Lecture 9: Capacitors

- Capacitors are used to store charge
- Charge is directly proportional to potential difference

$$Q = C\Delta V_C$$

- Constant of proportionality: Capacitance

$$C = \frac{Q}{\Delta V_C}$$

Unit: 1 F=1Q/1V Farad

Demos

Capacitance

From lecture 4: $E = \frac{Q}{\varepsilon_o A}$

$$Q = \frac{\varepsilon_o A}{d}\Delta V$$

From lecture 7: $\Delta V = Ed$

$$C = \frac{\varepsilon_o A}{d}$$

Capacitance depends only on the dimensions of the capacitor.

Example: demo capacitor, diameter 30cm, separation 2mm

Effect of plate separation

Demo

Remove battery

Increase plate separation

Because battery is removed, Q remains the same

Thus E remains the same

Because $\Delta V = Ed$, ΔV must increase

Deflection of electroscope increases

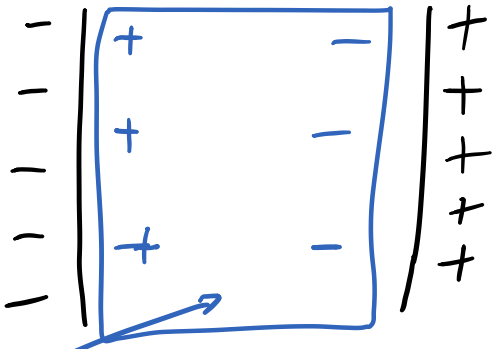
Dielectrics

Demo

Insert Teflon sheet between plates of fully charged capacitor

Deflection of electroscope decreases

ΔV decreases



dielectric becomes polarized

$$C = \frac{\kappa \varepsilon_o A}{d}$$

Increased by factor κ.
Can store more charge at same potential difference

K=80 for water, 2 for Teflon

Energy

Demo: discharge of capacitor

$$U = \frac{1}{2} Q \Delta V$$

Because $Q = C\Delta V$:

$$U = \frac{1}{2} C (\Delta V)^2 = \frac{1}{2} \frac{Q^2}{C}$$

Ex.: Energy store in 22,000 μF capacitor at 75V

Advantage of capacitor: energy is quick to retrieve
Battery stores more energy, but slower

Important application: defibrillator