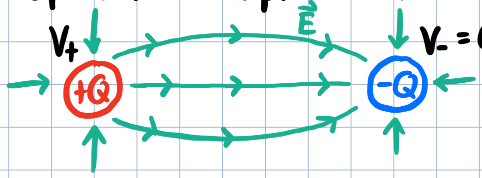
Capacitors: electrical devices that store charge

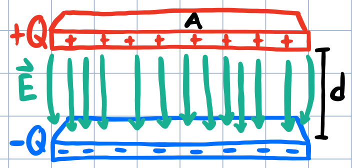
- A capacitor is comprised of two conductors with equal and opposite charge



$\Delta V = V_+ - V_- = V_+$

Capacitance $= C = \frac{Q}{\Delta V}$ $\left(\frac{\text{Coloumb}}{\text{Volt}}, \text{ Farad (F)}\right)$

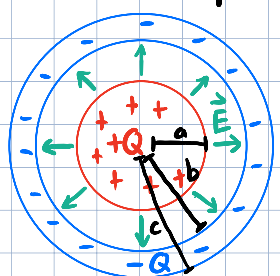
- What's the capacitance of a parallel-plate capacitor?



$\Delta V = \int_+^- \vec{E}\cdot d\vec{s} = \int_0^d \frac{\sigma}{\varepsilon_0} ds = \frac{\sigma d}{\varepsilon_0}$

$C = \frac{\sigma A \varepsilon_0}{\sigma d} = \frac{A\varepsilon_0}{d}$; not dependent on charge at all

- What about a spherical capacitor?



$\Delta V = \int_+^- \vec{E}\cdot d\vec{s} = \int_a^b \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{r^2} dr = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$

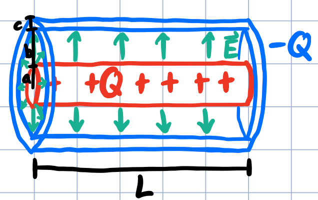
$C = \frac{Q}{\Delta V} = \frac{4\pi\varepsilon_0}{\frac{1}{a} - \frac{1}{b}}$; once again only relies on dimensions

- Isolated sphere?

$C = \frac{4\pi\varepsilon_0}{\frac{1}{a} - \frac{1}{b}}$, $b = \infty \rightarrow C = 4\pi\varepsilon_0 a$

For VanderGaff, $a = 0.125\text{m} \rightarrow C = 1.4\times10^{-11}\text{F}$

- Cylindrical capacitor?



$\Delta V = \int_+^- \vec{E}\cdot d\vec{s} = \int_a^b \frac{Q}{2\pi r L \varepsilon_0} dr = \frac{Q}{2\pi L \varepsilon_0} \ln\left(\frac{b}{a}\right)$

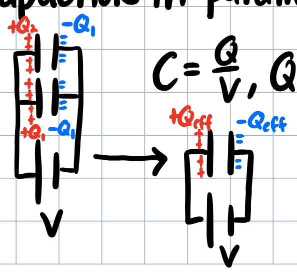
$C = \frac{Q}{\Delta V} = \frac{2\pi L \varepsilon_0}{\ln\left(\frac{b}{a}\right)}$

- Circuit symbols:

$|\,|$ = battery, $||$ = capacitor

pos neg

- Capacitors in parallel:



$C = \frac{Q}{V}$, $Q = CV \rightarrow Q_1 = C_1V_1$, $Q_2 = C_2V_2$; in parallel so V same $\rightarrow Q_1 = C_1V$, $Q_2 = C_2V$

$Q_{eff} = Q_1 + Q_2 \rightarrow C_{eff} = \frac{Q_1 + Q_2}{V} = \frac{Q_1}{V} + \frac{Q_2}{V} = C_1 + C_2$

So for parallel, $C_{eff} = \sum_{i=1}^{N} C_i$