PHYS 202L Ohm’s Law                         Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Introduction: Watch the following video: [Ohm’s Law](http://www.youtube.com/watch?v=J4Vq-xHqUo8)

**Theory:** Georg Simon Ohm (1787-1854), a German physicist, discovered Ohm’s law in 1826. This is an experimental law, valid for both alternating current (ac) and direct current (dc) circuits. When you pass an electric current (I) through a resistance (R) there will be an electric potential difference (V), also known as voltage, created across the resistance as shown below.

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Positive end of the power supply or battery has the high electric potential. Negative end has the lower potential. Electric current flows from high potential to low potential.   
  
In Ohm’s law the current (I) is directly proportional to the potential difference (V). The resistance R can be obtained using the following equation:

                   V = I R Units: V------> volt (V), I------> ampere (A), R-----> ohm (Ω).

Electric power, P is given by the following equation:

                    Power = Current x Voltage (P=I x V). Unit: P------> watt (W)

Electric utility companies use the kilo-watt-hour meter to measure the electricity usage by its customers. Kilo-watt-hour (kWh) is a unit for energy. 1 kWh = 1000 x 3600 J = 3.6 x 106 J.

For Ohmic devices, *V versus I* is a linear relationship, and they have a constant resistance. Resistance can be calculated using, R = V/I. The slope of the *V versus I*, line will also give the resistance, R.

For non-ohmic devices, *V versus I* is a non-linear relationship, and they have a varying resistance. The resistance at a particular point can be determined using the slope of the *V versus I* curve, at that point.

The relationship between current (I) and voltage (V) in a standard 10-ohm and 20-ohm resistors will be investigated first. Then, the relationship between current and voltage in the filament of a small incandescent light bulb will be explored.

A. Answer the following:

1. Electricity comes in two types. Name these two types and give an example for each.

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2. Name five quantities and their units, used in electricity.

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| **Terms in Electricity** | |
| **Physical Quantity** | **Unit (unit abbreviation)** |
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**B. Purpose:** To investigate Ohm’s law for ohmic and non-ohmic resistances using simulations.  
 **Procedure:**

**1. Ohmic resistances (10 ohm and 20 ohm)**

1. Go to the following simulation and click “Intro”:   
   <https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html>
2. Click on the battery symbol (), next to the battery on the right, to display circuit schematics.
3. Move the resistor to the center, click on the resistor and set the value 10 ohm. Move the battery below the resistor. Use the wire(s) to connect the resistor to battery and observe the flow of electrons. Click “Conventional” current and observe the flow of conventional current.

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| 1. Flow of Electrons | 2. Flow of conventional current | 3. Measuring current |
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1. Connect the ammeter to measure the current as shown above (Figure 3). Click on the battery to display the battery voltage.
2. Reduce the voltage to zero, and record the current and voltage. Repeat the measurements by increasing the voltage by 10 V, until the voltage reaches 100 V, as shown below, in Excel.
3. Repeat the measurements for the 20-ohm resistor.
4. Plot Voltage VERSUS Current graphs, in a single plot, and obtain the resistance values from the plot. Insert your plot.

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| 10-ohm Resistor | | 20-ohm Resistor | |
| Current (A) | Voltage (V) | Current (A) | Voltage (V) |
| 0 | 0 | 0 | 0 |
|  | 10 |  | 10 |
|  | 20 |  | 20 |
|  | 30 |  | 30 |
|  | 40 |  | 40 |
|  | 50 |  | 50 |
|  | 60 |  | 60 |
|  | 70 |  | 70 |
|  | 80 |  | 80 |
|  | 90 |  | 90 |
|  | 100 |  | 100 |
| Resistance value from plot: | | Resistance value from plot: | |

**2. non-ohmic resistance (Light Bulb)**

[**https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc\_en.html**](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html)

Open the following simulation and click “Begin”:

<https://www.thephysicsaviary.com/Physics/Programs/Labs/RealLightbulbsOfNJLab/>

1. In this simulation an incandescent light bulb is connected to a power supply. An ammeter is connected in series to measure the current through and the voltage can be read from the power supply.
2. Starting from the lowest power supply voltage (zero) record the voltage and current as you increase them. Voltage can be changed by clicking on the dial of the power supply. Starting from the lowest value, collect data for each click, until it reaches the highest voltage of 12 volt. Record them in a data table like below in excel, and plot Voltage VS. Current and insert the graph below.
3. What is happening to the resistance of the bulb, as the current and voltage increases?
4. To calculate the resistance, we need to find the slope. Use the following equation in cell C3: =(B3-B2)/(A3-A2), and drag it down. Power can be calculated by multiplying current and voltage. Enter =A2\*B2, in cell D2, and drag it down.

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| --- | --- | --- | --- |
| Current (ampere) | Voltage (volt) | Resistance (ohm) | Power (watt) |
| *0* | *0* | *XXXXXXXXX* | *0* |
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|  |  |  |  |
|  | *12* |  |  |

1. How is the brightness of the bulb changing with its resistance and power?

**3. Write a conclusion for Part B.**

C. Circuit Analysis Activity

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| Theory | Resistors in Series |  | Ohm’s law: V = IR |
| Resistors in Parallel |  |

1. Go to the following simulation and click “Intro”:   
   <https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html>
2. Click on the battery symbol (), next to the battery on the right, to display circuit schematics, and select “Conventional current”.
3. Set up Circuit-1 shown below, measure the currents using the ammeter, and calculate the currents using Ohm’s law.
4. Set up Circuit-2 shown below, measure the currents using the ammeter, and calculate the currents using Ohm’s law.

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| Circuit-1 | Circuit Element | Current Through (A) | |
| Measured | Calculated |
|  | 20.0 Ω |  |  |
| 10.0 Ω |  |  |
| 5.0 Ω |  |  |
| Battery |  |  |
| Circuit-2 | Circuit Element | Current Through (A) | |
| Measured | Calculated |
|  | 4.0 Ω |  |  |
| 3.0 Ω |  |  |
| 6.0 Ω |  |  |
| Battery |  |  |