

Voltage, Current, and Resistance

An electric circuit involves the flow of charge through a complete, conducting loop. The quantity **current** refers to the rate at which charge flows past a point. The **electric potential** describes the amount of electrical energy possessed by a unit of charge at any location on the circuit. Because it is expressed with the unit *volt*, it is commonly referred to as the **voltage**. Resistors are circuit components that can be wired into the circuit to hinder the flow of charge. The amount of hindrance offered by a resistor is known as the **resistance**. A group of students conduct the following experiments to determine the relationship between voltage, current and resistance.

Experiment 1

A 100-ohm resistor is connected to a battery pack containing four D cells. An ammeter is used to determine the current. A voltmeter is used to measure the voltage drop across the resistor. The students make measurements of current and voltage drop with varying number of cells in the battery pack. The results are shown in **Table 1**.

Table 1

| # of Cells | Voltage (volts) | Current (amperes) |
|------------|-----------------|-------------------|
| 4 | 5.98 | 0.0596 |
| 3 | 4.43 | 0.0451 |
| 2 | 2.88 | 0.0294 |
| 1 | 1.44 | 0.0139 |

Experiment 2

The students repeat Experiment 1 using a 56-ohm resistor in place of the 100-ohm resistor. The results of their study are shown in **Table 2**.

Table 2

| # of Cells | Voltage (volts) | Current (amperes) |
|------------|-----------------|-------------------|
| 4 | 5.85 | 0.1041 |
| 3 | 4.41 | 0.0792 |
| 2 | 2.82 | 0.0508 |
| 1 | 1.43 | 0.0258 |

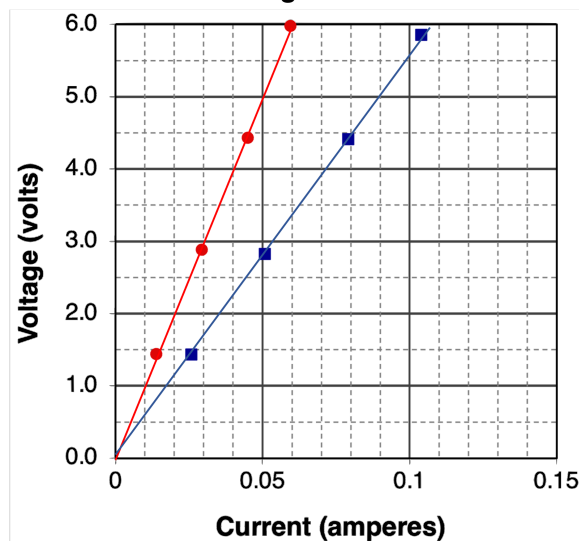
The students plotted voltage vs. current for the two resistors. Linear regression analysis was used to determine the slopes (**m**) and the regression constant (**COR**). The COR indicates the amount of agreement between the plotted points and the regression line. The plots are shown in **Figure 1**.

Other lab groups within the class conducted the same experiment. The teacher pooled the class data, providing a slope and COR of the voltage vs. current plots for six different resistors. The data are shown in **Table 3**.

Table 3

| Group | Resistance | Slope | COR |
|-------|------------|--------|-------|
| A | 120 ohm | 119 | 1.000 |
| B | 33 ohm | 29 | 0.998 |
| C | 100 ohm | 0.0100 | 0.999 |
| D | 210 ohm | 202 | 0.999 |
| E | 140 ohm | 135 | 1.000 |
| F | 45 ohm | 44 | 0.997 |

Figure 1



Experiment 1: $m = 98$
COR = 0.999

Experiment 2: $m = 55$
COR = 0.999