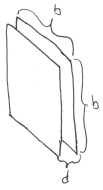
PHY 122 HW 4

1. If we multiply 1 Coulomb by 1 Volt, what type of quantity are we left with (i.e. force, power, distance, etc)? How does this quantity relate to an electron volt?

2. As a simple model of lightning, we can approximate a storm cloud and the ground to be plates on a capacitor. The cloud accumulates a charge at its base and induces an opposite charge in the ground forming the 'plates' of the capacitor with the air acting as a dielectric. When the electric field becomes sufficiently large (greater than the "dielectric strength"), dielectric breakdown occurs and electrons are pulled off of the air molecules. Using the table of dielectric constants and strengths on pg. 638 in the text, how much charge would a cloud with an altitude of 1000m and an area of 10,000m^2 need to accumulate in order to create lightning?

3. Shown below, we have a parallel plate capacitor with $b \gg d$. The plate on the left has charge +Q, the one on the right has charge -Q.

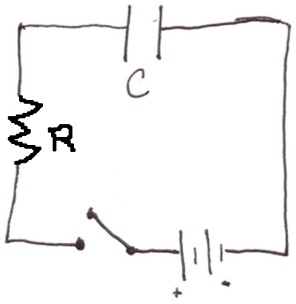


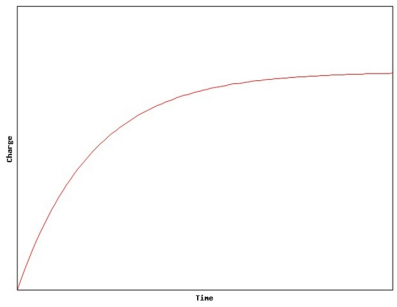
   (a) What is the magnitude of the electric field at points inside the capacitor?

   (b) Using this electric field, calculate the potential difference across the capacitor. Along with our given charge, use this potential difference to calculate the capacitance C.

   (c) Plugging into the formula $C = \epsilon_0 \frac{A}{d}$ given in the book, verify that we get the same answer as in (b).

4. If we have an open circuit like the one shown below,





and the capacitor initially has no net charge on either plate, when we close the switch a charge will begin to accumulate on the plates as shown in the above charge vs. time plot. Make a sketch of the magnitude of E and the potential difference across the capacitor as a function of time. Does the charge density σ on each plate necessarily have to increase in magnitude as the charge increases?

5. Given an energy density of$10^{-6} J/m^3$ stored in the electric field of a capacitor with capacitance C=12 μF held at 300 V, come up with reasonable dimensions for the capacitor.

6. Given the combination of capacitors below,

   (a) Find the equivalent capacitance.

   (b) Knowing the voltage difference between points a and b is 300 V, find the charge on each capacitor.