Ohm’s Law I – Elementary DC Circuits with Light Bulbs Prelab

by

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In our last lab, we learned about electric fields and how charges can move in an electric field. In this next lab, we are learning about electrical circuits. Electrical circuits contain an electric field that allows charges to move in a loop or circuit. A battery in a circuit pumps electrons around the circuit by converting chemical energy into electric potential energy. The electrons bump into each other and move in random directions, but their overall net movement will be in the direction of the electric field. Circuits may contain other elements such as resistors, capacitors, and inductors. In the Ohm’s Law I lab, the circuits will contain resistors, but our resistors are in the form of light bulbs. The electrons will lose energy in the resistors, and this energy goes into heat. In this lab, the heat causes the resistor to emit light (similar to when a hot poker glows after being put in a fire).

Although electrons are the entities that are typically moving in a circuit, the direction of current in a circuit is conventionally defined as the direction of positive charge flow (opposite the direction of electron flow). Benjamin Franklin defined the direction of current before it was known that electrons are moving in the circuit. Benjamin Franklin just knew that there were two types of charge from his study of electrostatics.

Resistance has to do with a material’s tendency to resist current flow.[2] An analogy would be a traffic jam. If you have two traffic jams in series (one after another), the flow of traffic will decrease more than if there is just one traffic jam. If there are multiple paths from A to B, then the traffic flow can increase because cars can take different routes just like you may use an app on your phone to find another way home if you see that there is an accident on the path you are currently traveling. This is analogous to electrons coming to a junction in a parallel circuit where some will go one direction and others will go another. The overall resistance is decreased and current is increased since there are multiple paths that the charge can take.

Go to:

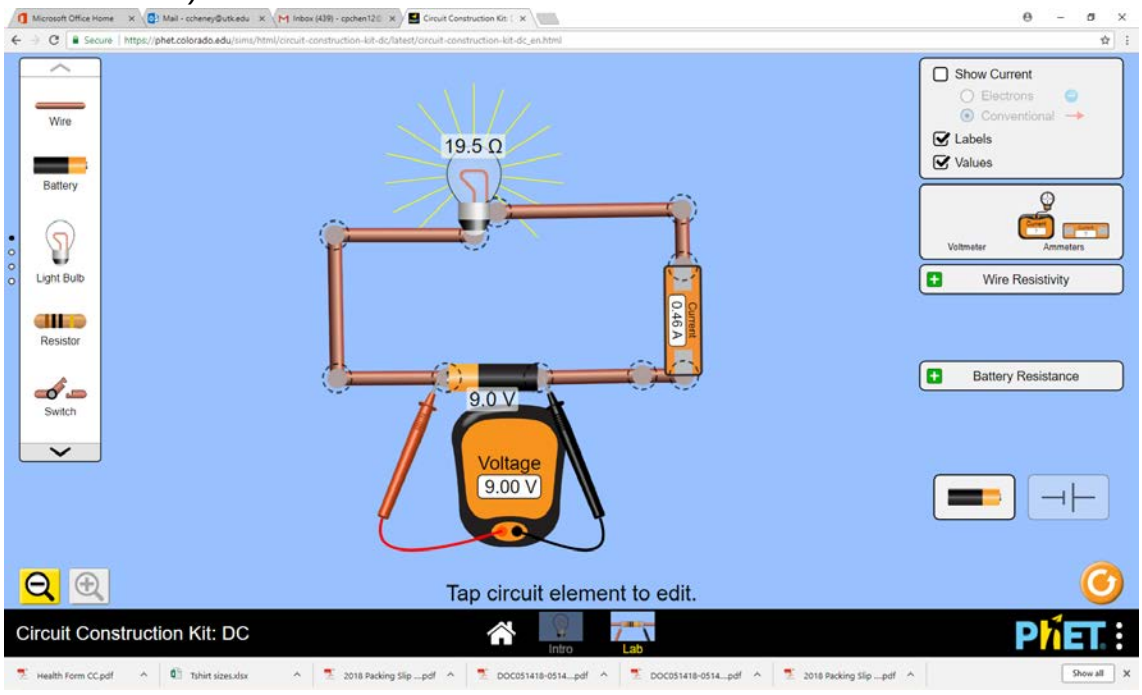
https://phet.colorado.edu/sims/html/ohms-law/latest/ohms-law_en.html

1. Set the resistor to 500 Ω.
2. Adjust the battery voltage to 8.0 V.
3. What is the reading of the current through the resistor?
4. Adjust the battery voltage to 4.0 V (half of the initial value).
5. What is the reading of the current through the resistor now?
6. Adjust the battery voltage to 2.0 V.
7. What is the reading of the current through the resistor now?
8. What is the relationship between voltage and current when the resistance is kept the same?
9. Set the resistance of the resistor to 100 Ω (or as close to 100 Ω as you can).
10. Adjust the battery voltage to 8.0 V.
11. What is the reading of the current through the resistor?
12. What is the relationship between resistance and current when the voltage is kept the same?

Go to:

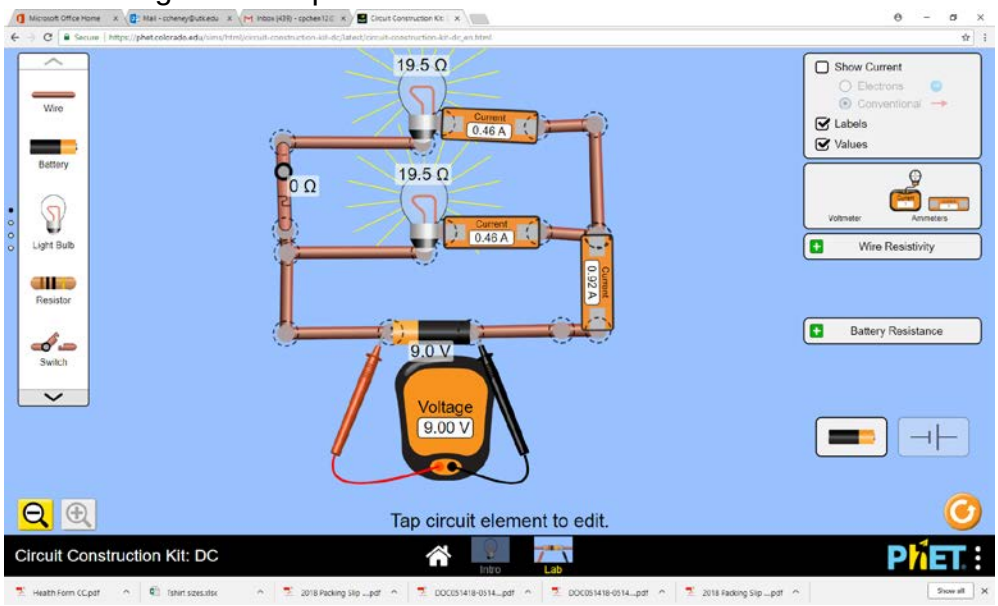
https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html

1. Click on the link to the lab section of the Phet simulation.
2. Build a Simple Circuit using the light bulb, wires, battery, voltmeter, and ammeter like the one picture below (Make sure that *Labels* and *Values* boxes are checked.):



3. Tap on the battery so that the voltage adjustment window pops up. Adjust the voltage and see how the current in the ammeter changes and how the brightness of the light bulb changes. Describe your results.
4. Now build the circuit with two light bulbs with 19.5 Ω each (Series Circuit). What is the current through the circuit with a battery voltage of 9.00 V? How does this compare to the current with just one light bulb of 19.5 Ω in the circuit? How much light is being emitted from each light bulb in the Series Circuit compared to the Simple Circuit? Change the resistance of the light bulbs and see how the current changes in the circuit and how the brightness in the light bulbs changes. Describe your results.

5. Add a second light bulb in parallel to the first like shown below:



6. Make sure that the light bulbs have the same resistance. How did the current change in the overall circuit? How did the current change in each branch of the parallel circuit? How did the brightness of the bulbs change?
7. Now open the switch of the circuit. How did the brightness and currents change?
8. Close the switch in the circuit. Change the resistance of one of the bulbs. How did this affect the currents in the circuit and the brightness of the bulbs?

References:

[1] https://phet.colorado.edu/

[2] https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law