More capacitors

Lecture 11

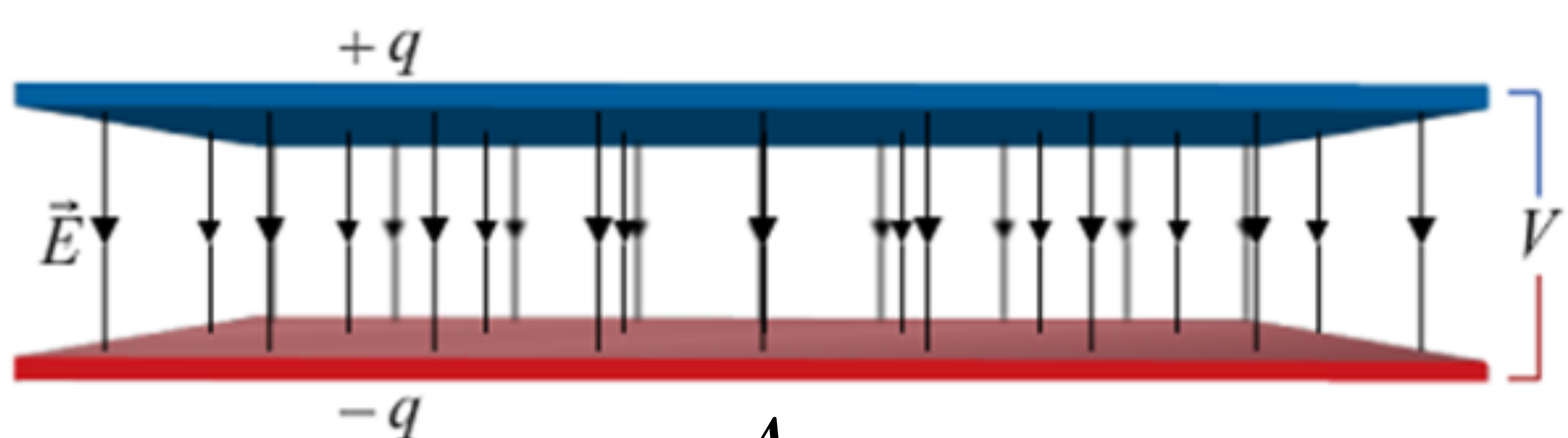
Announcements

- Re-grade requests due by **Friday (Today)**.
- Reading for Monday: 24.3-24.5

Review: Capacitance

- ***Capacitance***: *Capacity (or efficiency)* of conductor to hold charge at a potential difference.

$$Q = CV$$

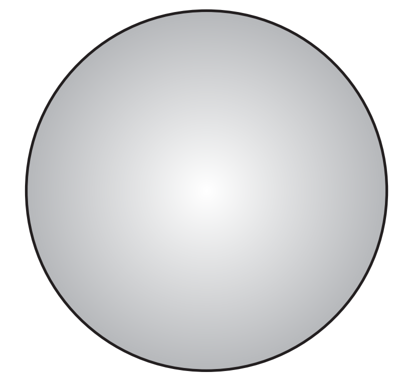


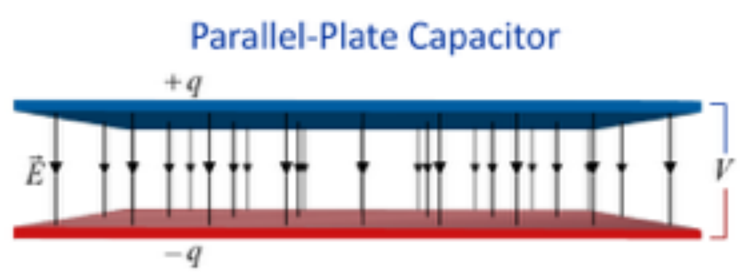
$$C = \frac{A\epsilon_0}{d}$$

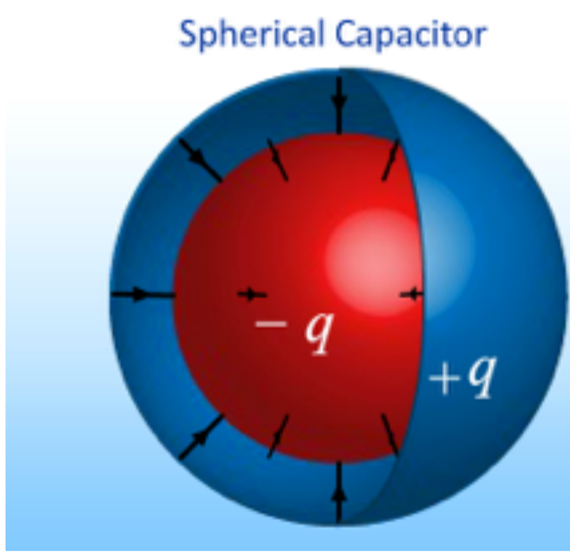
- Units: Farad = C/V.

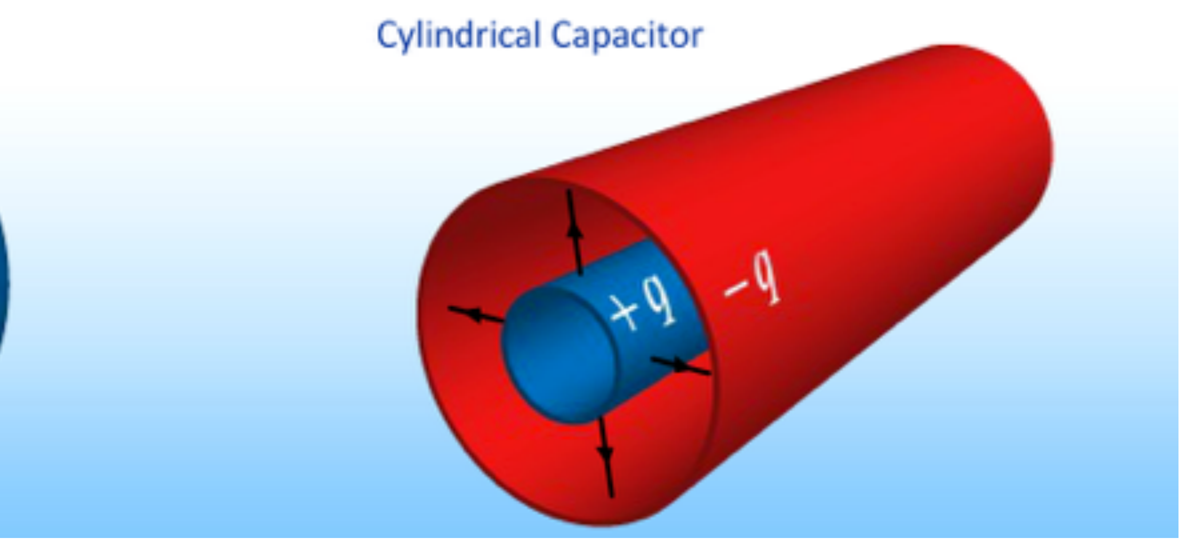
Capacitors

- Not just planes…
  spheres, cylinders, plates,
  isolated conductor…



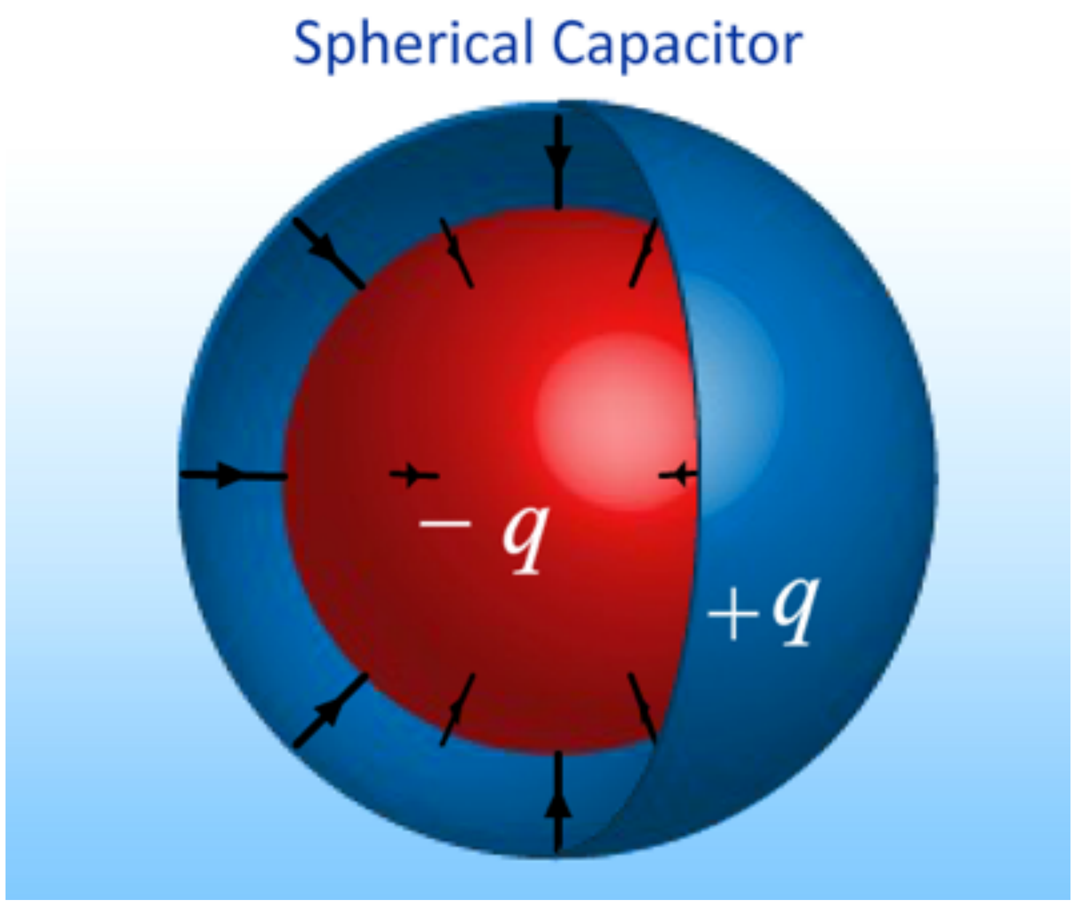






Capacitance depends only on geometry (not charge).

Concentric Spheres



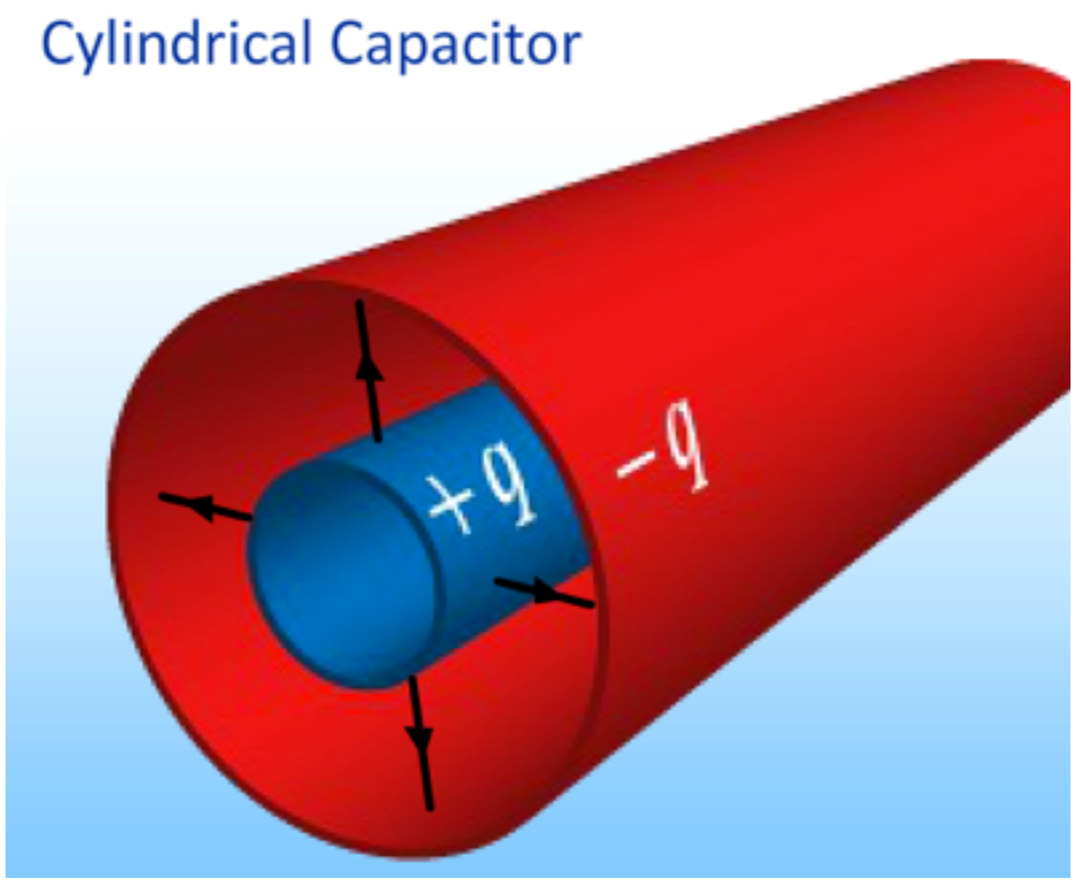
$$Q = CV$$

on overhead…

$$C = \frac{4\pi R_1 R_2 \epsilon_0}{R_1 - R_2}$$

limit?

Concentric Cylinders



$$Q = CV$$

on overhead…

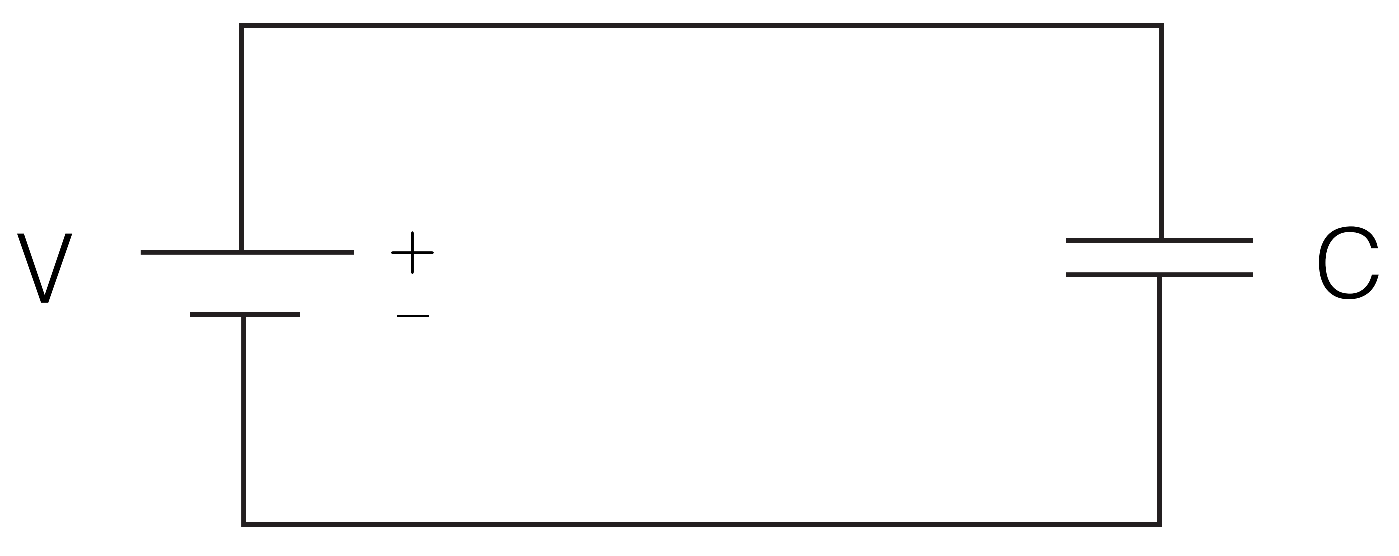
$$C = \frac{2\pi L \epsilon_0}{\log R_1/R_2}$$

limit?

Clicker

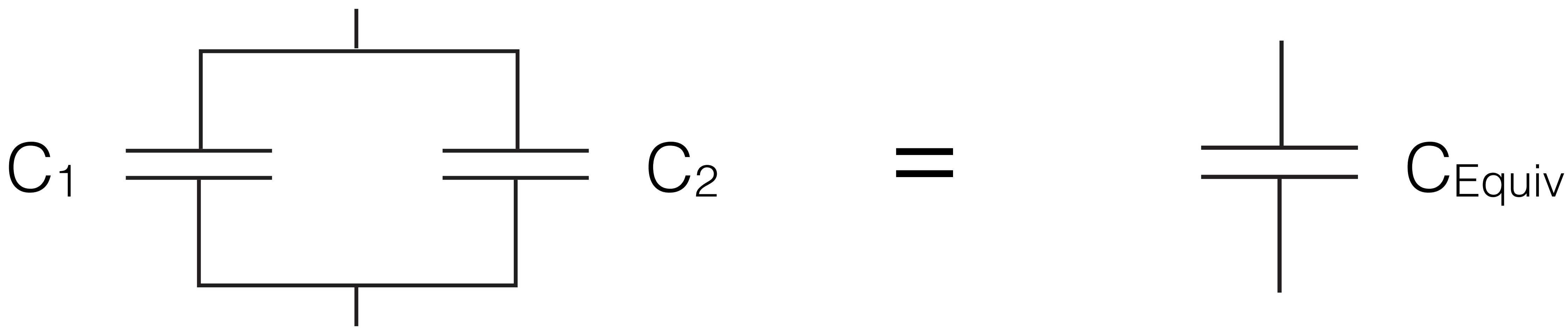
Capacitors in circuits

- Circuit Diagram:
  - Voltage Supply/Battery
  - Capacitor
  - … More symbols later …

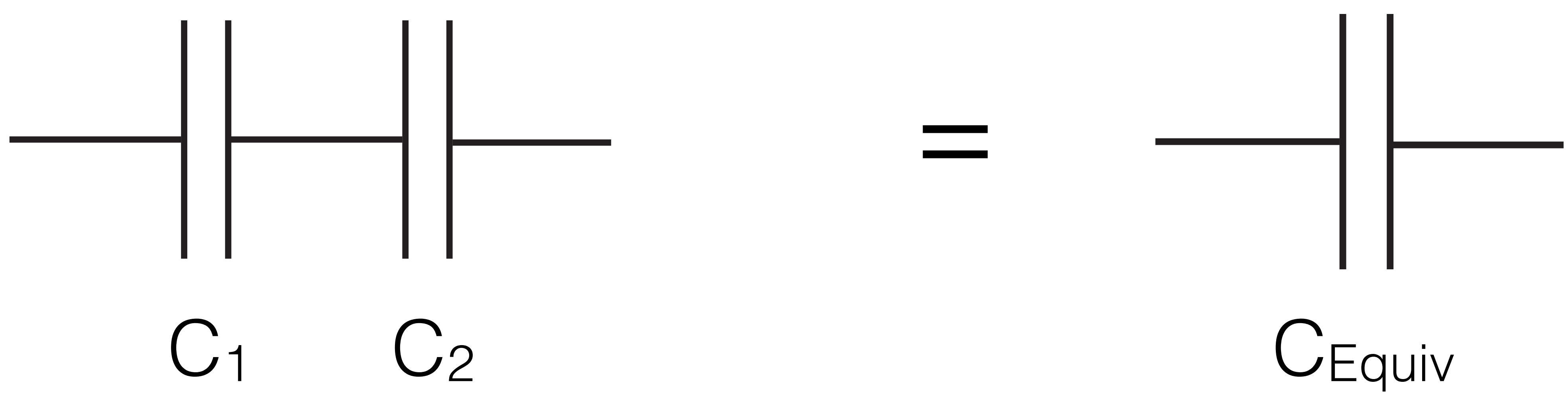


Parallel vs Series

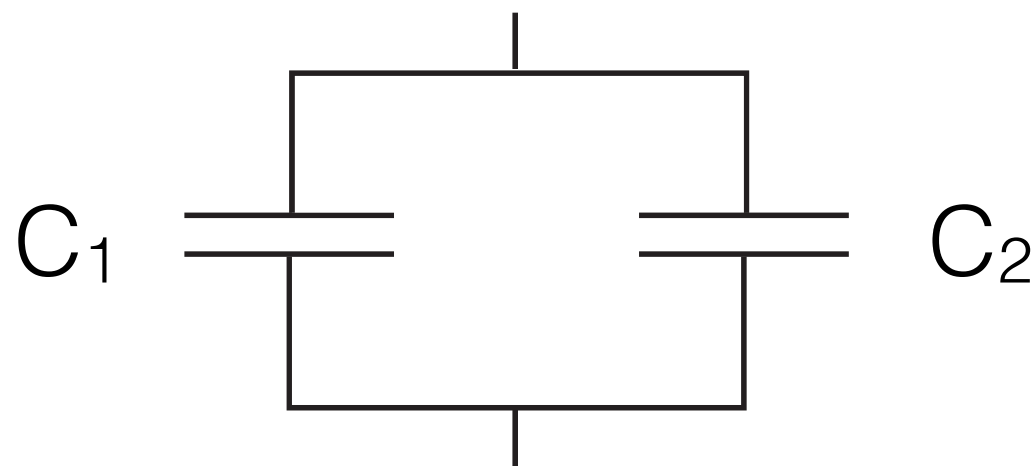
- **Parallel** configuration of capacitors:



- **Series** configuration of capacitors:



Equivalent Capacitance for **Parallel Capacitors**



(overhead)

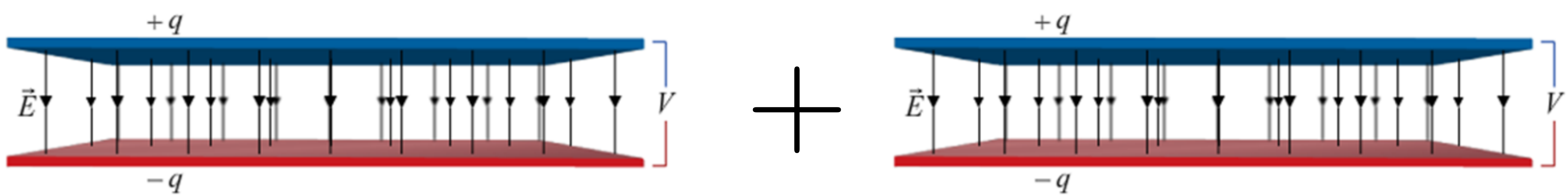
(~ Springs in parallel.)

$$C_{\text{Equiv}} = C_1 + C_2 = \sum_i C_i$$

Equivalent Capacitance for **Parallel Capacitors**

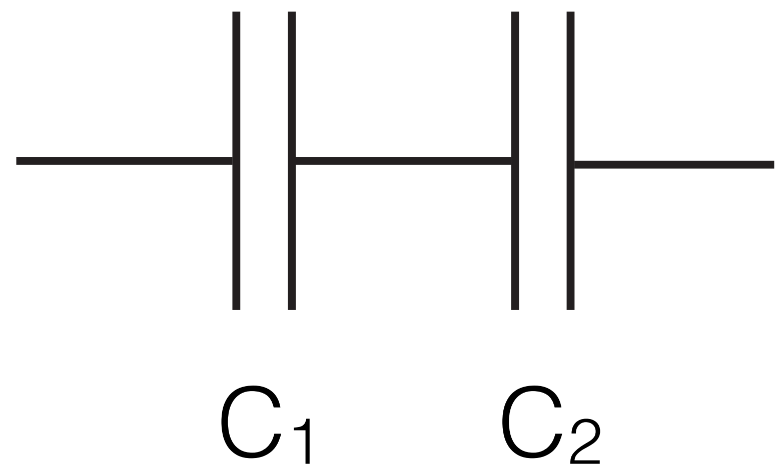
$$C_{\text{Equiv}} = C_1 + C_2 = \sum_i C_i$$

- Intuitive explanation: $C = \dfrac{A\epsilon_0}{d}$



- **Areas** just **add** therefore so does capacitance!

Equivalent Capacitance for **Series Capacitors**



(overhead)

(~ Springs in series.)

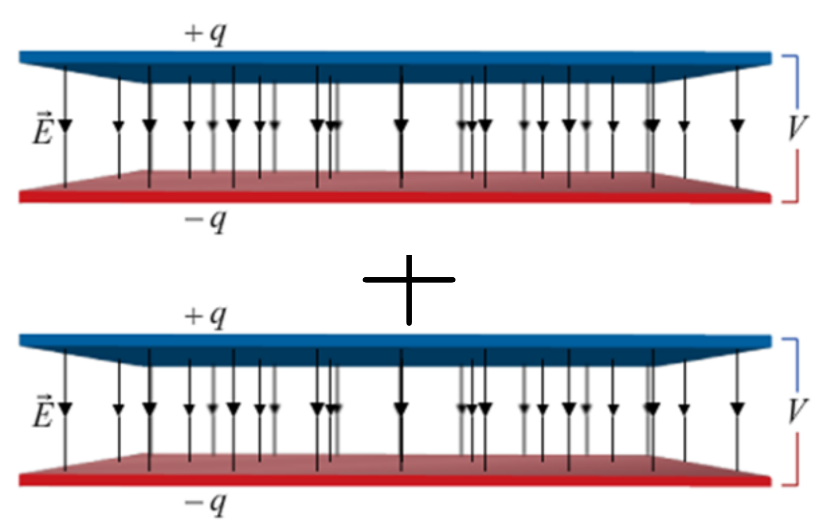
$$C_{\mathrm{Equiv}}^{-1} = C_1^{-1} + C_2^{-1} = \sum_i C_i^{-1}$$

Equivalent Capacitance for **Series Capacitors**

$$C_{\text{Equiv}} = C_1 + C_2 = \sum_i C_i$$

- Intuitive explanation:

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



Conductor sandwich!

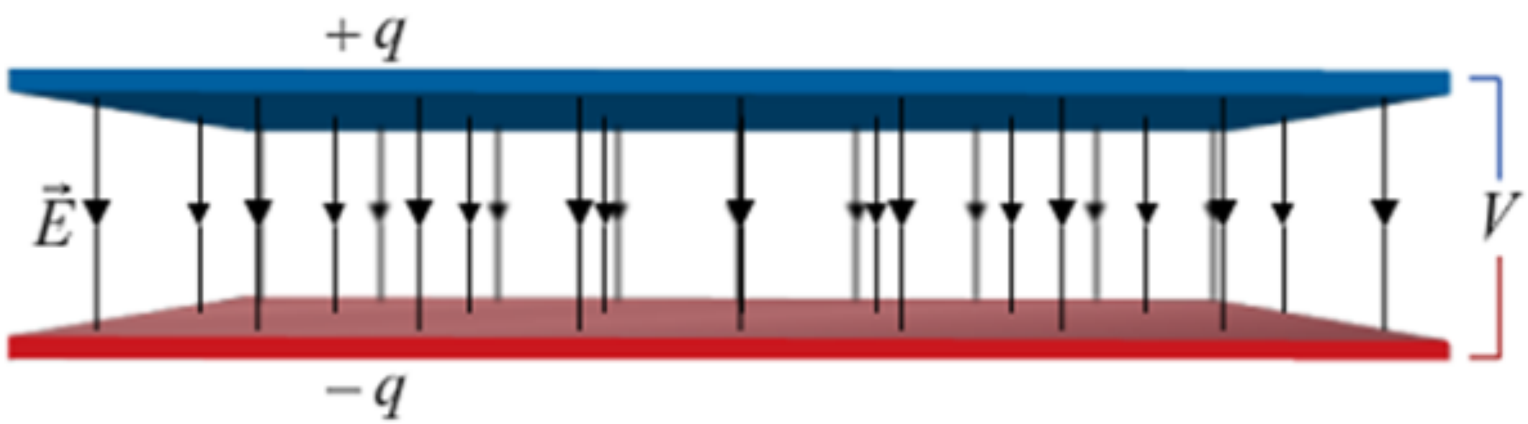
- **Distances** just **add** therefore so does inverse capacitance!

Energy is stored in the **E field**

- How do we think about Electric Potential Energy?
  - Negative **work** required to build **charge distribution**
  - … but where is the energy stored?
  - in the **Electric Field**

Energy is stored in the **E field**

- Use a capacitor to compute the energy…



- **E is constant** inside capacitor so it will be easy to deduce the dependence on E

(overhead)

Energy is stored in the **E field**

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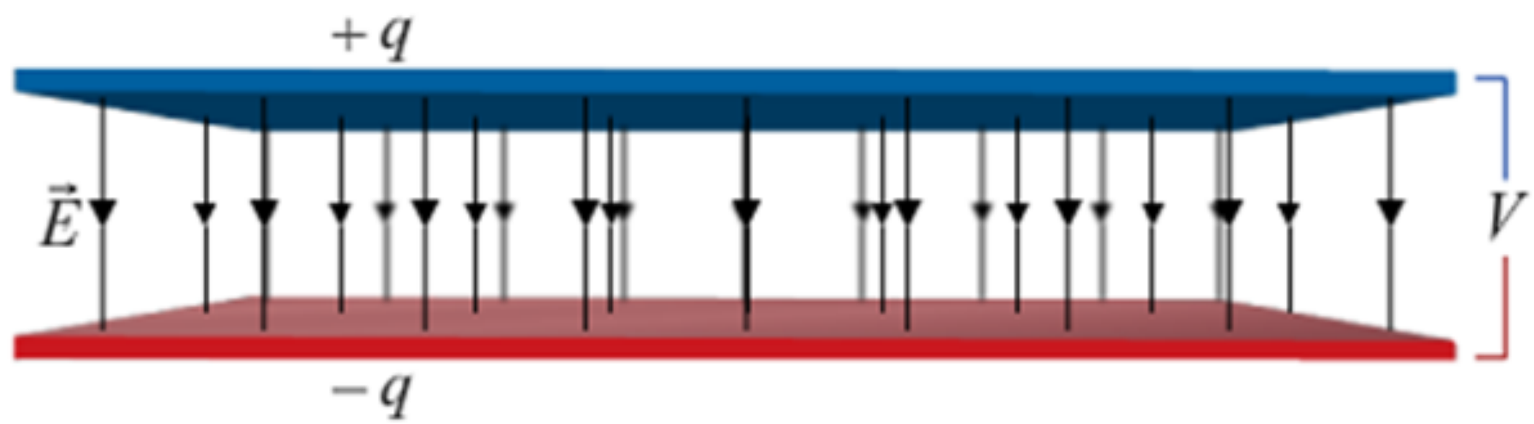

- **E is constant** inside capacitor so it will be easy to deduce the dependence on E

(overhead)

$$u = \frac{1}{2}\epsilon_0 E^2$$