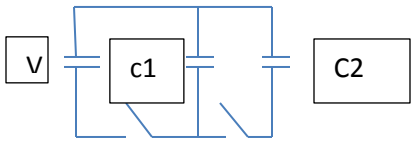
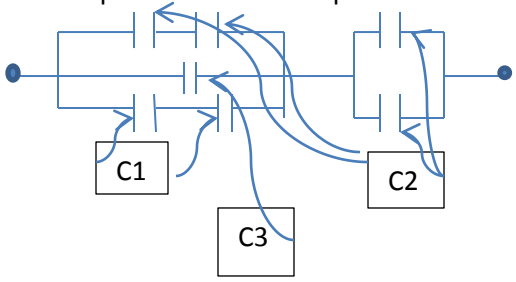
Capacitance and Dielectrics – Homework set 4.

1. Two capacitors give an equivalent capacitance of Cp when connected in parallel and Cs when connected in series. What is the capacitance of each capacitor?
2. Consider the circuit shown. Let C1 = 6 micro-farad and C2 = 3 micro-farad. Let the battery be 20V. Capacitor C1 is first charged by closing switch 1. Switch 1 is then opened and the charged capacitor is connected to the uncharged capacitor by closing S2. Calculate (a) the initial charge acquired by C1 and (b) the final charge on each capacitor.



3. Find the equivalent capacitance between points a and b for the group of capacitors shown.



Let C1 = C, C2 = 2C and C3 = 3C.

4. Two spheres have radii a and b, and their centers are a distance d apart. Find the capacitance of this system. Show that this result reduces to that of two spherical capacitors in series as d approaches infinity.
5. A parallel-plate capacitor of plate separation d is charged to a potential difference ΔVo. A dielectric slab of thickness d and dielectric constant κ is introduced while the battery remains connected to the plates. (a) Show that the ratio of energy stored after the dielectric is introduced to the energy stored in the empty capacitor is U/Uo =κ. (b) Give a physical explanation for this increase in stored energy. (c) What happens to the charge on the capacitor?
6. Two square plates of sides l are placed parallel to each other with separation d as shown in the figure. The plates have uniformly distributed static charges +Q and –Q . A block of metal has width L, length l and thickness slightly less than d. It is inserted a distance x into the space between the plates. The charges on the plates remain uniformly distributed as the block slides in. In a static situation, a metal prevents an electric field from penetrating inside it. The metal can be thought of a s a perfect dielectric, with κ→ infinity. (a) Calculate the stored energy in the system as a function of x. (b.) Find the direction and magnitude of the force that acts on the metal block.