Capacitance

Consider the two large metal plates shown above. Let's suppose that equal and opposite charges have been put on the plates and the charges will spread out uniformly on the inner surfaces of the plates. The plates will have surface charge densities $+\sigma$ and σ, respectively. **Use Gauss's law to find the Electric field between the plates in terms of the charge density.**

Calculate the potential difference, ΔV between the plates. The potential difference ΔV between the plates is the work per unit charge required to carry a small charge from one plate to the other. Your answer should depend on Q, the total charge of the plate A and the separation d between the plates.

You found that the voltage is proportional to the charge. Such a proportionality between V and Q is found for any two conductors in space if there is a plus charge on one and an equal minus charge on the other. That is $Q = CV$, where C is a constant. This coefficient of proportionality is called the capacity. **(a) Show that for a parallel-plate capacitor this constant C is: $C = \frac{\epsilon_0 A}{d}$. (b) From the definition of C what is the unit of C?** This unit is also called a farad.

Storing Energy in a Capacitor

Capacitors can be used to stored electrical energy. The amount of energy stored is equal to the work done to charge it. Imagine that the condenser has been charged by transferring charge from one plate to the other in small increments dq. **(a) What is the work dW required to transfer the charge dq?. (b) Integrate dW to obtain the total work to charge the capacitor from $q = 0$ to some final charge $q = Q$.**

Dielectrics

If a dielectric is inserted between the plates of a parallel-plate capacitor, while keeping the charge constant, experimentally it is found that the potential difference decreases by a factor of κ called the dielectric constant: $\Delta V = \Delta V_0/\kappa$. **P49: A 2.00-nF parallel-plate capacitor is charged to an initial potential differnece $\Delta V_i = 100V$ and is then isolated. The dielectric material between the plates is mica, with a dielectric constant of 5. (a) How much work is required to withdraw the mica sheet? (b) What is the potential difference across the capacitor after the mica is whitdraw?**