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Resistance of a Graphite Pencil

Introduction

Graphite has taken a large step in the field of conduction being used to conduct electricity and heat on products like batteries and solar panels.Often referred to as “pencil lead”, Graphite is conductive and should act as wire on a circuit with a given resistance. The purpose of this experiment is to determine whether the online simulation PHET tool (DC Circuits and Resistors) is accurate when measuring the resistance of a circuit with the presence of a graphite pencil.

When a circuit is connected to a battery, the resistance of the circuit at a given point can be measured using the equation:

$$V/I=R$$

V is the voltage of the battery (Volts) , I represents the current through the wire (Amps), and R is the resistance at a given point (Ω). V/I should cause a linear relationship representing the total R of the circuit. The voltage of the battery is the independent variable as this can be changed easily and will affect the current. Furthermore, the current will be the dependent variable.

Understanding the relationship between these variables, the resistance of the battery in a series should equal the resistance when calculated using the resistivity equation of a graphite pencil. PHET simulations are accurate simulators that individuals can use to solve real world problems and accurately represent the real world. If we test the resistivity of a graphite pencil in theory, this will match the total resistance of a graphite pencil in a series circuit on the PHET simulation.

Methods

In order to measure the DC circuits accuracy in portraying the resistance of graphite we compared the resistance of graphite in reality to the resistance of the graphite in the simulation. We first found the resistance of the graphite in the typical pencil which according to (Gravesen, 2016) ranges from 6-25 ohms. In the DC circuit we constructed a series circuit using wires, a 120 volt battery, a switch, a pencil, and three 10 ohm resistors. We set up the circuit so that there were three 10 ohm resistors in series between the 120V battery and the pencil all connected with copper wires. We then recorded the voltage and current going through the pencil in order to calculate the resistance. We varied voltage by increments of 10 starting at 120 volts and ending at 60 volts and used a voltmeter to measure exactly how much voltage was going into the graphite. This gave us varying currents and voltages to plug into the equation R=V/I to make sure that the resistance we found was accurate. After calculating the resistances from the seven different voltages we averaged them and compared them to the resistance of pencil graphite in reality.

(PHET Simulation/Data collection)

Results

Voltage (V)	**Current (A)**
54.55	**2.18**
50	**2**
45.45	**1.82**
40.91	**1.64**
36.36	**1.45**
31.82	**1.27**
27.27	**1.09**

Table 1. The table above displays the raw collected data of 7 different voltages

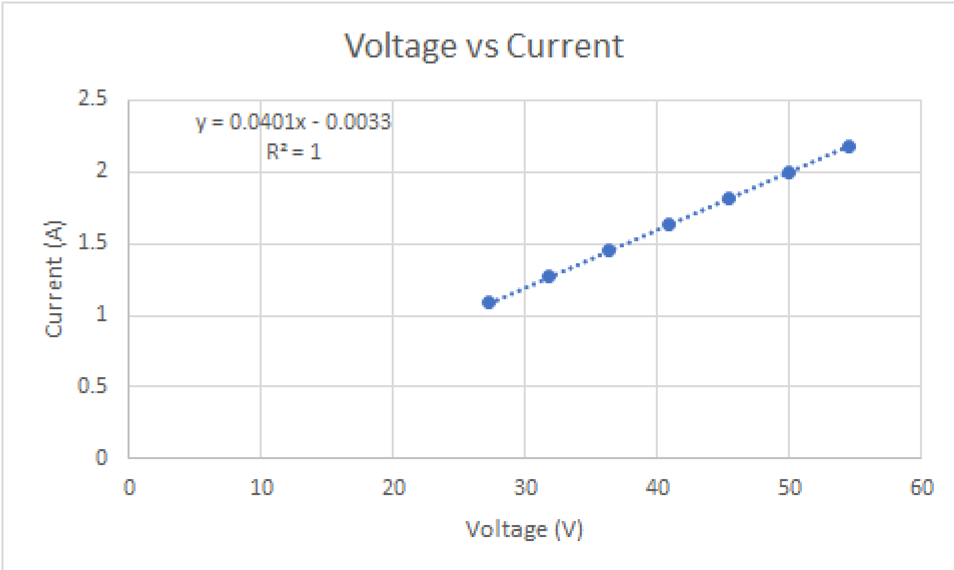
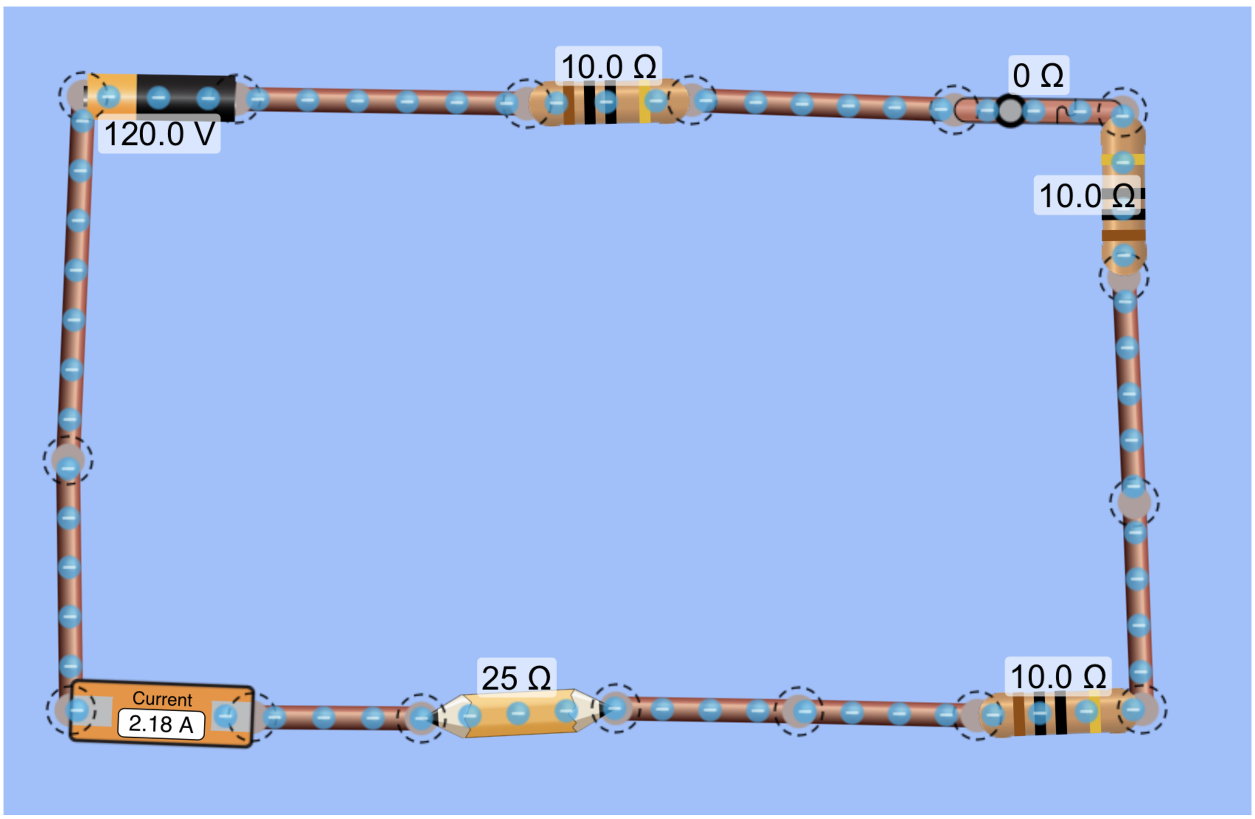


Figure 1. The graph above shows the relationship between Voltage (V) and Current (A).

Discussion

Based on our findings it can be concluded that the virtual DC circuit does in fact accurately depict that resistance of graphite in pencils by using multiple points to accurately calculate the resistance of the graphite which was 25 ohms. As seen in our graph, the data trend is Linear, and when calculating the resistance, R= 25 Ohms. Following the equation R=V/I, we calculated that the resistance is equal to the theoretical resistance given by the graphite pencil.

According to both (Gravesen, 2016) and the resistance we got from using the equation R=rho*L/A in a theoretical context we got a resistance range between 6-25 ohms which matches up with the resistance in the simulator. Our results proved our theory that the resistances should line up, and gives us the implication that virtual labs can be used in practical applications when designing circuits and calculating currents, resistances, and currents for real life applications. This increases the scope for both research and invention possibilities in this field and opens new doors to expand the depth of virtual online circuits.


10.0 Ω
0 Ω
120.0 V
10.0 Ω
25 Ω
10.0 Ω
Current
2.18 A

Work cited

Gravesen, T. (2016). Graphite resistors. Retrieved March 30, 2021, from http://www.troelsgravesen.dk/graphite.htm

Pencils. (2000). Retrieved March 30, 2021, from https://www.sizes.com/tools/pencils1.htm