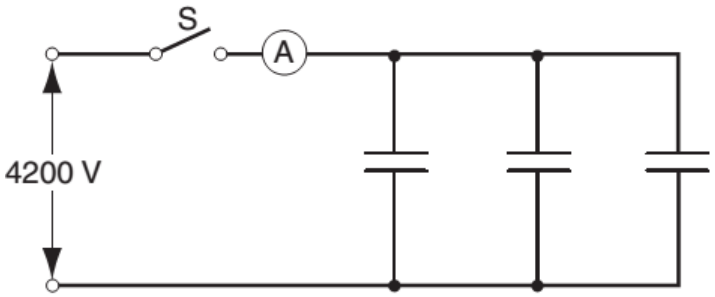
13 DC Circuits – Capacitors

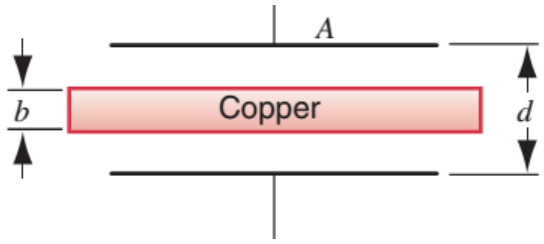
$$Q = CV \qquad C_{\text{eq, parallel}} = \sum_i C_i \qquad C^{-1}_{\text{eq, series}} = \sum_i C_i^{-1}$$

$$C_{plate} = \epsilon_0 \frac{A}{d} \qquad C_{dielectric} = \kappa C_0 \qquad U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$$

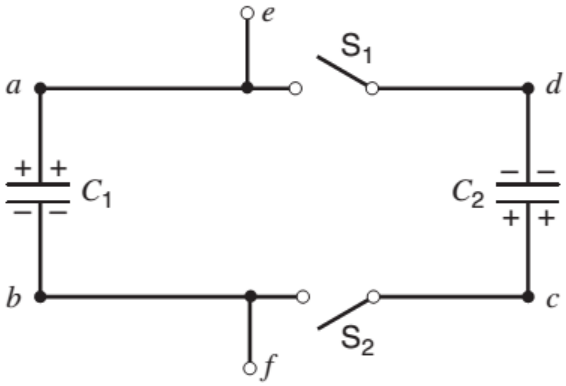
1. *(RHK Exercise 30-12)* Each of the uncharged capacitors in the figure below has a capacitance of 25 μF. A potential difference of 4200 V is established when the switch S is closed. How much charge then passes through the ammeter A?



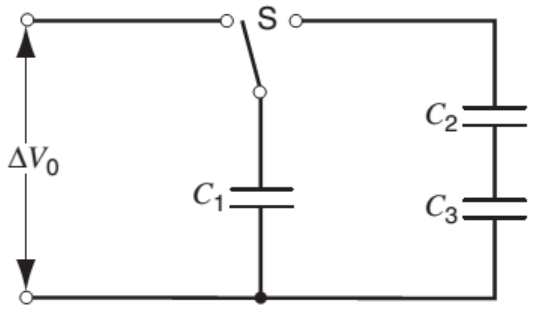
2. *(RHK Exercise 30-37)* A slab of copper of thickness b is thrust into a parallel-plate capacitor as shown below. *(a)* What is the capacitance after the slab is introduced? *(b)* If a charge q is maintained on the plates, find the ratio of stored energy before / after the slab is introduced. *(c)* How much work is done on the slab as it is inserted? Is the slab pulled in or do you have to push it in? *(d)* What changes if the potential ΔV is held fixed, instead of q?



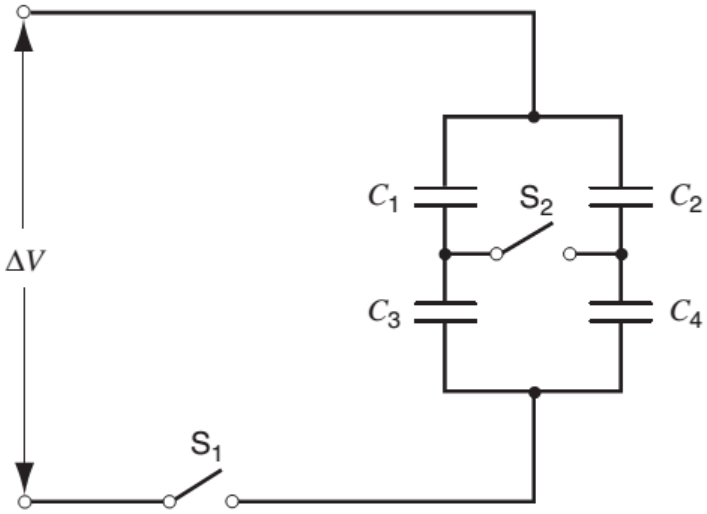
3. *(RHK Problem 30-5)* In the figure below, capacitors $C_1 = 1\ \mu F$ and $C_2 = 3\ \mu F$ are each charged to a potential difference $\Delta V = 6$ V, but with opposite polarity, so that points a and c in the figure are on the positively charged side, and points b and d are on the negative side. After closing switches S_1 and S_2: *(a)* What is the potential difference between points e and f? *(b)* What is the charge on C_1? *(c)* What is the charge on C_2?



4. *(RHK Problem 30-6)* When switch S is thrown to the left in the circuit below, the plates of the capacitor C_1 acquire a potential difference ΔV_0. The other capacitors C_2 and C_3 are initially uncharged. The switch is now thrown to the right. What are the final charges q_1, q_2, q_3 on the corresponding capacitors?



5. *(RHK Problem 30-9)* In the circuit below, a battery supplies a potential difference of $\Delta V = 12V$. *(a)* Find the charge on each capacitor when the switch S_1 is closed and *(b)* when (later) switch S_2 is also closed. Take $C_1 = 1\ \mu$F, $C_2 = 2\ \mu$F, $C_3 = 3\ \mu$F and $C_4 = 4\ \mu$F.



6. *(RHK Problem 30-10)* Find the equivalent capacitance between points x and y in the circuit below. Assume that $C_1 = C_3 = C_4 = C_5 \equiv C$, but $C_2 \neq C$. *(Hint: Apply a potential difference ΔV between x and y and write down all the relationships that involve the charges and potential differences for the separate capacitors.)*