Homework 16.

Capacitance.

Last class we discussed electric capacitance. Let us consider the electrical circuit shown below:

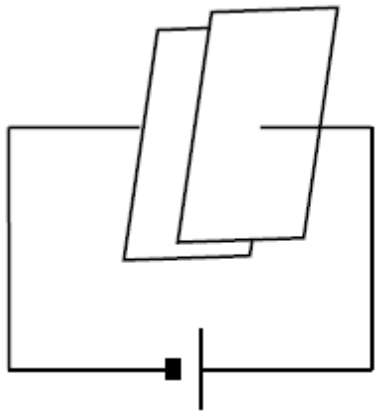


Figure 1.

The circuit consists of two metal plates separated by a distance d and connected to a battery. The area of each plate is S. Since the plates are separated, it is natural to assume that no current will flow through the wire. This assumption is correct in a long time perspective, but for a short time, immediately after we have connected the battery, the current will flow. It happens, because in the first moment, electrons "do not know" that there is a disruption in the circuit and flow from the negative terminal of the battery to the plate which is connected to this terminal, while electrons from the other plate are being "sucked" to the positive terminal of the battery. The plates are getting electrically charged, and it takes some time. The charging current will flow until electrical potentials of the "negative" and "positive" plates are equal to the potentials of the negative and positive terminals of the battery. In other words, the charging current will flow until the potential difference (voltage) between the plates is equal to the battery voltage. The magnitude of the final charge on each plate Q is proportional to the voltage on the plates U:

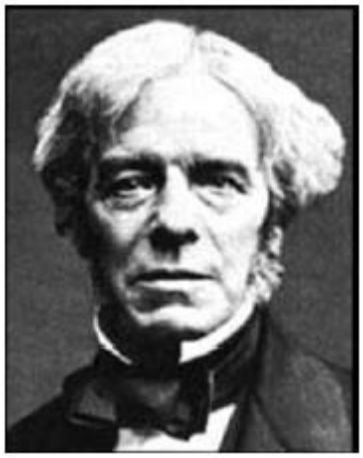
$$Q = C \cdot U \qquad (1)$$

The coefficient C is called electrical capacitance. It depends on the area of the geometry of the plates. In our case –two parallel metal plates of same shape and size -the capacitance depends on the area of the plate ***S***, the distance ***d*** between the plates and the material between the plates (2),

$$C = \frac{\varepsilon_0 \varepsilon S}{d} \qquad (2)$$

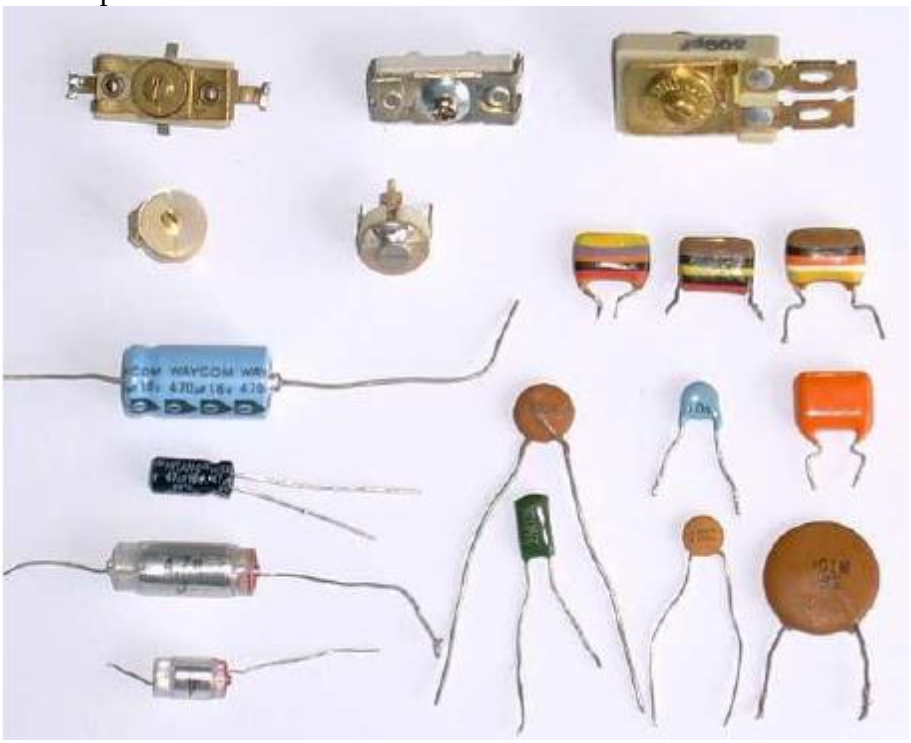
Where, ε_0=8.85 x10^{12}C/Vm is the parameter called electric constant, ε is the dimensionless number which characterizes the material between the plates. This parameter is called dielectric

constant of the material. ε=1 for vacuum. The unit of capacitance is Coulomb per Volt (1C/V) or Farad. This unit is named after famous English physicist and chemist Michael Faraday



Michael Faraday(1791-1867).

The electrical element which consists of separated metal plates is called capacitor. The capacitors can be of various shapes and sizes:



Problems:

1. You connected a capacitor to a battery. After a short time the current in the circuit is zero. Then you started increasing the distance between the plates. Will the current be zero while you are increasing the distance? Explain your answer.

2. Calculate the capacitance of a plane capacitor if the area of the plate is $6cm^2$ and the distance between the plates is 1mm. Assume that the plates are in vacuum