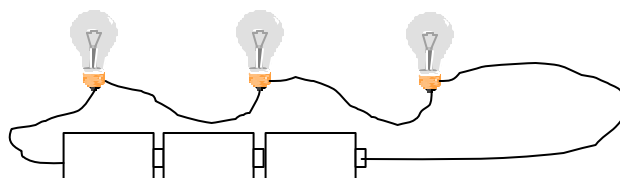
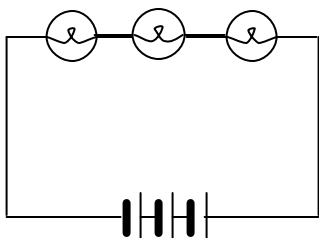


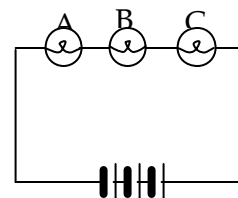
Reference: The closest reference in Cutnell & Johnson is Chapter 20, sections 1,2, 6, 7, and 8. Or look at the alternative reading linked on the course web page. The topics are current, resistance, voltage, Ohm's Law, and parallel and series circuits.

- 1) Here's a circuit for you to consider, and I'm going to ask you to try to think about it in several ways. Each of the batteries is a 1.5 V battery, and the bulbs are all identical. (These both depict the same circuit.)

The overall question here is this: Which bulb, if any, would be the brightest? But I want you to answer it from three different ways of thinking about electricity.

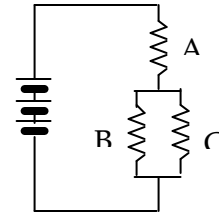


- a) Sometimes people think the reason there are two connections to the batteries is because a positive current flows out of one end and a negative current flows out of the other. It's when they hit each other that you get light. (Ampere had an idea just like that, in the early 1800s, known as Ampere's model of clashing currents.) How would someone thinking in this way answer the question?
- b) In lecture we talked about an analogy to pulling a rope: Charge is like rope, moving charge is like moving rope, a battery is like someone pulling the rope to try to make it move, and a bulb is like something the rope rubs as it passes. How would someone using that analogy answer the question?
- c) We also talked about an analogy to flowing air: Charge is like air, moving charge is like moving air, a battery is like an air pump with a high pressure output and low pressure input, and a bulb is like a whistle that constricts the flow of air a little. How would someone using that analogy answer the question?
- 2) This time, give what you think is the best answer, using whatever way or ways of thinking about it you choose. We'll start with the same circuit as in question 1, with three 1.5 V batteries, everything in series.

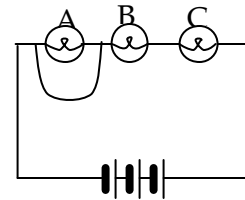


- a) What's the voltage across each of the bulbs in this circuit? (i.e. the voltage from one side of the bulb to the other.)
- b) How would the currents through each of those bulbs compare?

- c) Here's a harder circuit, with resistors (like the ones you used in lab) instead of bulbs. What is the voltage across each of the resistors?
- d) How would the currents through each of these resistors compare?

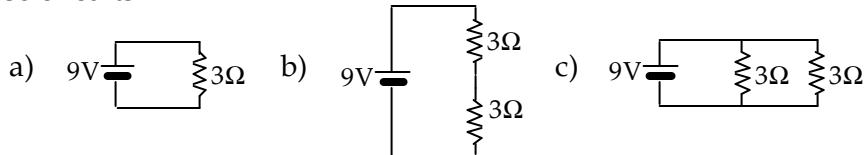


- 3) Back to the first circuit again. What if you were to connect a wire from one side of bulb A to the other, as I've shown here? How would that affect the voltages across and currents through bulbs A, B, and C?

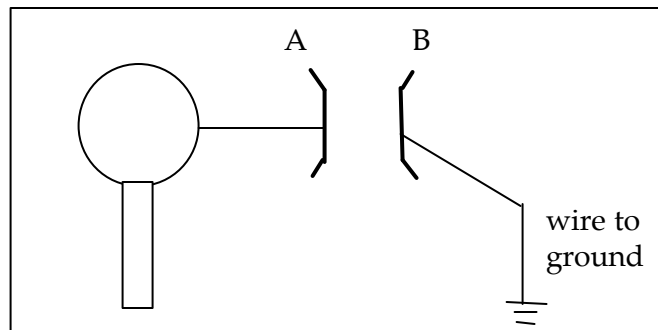


- 4) You've started to study the relationship between the voltage across a circuit element (a resistor, a light bulb, a bit of goop, whatever!) and the current that goes through it. For some materials, it's a linear relationship: The voltage and current are proportional. That's Ohm's Law (and thus the units of proportionality constant were called "Ohms"). (Ohm's Law is not really a law! Coulomb's Law is a Law – a foundational principle that underlies everything we're doing – our model depends on the idea that it *always* holds. Ohm's law is an empirical relationship that we find *usually* holds not always. We should really call it "Ohm's Empirical Relation" or something like that.)

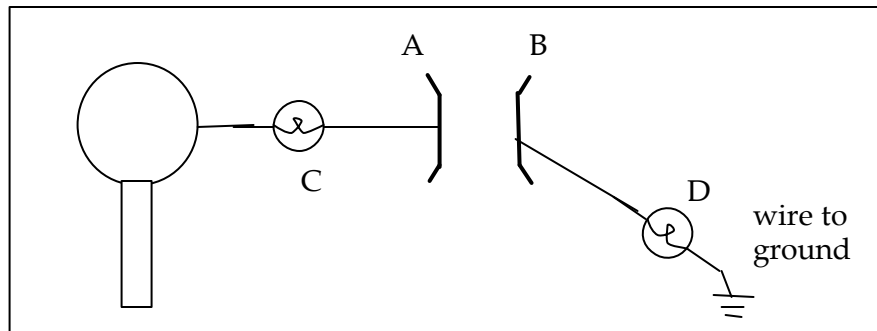
So: $V=IR$, where V is Voltage (in Volts), I is current (in Amperes), and R is Resistance (in Ohms). Use Ohm's Empirical Relation to find the current through each of the resistors in these circuits.



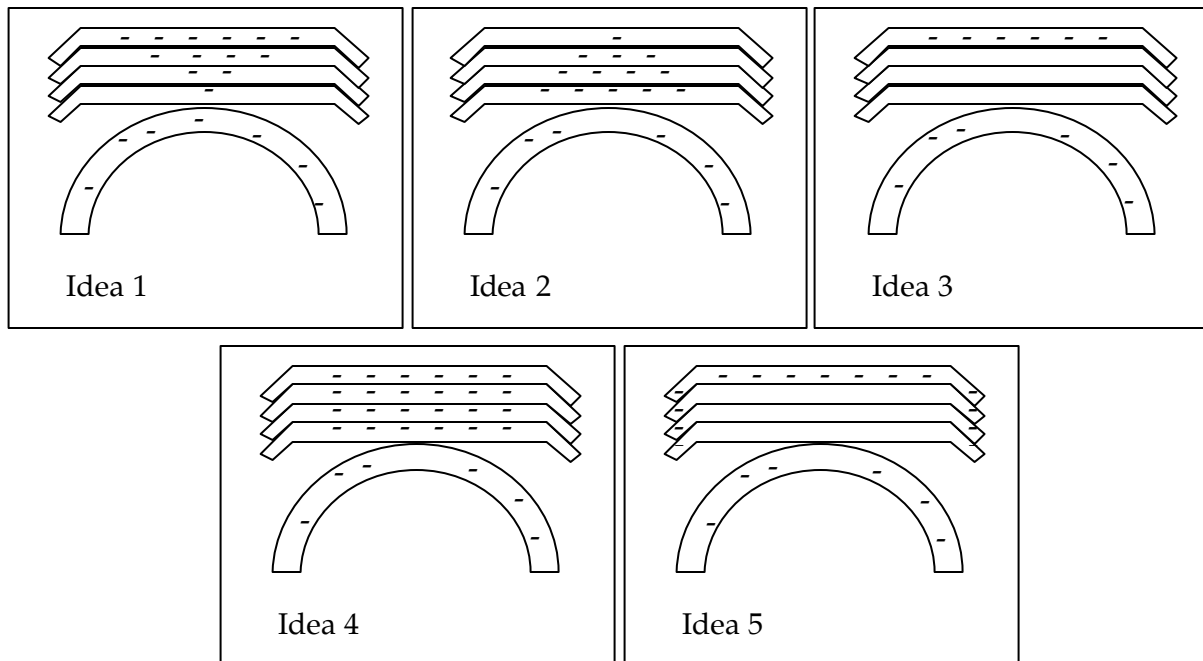
- 5) Suppose you had a pie plate connected to a Van de Graaf generator by a wire as shown. A second pie plate is brought near the first and is connected by a wire to the ground. (Remember, for ground, think "huge, huge conductor.") Assume that it is a really dry day and that there is not much charge flowing through the air.



- a) Draw a diagram showing where the charge will be while the generator is running.
- b) Do the excess charges on the two pie plates have the same sign or different signs, and is there about the same amount of charge on the two plates or is it different, and how? (Does A have more or B?)
- c) If pie plate B were much further away, how would that change the amount of charge on A and on B? If B were much closer (but still not touching and still not close enough to make a spark), how would that change the amount of charge on A and on B?
- d) If before you turned the generator on you hooked up light bulbs at positions C and D, and then turned on the generator, would either of the bulbs light? Which one(s)?



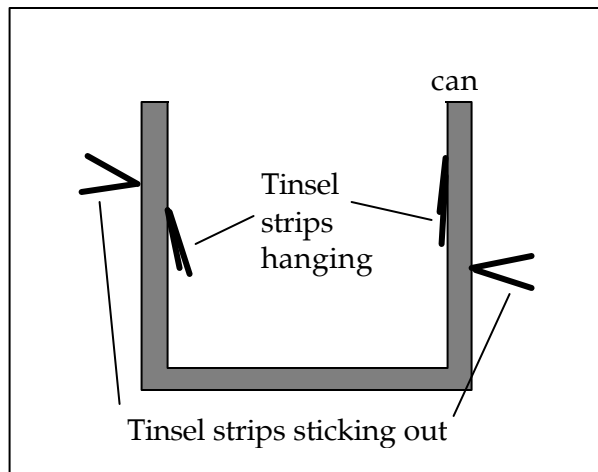
- 6) In class we discussed 5 possibilities for the arrangement of the charges on the pie plates when they are sitting on the charging Van de Graaf generator.



Trying to see which ideas explained our observations, we decided that all would predict a repulsive force on the top pie plate, but that number 2 and number 5 would predict that after the first pie plate came off, the next ones would come off immediately, which was different from what we saw.

In Joe Redish's 122 class last week, he showed the following demonstration. He had a can with several small pairs of tinsel strips stuck in different places. When he charged up the can with a generator, the tinsel on the inside of the can didn't stick up, but the tinsel on the outside did, as shown below (the can is shown in cross section.)

- a) Explain why the tinsel did this and which of the ideas for the pie plates fits with this observation.



- b) In class on the 11th, we also started talking about the arrangements of charges over a conductor being driven by an electrical analog to pressure. What does this say about the different ideas for the pie plates?
- 7) In this class, we've been trying to get across the value of considering different analogies for electricity. How are we doing so far? In what ways do you see this as useful and in what ways do you think it is not? [Note that what I'm trying to do here is to get feedback from you as well as to get you to reflect a bit on what you think of all this. Thus, you will only be graded on your thoughtfulness, not in any way on what we might want you to say. Please be honest!]