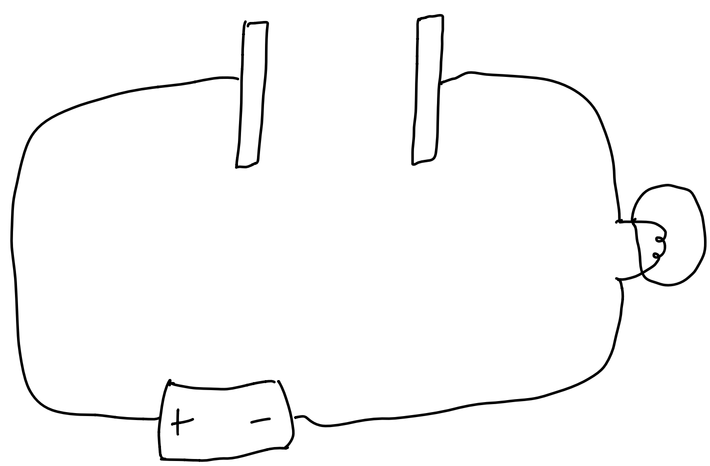
Circuit Elements

- Capacitors
- Resistors
- Circuit analysis

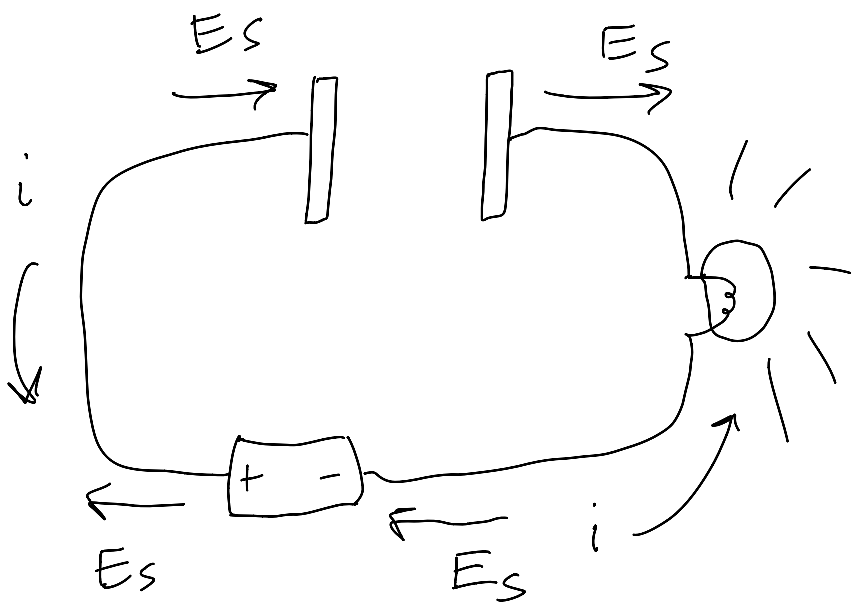


What happens?

- Surface charge "instantly" arranges and we get a uniform field everywhere

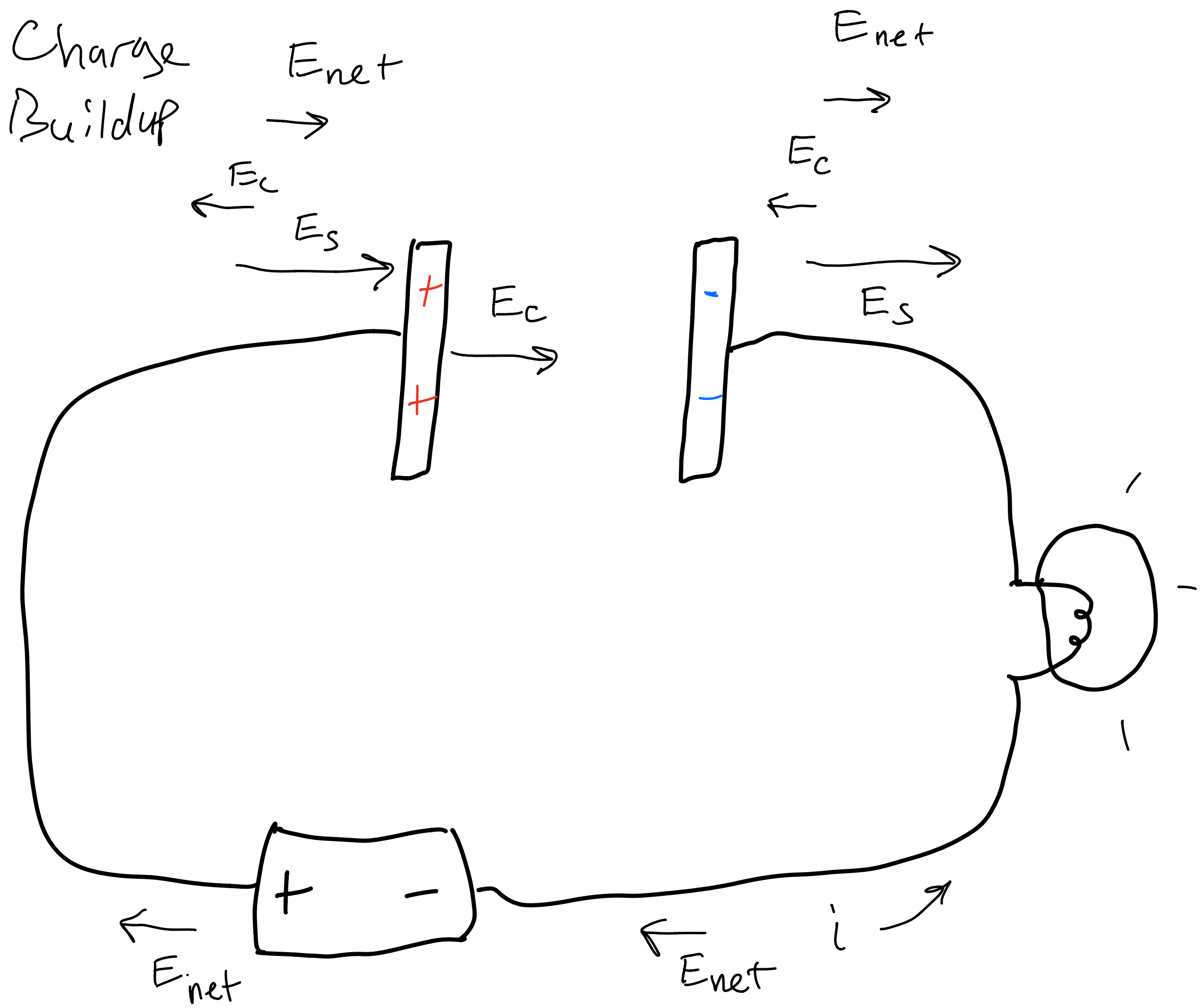
- Uniform electron current
- Bulb lights up

$\vec{E}_s = \vec{E}$ of steady state (batt + surf)

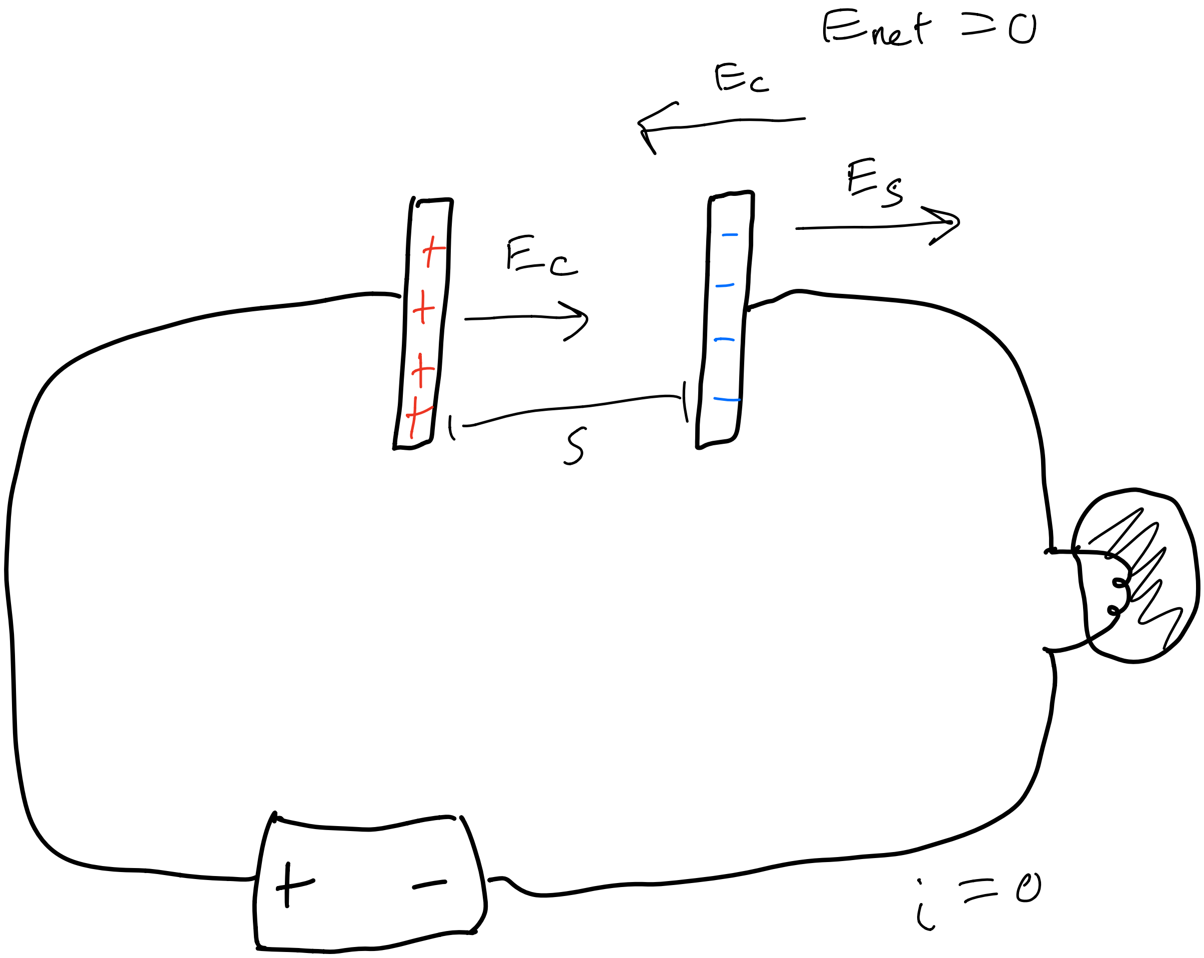


Does current cross the capacitor gap?

No!



Charge Buildup
E_{net}
E_c
E_s
+
+
E_c
E_{net}
E_c
-
-
E_s
+
-
E_{net}
E_{net}
i



What is ΔV_c?

$$\varepsilon - |\Delta V_c| = 0$$

$$|\Delta V_c| = \varepsilon$$

What is the charge on the capacitor?

$$E_c = \frac{Q/A}{\epsilon_0}$$

$$\Delta V_c = \frac{Q/A}{\epsilon_0} s$$

$$Q = \frac{\epsilon_0 A}{s} \Delta V_c$$

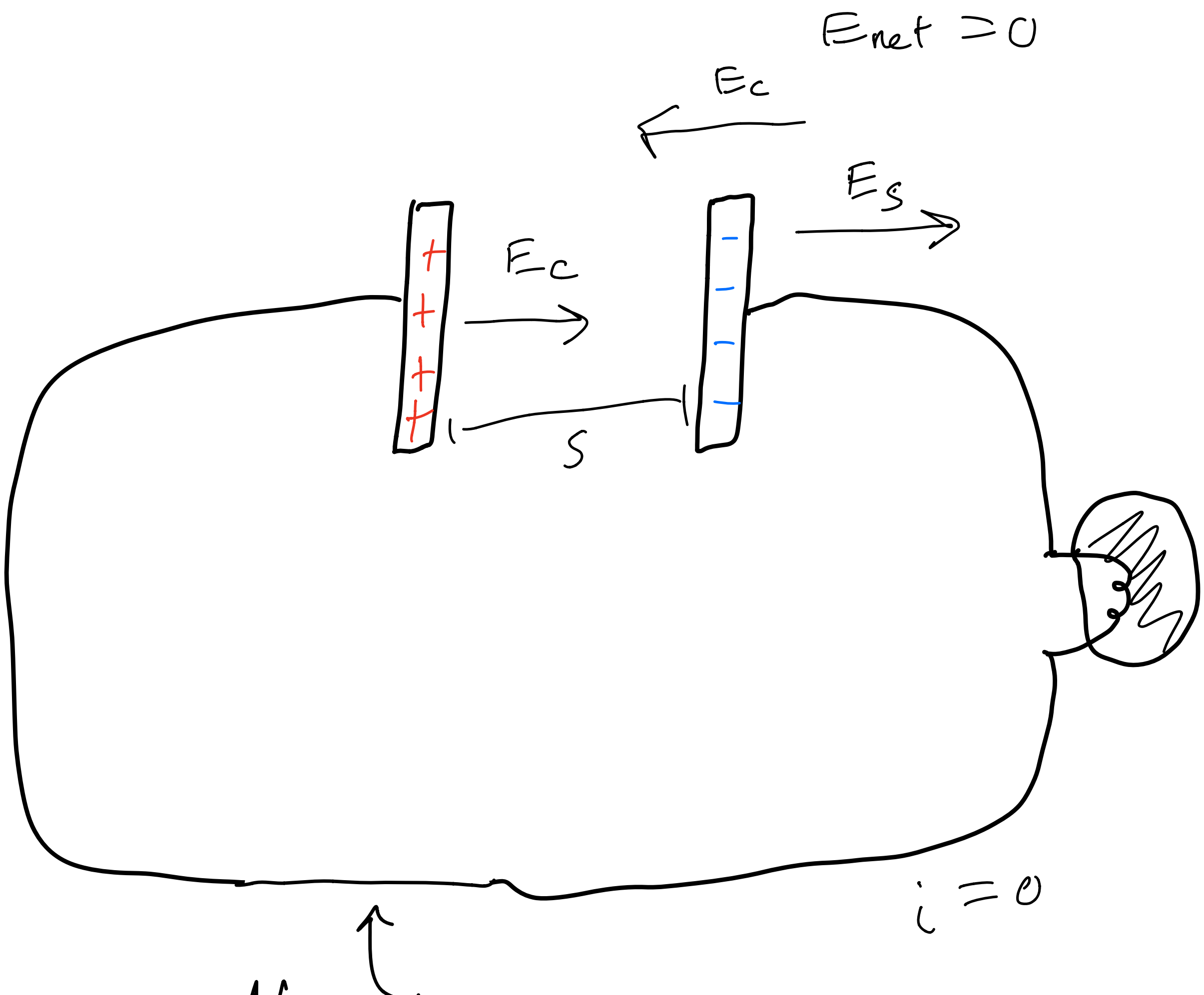
$$Q = C \Delta V_c, \quad C \equiv \frac{\epsilon_0 A}{s}$$

C = "capacitance" Unit: Farad

How much charge per volt? (C/V)

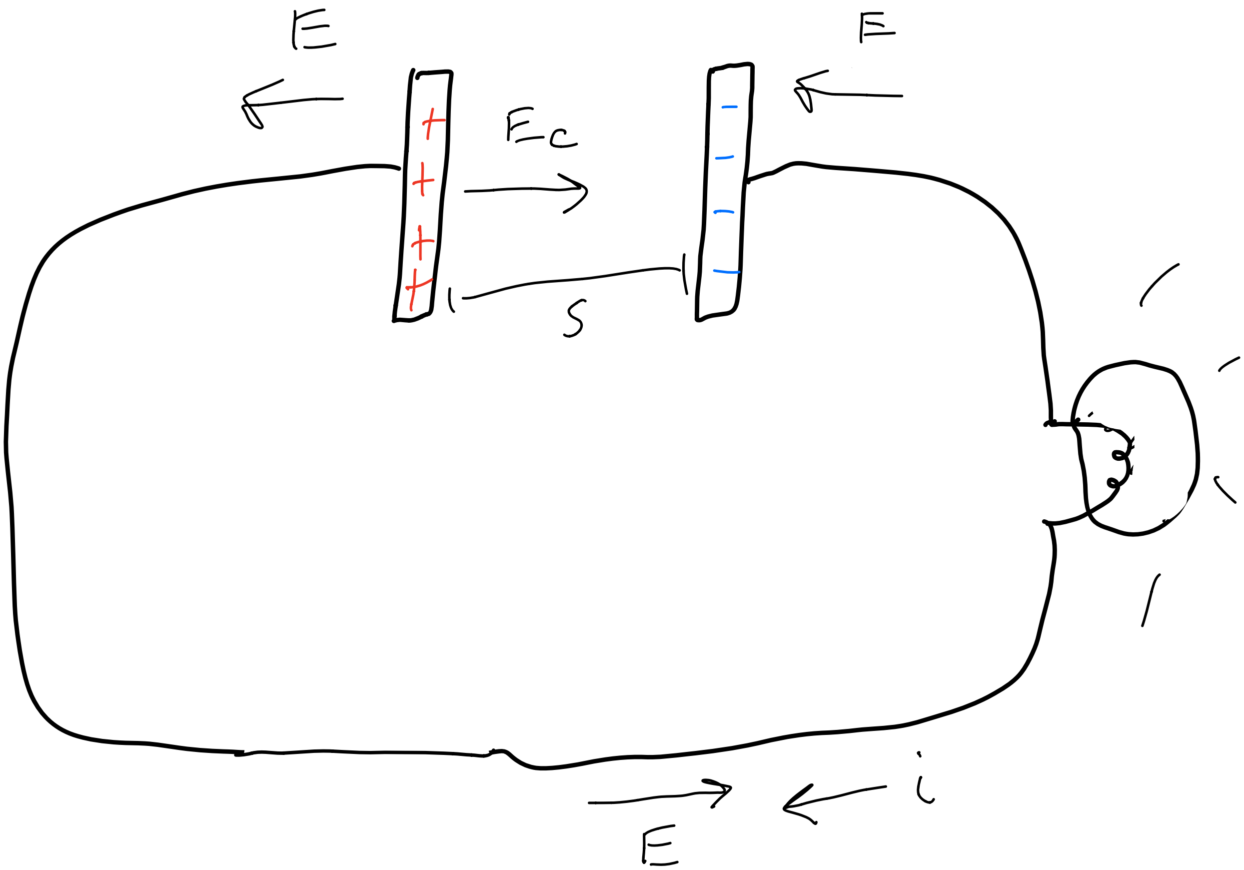
- Fx of geometry only

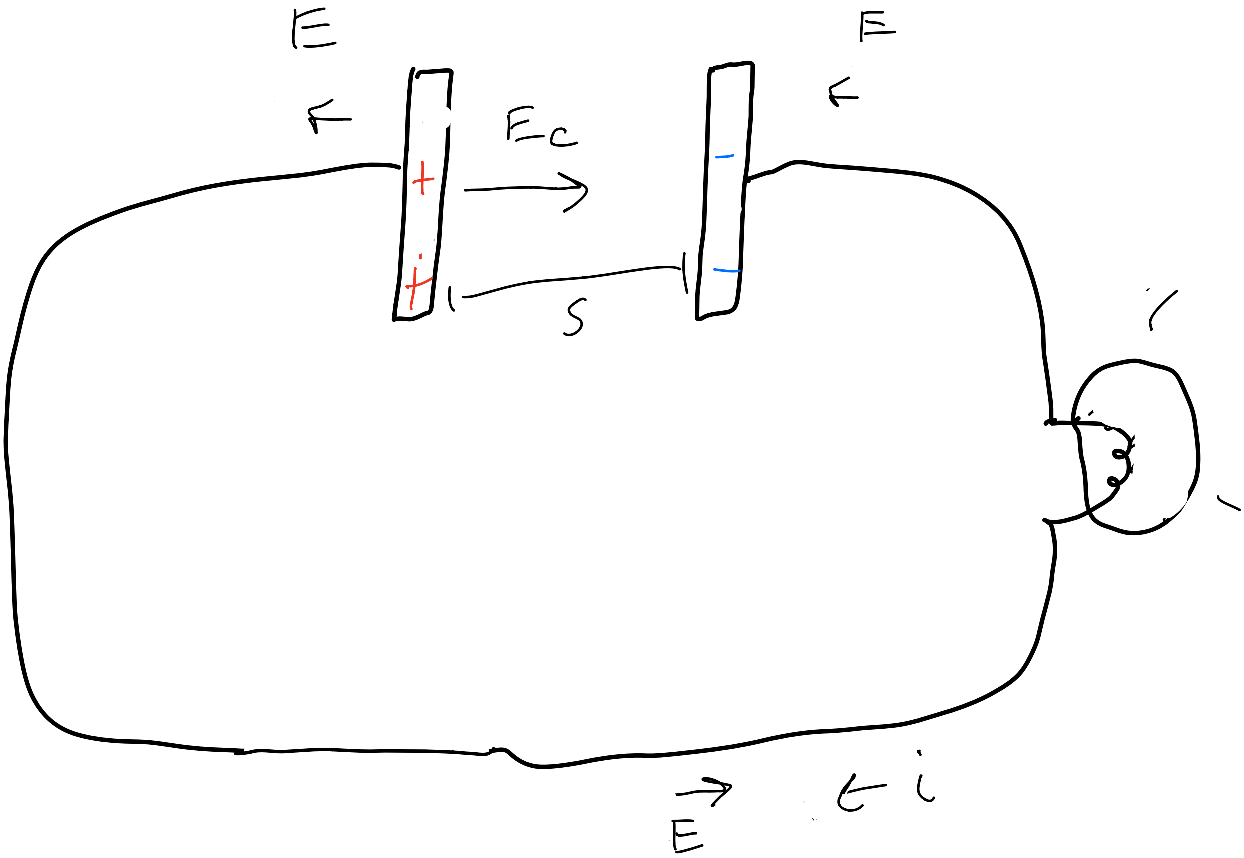
Q + ΔV change, C does not



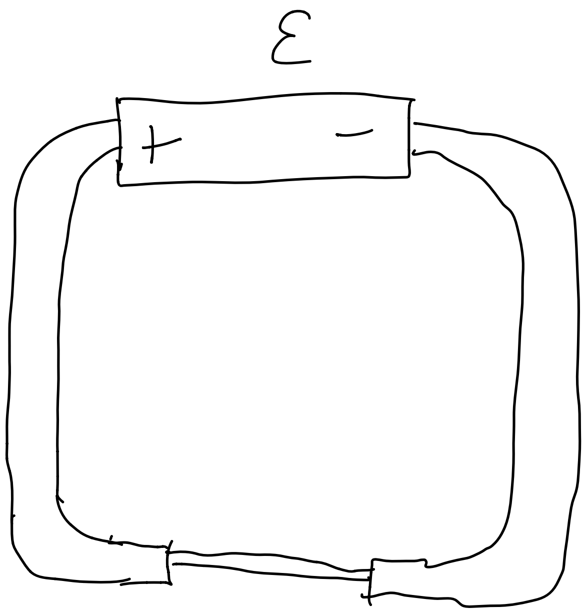
Now remove Battery

What happens?


E
F
F_c
s
i
E



Eventually, current stops



$$i = nAuE$$

$$I = |q|nAuE$$

$|q|, n, u$ are all properties of the material

$$J = \frac{I}{A} = |q|nuE$$

$$J = \sigma E, \quad \sigma = |q|nu$$

I runs in same direction as E

so:

$$\vec{J} = \sigma \vec{E}$$

$$|\Delta V| = E L = \frac{1}{\sigma} J L$$

$$\Delta V = \frac{L}{A\sigma} I$$

$$\Delta V = R I$$

$$R = \frac{L}{A\sigma}$$

$$R = \frac{\rho L}{A}, \quad \rho = \frac{1}{\sigma}$$

combination of
conductivity & geometry

What does R mean?

$$I = \frac{V}{R}$$

Higher R $\longrightarrow$ less current

Units of R: Ohm (Ω)

$$\text{Volts}/\text{Amp}$$