RQ: How does the length of a variable resistor affect resistance?

Introduction

In electrical circuits, resistance is a fundamental concept that plays a crucial role in the behavior of electronic systems. Resistance, as a definition, is the property of a circuit element that nuances the flow of an electric current. It occurs due to the interactions between charge carriers and a variable resistor.

A variable resistor, or a rheostat, allows for adjustment in resistance within a circuit. It is made of a resistive element, along with a sliding contact that can modify the length of its resistive path. The resistive element is uniform throughout its length, and the overall resistance is changed by adjustment of the wiper. There is a direct relationship between the amount of resistance and length of wire. (Physics Classroom, n.d.) Resistance occurs as the result of collisions between charge carriers and the atoms of the resistive material the wire is made out of. (Physics Classroom, n.d.) In the end, the longer the wire, the more likely it is to have collisions, which means more resistance. (Physics Classroom, n.d.)

To investigate how the length of a variable resistor affects resistance, we will set up a simple circuit consisting of a power source, an ohmmeter to measure resistance, and the variable resistor. Initially, the variable resistor will be set to nearly its smallest length. The ohmmeter will be connected in series with the variable resistor to measure the resistance on the circuit. The length of the variable resistor will then be gradually increased, and the corresponding resistance readings will be recorded. This process will be repeated multiple times, each time adjusting the length of the variable resistor incrementally. The collected data will be analyzed, and a relationship between the length of the variable resistor and the resulting resistance will be established. This investigation will provide insights into the influence of length on resistance and contribute to a better understanding of electrical circuits.

Apparatus -

- Ohmmeter
- Variable resistor
- 2 Alligator clips
- Wires

Variables -

Control :

- Amount of electricity going into the resistor
- Positioning of wires

- Type of wires
- Location of alligator clips

Independent :
The independent variable is the length of the resistor in centimeters.
Dependent :
The dependent variable is the resistance caused by the resistor, measured in ohms.

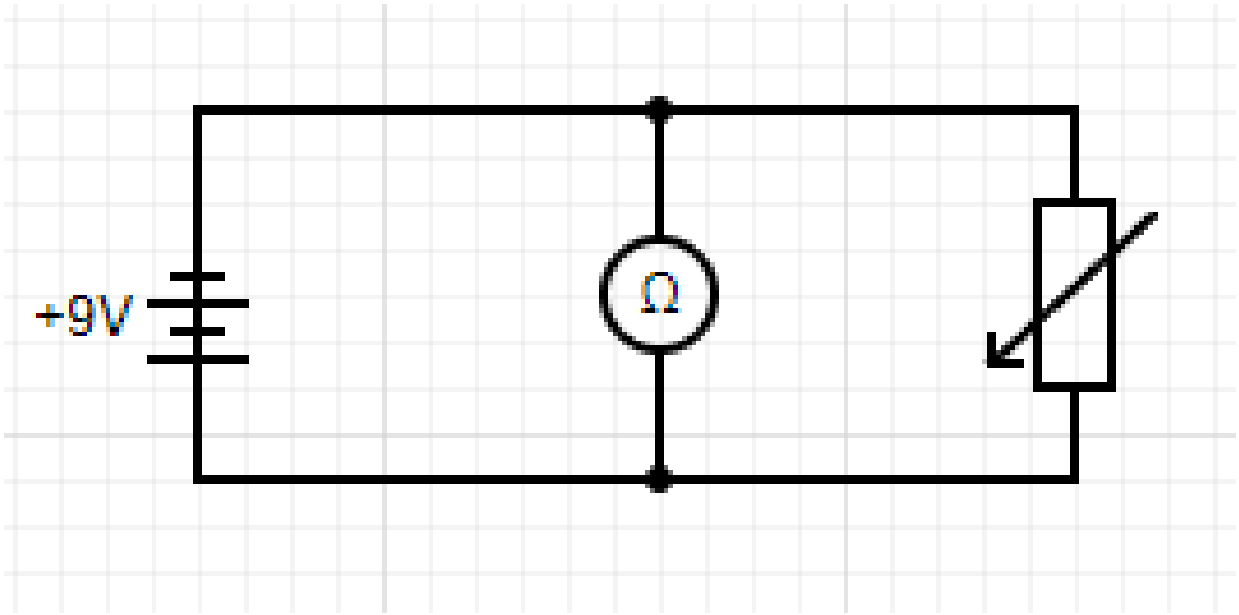
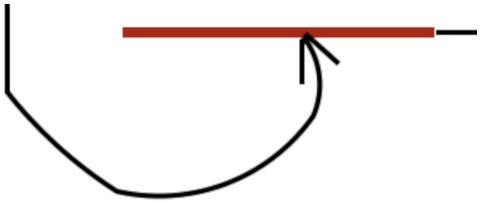


Figure 1: Circuit diagram of procedure

In figure 1, the diagram shows a closed circuit consisting of a +9V battery, ohmmeter and variable resistor. Throughout the procedure, it is important to make sure no changes are made within the circuit when changing length in the resistor.

When gathering data from the same length for different trials, it is important to make sure the slider stays exactly the same for all three data collections.

The slider on the resistor determines the length. Illustrated in the image below, a piece of lead and a connector acts as a substitute to a resistor. The red line represents the lead, while the arrow indicates the connector that can be slid backwards and forwards. The further up the lead the connector is, the less distance the electricity has to travel through the resistive material in the resistor. The current decreases as more graphite is in the circuit, and vice versa. (Fizzics Organisation, 2019)



Analysis

Table 1: Procedure results

	Resistance (Ω) (±0.2)					
Length of resistor(0.5cm)	3.5	5.0	7.0	10.0	13.0	15.0
Trial 1	15.7	27.0	43.0	65.4	90.9	109.3
Trial 2	15.5	26.8	42.9	65.5	91.5	109.8
Trial 3	16.2	26.9	43.2	65.7	90.1	109.1
Average	15.8	26.9	43.03	65.53	90.8	109.4

As seen in Table 1, six resistors varying in length were used during the procedure. The result yielded a consistent increase in resistance, with a fractional uncertainty of 0.2 amps added, as the length of the resistor increased. In all three trials per length, the outcomes all fell within a margin of 1 amp. There were no outliers during the procedure, and results show evidence of a direct relationship between the amount of resistance and length of wire.

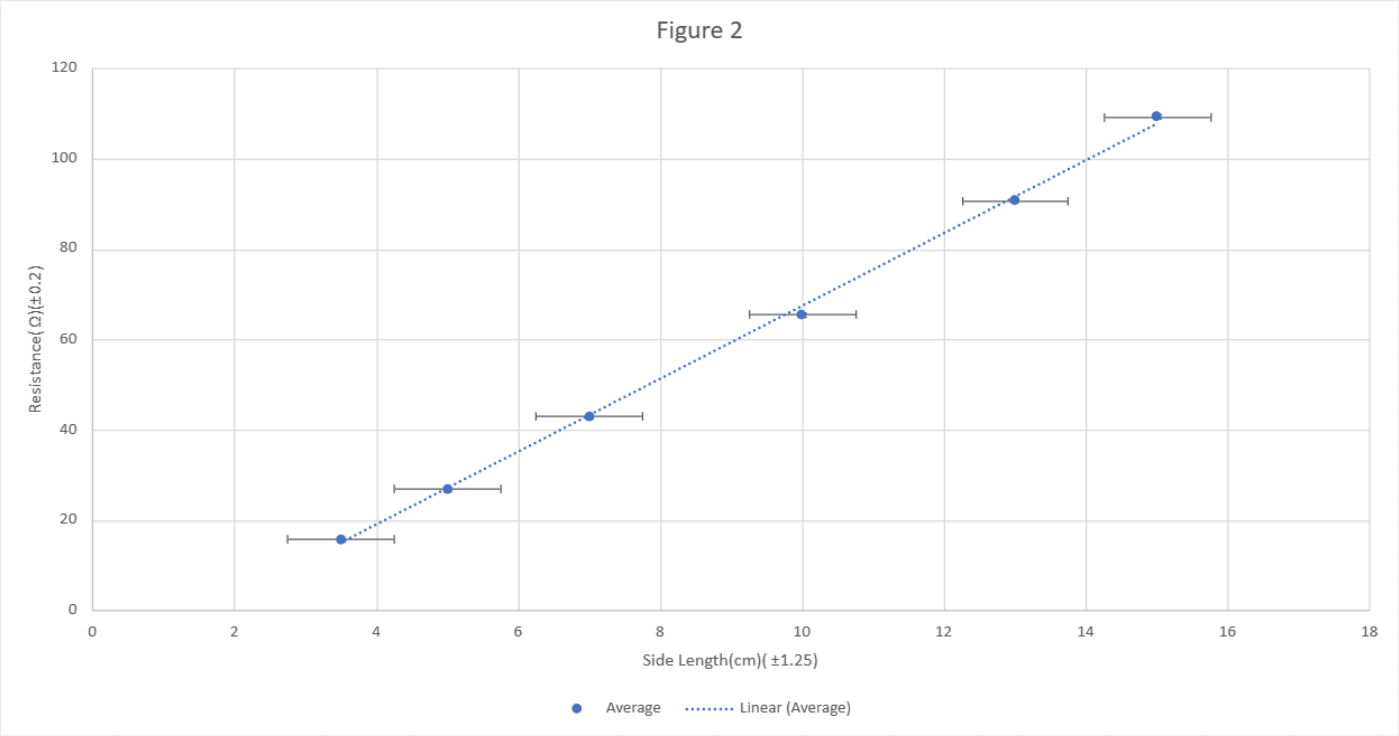


Figure 2: Linear relationship between length of resistor to resistance

In this figure, the data taken from Table 1 has been transferred onto a scatter plot with a line of best fit. The margin of error is marked due to the slider on the variable resistor not being tight enough, causing possible errors in data. The length of resistor and resistance have a linear relationship, and as the side length increases, the resistance increases.

Conclusion

In conclusion, the procedures conducted, along with the observations made from the above figures confirms the RQ, that resistance in an electrical circuit is directly proportional to the length of the variable resistor. As seen in Figure 2 and Table 1, resistance increases as the length of the variable resistor increases, because there are increased amounts of collision of the energy and material in the resistor.

Evaluation

Though the procedure followed through as planned, there were margins for error due to the possibility of inaccuracy from the equipment. In both the control and measurement of resistance, there were factors contributing towards precision in data results. This is due to the equipment being older and not working in mint condition. Most of the issues, systematic errors, and random errors appear due to the measuring device.

Error	Effect	Corrections
The ohmmeter numbers were fluctuating during the recording.	A marginal error of 0.2 ohms in the data, making it slightly inaccurate.	To use an ohmmeter with a more precise meter, or a more modern ohmmeter with higher accuracy.
The slider in the variable resistor was slipping on the resistor because it wasn't tight enough.	A possible side length difference of up to 1.25cm, possibly making the three different trials different.	To use a different variable resistor, and confirm that it is well functioning before starting the procedure.

Works Cited

Physics Classroom. (n.d.). Resistance. In Lesson 3: Resistance. Retrieved from https://www.physicsclassroom.com/class/circuits/Lesson-3/Resistance

Fizzics Organisation (2019, May 2) Variable resistors, how they work and what they do: fizzics.org. Retrieved from https://www.youtube.com/watch?v=DxQEwzmbmhw