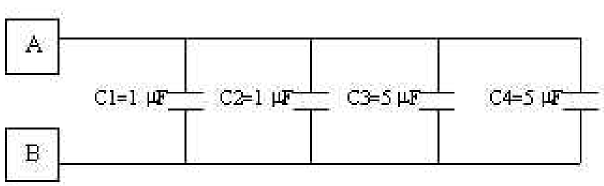
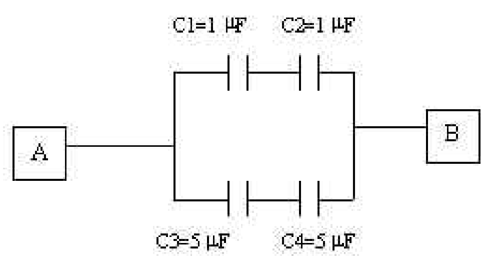
Workshop module 4 - Physics 142, Fall 2010

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) **Hmmm. The net charge in a capacitor is zero. What does a capacitor store??**

4) **Two parallel conductive plates of area A are separated by a distance d, where d is much smaller than the length and width of the two plates. Equal and opposite electric charges are placed on the two plates. One plate carries a positive charge distributed uniformly with area charge density σ. The other plate carries a negative charge distributed uniformly with area charge density -σ. How much work does it take to move the two plates so the separation between them is 2d?**

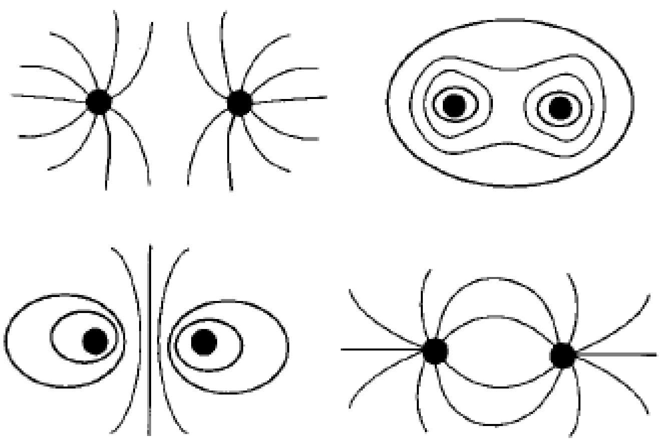
5) **Tandem van de Graff accelerators are used to accelerate nuclear particles to high energies. Beams of these particles can be used to study nuclear reactions and nuclear structure. Another use for such beams is the treatment of cancerous tumors. It turns out charged particles lose energy as they interact with matter by ionizing the medium they pass through. One of the more fortunate aspects of this energy loss is that most of the energy is dumped right at the end of the particle's path. If one tunes the energy of a particle beam so that the average range of the particle through the body is just sufficient**

to reach the tumor, most of the energy is released in the tumor, destroying only the tissue you would like to destroy. Cool, huh?!

A tandem van de Graff accelerator consists of a negative ion source at ground (zero potential), a positively charged high voltage terminal, and an electron stripping foil. A negative ion from the source is accelerated toward the positive high voltage terminal. As the ion passes through the thin stripping foil, all the electrons are removed, leaving only the bare positive nucleus. This nucleus is now accelerated (repelled) by the positive high voltage terminal.

If a He^{-} ion is accelerated from ground through a potential difference of 20 million volts, stripped of all its electrons to form the He^{++} ion, and then accelerated again from +20 million volts to ground, what is its final kinetic energy?

6) Choose the diagram that corresponds to lines of constant potential around an electric dipole where the electric charges that make up the dipole are given by the positions of the large black dots. Justify your answer briefly to the right of the drawing.



7) A non-conducting wire forms a circle with radius R in the x-y plane centered at the origin. A charge of +3Q is placed uniformly on the region of the wire ranging from the negative y-axis counter-clockwise to the negative x-axis. A charge of -Q is placed uniformly on the region of the wire ranging from the negative x-axis counter-clockwise to the negative y-axis. Calculate the electrostatic potential at point P.