Potential and Capacitance Problems

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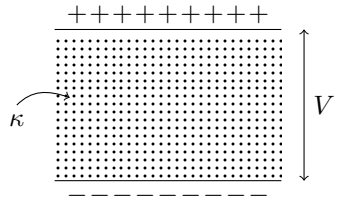
1. **E** Determine whether these statements are true or false
   (a) The surface of a conductor is an equipotential surface
   (b) The electric field is always normal to the surface of a conductor
   (c) Charges tend to avoid "pointy bits"
   (d) Capacitors initially act as a wire in a circuit. After a long time, they act as a block in the circuit.

2. **E** Find the capacitance of a spherical capacitor with spherical plates (of radius a and b) holding charges Q and $-Q$. Determine the energy stored in this capacitor.

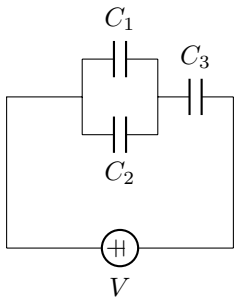
3. **M** Consider two concentric, spherical shells of radius a and b. The inner shell is grounded and the outer shell has a charge Q. Find the charge on the inner shell. You may assume that the potential far away from the shells is 0.

4. **M** Consider the parallel plate capacitor shown below with a dielectric of a strength κ placed between them. The effect of the dielectric is to increase the capacitance by a factor of κ. Determine the voltage between the plates, energy stored, charge on the plates, and charge on the dielectric for the following scenarios

   (a) A capacitor initially has a charge Q on its plates. The voltage difference between the plates is V when the dielectric is suddenly slipped into the capacitor.
   (b) A capacitor is connected to a circuit with a fixed voltage V when the dielectric is slipped into the capacitor.



5. **M** Three capacitors and a power supply are connected in a circuit as shown. Find the charge and



   voltage on each capacitor.

6. **H** Two electrodes are placed into a solution with conductivity σ. Show that the resistance of this arrangement can be written in terms of its capacitance as

$$R = \frac{\epsilon_0}{\sigma C}.$$

   Now, consider the fact that charges will flow from one electrode to another. Determine a differential equation describing the charge in the electrodes as a function of time. Solve your differential equation if the voltage across the electrodes is initially V_0.