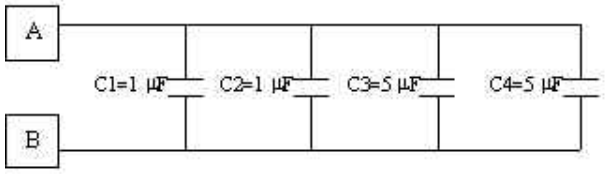
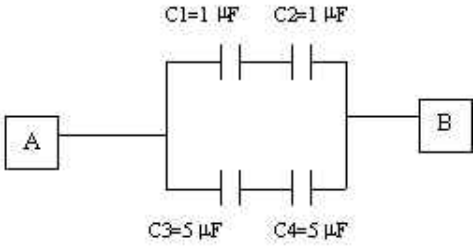
Workshop module 5 - Physics 142, Fall 2014

1) A parallel plate capacitor is charged by being connected to a battery and is then disconnected from the battery. The separation between the plates is then doubled. How does the electric field change? The potential difference? The total energy? Explain your reasoning.

2) You are a pencil-necked geek, fresh out of electrical engineering school, ready to change the world! With decent grades and a good word from a friend of a friend, you land a prestigious job as a technical engineer at Bob's High Tech Circuit Design Emporium and Car Wash on the edge of Silicon Valley, south of San Francisco. After working for a week drying cars, you are finally given your first assignment. Bob asks you to design a little circuit destined to make a McDonald's happy meal toy light up when squeezed. He also tells you that "due to a clerical error" the company has a huge surplus of 1 and 5 microfarad capacitors. He leaves you with the kind words of support, "Use them in your design, or else!"
After some work, you decide there are two possible configurations of capacitors (shown below) that you could use in your circuit. Your circuit requires the configuration with the larger stored electrical energy. Which circuit should you choose? Explain your reasoning and show your work. Assume the potential difference across each configuration is V.





3. Batteries are always labeled with their emf; for instance, an AA flashlight battery is labeled "1.5 volts." Would it also be appropriate to put a label on batteries stating how much current they provide? Why or why not?

4. A parallel-plate capacitor has plates of area 600 cm^2 and a separation of 4 mm. The capacitor is charged to 100 V and is then disconnected from the battery. (a) Find the electric field E_o and the electrostatic energy U. A dielectric of constant $\kappa=4$ is then inserted, completely filing the space between the plates. Find (b) the new electric field E, (C) the potential difference V and (d) the new electrostatic energy.

5. A constant potential difference of 24 V is maintained between the terminals of a 0.25 μF parallel-plate air capacitor. A) A sheet of Plexiglas (K=3.4) is inserted between the plates of the capacitor, completely filling the space between the plates. When this is done, how much additional charge flows onto the positive plate of the capacitor? B) What is the total induced charge on either face of the plexiglas sheet? C) What effect does the plexiglas sheet have on the electric field between the plates? How does this jive with the increase in the charge on the plates which should serve to increase the field between the plates?