

Ohm's Law and Simple Electrical Connections.

The purpose of this experiment is to introduce the student to Ohms Law and to provide experience in making series and parallel electrical connections.

TO AVOID RUINING FUSES CHECK ALL CIRCUIT CONNECTIONS BEFORE CONNECTING THE CIRCUIT TO THE POWER SUPPLY. DISCONNECT THE CIRCUIT FROM THE POWER SUPPLY BEFORE CHANGING ANY CIRCUIT CONNECTIONS.

Part I

In this lab we will verify Ohms Law ($V=IR$), which states that the voltage drop V across a substance is directly proportional to the current I which flows through it. This constant of proportionality is called the resistance. Not all substances follow this law, those that do are called ohmic.

Procedure:

1. Begin by setting up circuit 1, with an ammeter in series and a voltmeter in parallel with an unknown resistor (the ammeter and voltmeter are both Digital Volt Meters, set to measure current and voltage respectively). Be sure to verify each connection before supplying power to the circuit. Adjust the variable voltage supply and take readings of voltage for V on the digital voltmeter equal to 0.25V, 0.5V, 1.0V, 2.0V, 3.0V, 4.0V, 5.0V, 6.0V, 7.0V, 8.0V, 9.0V, and 10.0V. Take readings of current on the digital current meter for each corresponding voltage above. Record all these measurements in a table. You should note the uncertainties in your measurements. **Make sure your meters are set to give the most significant figures.**

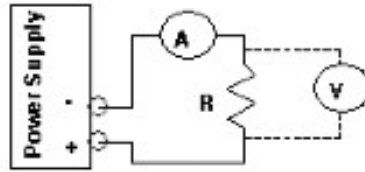


Figure 1: Circuit #1.

2. Plot your measured values of V vs. I using the full page.
3. Verify that the plot is a straight line. Calculate the slope of the line (watch units). Note that if a device follows Ohms law the slope of the linear line is the resistance.
4. Replace the resistor used in the circuit above with the headlight. Adjust the variable voltage supply and take readings of voltage for V on the digital voltmeter equal to 0.25V, 0.5V, 1.0V, 2.0V, 3.0V, 4.0V, 5.0V, 6.0V, 7.0V, 8.0V, 9.0V, 10.0V, 11.0V and 12.0V. Take readings of current on the digital current meter for each corresponding voltage above.
5. Plot your results as a separate graph from above. Note that not all substances have constant resistance so V/I is not always constant. Your graph should clearly show whether the lamp could be considered an ohmic circuit element or not.

Make sure you dial the voltage supply to zero before starting Part II.

Part II

Now, we will explore different ways that resistors can be connected in a circuit. Most complicated circuits can be reduced to sub-units where the resistors are connected in one of two basic ways. These are called series and parallel. In a series connection, the current must flow first through one resistor, and then through the next, there is

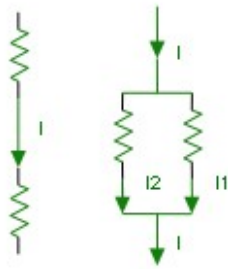


Figure 2: Series and Parallel Connections.

no alternate path (see figure 2). In a parallel connection, the current can split into two or more paths and may be different for the different paths. The current then recombines on the other side.

Procedure:

Series Circuits

- Three important facts can be learned from the following exercise with resistors in series:
 - In a series connection, the current is the same in all parts of the circuit (to within the uncertainty of the meter).
 - The voltages across two resistors in series are not necessarily equal.
 - Resistors in series act like one resistor with $R_{total} = R_1 + R_2 + . . .$
- Place two 100Ω resistors in series with each other (see figure 3). Connect two ammeters in series with, and on either side of, the resistors, then plug the circuit into the variable voltage supply. Dial the voltage up to 5 volts (**DO NOT EXCEED 5V**) Connect the voltmeter first across one resistor and then across the other, taking a reading for each connection. Then connect the voltmeter across both resistors and record the total voltage. Also record the ammeter readings and uncertainties in your measurements.

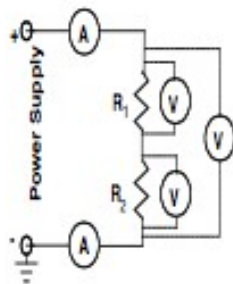


Figure 3: Circuit #2.

- Calculate R_1 from your measurements of V_1 and I_1 . Calculate R_2 from your measurements of V_2 and I_2 , and calculate R_{total} from your measurement of V_{total} and what you infer from the facts known about resistors in

series for I_{total} . Compare your calculated R_1 and R_2 values to the values of R_1 and R_2 given on the resistor blocks. Compare your calculated R_{total} to the addition of the R_1 and R_2 given on the resistor blocks.

4. Replace one of the 100Ω resistors with the 25Ω resistor and make the same measurements (V_1 , I_1 , V_2 , I_2 , and V_{total}) and calculations (R_1 , R_2 , and R_{total}) as above.

Parallel Circuits

1. Three important facts can be learned from the following exercise with resistors in parallel:
 - (a) In a parallel connection, the voltage across all resistors are equal (to within the uncertainty of the meter.)
 - (b) The currents through resistors in parallel are not necessarily equal.
 - (c) Resistors in parallel act like one resistor with $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
2. Now connect the two 100Ω resistors in parallel with each other (see figure 4). Note that each resistor must be connected in series with its own ammeter in order to measure the amount of current flowing through each resistor individually. Measure the voltage across each resistor in turn with the single voltmeter provided. Record the ammeter readings for each resistor and the uncertainties in your measurements.

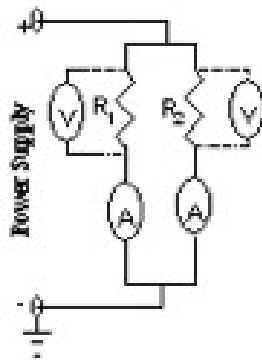


Figure 4: Circuit #3.

3. Calculate R_1 from your measurements of V_1 and I_1 . Calculate R_2 from your measurements of V_2 and I_2 , and calculate R_{total} from what you infer from the facts known about resistors in parallel for V_{total} and I_{total} . Compare your calculated R_1 and R_2 values to the values of R_1 and R_2 given on the resistor blocks. Compare your calculated R_{total} to the calculation of R_{total} using the formula given in the facts known about resistors in parallel above using the values of R_1 and R_2 given on the resistor blocks.
4. Replace one of the 100Ω resistors with the 25Ω resistor and make the same measurements (V_1 , I_1 , V_2 , and I_2) and calculations (R_1 , R_2 , and R_{total}) as above.