things together. Charge would be built up on the inner foil, which would attract charges from the surroundings to go into the outer foil, thus creating a capacitor. Before batteries, Leyden jars were the primary way that electricity was studied, though they only worked once before they needed to be recharged.

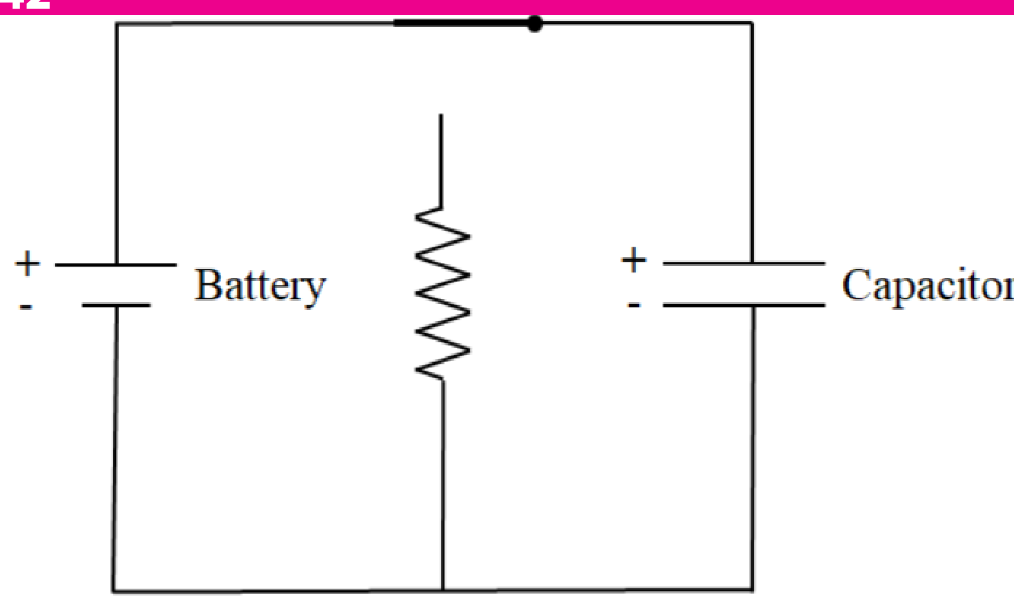
If you connect a capacitor to a battery, after a while it will accumulate the same voltage as the battery itself. What makes a capacitor different from a battery is that the capacitor does not have a way to maintain that voltage if current finds a way to flow from one end of the capacitor to the other. In other words, if you took a charged capacitor and connected the ends of it with wires, then the separated charges would neutralize each other, and the capacitor would no longer be charged.

Capacitors are often used in situations in which you want a quick, temporary flow of current. For example, a camera flash is powered by a capacitor, which is charged up and ready for a big discharge of current for a short time. Capacitors are also used to temporarily store data in a computer's random-access memory (RAM) or to provide a backup source of energy in case of a power outage. This also means that capacitors in electronic devices can store energy even when the devices are unplugged, which can potentially flow through you if you're not careful, so avoid taking apart any electronic device unless you really know what you're doing.

How much charge a capacitor can store depends on a property known as capacitance, which is based on the physical properties of the capacitor, such as the size of the conductors and their distance apart. If a capacitor's physical properties change, such as the conductors being moved closer together or further apart, this can produce a measurable effect on the circuit to which it is connected. Keys on a computer keyboard are attached to a metal plate with another metal plate below it, making a capacitor. Each time you press a key on your keyboard, you bring the metal plates closer together and change the capacitance, which sends an electric signal through the computer. A similar effect happens on touch screens, where the screen is coated with a conducting chemical, and your finger acts as the other conductor.

In a circuit diagram, capacitors look similar to batteries, but the two lines are the same length (Figure 42). This means that either end of a capacitor can become positive or negative, depending on how it is connected. In this diagram, current will flow through the resistor and build up on the plates of the capacitor. Eventually the plates of the capacitor will accumulate enough charge to push back against the current. This happens once the voltage in the capacitor is the same as that of the battery. In effect, the capacitor becomes a sort of anti-battery, resisting the flow of current as much as the battery drives it.

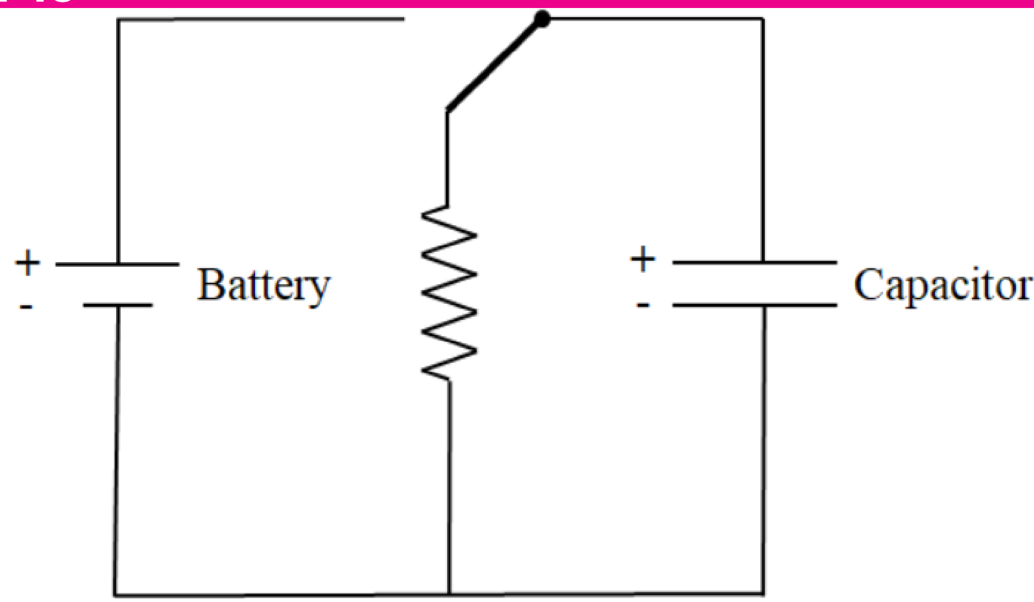
## FIGURE 42




*Current flows from the battery to the capacitor so that the ends of the capacitor match the ends of the battery.*

If we then open the switch, cutting the capacitor off from the battery, current will flow once again, from one end of the capacitor to the other (Figure 43). But the capacitor is not a battery, so as the opposite charge flows to the opposite end, it gradually neutralizes it, and eventually the capacitor becomes nothing more than two neutral plates, and current stops flowing.

**FIGURE 43**



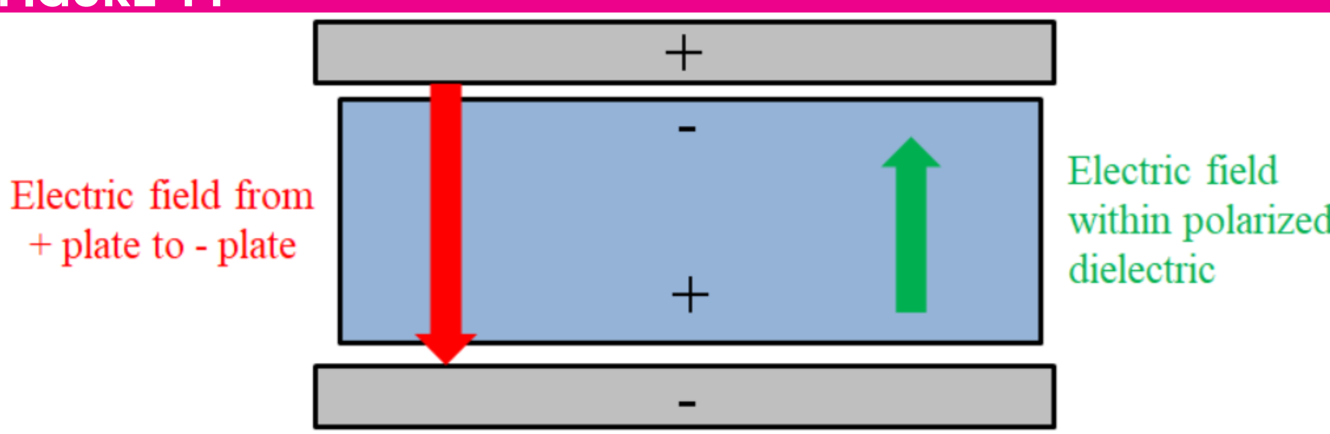

*When the battery is disconnected, current will flow through the resistor, but only temporarily, as the capacitor will eventually neutralize itself.*

## Dielectrics

The voltage on a capacitor can never exceed that of the battery that charged it up. However, you can increase the amount of charge a capacitor can store with something called a **dielectric**. A dielectric is a material you put in between the two conductors in a capacitor. The most basic capacitor, with no dielectric, is two metal plates separated by nothing but an empty vacuum, so even air between two plates can be considered a dielectric.

The way dielectrics work is that when the conductors become charged, they polarize the dielectric. The capacitor has an electric field that points from positive to negative, but the dielectric, being polarized, creates its own electric field within it that points in the opposite direction (Figure 44).

**FIGURE 44**




*A dielectric within a capacitor can prevent the discharge of the capacitor by creating an opposing electric field.*