Passage V

The electrical resistance of a conductor represents its opposition to the flow of electrons and is defined by the relationship known as Ohm's law:

$$R = \frac{V}{I} \qquad \text{(Equation 3)}$$

where R is the conductor's resistance in ohms (Ω), V is the potential difference across the conductor, or voltage, measured in volts (V), and I is the electrical current applied to the conductor in amps (A). The material from which a conductor is made, the length of the conductor, the diameter of the conductor, and the temperature of the conductor are all things that impact its resistance.

Using a simple circuit (Figure 5), a group of students investigated the dependence of a conductor's electrical resistance on its length, material, and diameter. The ammeter measures the current produced by a variable power supply. The voltmeter measures the potential voltage across the conductor.

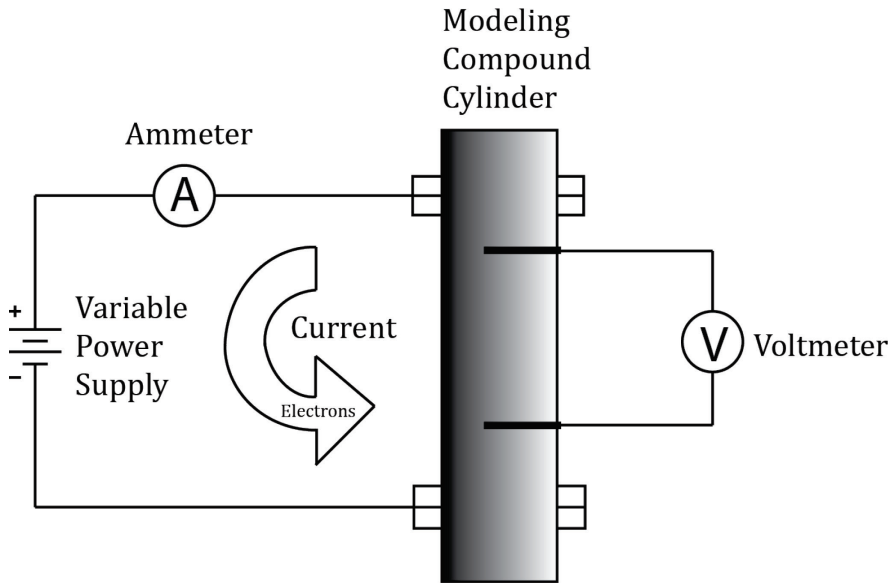

Figure 5

Experiment 1

To study the effect of a conductor's length on its resistance, the students used red modeling compound to make a cylinder 0.01 m in diameter and slightly longer than 0.1 m in length. The cylinder was connected to the circuit and a current of 0.04 A was applied. The voltmeter probes were inserted in the cylinder with a separation of 0.02 m and the voltage reading recorded. The separation distance between the probes is the conductor length. The separation was then increased by 0.02 m and the voltage recorded again. This was repeated until a total separation (conductor length) of 0.10 m was reached. The students calculated the resistance for each conductor length using Ohm's law. The results are summarized in Table 6.

Table 6: Experiment 1 Results			
Trial	Conductor Length (m)	Voltage, V (V)	Resistance, R (Ω)
1	0.02	1.58	39.5
2	0.04	3.15	78.8
3	0.06	4.79	119.8
4	0.08	6.34	158.5
5	0.10	8.10	202.5

Experiment 2

To study the effect of a conductor's material on resistance, the students repeated Experiment 1 for an identical cylinder made of blue modeling compound. The results are summarized in Table 7.

Table 7: Experiment 2 Results			
Trial	Conductor Length (m)	Voltage, V (V)	Resistance, R (Ω)
1	0.02	1.22	30.5
2	0.04	2.43	60.8
3	0.06	3.76	94.0
4	0.08	4.96	124.0
5	0.10	6.15	153.8

Experiment 3

To study the effect of a conductor's diameter on resistance, the students used red modeling compound to make three cylinders, each 0.12 m long and with diameters of 0.01 m, 0.02 m, and 0.03 m, respectively. Each cylinder was connected to the circuit with a voltmeter probe separation of 0.10 m and an applied current of 0.04 A. The resulting voltage reading was recorded for each cylinder diameter and the resistances calculated. The results are summarized in Table 8.

Table 8: Experiment 3 Results			
Trial	Conductor Diameter (m)	Voltage, V (V)	Resistance, R (Ω)
1	0.01	8.10	202.5
2	0.02	2.04	50.9
3	0.03	1.02	25.5