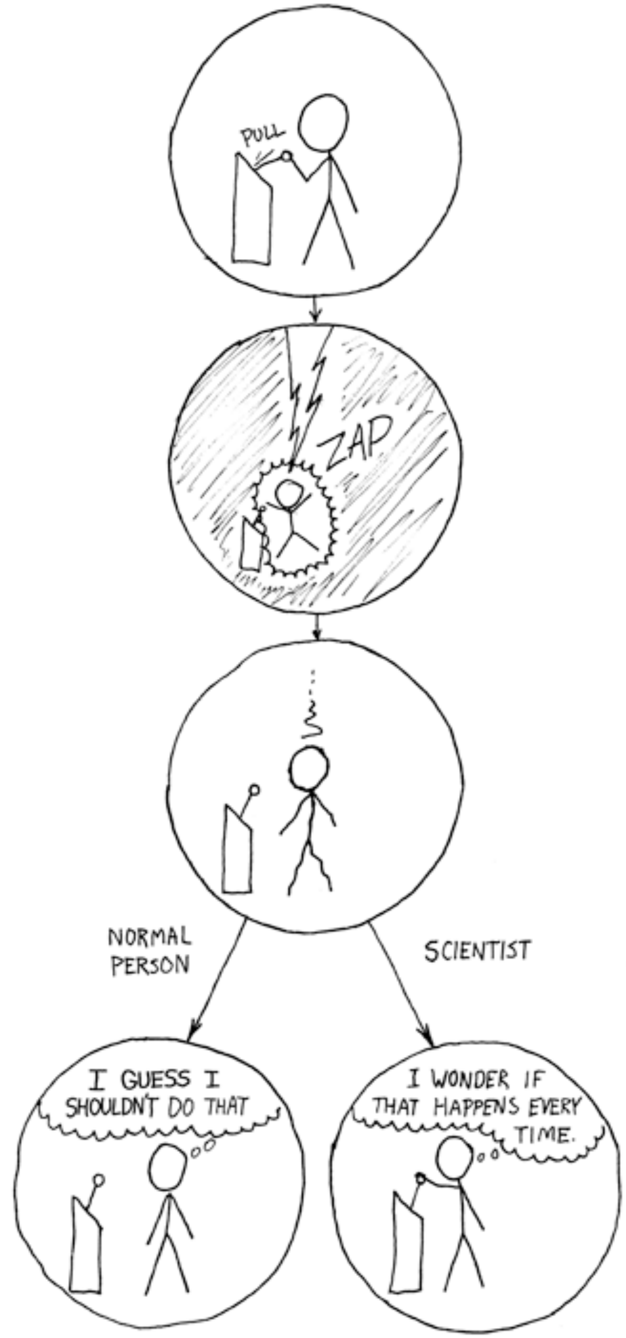
March 7, 2016 Physics 132

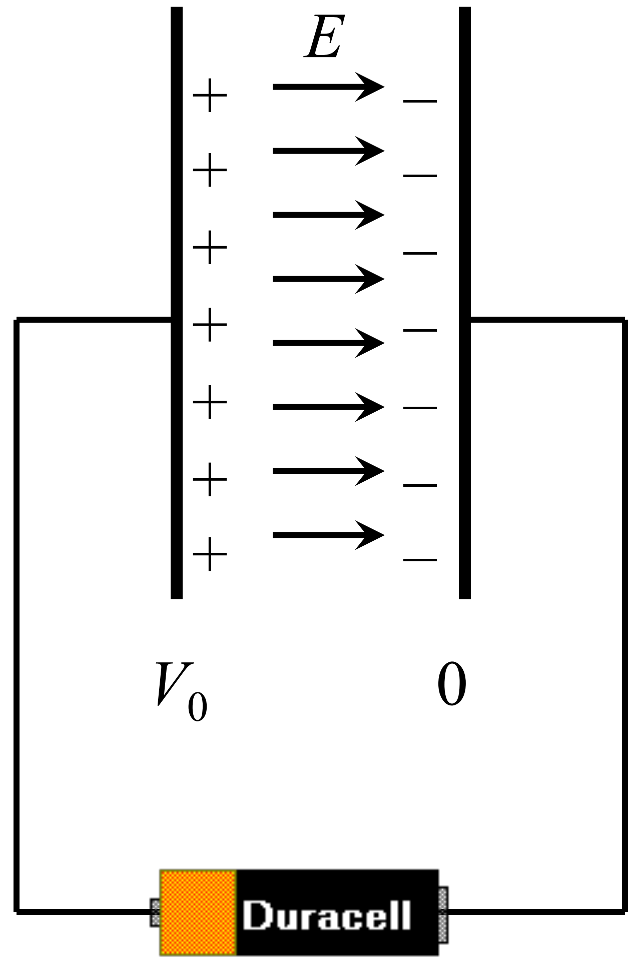
Prof. ~~E.F. Redish~~ B. Dreyfus

- **Theme Music:**
  Marcia Griffiths,
  Electric Boogie
- **Cartoon:**
  Randall Munroe, *xkcd*



Charging a capacitor

- What is
  the potential difference
  between the plates?
- What is the field
  around the plates?
- How much charge
  is on each plate?



Capacitor Equations

$$\Delta V = E\Delta x = Ed$$

$$E = 4\pi k_C \sigma = 4\pi k_C \frac{Q}{A} \quad \Rightarrow \quad Q = \left(\frac{A}{4\pi k_C}\right)E$$

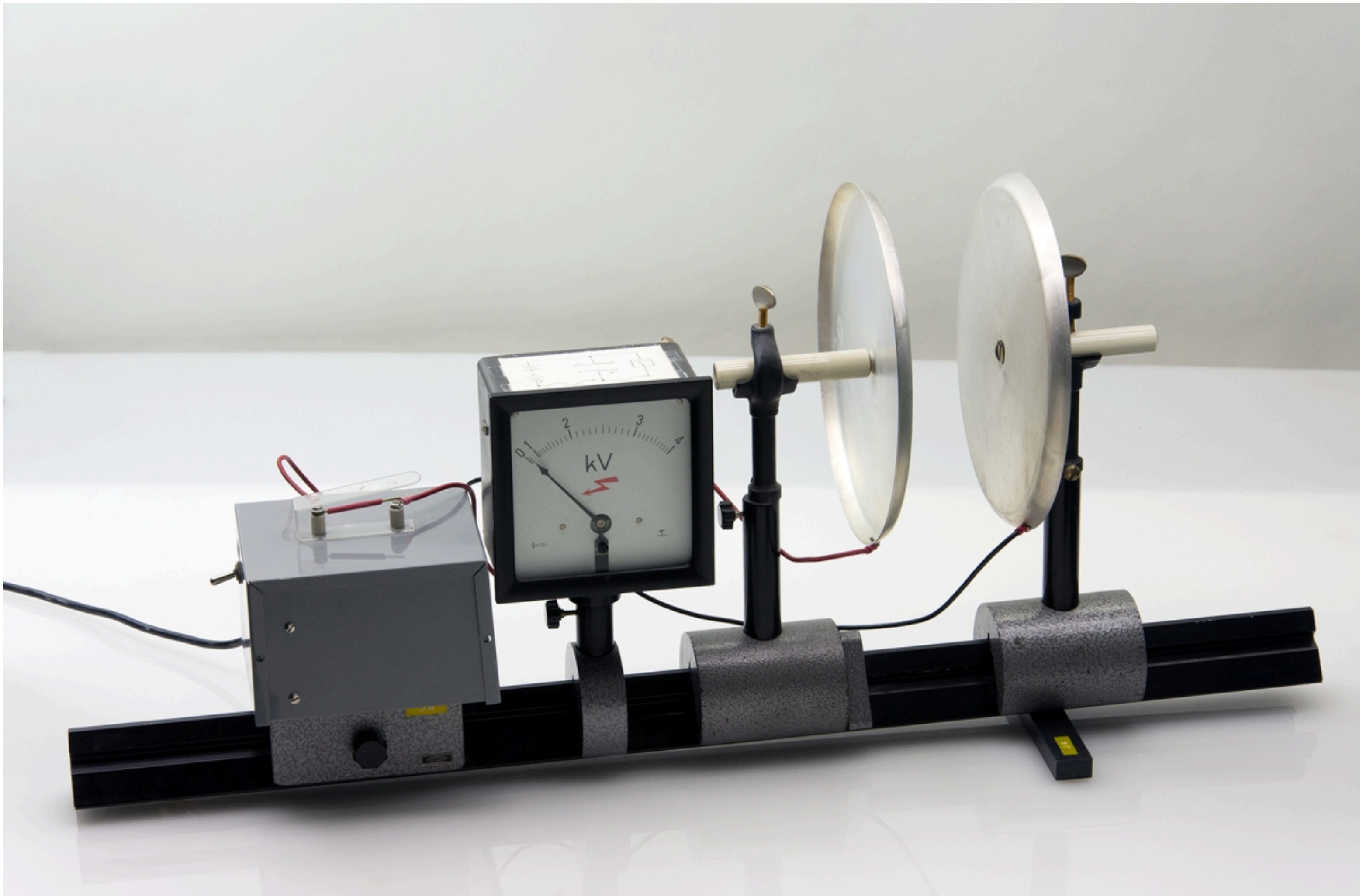
$$Q = \left(\frac{A}{4\pi k_C d}\right)\Delta V$$

$4\pi k_c$ is often written as "$1/\varepsilon_0$"

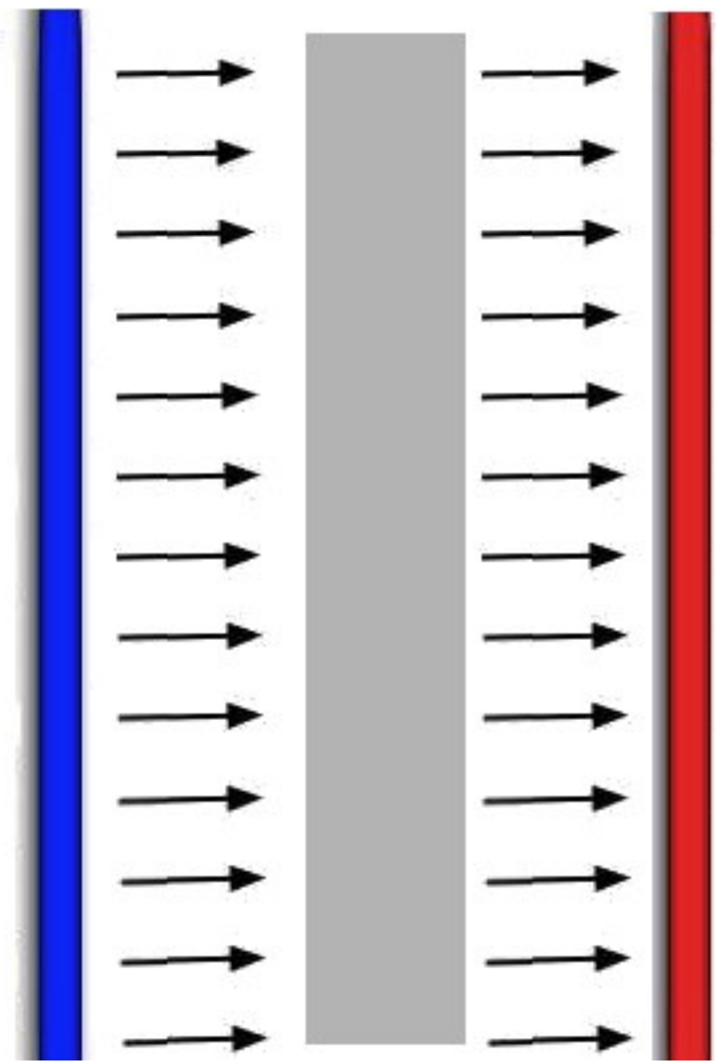
$$Q = C\Delta V$$

What does this "Q" stand for?

Demo (next few CQs)

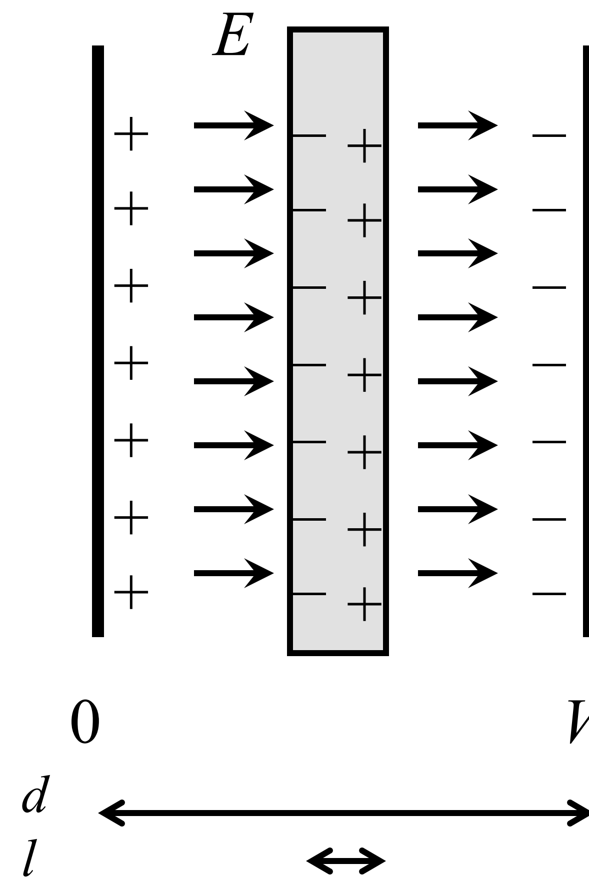


What happens
if I put
a conductor into
an electric field?



Consider what happens with a conductor

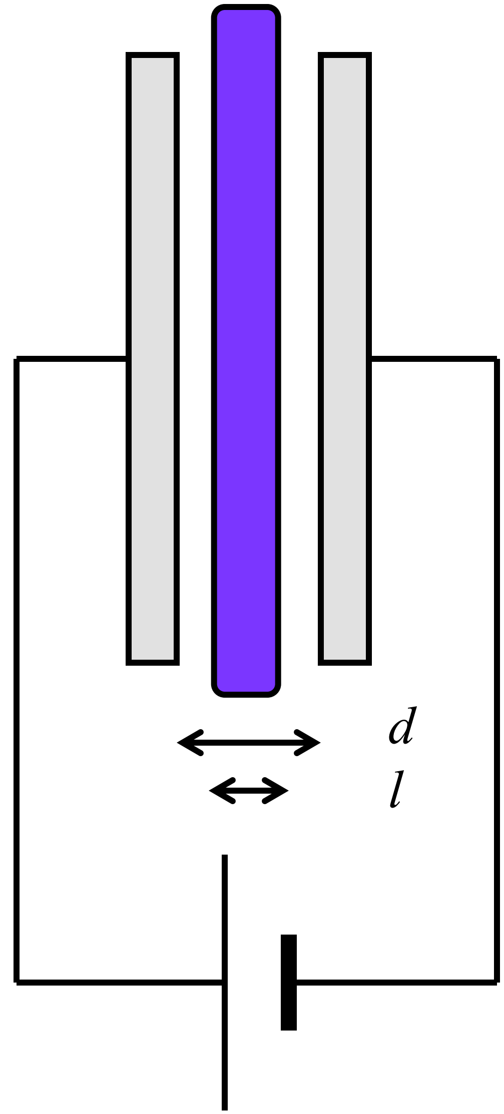
- The potential difference is produced by adding up $E\Delta x$.
- If we can reduce E along the path, we can reduce ΔV.
- Inside a static conductor, there can be no E field. (Why not?)
- What happens if we put a conducting sheet between the plates?



Conductors

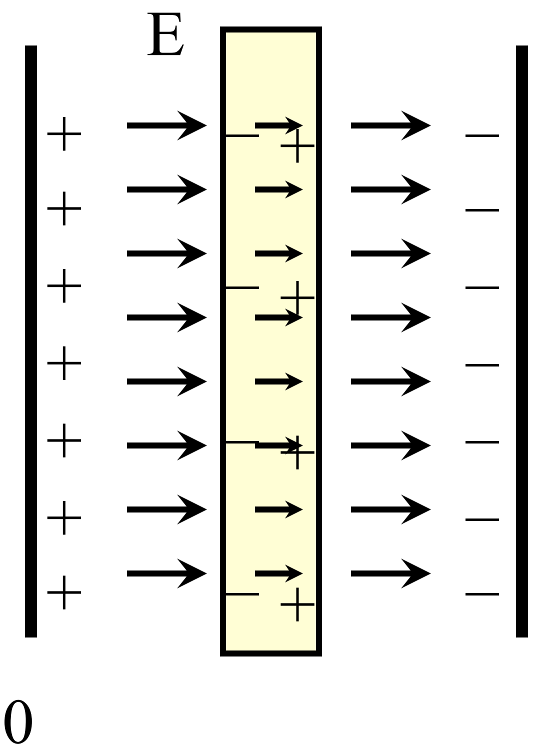
- Putting a conductor inside a capacitor eliminates the electric field inside the conductor.
- The distance, $d' = d - l$, used to calculate the ΔV, is only the place where there is an E field, so putting the conductor in reduces the ΔV for a given charge.

$$C = \frac{1}{4\pi k_C} \frac{A}{d'}$$



Consider what happens with an insulator

- We know that charges separate even with an insulator.
- This still reduces the field inside the material, just not to 0.
- The field reduction factor is defined to be κ (*the dielectric constant*).



$$E_{\text{inside material}} = \frac{1}{\kappa} E_{\text{if no material were there}}$$