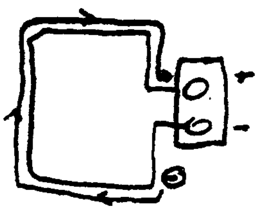
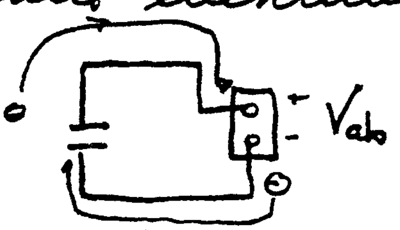
MORE CAPACITANCE

What happens if you connect the terminals of a battery together with a wire (don't worry about details of battery just consider it a source of potential difference (a charge)



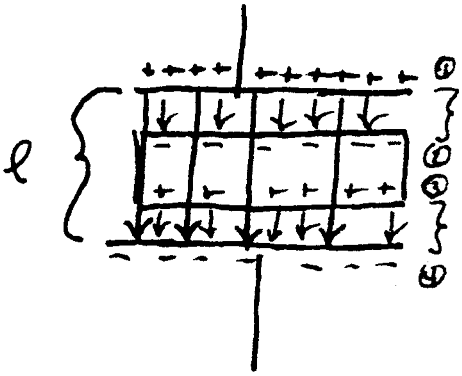
Current will flow from one terminal to the other (in reality we know that the e^- carry the charge until eventually battery runs down.



Put in capacitor - flow of current will continue until voltage between plates builds up (charge can't get through insulator) and equals V_{ab}

The relationship between the amount of charge necessary to provide a given potential difference is called the capacitance and is a property of the geometry of the capacitor

Can we increase the capacitance of a given geometrical configuration?

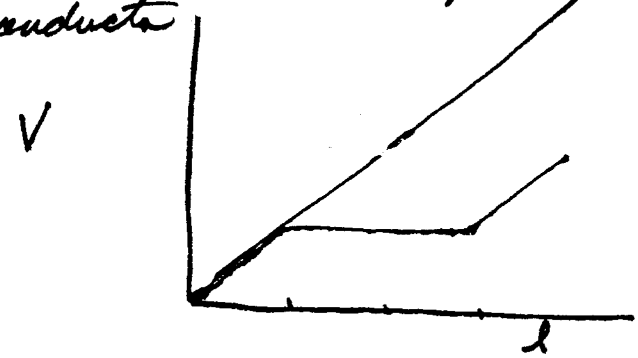


Consider a parallel plate capacitor with

$$C_0 = \frac{\varepsilon_0 A}{\ell}$$

$$V_{ab} = \frac{Q\,\ell}{\varepsilon_0 A}$$

Suppose we insert a conducting plate inside the capacitor what happens? Apply voltage V to charge plates + disconnect from source of p.d. insert conductor



Resulting V is less for same charge

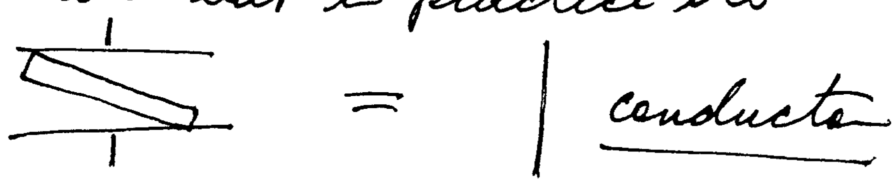
$$V_{12} = \frac{Q\,\ell/4}{\varepsilon_0 A} \qquad V_{34} = \frac{Q\,\ell/4}{\varepsilon_0 A}$$

$$V_{14} = \quad = V_{12} + V_{34} = \frac{Q\,\ell/2}{\varepsilon_0 A}$$

$$C = \frac{Q}{V} = \frac{Q}{\left(\frac{Q\,\ell/2}{\varepsilon_0 A}\right)} = \frac{2\,\varepsilon_0 A}{\ell}$$

$$C = 2\,C_0$$

We increase the capacitance by a factor of two but in practice its tricky



Suppose we place an insulating mat'l between the plates - dielectric - this also increases capacitance, but not as much as a equivalent conductor (N.B. previous result depends upon how much of space conductor fills w/ dielectric can fill entire space) Again charge capacitor + disconnect from source see V decrease when we put mat'l between plates $V < V_0$

$$C_0 = \frac{Q}{V_0}$$

$$C = \frac{Q}{V} \qquad V < V_0 \Rightarrow \underline{\underline{C > C_0}}$$

The amount that the capacitance increases depends upon the characteristics of the mat'l itself, we define the dielectric constant of the mat'l

$$K = \frac{C}{C_0}$$

$$K_{vacuum} = \frac{C_0}{C_0} = 1 \qquad K_{air} \simeq K_{vacuum} = 1.0005$$