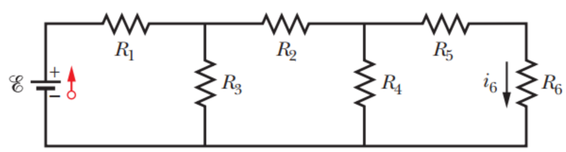
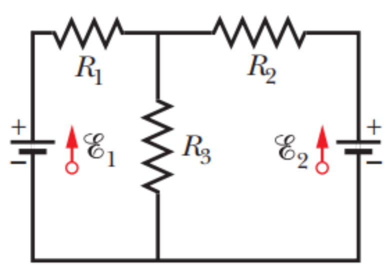
Assignment V, PHYS 112 (General Physics II)
Fall 2020
Due via pdf upload to OAKS prior to Friday, September 25th at 10:00 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units.

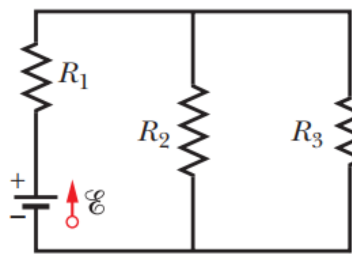
1. A parallel plate capacitor is made out of two flat plats that each have dimensions of 5 mm x 5 mm and are separated by a distance of 10 nm.
   a) What is the capacitance of this (air-filled) capacitor?
   b) If the capacitor is hooked up to a source that forces the potential difference between the plates to be 120 V, what is the net surface charge density σ on the negative plate?
2. Consider the schematic below. Let all resistors have a resistance of 200Ω, and let the battery have $\mathcal{E} = 20$ V. Find the current through R_6.



3. In the figure below, the batteries have $\mathcal{E}_1 = 500$V, $\mathcal{E}_2 = 700$V, $R_1 = 100\Omega$, $R_2 = 500\Omega$, and $R_3 = 1000\Omega$. Find the current, voltage drop, and power consumption of each resistor.



4. In the below figure, the resistances are $R_1 = 2.00\Omega$, $R_2 = 5.00\Omega$, and the battery is ideal (aka we will assume the battery has no internal resistance). What value of R_3 maximizes the dissipation rate in resistor R_3?

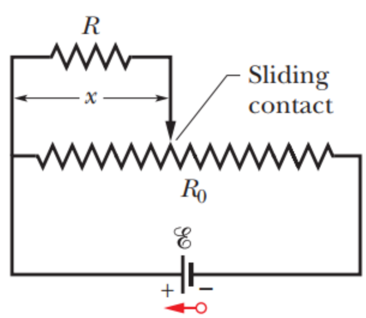


5. The figure below shows a schematic with a battery connected across a uniform resistor $R_\circ$. A sliding contact can move across the resistor from $x = 0$ at the left to $x = 10$cm at the right. Moving the contact changes how much resistance is to the left of the contact and how much is to the right.

   a) Find the rate at which energy is dissipated in resistor R as a function of α where $\alpha \equiv x/10$ cm. (In other words, use α is a dimensionless quantity describing the "fraction of the resistance that is in parallel with R". Your answer should be symbolic and in terms of α, V, R, and $R_\circ$ *only.*

   b) *Plot the function you found in part (a) for* $\mathcal{E} = 50$ *V,* $R = 2000\Omega$*, and* $R_\circ = 100\Omega$.

   c) *Use your result from part (a) and the circuit parameters introduced in part (b) to determine what the power dissipated is for* $x = 7.3$*cm. (This is just plugging values into your answer to part (a) to make sure you got something reasonable. Make sure to include a legitimate unit for your answer.)*



6. If you have ten 1 kΩ resistors, you can design a sub-circuit having resistance anywhere from 100 Ω (putting all resistors in parallel with each other) to 10kΩ (putting all resistors in series with each other).

   a) Consider a fixed voltage difference ΔV that drives this sub-circuit.. Which of the two resistor alignments alluded to above results in the greatest total power dissipated through the resistors? (Justify your answer with calculations and/or detailed reasoning).

   b) Come up with a resistor configuration involving 7 or fewer 1 kΩ resistors giving total resistance of exactly 1750Ω.