DEPARTMENT OF BIOLOGICAL, CHEMICAL, AND PHYSICAL SCIENCE
ILLINOIS INSTITUTE OF TECHNOLOGY
PHYSICS 221

Simple DC Circuits and Resistors

Lab #3
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Date of Experiment: 29 September 05
Due Date: 19 October 05
Lab section 003

Statement of Objective

This experiment was intended to affirm Ohm's Law and Kirchhoff's Laws through the use of circuits and resistors. Using the theoretical results (derived from the laws) and comparing them to the experimental results it can be proven that the laws are correct.

Theory

Ohm's Law states:

$V=IR$

Where I is the current through a resistor, R is the resistance, and V is the potential difference of energy across the resistor. Each resistor is color coded with 4 color bands to determine its R value. Each color represents a known value that can be looked up. R is calculated by the formula:

$R=AB*10^{C}\pm D\%$.

A is the value for the first color, B is the value of the second color, C is the third, and D is the fourth value.

Kirchhoff's Laws are used to find the resistance, current, and voltage for a circuit. His first law states that the current entering a junction is equal to the current leaving the junction. His second law states that the sum of all the voltage drops around a closed circuit is zero. Kirchhoff's laws can be applied to both parallel and series circuits.

In a series circuit where there are no junctions the current entering each of the resistors is identical, $I=I_1=I_2=I_3=\ldots I_n$, and Appling Kirchhoff's Second Law it can be found that:

$V-V_1-V_2-V_3-\ldots V_n=0$ or $V=V_1+V_2+V_3\ldots V_n$

Ohm's Law can be substituted in giving:

$IR=I_1R_1+ I_2R_2+ I_3R_3+ I_nR_n$

Also since all the currents are equal it can be said that:

$R= R_1+ R_2+ R_3+ R_n$

Parallel circuits are a little different since the changes break off and go through different processes. Starting with:

$I= I_1+ I_2+ I_3+\ldots I_n$

In this case the potential difference for each resistor remains the same. Thus:

$V=V_1= V_2= V_3=\ldots V_n$

and due to Ohm's Law it becomes:

$V/R=V_1/R_1+V_2/R_2+V_3/R_3+\ldots V_n/R_n$ or $1/R=1/R_1+1/R_2+1/R_3+\ldots 1/R_n$

These equations allow for the mathematical analysis of parallel and series circuits that have only resistors in them.

Equipment List

- Circuit board with resistors
- Multi-meter
- DC power supply
- Connecting wires
- Ammeter

Procedure

Part A

First construct the circuit in accordance with the lab manual and checking the polarity of the meters to make sure that there are no negative readings. Make the volts across the resistor read 1 V, and record the current. Then do the same thing for V= 2, 3, 4, and 5 volts. Again repeat the experiment after adjusting the circuit arrangement in accordance with the lab manual.

Part B_1

Make a circuit in accordance with the lab manual hook the multi-meter up across R_1. Set the power supply to 10 volts. Measure and record the potential across R_1, R_2, R_3, and across all 3. Switch off the circuit and find the resistance ofall the resistors as in part A.

Part B_2

Make a circuit in accordance with the lab manual and hook up the multi-meterto measure I_1. Set the power supply to 10 volts. Measure V and I_1, I_2, and I_3. Connect the ammeter in series with the battery and resistors and measure the total current I.

Part C

Make a circuit in accordance with the lab manual using a multi-meter and an ammeter and find I_1 and V_1 through I_3 and V_3.

Data

Part A

V (V)	I(A)	R=V/I
1	0.003	333.33
2	0.0062	322.58
3	0.0092	326.09
4	0.012	333.33
5	0.015	333.33

Circuit as in Figure 2

V (V)	I(A)	R=V/I
1	0.0027	370.37
2	0.0052	384.62
3	0.008	375
4	0.012	333.33
5	0.014	357.14

Circuit as in Figure 3

The resistor has a resistance of 140 $\pm$ 14 Ohms.

Part B

I=.554A	V (V)
V1	0.594
V2	3
V3	5.92

Resistors in a series

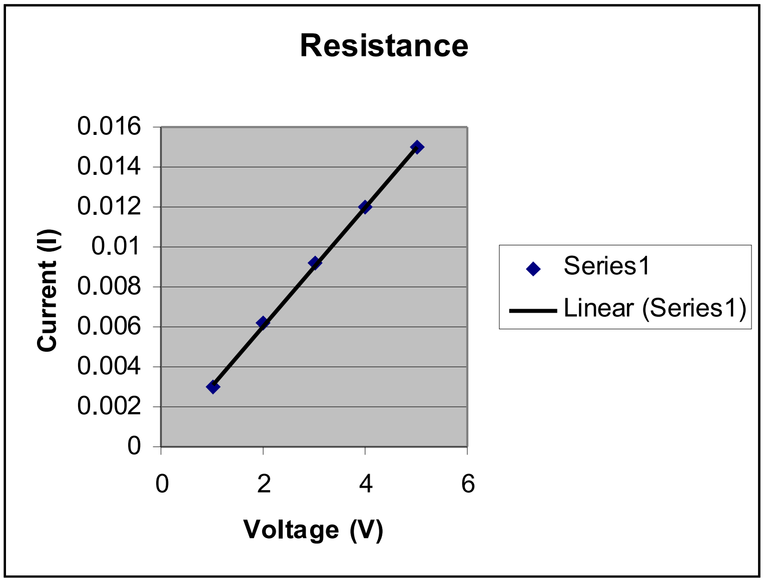
V=9.8 V	I (A)
I1	0.0094
I2	0.0019
I3	0.001

Resistors in parallel

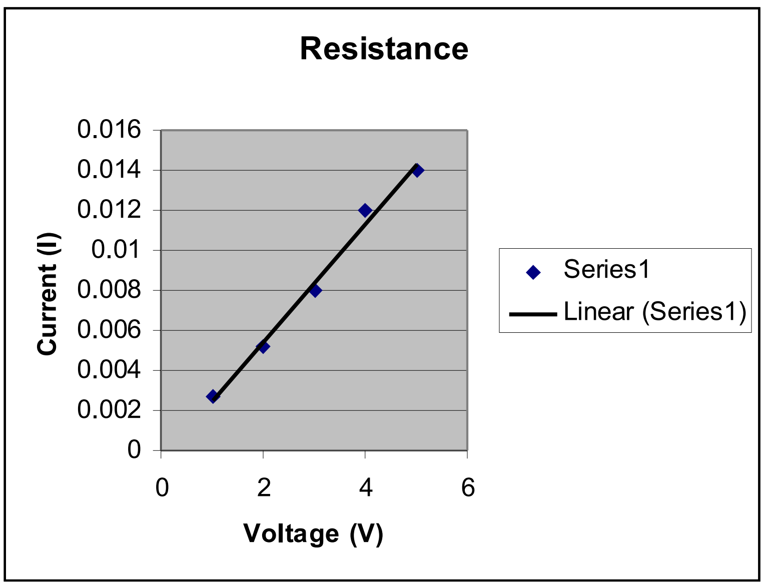
The total voltage in the first case was 9.5 V, and the total current for the second case was .011A. Resistors in part B had the following resistances in Ohms: 1 $\pm$ .05, 5 $\pm$ .25, and 10 $\pm$ .5.

Analyze Data

Part A



For figure 2



For figure 3

Resistance is equal to voltage divided by current. With the plot of V vs I, R will equal the slope of the best fit line. In the first case R is 335.4 Ohms and in the second R is 337.13 Ohms.

Part B

V=9.514V which is very close to the measured value. The total R value was calculated to be 17.2 Ohms. The total I value was found to be .0123 A and from that the total R value for the circuit was found to be 797 Ohms (obviously there was some mistake in the collection of data in order for this to be so extremely off).

Part C

Here R_1 = 11,800 ohms, R_2 = 5,650 ohms, R_3 = 1,829 ohms. The currents across R_1 to R_3 respectively are .021 A, .0024A, and .0024 A. The Voltage across the system is 30.1 and the voltages across R_1 to R_3 respectively in volts are 26.9, 3.2, 3.2.

Conclusion

Part A was used to confirm Ohm's Law. The calculated resistance (using the slope of the graph) was very close to the measured R with minimal error, and there by confirming the relationship V=IR. In Part B, we investigated a parallel circuit and a series circuit. The resistance values were not anywhere near the same ball park and I can only attribute this to poor data gathering as well as maybe some internal resistance and experimental errors. Finally in part C, a complex circuit was constructed and the values for I_1, I_2, I_3, V, V_1, V_2, and V_3 were gathered. Here things seemed to go a little smother and the values jived; the theoretical and experimental values were quite close. Despite some errors the lab did its over all objective of confirming Ohm's Law and Kirchhoff's Laws.