Analyzing Circuit Resistance with Various Lengths of Nichrome Wire

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1 Introduction

How does the length of nichrome wire in a circuit affect the current of the circuit?
The goal of this lab was to analyze how varying lengths of a resistor, nichrome wire, affected current flow in a circuit. My hypothesis is that as resistor length increases, current flow within the circuit will decrease, as the more resistance there is in a circuit, the lower the current will be. For the experiment, increasing lengths of nichrome wire will be inserted into a circuit; if the current in the circuit decreases as the length of the nichrome wire increases, my hypothesis will be validated. The manipulated and responding variables are the length of the nichrome wire and the current through the circuit, respectively. The controlled variables are the battery used (for power level), the voltage of the battery, the length of the low-resistance wire, the ammeter used, and the sensitivity setting used on the ammeter.

2 Materials

- 1 Ammeter
- 1 Battery
- 1 Section of Low-Resistance Wire
- 5 Sections of Nichrome Wire (Varying lengths)

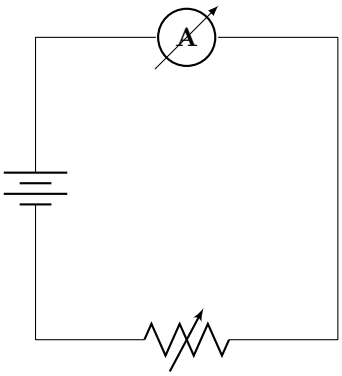
3 Procedure

1. Set up ammeter with battery and low-resistance wire:
    - Positive terminal of battery connected to positive terminal of ammeter

- Negative terminal of battery connected to negative terminal of ammeter
- Low-resistance wire attached to one of two terminals, other terminal reserved for nichrome wire
  - Note: Use 1 A sensitivity instead of 5 A sensitivity

2. Attach ends of nichrome wire to open terminals of battery and ammeter
   - For simplicity, start with the shortest length of nichrome wire
3. Record amperage shown on ammeter
4. Repeat steps 2-3 as necessary for data averaging
5. Repeat steps 2-4 with increasing nichrome wire lengths

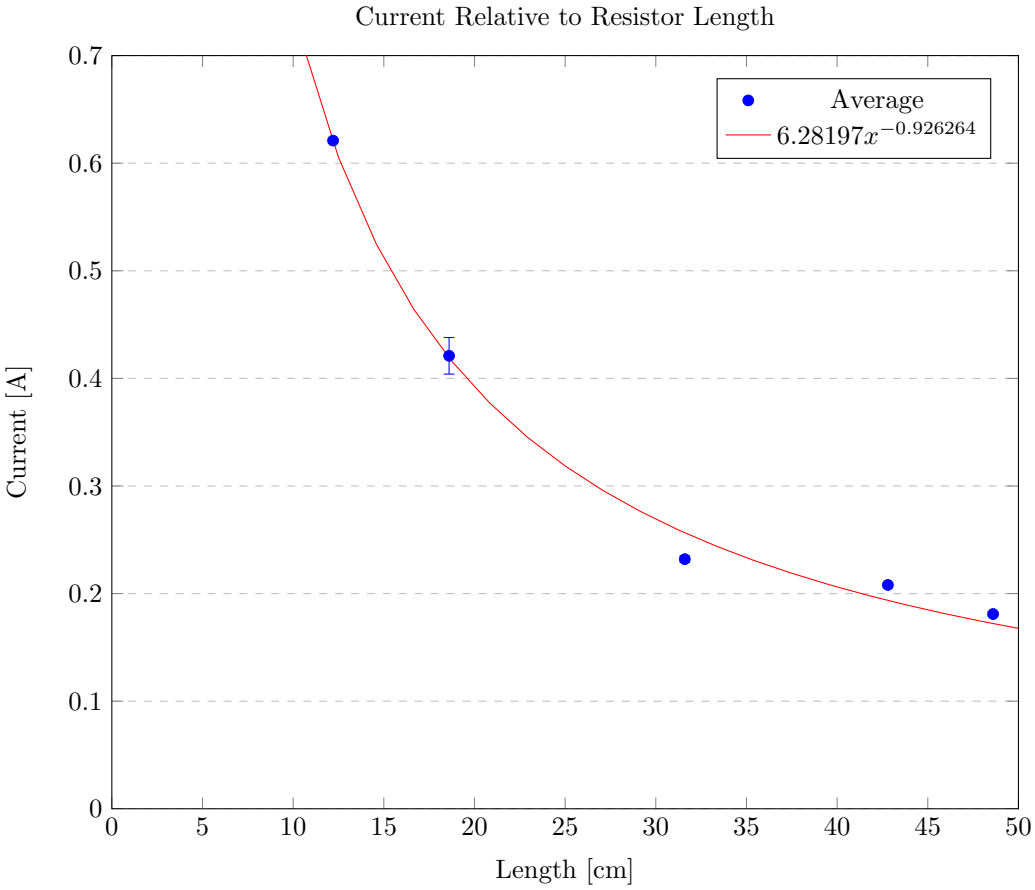
4 Diagram

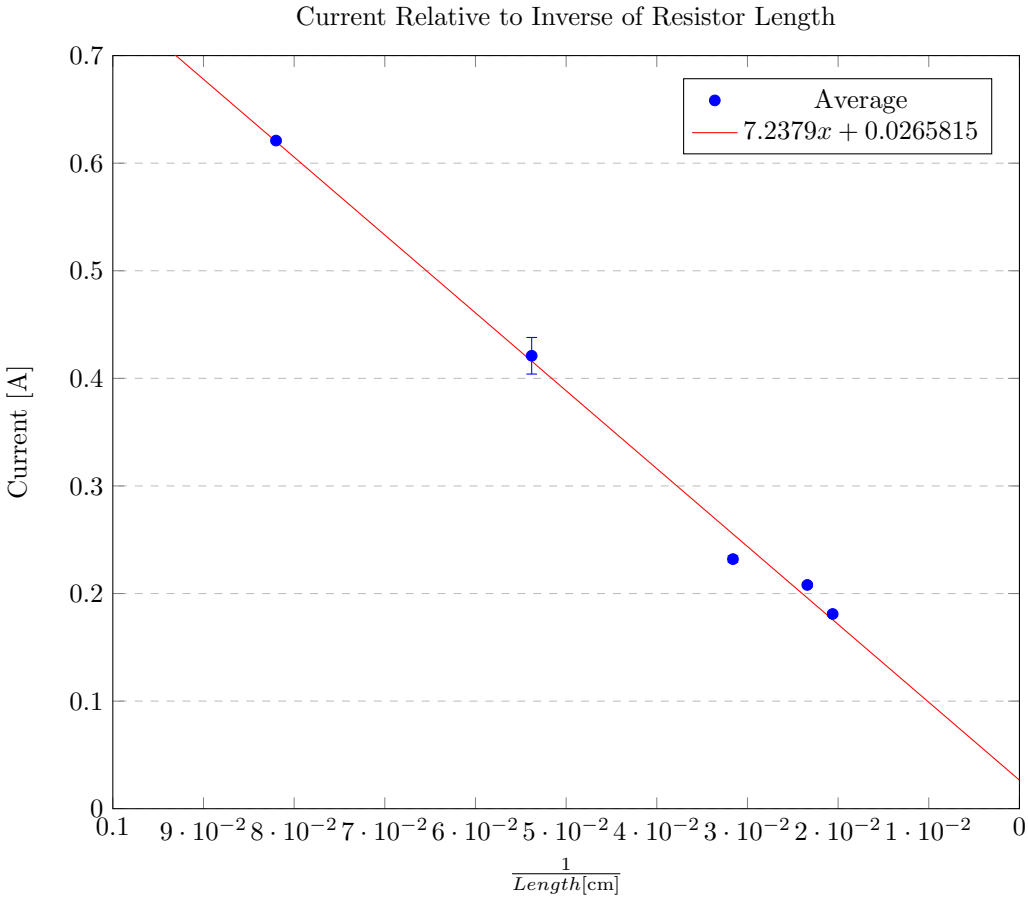


5 Data

Length	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
12.2 cm	0.620 A	0.621 A	0.619 A	0.622 A	0.622 A	0.621 A
18.6 cm	0.406 A	0.430 A	0.423 A	0.422 A	0.423 A	0.421 A
31.6 cm	0.232 A	0.231 A	0.229 A	0.234 A	0.233 A	0.232 A
42.8 cm	0.210 A	0.208 A	0.206 A	0.206 A	0.208 A	0.208 A
48.6 cm	0.182 A	0.181 A	0.180 A	0.179 A	0.181 A	0.181 A

Length Error	Amperage Error
0.05	0.002
—	0.017
—	0.003
—	0.002
—	0.002


Current Relative to Resistor Length
Average
$6.28197x^{-0.926264}$
Current [A]
Length [cm]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
5
10
15
20
25
30
35
40
45
50



6 Calculations

For below calculations, $t_i = t_1$

6.1 Average

$$t_{avg} = \langle t_i \rangle \tag{6.1.1}$$

where t_i is the set of results for wire i. Therefore,

$$t_{avg} = \langle [0.620, 0.621, 0.619, 0.622, 0.622] \rangle = 0.621 \tag{6.1.2}$$

6.2 Error

$$t_{err} = \pm |t_{avg} - t_E| \tag{6.2.1}$$

where t_E is the element of set t_i with the highest deviation from t_{avg}. Therefore,

$$t_{err} = 0.621 - 0.619 = \pm 0.002 \tag{6.2.2}$$

7 Conclusion

It can be observed through the data that the current through the example circuit decreased as the length of the nichrome wire increased. When the nichrome wire was 12.2 cm long, the average current was 0.621 A. However, when the length increased to 18.6 cm, the current decreased to 0.421 A This was to be expected, as we observed through tests with bulbs that as bulbs were added to the circuit, resistance increased, lowering the current of the circuit. In this case, however, bulbs are replaced by nichrome wire, and the number of bulbs is analogous to the length of the wire. The graphs show the inverse relationship between resistor length and current; the best-fit graph is nearly equivalent to an inverse function: $y = ax^{-1}$ and $y = 6.28197x^{-0.926264}$. This validates my prediction that current would decrease as resistance increased.

One of the major difficulties with the lab was getting an accurate length for the nichrome wire. As our group used longer lengths of wire, the wire curved more, making accurate measurement of its length more difficult. This is slightly reflected in the graph, with more deviation from the best-fit line as the length of the wire increased.

The goal of this lab is to understand how resistance affects current flow in a circuit. Noting that, the length of nichrome wire in a circuit seems less important. Instead, the effective *resistance* of the wire seems more important. So instead of using resistors of inconsistent resistance, it would be simpler to use resistors of constant resistance, and simply add more resistors in series to increase the resistance. This would remove the variable of the length of the wire, removing a source of possible error.