Capacitors

Scott N. Walck

February 17, 2021

Parallel-Plate Capacitor

- Two parallel sheets of metal
- Positive plate has charge $Q > 0$ on it.
- Negative plate has charge $-Q$ on it.
- A is the area of the positive plate.
- A is also the area of the negative plate.
- $\sigma = Q/A$ is the surface charge density on the positive plate.
- $-\sigma = -Q/A$ is the surface charge density on the negative plate.

Parallel-Plate Capacitor: Relationship between electric field and voltage

$$\Delta V = Ed$$

- ΔV is the difference in electric potential between the plates
- E is the electric field between the plates
- d is the distance between the plates

Parallel-Plate Capacitor: Definition of capacitance

$$Q = C\Delta V$$

- ΔV is the difference in electric potential between the plates
- Q is the charge on the positive plate
- $-Q$ is the charge on the negative plate
- C is the capacitance of the capacitor
- If you double the charge Q, then ΔV will double.

Parallel-Plate Capacitor: Geometric expression of capacitance

$$C = \epsilon_0 \frac{A}{d}$$

- d is the distance between the plates
- A is the area of the positive plate
- A is also the area of the negative plate
- C is the capacitance of the capacitor

Parallel-Plate Capacitor: Energy stored in capacitor

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

- Q is the charge on the positive plate
- ΔV is the difference in electric potential between the plates
- C is the capacitance of the capacitor
- PE is the energy stored in the capacitor