Online Lab: Ohm's Law

Name: Date:

Instructor: Section:

Theory:

In metals and some other materials (in particular, commercially manufactured resistors), one finds experimentally that the voltage drop, V, across the material is directly proportional to the current, I, through the material (provided the temperature remains relatively constant):

$$V \propto I,$$

which is referred to as Ohm's Law. It is convenient to define a proportionality constant called the resistance (unit: Ohm [Ω] = V/A) such that

$$V = IR. \tag{1}$$

A resistor generally means a device that obeys Ohm's Law (many devices do not) and has a resistance R. Two (or more) resistors can be connected in series (as in the Figure on Page 4), or in parallel (as in the Figure on Page 5).

An equivalent resistor is a single resistor that could replace a more complex circuit and produce the same total current when the same total voltage is applied. For a series circuit, the resistances are additive:

$$R_{eq} = R_1 + R_2 + R_3 \tag{2}$$

where R_{eq} is the equivalent resistance. For a parallel circuit, the resistances add as reciprocals

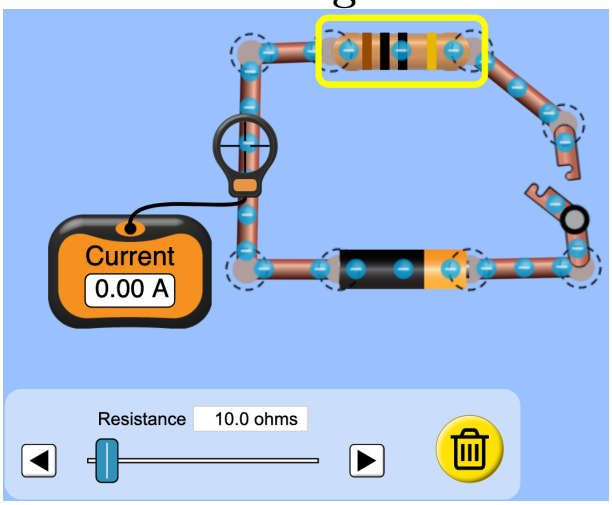
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \tag{3}$$

Online Experiment Setup Instructions:

1. Go to the following website:
   https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html
2. Click Intro on the PHeT simulation.

3. To add elements to your circuits, simply drag an item into the work area.
4. To remove and item or change it, right click the item you wish to change.
5. To uncouple two circuit elements, right click on the circular junction and choose split junction.
6. To measure voltage Drag the Voltmeter in the panel on the right to the workspace. Place the red on one side of an element and the black on the other side. If the voltmeter reads a negative, switch the red and black.
7. To measure current Drag the Ammeter in the panel on the right to the workspace. Place the cross-haired target at a point along the wires between elements.

Changing Resistance and Voltage



Changing Voltage

1. Construct the simple circuit above.
2. CHECK the **Values** box in the upper left control panel and CHANGE the current from Electrons to **Conventional**.
3. Click the resistor to **SET** the value of the resistor, $R = 30\ \Omega$.
4. **SET** the value of the battery, $V = 10\ V$.
5. Using the ammeter, to Measure the Current, I. Record this value in Table 1 below.
6. Repeat steps 3 & 4 for Voltage, V = 20 V, 30 V, 40 V, 50 V.

Changing Resistance

1. **SET** the value of the resistor, $R = 10\ \Omega$. **SET** the value of the battery, $V = 12\ V$.
2. Using the ammeter, to Measure the Current, I. Record this value in Table 2 below.
3. Repeat steps 1 & 4 for Resistance, R = 20 Ω, 30 Ω, 40 Ω, 50 Ω.

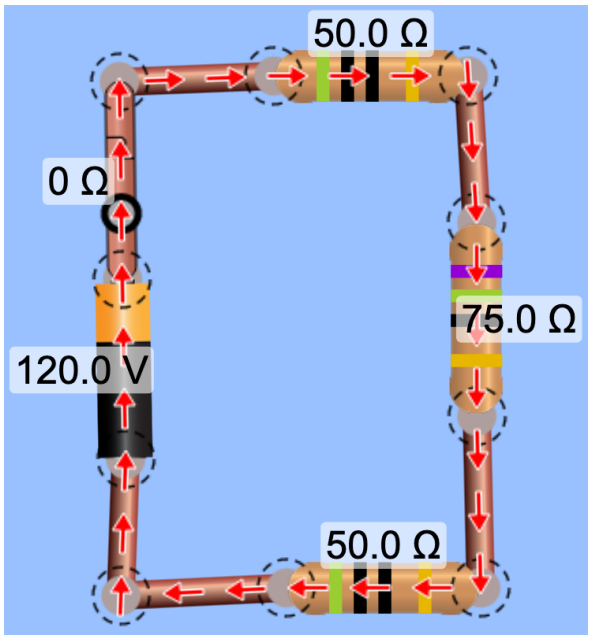
Voltage (V)	**Current (A)**

Table 1: Changing Voltage, R = 30 Ω

Resistance (Ω)	**Current (A)**

Table 2: Changing Resistance, V = 12 V

Series Circuit

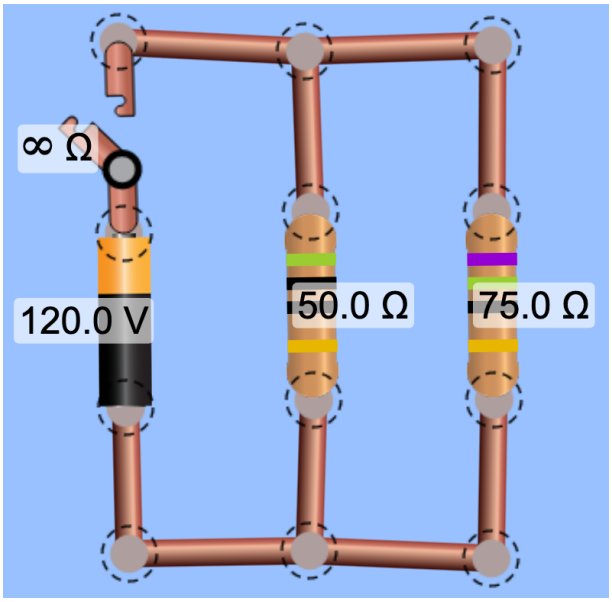


1. Construct the circuit above with **SET** values of $R_1 = 50\ \Omega$, $R_2 = 75\ \Omega$, $R_3 = 50\ \Omega$ and a voltage, $V_T = 120\ V$ for the battery. Record these values in Table 3 below.
2. In a series circuit, since there is only one path for electricity to flow at each Resistor the current stays the same. Thus we can say $I_T = I_1 = I_2 = I_3$. Verify this by using the Ammeter, to Measure the Current, I across each resistor. Record these values in Table 3.
3. For total voltage or change in voltage, the voltage drop at each of the resistors will add up to the total voltage. Thus $\Delta V_T = \Delta V_1 + \Delta V_2 + \Delta V_3$. Using the Voltmeter to Measure the Voltage, V across each resistor. Record these values in Table 3.
4. Use Equation 2 and the values for the resistors from Table 3, Calculate the equivalent resistance, R_{eq} for the circuit above. Enter this value in Table 3.
5. Calculate how much power is dissipated by each resistor. **Recall that** $P = VI$. Record these values in Table 3 below.

Table 3: Analysis: Series Circuit

Voltage V (V)	**Current I (A)**	**Resistance R (Ω)**	**Power P (W)**
$\Delta V_1 =$	$I_1 =$	$R_1 =$	$P_1 =$
$\Delta V_2 =$	$I_2 =$	$R_2 =$	$P_2 =$
$\Delta V_3 =$	$I_3 =$	$R_3 =$	$P_3 =$
$\Delta V_T =$	$I_T =$	$R_{eq} =$	$P_T =$

Parallel Circuit



1. Construct the circuit above with **SET** values of $R_1 = 50\ \Omega$, $R_2 = 75\ \Omega$, and a voltage, $V = 120\ V$ for the battery. Record these values in Table 4 below.

2. In a parallel circuit, the resistance adds inversely as in Equation 3. Calculate the equivalent resistance, R_{eq} for the circuit above. Enter this value in Table 4.

3. In a parallel circuit, there are different paths for electricity to flow and some current is lost at each branch. But once it flows through each branch it add up to be the total current, I_T. Thus $I_T = I_1 + I_2$. Verify this by using the Ammeter, to Measure the Current, I across each resistor. Record these values in Table 4.

4. In a parallel circuit, the total voltage or the voltage drop at each of the resistors is the same throughout the entire circuit. Thus $\Delta V_T = \Delta V_1 = \Delta V_2$. Using the Voltmeter to Measure the Voltage, V across each resistor. Record these values in Table 4.

5. Calculate how much power is dissipated by each resistor. **Recall that** $P = VI$. Record these values in Table 1 below.

Table 4: Analysis: Parallel Circuit

Voltage **V (V)**	**Current** **I (A)**	**Resistance** **R** (Ω)	**Power** **P** (W)
$\Delta V_1 =$	$I_1 =$	$R_1 =$	$P_1 =$
$\Delta V_2 =$	$I_2 =$	$R_2 =$	$P_2 =$
$\Delta V_T =$	$I_T =$	$R_{eq} =$	$P_T =$

Conclusions

1. As voltage increases, current (increases / decreases)

2. As resistance increases, current (increases / decreases)

3. How well does your data support Ohm's Law? Explain fully!

4. Create a graph of Voltage vs Current using your results in Table 1.
   Upload it with this Lab Report in D2L.

5. Measure the slope of the line using any method you are comfortable with. Record the slope here. What is the physical meaning of the slope of the Linear Fit to the data on the Ohm's Law graph? Hint: What are the units of the slope?

6. **Take a photo or scan a copy showing ALL calculations performed during this lab and upload it with this Lab Report in D2L.**