Conductors and Capacitors

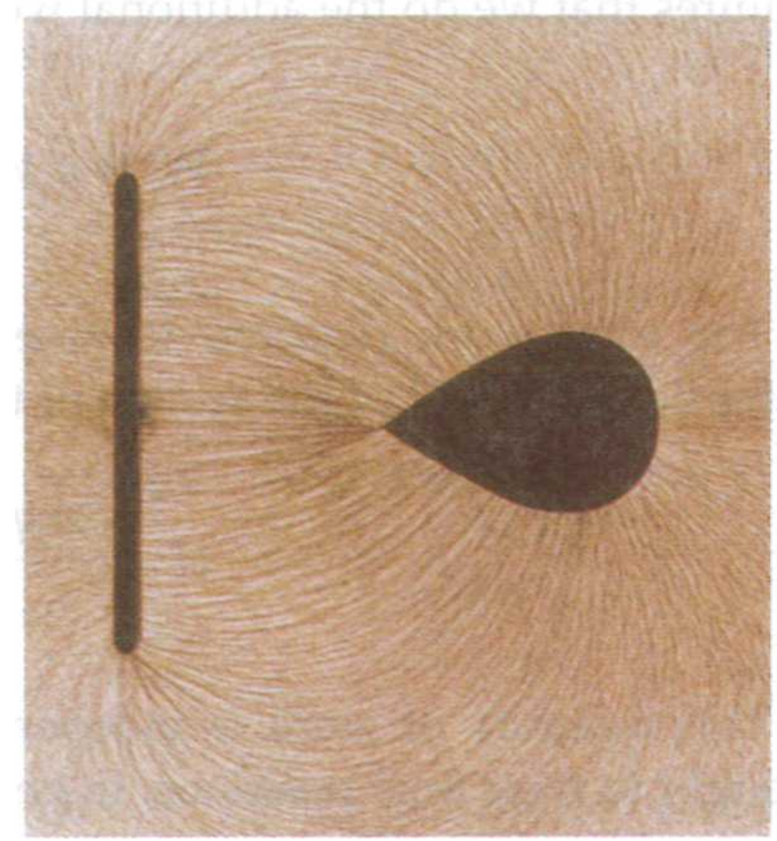
Lecture 10

Announcements

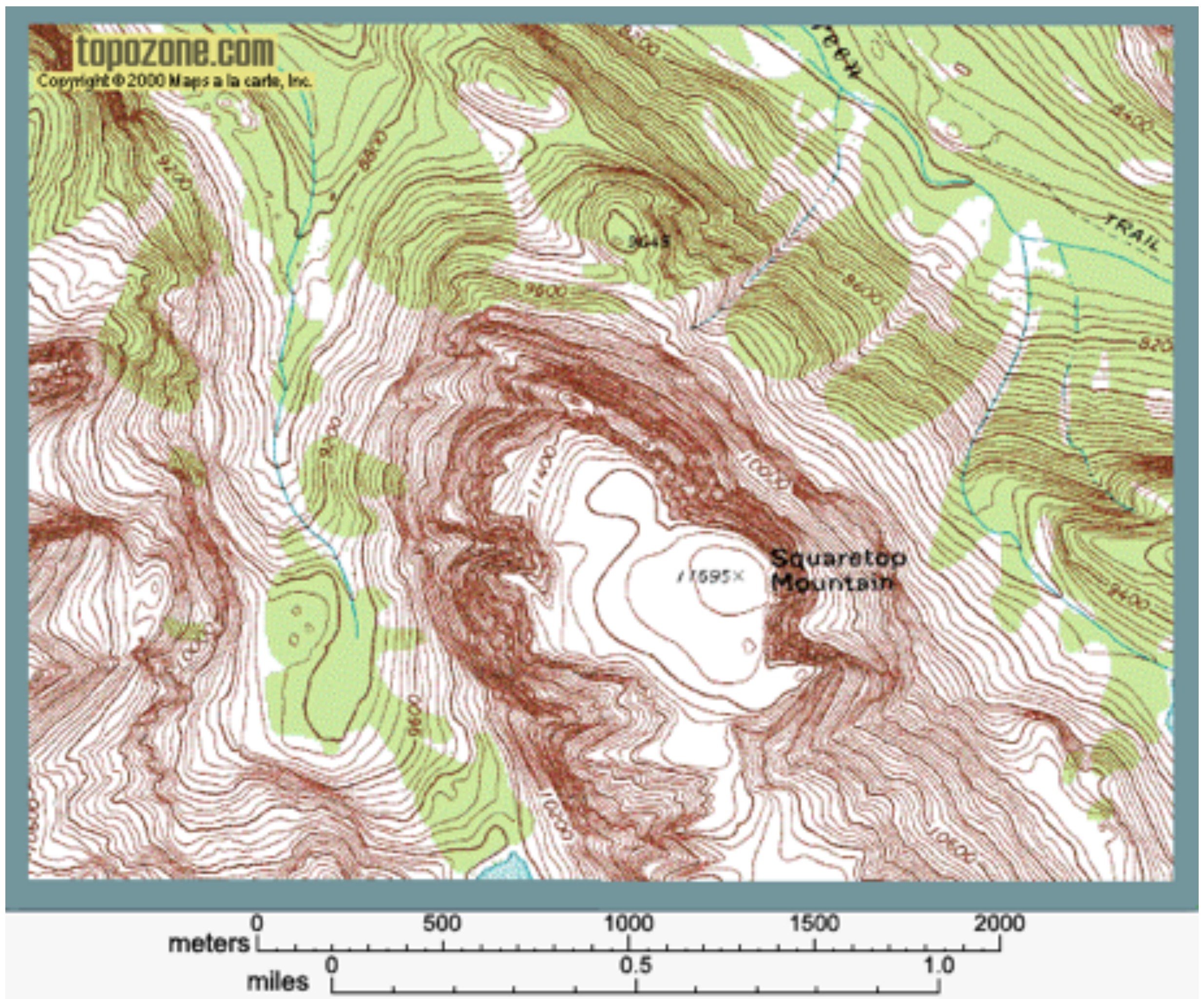
- Come pick up your exams.
  - All 122 class: 65 +/-
  - Susan Miller has several no-name exams. (Please see her if this is you.)
  - Regrade requests due by Friday.
- Reading for Friday: 24.1-24.2

Conductors review…

- Charges free to move
- E = 0 in a conductor
- Surface = Equipotential
- E at surface perpendicular to surface



Understanding potential



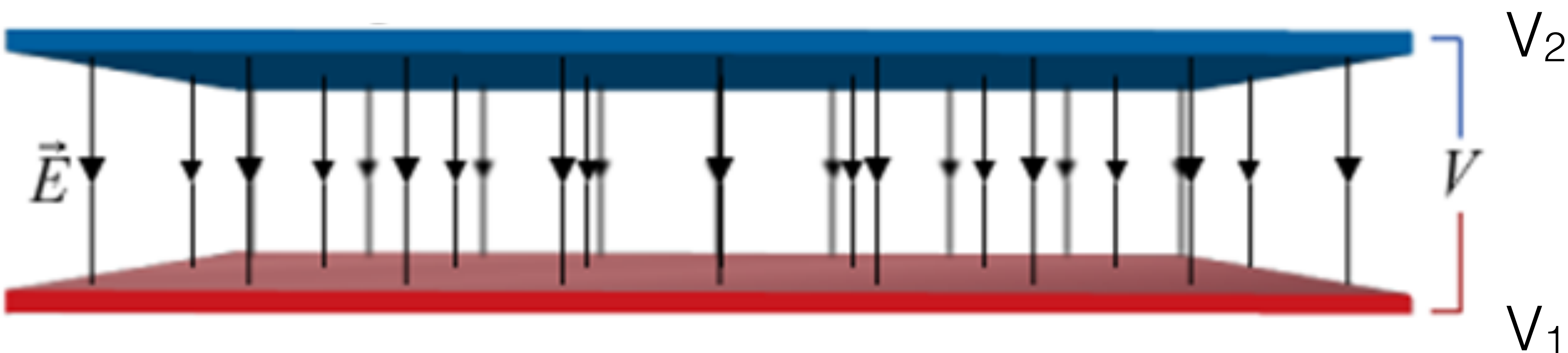
- Only **relative** values of potential matter
- Changes (gradients) in potential generate force

Potential is always relative to some reference (often ∞)

… whereas E field can be defined locally.

Intuitively, how do I know whether the potential difference is +/-?

$$V_{12} \equiv V_2 - V_1$$

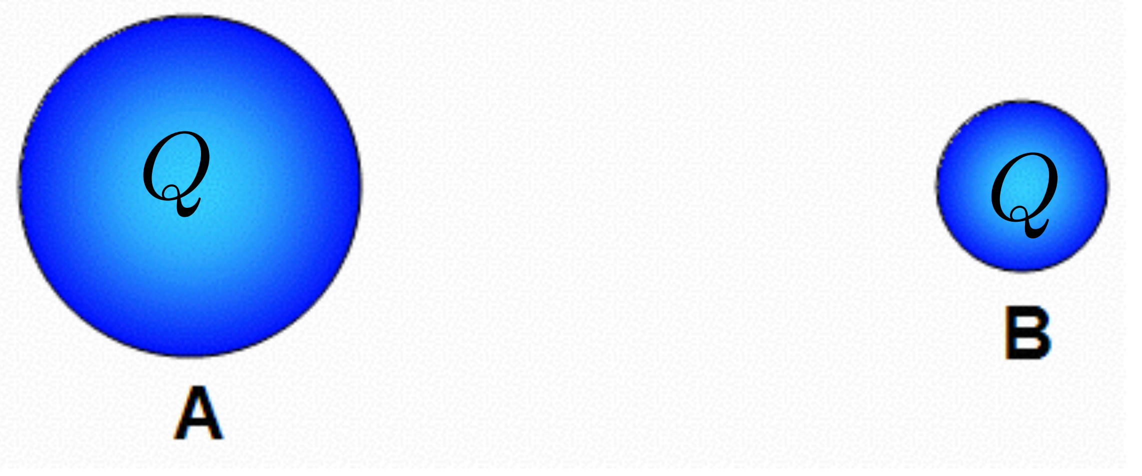


"Field line always points in the direction of reduced potential."

"+ charges are at + potential, - charges are at - potential."

Interesting problem from the prelecture/checkpoint

- Compute the potential of a charged conducting spheres

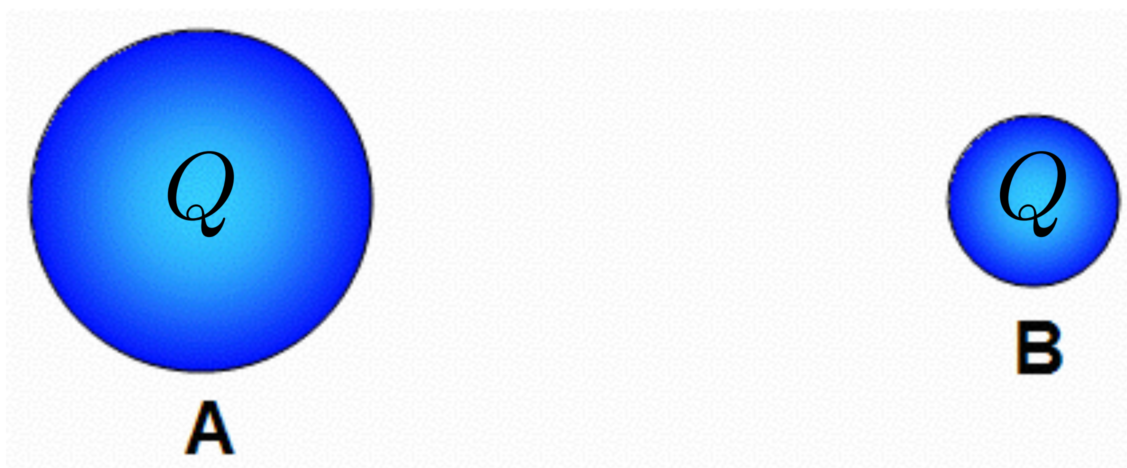


$$V_A = \frac{kQ}{R_A} \qquad V_B = \frac{kQ}{R_B}$$

- what is the relation between V_A and V_B?

Interesting problem from the prelecture/checkpoint

- Now the sphere are connected by a wire that allows the sphere to exchange charge. What happens?

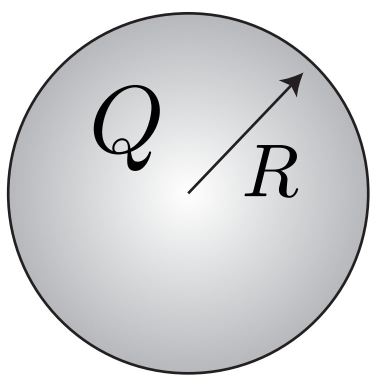


$$V_A = \frac{kQ}{R_A} \qquad V_B = \frac{kQ}{R_B}$$

- work out details…

Capacitance

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



$$V(R) = \frac{kQ}{R}$$

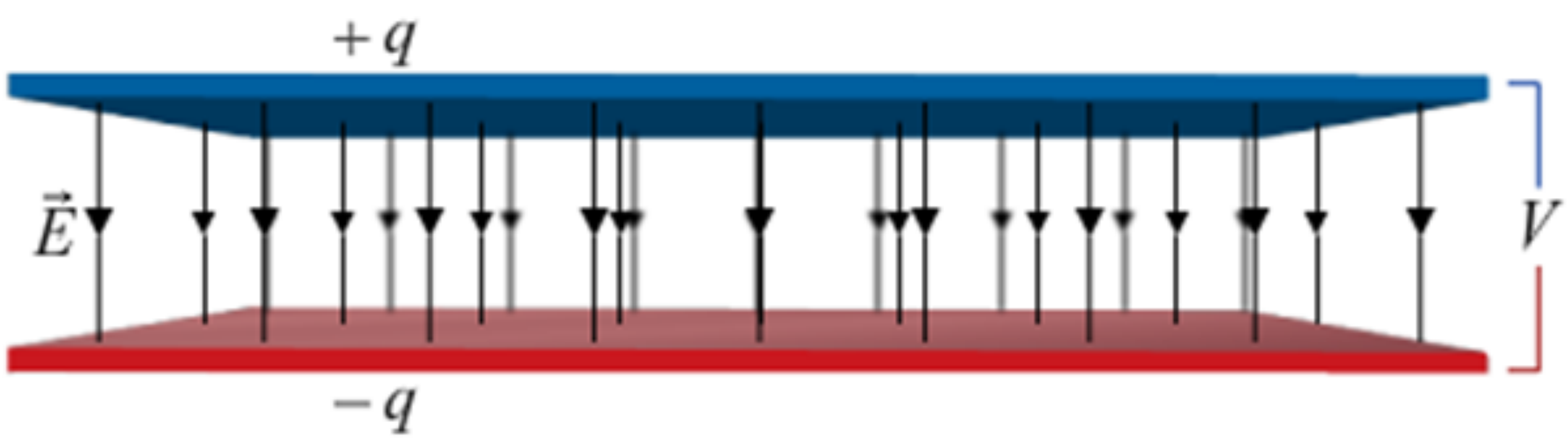
- In general, we always find that whatever the geometry of the conductor:

$$V = Q/C$$

- where the **capacitance C** depends on the geometry

Clicker

Compute C for a plate capacitor…

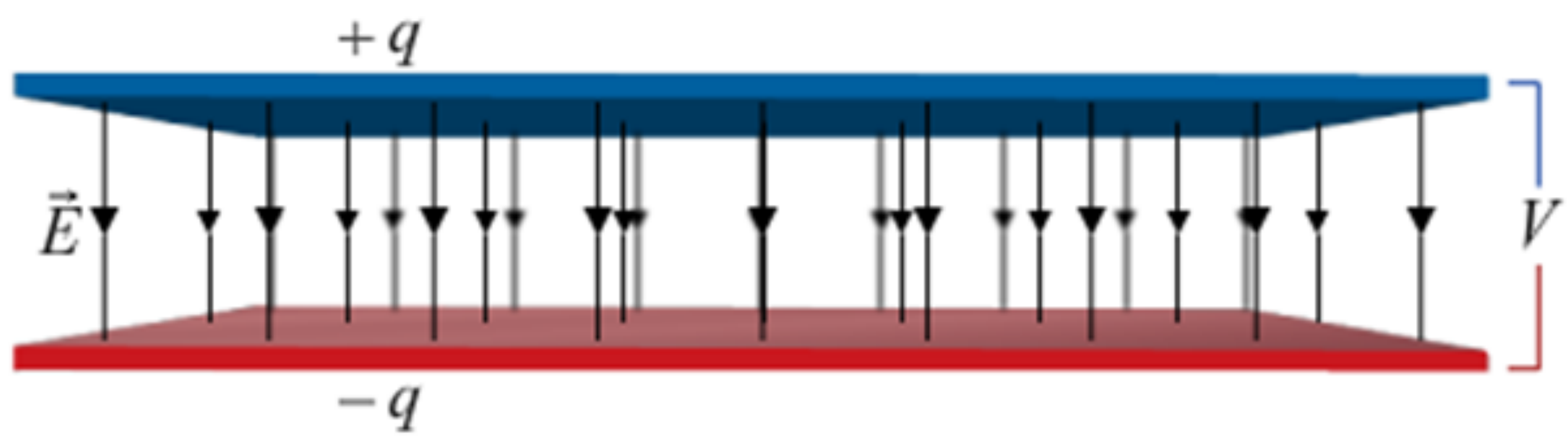


$$Q = CV$$

on overhead…

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

Compute C for a plate capacitor…



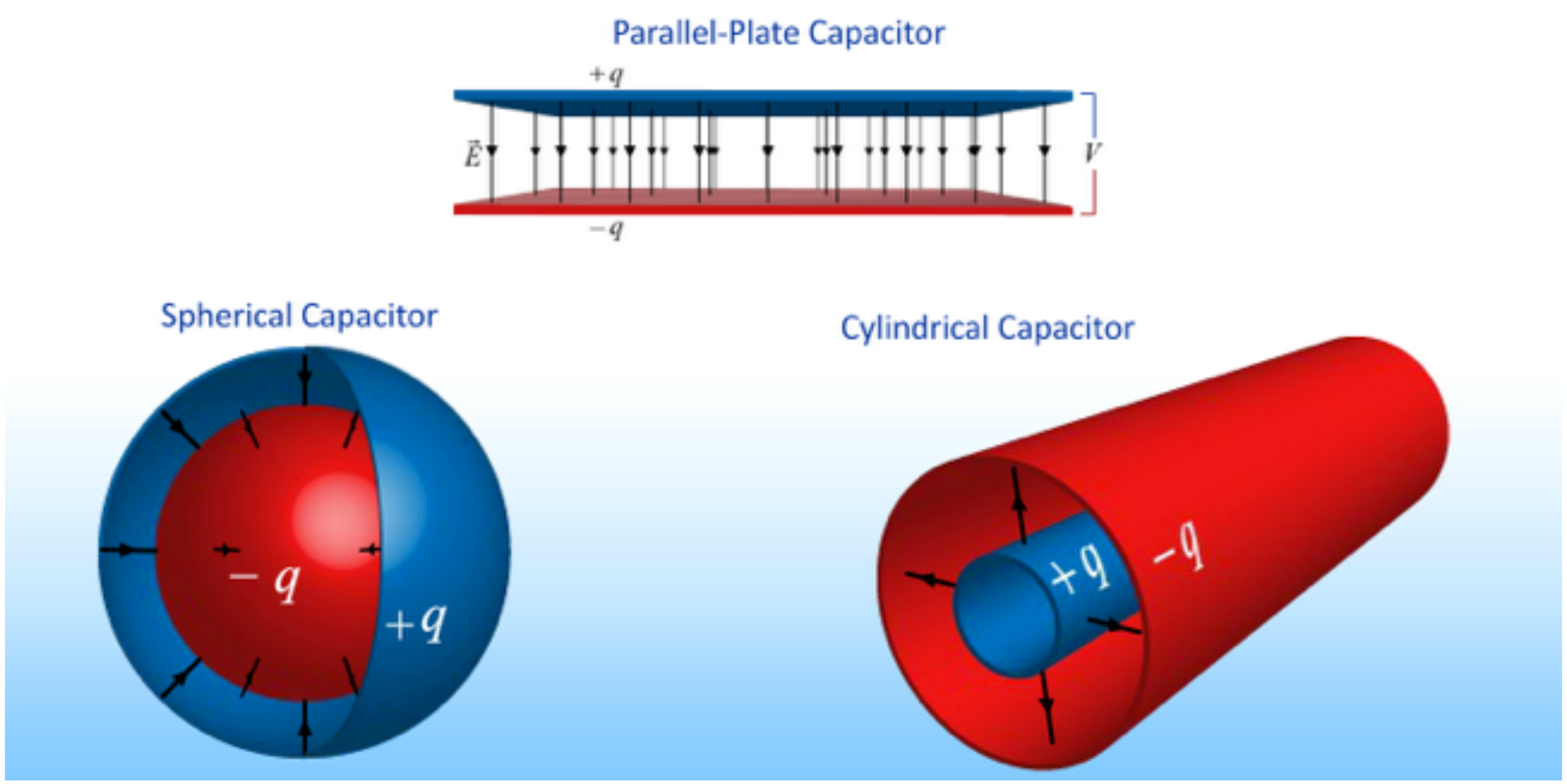
$$Q = CV \qquad\qquad C = \frac{A\epsilon_0}{d}$$

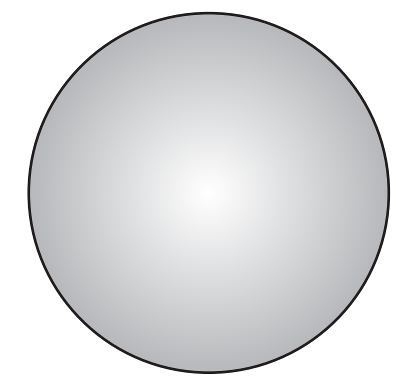
Intuitive meaning…

Clicker

Capacitors

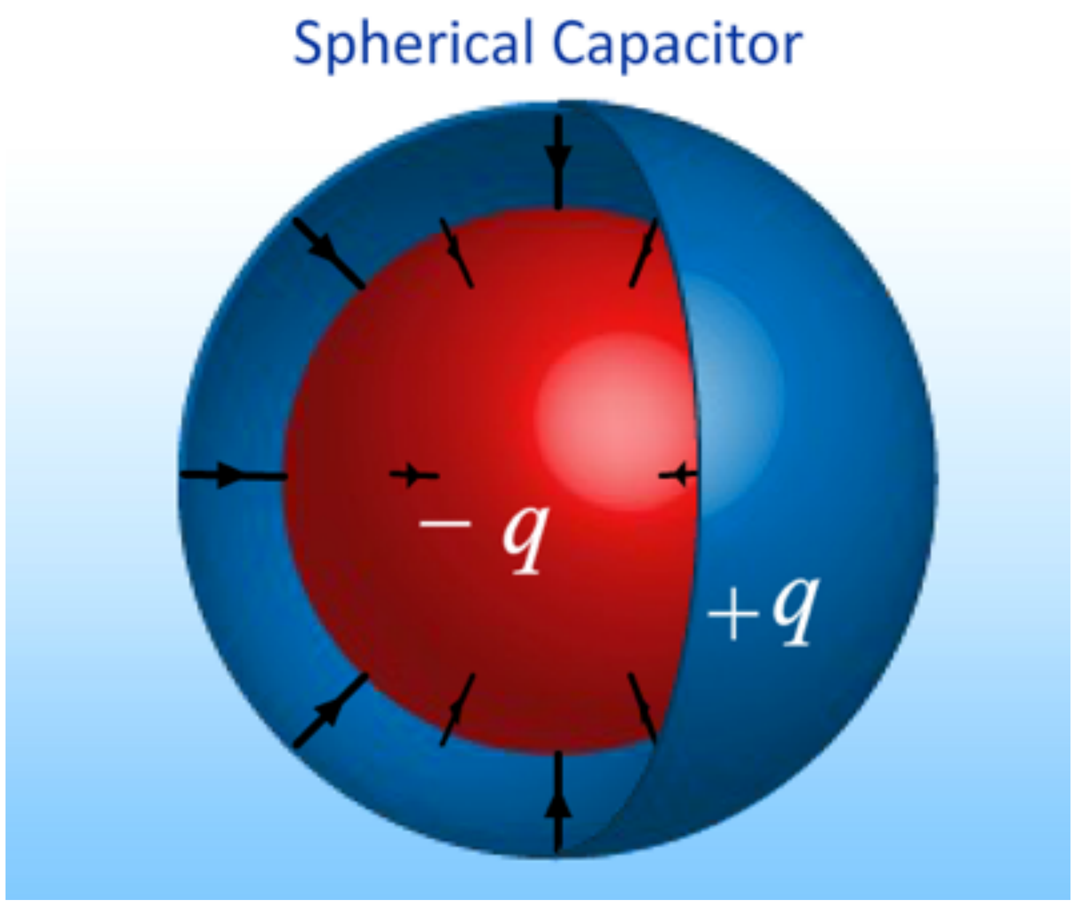
- Not just planes…
  spheres, cylinders, plates,
  isolated conductor…





Capacitance depends only on geometry (not charge).

Concentric Spheres



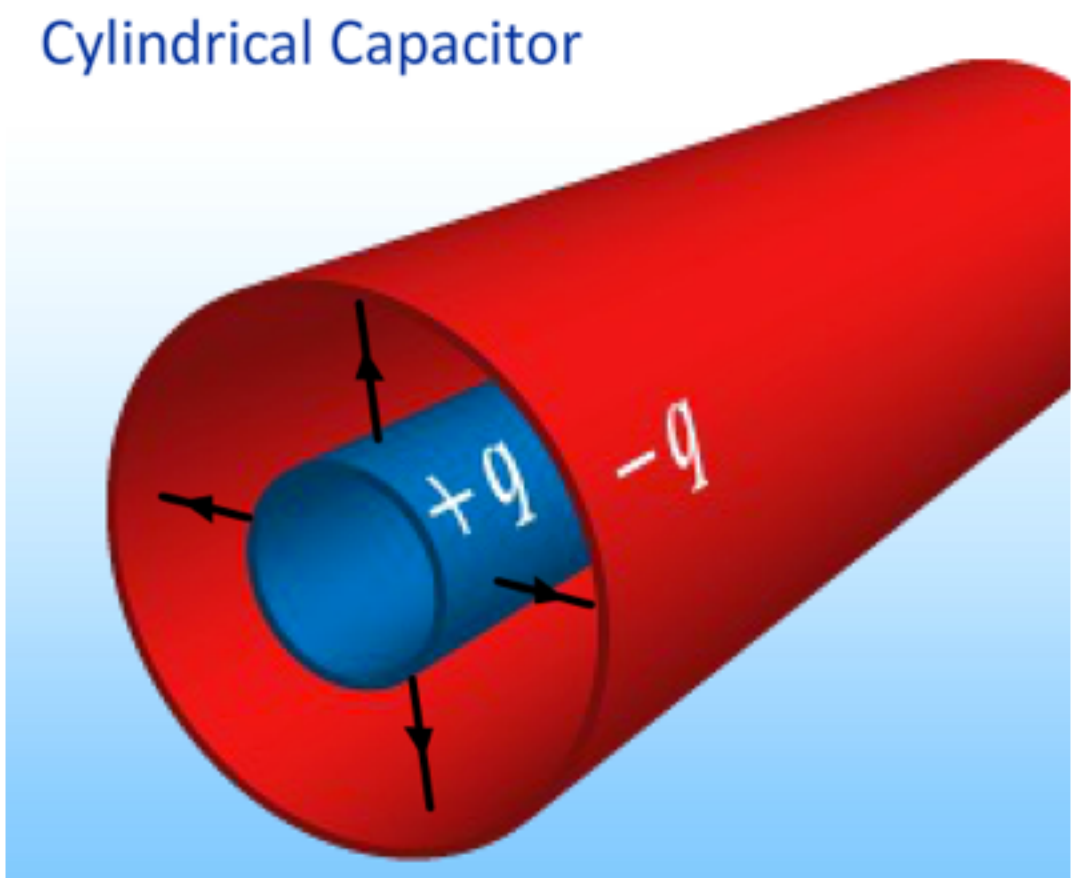
$$Q = CV$$

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?