose of this experiment is to investigate how the capacitance of a parallel-plate capacitor changes as the plate separation is altered and to observe the effect of introducing a dielectric material between the plates.

Apparatus

- Basic Electrometer (ES-9078)
- Basic Variable Capacitor (ES-9079)
- Electrostatics Voltage Source (ES-9077)
- 850 Universal Interface (UI-5000)
- PASCO Capstone (UI-5400)
- Paper

Theory

A capacitor is device that stores charge. One of the types is a parallel-plate capacitor, which consists of two opposite plates separated by a distance d. The capacitance (C) is defined as the amount of charge (Q) stored per unit of potential difference (V), which expressed as C=Q/V. For a parallel-plate capacitor, the capacitance is inversely proportional to the separation between the plates. When a dielectric material like a paper is placed between the plates, it increases the capacitance which in turn causes a drop in voltage if the charge is kept constant.

Method

For procedure A:

The capacitor plates were set to an initial separation of 0.3 cm. The electrometer was turned on and set to the 100 V scale. Any existing charge was removed by touching both plates. The electrometer was zeroed by pressing the 'ZERO' button. The capacitor was charged by momentarily connecting a cable from the +30 V outlet on the voltage source to the movable plate. The movable plate was then slid to 8.0 cm. Data collection was started by pressing the PREVIEW button. The voltage was recorded, and the movable plate was slid to successive 1 cm intervals down to 0.3 cm, with a voltage reading taken at each position. Data collection was stopped, and the resulting graph was examined for a smooth curve.

For procedure B:

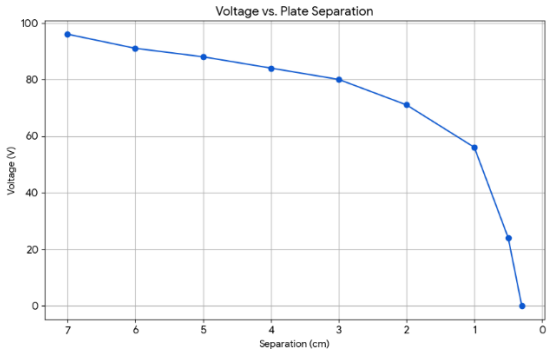
The movable capacitor plate was positioned at 8 cm. The electrometer was turned on, set to the 100 V scale, and zeroed after touching both plates to remove any charge. The capacitor was charged by momentarily connecting a cable from the +30V outlet to the movable plate. Data collection was started by pressing the PREVIEW button. A stack of paper (the dielectric) was held above the plates, and the voltage was recorded. The paper was then lowered between the plates without touching them, and a second voltage reading was taken. This process was repeated several times. Data collection was stopped, and the data was examined.

Results

Procedure A:

Separation (d)	**Voltage(V)**
7.0 cm	96 V
6.0 cm	91 V
5.0 cm	88 V
4.0 cm	84 V
3.0 cm	80 V
2.0 cm	71 V
1.0 cm	56 V
0.5 cm	24 V
0.3 cm	0 V

For analysis A:



1. As the plates were moved closer together, the voltage decreased.
2.

3. The discrepancies might be caused by the approximations made when deriving the parallel plate
4. Computer modelling is valuable because it allow us to test a theoretical model against experimental data

Procedure B:

Paper position	**Voltage(V)**
Out	30 V
In	25 V
Out	28 V
In	24 V
Out	26 V
In	23 V
Out	26 V
In	23 V
Out	25 V

Discussion

As the plates were moved closer the voltage decreased. As shown in the data collected. The inverse relationship between capacitance and separation was proven.

The data collected from Procedure B shows that by inserting the paper dielectric caused the voltage to drop, which aligns with the theory that a dielectric increases capacitance and therefore reduces voltage for constant charge.

Conclusion

The experiment successfully demonstrated the relationship between capacitance, plate separation, and the presence of a dielectric material. As the plates of the capacitor were moved closer together, the voltage across them decreased, consistent with the theoretical model that includes the system's capacitance. Introducing a dielectric paper between the plates also caused a decrease in voltage, confirming that dielectric materials increase the capacitance of a capacitor as predicted by theory.

References

[1] Experiment 3 Capacitance, https://learn.unizulu.ac.za/facultyOfScience/pluginfile.php/224271/mod_resource/content/0/Experiment%203%20Capacitance.pdf