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Series and Parallel Lab Report

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Purpose: To discover how to set up light bulbs and resistors in series and parallel and investigate current and resistance in the current.

Procedure:

Using a voltage source and multiple resistors, we set up circuits in parallel and in series, with two or three resistors. First, the voltage source was set to 10V, and its actual voltage was measured and recorded. Then, two resistors were set up in parallel with the power source, and their stated resistances from the color bands and the circuit's current was measured. This was repeated for a circuit with two resistors in parallel, three resistors in series, and three resistors in parallel.

Data

Two Resistors in Series

Measured Voltage (V)	Resistor 1 Stated Resistance (Ω)	Resistor 2 Stated Resistance (Ω)	Measured Current (mA)	V/I Equivalent Resistance (Ω)	Calculated Equivalent Resistance (Ω)	Equivalent Resistance Percent Error (%)
10.05	10000	2200	0.829	12123	12200	-0.63
10.05	10000	330000	0.030	335000	340000	1.47
10.05	1000000	330000	0.008	1256250	1330000	5.55

* resistor colors: 10kΩ: brown black orange gold; 330kΩ: orange orange yellow gold; 1MΩ: brown black green gold

Two Resistors in Parallel

Measured Voltage (V)	Resistor 1 Stated Resistance (Ω)	Resistor 2 Stated Resistance (Ω)	Measured Current (mA)	V/I Equivalent Resistance (Ω)	Calculated Equivalent Resistance (Ω)	Equivalent Resistance Percent Error (%)
10.05	10000	2200	5.64	1782	1803	-1.16
10.05	10000	330000	1.038	9682	9706	-0.25
10.05	1000000	330000	0.041	245122	248120	-1.21

Three Resistors in Series

Measured Voltage (V)	Resistor 1 Stated Resistance	Resistor 2 Stated Resistance	Resistor 3 Stated Resistance	Measured Current (mA)	V/I Equivalent Resistance	Calculated Equivalent Resistance	Equivalent Resistance Percent

	(Ω)	(Ω)	(Ω)		(Ω)	(Ω)	Error (%)
10.05	15000	2200	10000	0.375	26800	27200	-1.47

* resistor colors: 15kΩ: brown green orange gold; 2200Ω: red red red gold; 10kΩ: brown black orange gold

Three Resistors in Parallel

Measured Voltage (V)	Resistor 1 Stated Resistance (Ω)	Resistor 2 Stated Resistance (Ω)	Resistor 3 Stated Resistance (Ω)	Measured Current (mA)	V/I Equivalent Resistance (Ω)	Calculated Equivalent Resistance (Ω)	Equivalent Resistance Percent Error (%)
10.05	15000	2200	10000	6.31	1593	1610	-1.06

Calculations

Observed equivalent resistance (by Ohm's Law) = $\frac{Voltage}{Current}$

Calculated equivalent resistance for series circuits: $R_{eq} = R_1 + R_2 \ (+ R_3)$

Calculated equivalent resistance for parallel circuits: $R_{eq} = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2} \ (+\frac{1}{R_3})}$

(where R_{eq} is the circuit's equivalent resistance, R_1 is the resistance of the resistor 1, R_2 is the resistance of resistor 2, and R_3 is the resistance of resistor 3 (for the three-resistor circuits))

Percent error = $\frac{measured\ equivalent\ resistance - calculated\ equivalent\ resistance}{calculated\ equivalent\ resistance} \times 100\%$

Example Calculations

Observed equivalent resistance (two resistors in parallel trial 1): $R = \frac{10.05V}{0.000829A} = 12123\Omega$

Calculated equivalent resistance for series (three resistors): $R_{eq} = 15000\Omega + 2200\Omega + 10000\Omega = 27200\Omega$

Calculated equivalent resistance for parallel (three resistors): $R_{eq} = \frac{1}{\frac{1}{15000\Omega}+\frac{1}{2200\Omega}+\frac{1}{10000\Omega}} = 1610\Omega$

Percent error (three resistors in parallel): $\frac{1593\Omega - 1610\Omega}{1610\Omega} \times 100\% = -1.06\%$

Analysis

Data and Error Analysis

The calculated equivalent resistance values were fairly close to the observed values. Even with very large resistances, we had one trial that had a 5.55% percent error, while the rest had a percent error of less than 1.5% (in magnitude).

One potential source of error is that proper significant figures were not used in the calculations, mostly because some of the values only had one significant figure (large stated resistances and small measured

currents). But this would not have changed the fact that the measured data were so close to the theoretical resistances, and uses proper sigfigs would probably decrease the percent errors due to rounding.

Another possible source of error is that we did not measure the resistors using the multimeter during each trial, instead using their stated resistances to calculate the theoretical equivalent resistances. However, because all of the resistors used had a gold tolerance (±5% resistance), we don't expect the measured resistances of the resistors to be far off from what the stated values.

Conclusion

The equivalent resistances of circuits set up with multiple resistors set in series or in parallel can be accurately calculated either with:

- Ohm's law, if the current and voltage drop over the resistor are known; or
- the equations for the equivalent resistances of series and parallel circuits.